garbage and sewage which was then dumped into the rivers. Along with the development of roads, various factories moved into the region. The vegetable oil refinery, the largest scale industry in the Lake basin, discharges high concentration waste water without treatment.

Small farmers, due to their low income, cannot afford to use excess fertilizer and agricultural chemicals to overcome the poor soil condition. In the pasture which occupies a large area in the Lake basin extensive pasturage has been continued. Although cattle produces large amounts of manure, most of which is decomposed to inorganic substances, in the heavy rains it has been allowed to be washed away into rivers.

With these practices continuing, proper use of the water in the rivers and the lake becomes impossible. Furthermore, the long-term effects of the continued sand and mud runoff and deterioration of the water quality, eventually destroying Lake Ypacarai and its surrounding ecological system.

It is the natural phenomenon that the shallow lake become smaller by eutrophication and sand and mud inflowing. However, with increased human activity in the basin area, this process is accelerated and the life span of the lake is reduced. Therefore, if improvement in the condition of the lake and extension of its life span are desired, strict regulations must be applied.

Planning for water quality conservation means to cut the flow of environmental change shown in Fig. S9.11, at some point. Cutting the flow near its source would be the fundamental measure, but gaining approval from those directly affected will take a long time. During that time, the environmental condition would only get worse. On one hand, cutting the flow near its end would be a comparatively short-term solution, but long-term effectiveness is difficult. Consequently, it is necessary to combire the long-term fundamental measure and the short-term immediatley effective measure for water quality conservation taking into consideration.

1.2 Generation and Discharge Conditions of Pollutants in the Lake Basin

The pollution sources can be classified into two categories, point sources and non-point sources. Point sources are those identified. Non-point sources are those areas where generation and discharge conditions are not easily determined.

The point sources of the Ypacarai Lake basin can be classified into the following categories: domestic sources consist of private housing; tourism sources consist of hotels and clubs; public facility sources consist of sewage treatment plants and hospitals, industry sources consist of vegetable oil refineries, butchery, food production factories and others. The characteristic feature of pollution sources within the Lake basin is that most of the industry sources deal with agriculture and livestock derived product.

Figure S9.14 shows the distribution of the major point sources. Industry sources is centered around the Yuquyry river basin, and the tourism sources is concentrated on the east side of the lake around San Bernardino.

The basin population is about 210,000, however, most domestic waste water is treated by infiltration tanks at individual homes, and that of only about 15,000 househodls is sent to sewage plant by sewarage. At tourism sources, septic tanks and storage tanks are installed, however, in many cases, there is not appropriate monitoring of these. The largest problem among industrial sources are the 4 oil refineries which discharge a large amount of hgh concentration waste water. At other samll- and medium-scale factories, as well, there are scarcely lagoons provided, resulting in the water being discharged into the rivers, untreated. As for generation load from point sources, domestic-origin load is highest, followed by that of industry.

On the other hand, the non-point sources can be classified by land use into the following five categories: pasture, cultivated fields, forest, urban zone and other areas (water area and barren land). All these areas and their corresponding specific distribution rates are illustrated in Fig.S9.15. Considering the entire basin area, therea is a relatively high proportion of pasture land. In the Pirayu basin, there is much pasture land, but in the Yuquyry basin there are more cultivated fields and urban zone. During normal time in these areas, the pollutant is accumulated and in flood time, the amount of pollutant is discharged. The sand and mud, a king of pollutant discharged from non-point sources, generate at the mountains and hills without vegetation cover and at the riverbank suffering lateral erosion remarkably.

1.3 Present Pollution State of Inflowing Rivers and the Lake

There are two major rivers flowing into Lake Ypacarai, from the north, the Yuquyry, and from the south, the Pirayu (the latter splits into the Yagua-Resa-u and Y-Pucu rivers at its downstream). Both river systems cover nearly the same area, but the amount of water coming from the Yuquyry is about double that of the Pirayu at the normal water level. The Yuquyry flows mostly through urban area, making its discharge rate rather high. Besides these two major rivers, in the east and west, several small streams also flow directly into the lake.

At times, the river water quality is affected by drastic changes, especially the Yuquyry. It can be said, however, that these changes are not seasonal. Yet, when comparing the water quality in the Yuquyry, the Yagua-Resa-u and the Y-Pucu, in every item the Yuquyry is by far the worst at normal water level. This is because the Yuquyry River has a large population and most of the industrial pollution sources in its basin, it is believed. However, the water quality of the Yagua-Resa-u and the Y-Pucu is remarkably poor during flooding. This is thought to be due to the high contribution rate of load discharge from non-point sources in both rivers. It is estimated that about 50% of the load enters the Lake (including the marshes) from the Yuquyry and about 30% from the Pirayu.

Water from the Yuquyry passes through the wide marshes before entering the Lake, and, the pollutants within the water are removed within the marshes. Figs. S9.16~S9.18 show the water quality before and after passing through the marshes, and also the lake's water quality. From this, we learn that the water before passing is of a quality much worse than that of the lake and that after is equal or better than that of the lake. As for the Yuquyry, at normal water level, around 80% of SS, 75% of TN and 70% of TP are removed. The marshes in the Pirayu are of a small-scale, thus, the removal of pollutants is fairly lower than in the former.

The following is a look at the pollution conditions divided into various components.

Bacterial Pollution: There is no reliable data regarding the consequences of this type of pollution. In San Bernardino, doctors have yet to report any bacterial sickness due to drinking the city's water or bathing in it. However, a report by the ICB cites cases of irritation of the skin, lips, ears or eyes of people who have bathed in the Lake.

Counts on the number of fecal coliforms are as follows: downstream in the Yuquyry it is high, with tens of thousands per 100mℓ in the summer; and with more than 1000 MPN per mℓ in the winter (by Japanese regulations, water containing more than 1000 per mℓ is considered unsuitable for bathing). Throughout the year, the counts of number in the lake were extremely low.

Contamination by Toxic Materials: There is no available data addressing this issue. During a survey done in July 1988, heavy metals in the water were analyzed only once and were found to be at an extremely low level.

Organic contamination: As for organic contamination, the indexed COD concentration reaches a high of 50mg/ℓ, and a low of 20mg/ℓ. By this, the rapid progress of pollution can be understood. The BOD density being much lower than the COD indicates that a better part of the organic matter must be difficult-to-decompose. With a high COD density, however, DO saturation is high at the bottom layer, the anaerobic water body is not formed.

Eutrophication: From the result of this and past studies, it is apparent that eutrophication is at an advanced stage. The following data was compiled on the quality of the surface water from February 1988 to February 1989 (average value of 5 points): TN density was at its highest at 3.3mg/ℓ and lowest at 0.7mg/ℓ; TP density the highest level of exceeded 0.2mg/ℓ, and the lowest level was 0.07mg/ℓ, thus reaching a hypertrophic condition. Low transparency levels cause plankton to breed at an unusually high rate. This can be controlled, but at times, strange odors and tastes have arisen in the water.

Turbidity: As turbidity is the most remarkable characteristic of the lake, the indexed transparency degree, according to existing data, is normally at an extremely low less than 15cm. This takes away from the aesthetic beauty and pleasant bathing atmospehre. The SD was 60~80cm from Feb.~Sept. 1988, however, according to the nearby inhabitants, this as quite uncommon. Furthermore, the SD dropped 25cm in Feb.~Mar. 1989.

When SD is lower than 30cm, the water color appears as the color resulting when gray ash is mixed with something black, and the attenuation of the luminous internsity is remarkable. In contrast, SD at 60~80cm results in a brown/green color in the water, and the attenuation of the luminous intensity is not as small as in the above case. The content of the matter within the Lake when the water is black is still not clearly known.

1.4 Pollution Factors and Mechanism in the Lake

According to the conclusion of the water balance calculation, the retention time in the lake is estimated at around 150 days. As the lake water is mixed well vertically and horizontally, the differences in water quality between points are small.

From the variation of the lake water and the conclusion of pollution simulation during the investigation period, we can assess the main facotrs which control the water quality in the lake as the following: ① remaining load which inflow from the river, ② the increase of phytoplankton in the lake, ③ elution from bottom mud and stirring up of bottom mud by wind and waves. Each ratio varies depending on weather and water conditions, for example, doing flooding the ratio for ① increases and in summer which the water temperature is high and the sunlight is strong, the ratio for ② increases. Further, from July to September, when the wind is strong, the ratio for ③ increases. Fig. S9.19 graphically shows the behavior of pollutants in the lake.

Because the numerical model has not yet been completed, we can't wholly trust the conclusion of pollution simulation using that model. However, if the amount of polluted matters (COD) inflowing from the basin were decreased by half, the water quality would not be improved very much, and if no measures were taken, pollution would increase rapidly.

CHAPTER II

OUTLINE OF WATER QUALITY CONSERVATION PLAN

2.1 Procedure for Deciding on an Appropriate Plan

Water quality conservation planning usally follows the procedure below:

(1) Establishment of conservation goals

In accordance with the activity in the basin and its effect on future usage demands, conservation goals and itemized water quality levels should be established.

(2) Selection of applicable measures

Considering natural and socioeconomic conditions from the several goals outlined in (1), applicable plans should be selected.

(3) Formulation of alternative plans

In order to preserve the water quality in the lake and swamps, one single plan is not sufficient, a combination of several carefully constructed measures is needed. At this stage, the plans decided on in (2) should be combined and alternative measures should be drawn up.

(4) Selection of a plan that will meet the proposed goals

Through simulation and other techniques, the best alternative from (3) should be chosen.

(5) Evaluation and selection of an alternative plan

The plan selected in (4) should be thoroughly evaluated according to cost, reaction from the people in the basin, predicted results, effect on the environment and society. Then the most suitable proposal should be selected.

For this study, a plan of conservation will be devised according to the above procedures. However, because of Paraguay's socioeconomic condition, the scope of the plans will be limited from the beginning, and due to the fact that

sufficient data in several areas has yet to be collected, the selection process from (3) to (5) will be simplified and a plan drawn up.

2.2 Keynotes of Strategy

Among the measures for the lake water quality conservation, included are: the basic investigation and research to clarify the gist of measures, water purification techniques for the prevention of pollutant generation, discharge and influx, removal of pollutants, and legislative and administrative systems for the regulation of human activities which induce pollutant development and discharge. Furthermore, education and enligightenment on water quality conservation and strengthening of the administrative system are indispensable to get the support from citizens on every strata on the application of water purification techniques and the new legislative system.

Here we propose the promotion of the Lake Ypacarai basin water quality conservation plan as based on the five following objectives: ① basic investigation and research, ② application of water quality improvement techniques which consider, as well, the conservation of the environment, ③ implementation of legislation related to water quality conservation, ④ diffusion of the concept of water quality conservation, ⑤ reinforcement of a water quality conservation administration.

From the results of the pollution simulation, this is predicted that, even if the pollutant inflow from the basin were cut in half, a sudden improvement in the quality of the lake water could not be expected. Furthermore, it is not a question of the inexistence of techniques which could temporarily improve the water quality, on a short-term basis. However, as there are many problems which require investigation, at the present stage, the measures must be all-encompassing. Preferably, from the point of view of improvement in the living environment in the basin, a plan for the improvement in the water quality of the rivers and the lake, resulting from the designing and implementation of long-term pollution measures, is desired.

Furthrmore, development is progressing, it can be said, and a flourishing natural environment still remains in the basin. Consequently, even if the aim is for the application of water quality improvement techniques, it is not only a question of the establishment of water treatment and purification facilities, but

the positive conservation and expansion of forests and marshes and the necessary use to the fullest extent of the natural purification potential.

CHAPTER III

EXAMINATION OF THE GOALS OF WATER CONSERVATION

3.1 Present Use and Future Demand of Lake Ypacarai, its Inflowing Rivers and the Area around the Lake

Presently the lake's water is used by CORPOSANA to supply domestic water to San Bernardino's 1,095 houses. Only 20,000 (winter)-60,000 (summer) m3/month is taken and none is used for agricultural nor industrial purposes. As discussed in 5-3, the eutrophication and organic contamination in the lake progress signigicantly, however as the turbidity is normally remarkable, the phytoplankton production is suppressed, and it is two or three times a year that obstacles occur in the San Bernardino water purifying plant, and strange odors and tastes appear in the public water.

The lake basin primarily is used for bathing and yachting in summer, and not in the least as a fishculture grounds.

According to the survey done by SENASA and CORPOSANA, at the present rate with the rise in population around the lake, in 5-10 years, San Bernardino, as well as Ypacarai, Itaugua, Capiata and a portion of San Lorenzo, will lose the ability to receive drinking water from the lake. The report also states that the groundwater in these areas is scant and that the water is salty, therefore it is not adequate for drinking water

Incidentally, the total of the above-mentioned districts' urban population is 50,000, and at the present growth rate will reach 70,000 in 5 years (7%/year average) and in 10 years, 100,000. If this size of population were to depend on the lake all of their necessary, in ten years, CORPOSANA would have to treat 8~10 times the present amount of water at the San Bernardino water purifying plant.

Tourism and recreational activities which utilize the shores and water surface, along with the improvement in the national standard of living, are expected to increase more and more. In the base area of all these activities, San Bernardino, the recent population increase rate is the highest in the basin (1972-1982, average of 8.9% a year) with the expansion of hotel and boating facilities, and the opening of many shops intended to attract tourists and recreators.

The scenic beauty of the lake and its surroundings is an important factor for tourism and recreation zone. It is necessary, then, to maintain the ecosystem with priority given to vegetation. It is also important to prevent the rise of foul odors caused by deterioration of the water quality, which would negatively affect the tourist and recreation trade.

Use of the rivers to serve recreational needs is disappearing because of deterioration of water quality and privitization of river banks. However, 15 years ago, people living near the basin often used the rivers as a recreational area. Presently people who are logistically unable to use the lake hope that the rivers will be cleaned up and made suitable for recreation as before. Finally, preservation of the riverside forest is needed to enhance and maintain the scenic beauty of the area, as well as help in water conservation efforts.

3.2 Content of the Goals for Water Quality Conservation

If in the future, the water use in the lakes and rivers, and the surrounding land use take the same shape as described in the previous paragraphs, it will be necessary to propose the following as objectives: ① use of the lake water for potable water supply, ② use of the surface of the lakes and rivers for recreation, and ③ maintenance of the aesthetic quality and ecosystem of the area surrounding water bodies.

It is desirable that, as far as possible, water used as potable water not only be free of bacteria and organic matters which are hazardous to the health, but also be free of matter which hinders water purification (a large amount of particulate substances) and matter which causes unpleasantness during usage (Phytoplankton which causes unpleasant odores and tastes and iron and humic acid which cause strange colors to appear). These undesirable matters could be removed by purification processes, however, the higher the concentration of such matters in the water, the higher the technology required must be, and the higher the cost for purification becomes.

As for the water surface of lakes and rivers used for recreational purposes, besides the problem of the existence of bacteria and organic matters which pose health hazards, there is also that of the existence of turbidity which results in the loss of aesthetic pleasure.

In the case of Lake Ypacarai, on a normal basis, turbidity is remarkable (SD is usually less than 15cm). The matters causing this turbidity are the following: ① dissoled substances inflowed with river water (thought to be princiaplly consisting of difficult-to-decompose organic matters), ② the phytoplankton produced in the Lake and its dead remains, ③ bottom mud stirred-up by wind and waves. However, the rate of amount and composition fluctuate greately depending on the weather and hydological conditions. What is a particular problem is the turbidity when the water is a black color, however the composition of this is yet unknown. Furthermore, as the lake is shallow, the turbidity described in ③ cannot be avoided.

In order to maintain the scenic character and the eco-system surrounding the water body, gross problems arise with the presence of organic matters which reduce the oxygen in water and the lower areas, as well as with the nutrient salts which accelerate the internal production. Fig. S9.31 shows the possible effects an increase in organic matters and nutrient salts could have on the water body eco-system and environment.

In Lake Ypacarai, because of a continuous vertical mixture of the waters, oxygen exists in lower reaches of the lake. If the aaccumulation of organic substances continued, anoxic water body and extremely deteriorated bottom materials will be formed in such inlets at the lake margin where mixing of water is insufficient. Further, such environmental change will result a root rot of aquatic plant and the generation of foul odor. In a portion of the Yuquyry water sytem, there are such areas where organic matters are retained to rot and send out foul odors.

As stated above, in implementing water quality conservation objectives, through the use of the raw water for potable water, such problems as health hazards (bacteria, organic matters), obstacles to purification, unpleasantness in use, and thus, the pollution of recreational and domestic environments will be fought. Although these may be desired, all of them may not necessarily be needed depending on the nature of the environmental administration.

Looking at water supply in Japan, 26 items of water quality standards are fixed, however, from the viewpoint of environmental administration objectives, while respecting these standards, other more convenient ones, with consideration for other hydrologic uses are applied to public water bodies. These standards are divided into two categories: human health protection and life environment conservation; the former are applied as one uniform standard to any

public water body, and the latter applied in varied forms as it attempts to respond to the specific needs of the particular water body. The establishment of the same type of water quality conservation and administration objectives is thought to be suitable for Lake Ypacarai and the inflow rivers.

3.3 Index and Viable Goals for Water Quality Conservation

In order to establish the level of the water quality as an administrative goal, there must be certain basic technical criteria (decision conditions) which comply with objectives for these water bodies. Thus, even if these criteria are present, if we do not have the necessary polluted water treatment and water purification techniques or the ability to bear the expenses needed to execute the measures, we cannot set these criteria as administrative goals. Therefore, in order to establish viable goals for the administration, it is necessary to evaluate general scientific criteria, as well as legislative, administrative and technical applicability. Also, we must look at the relationship between social benefits and losses before implementing these goals.

For the Ypacarai basin, the pollutants and their effects on human and animal life are not yet sufficiently known. Furthermore, in order to achieve the water quality standards, the administrative and technical demands present a future problem. Consequently, at this point it is difficult to establish an objective level of an adequate foundation, however, based on the water quality data obtained by this study, by ICB and SENASA in the past and the standard value of Japan, the following tentative items are proposed.

1) Health Items (Toxic Substances)

Table S9.31 shows the categories and standard levels set up in Japan. As it is believed there is no great difference among races and individuals in tolerance of toxic substances, we will tentatively apply this reasoning.

Among these toxic substances are cyan, mercury, cadmium, lead, chrome, arsenic and PCB which originate at sources such as metalliferous mines and factories, and mercury, organic phosphorous and arsenic which are contained in agricultural chemicals.

Within the basin, there are no metalliferous mines, and factories which possibly discharge the mentioned toxic substances are few in number (San Lorenzo chemical factory and tanneries scattered around the Ypacarai). Moreover, the agricultural chemicals used in the basins are sumichion (Japanese made) and Tiodan (German made), which are low in poison content and are used sparingly.

Consequently, what would be more effective at this point, instead of depending on a water quality survey, would be an adequate understanding of the situation of toxic substances in use at selected factories; and an understanding of relevant agricultural sales, followed by guidance on suitable use methods and treatment methods.

2) Items related to Living Environment

As Table S9.32 shows, in Japan, for lake water storage at over 10^7 m^3, 7 water quality items have been selected: pH, COD, SS, DO, number of fecal coliform, TN and TP. In addition, standard levels of average yearly values which respond to the usage objectives have been established.

If the attempt is made to use lake water as potable water following ordinary purifying process by sedimentation and filtration, in Japan, the A-type standard shown in Table S9.32 (TN and TP -related II-type) would be applied to the lake in question. However, in the case of Lake Ypacarai, with the present water quality, it is being used as a potable water resource with no major problems. Therefore, we propose, at this point, that an administrative objective be the maintenance of the present water quality. From the point of view of eco-system support, if the present water quality is maintained, it is believed that the result would be neither a anoxic water body nor any other major problems.

In Figs. S9.32~S9.34 graphs show the lake water quality fluctuations during this survey period, in combination with the 1984 water quality fluctuation range (ICB survey results), and the Japanese A-type standard.

Judging from these figures the content of the "present water quality level (average yearly value)" which should be maintained is as follows.

pH, as it is an important controlling factor in the purification process, for A-type lakes in Japan, has a standard level of 6.5~8.5. In Lake Ypacarai from Feb.~June, 1988, it showed a level of above 8.5, however, after this it decreased to 6.5~8.5. The 1984 pH was 6.4~7.9. Moreover, pH in the inflowing rivders almost never exceeded 7.5. Consequently, it doesn't seem a problem to establish the pH standard level at the A-type 6.5~8.5.

COD is an index of the organic matter content and its high value generally means low self-purification capacity. The upper limit of the standard level of A-type water area in Japan is 3mg/ℓ, which is the value measured by potassium permanganate method and roughly corresponds to 10~15mg/ℓ by potassium dichromate method. The average value during the study at the lake was 20~27mg/ℓ. That of 1984 was 12~18mg/ℓ. Accordingly, this was lower than the average during the study, however, we suggest the working index to stand at 20mg/ℓ as the COD standard.

SS is one index for turbidity, and for the A-type, below 5mg/l is the standard. During the study and in 1984, it was frequently above 20mg/ℓ, however, it was very fluctuated. Then, as in Feb.~Mar. 1988, when the SS density was low and the water temperature was high, phytoplankton increased and resulted in the development of water use obstacle. Consequently, it is thought meaningless to establish a standard level value for SS.

DO is the amount of oxygen dissolved in the water, thus it shows the purification cacpaity of the water body. The A-type standard in Japan is above 7.5mg/ℓ. In Lake Ypacarai DO value was 6~11mg/ℓ at its surface and 5~10mg/ℓ at the bottom during the study period. In 1984, DO value was 6~10mg/ℓ. Consequently there is no problem to set the standard level at 7.5mg/ℓ.

Fecal coliform is a cause of digestive illnesses, thus the A-type standard in Japan is less than 1,000MPN/100mℓ. In Lake Ypacarai the number of fecal coliforms does not exceed 100 No/100mℓ, and usually it is 50 No/100mℓ or less during the study period. However, downstream in

the Yuquyry, a high value at 1,000~10,000No/100mℓ was presented. Consequently, we proposed to establish the standard at below 1,000MPN/100mℓ after the A-type standard in Japan.

Nutritive salts are a principal cause for an increase in phytoplankton. When this occurs, the transparency level decreases and filtration hindrances for purification develop. Thus, the following are established standards for II-type water area in Japan: TN below 0.2mg/ℓ and TP below 0.01mg/ℓ. During this study, the TN was high at 0.7~3.4mg/ℓ, with a wide fluctuation range. However, in 1984, it was stable at 0.5~0.8,mg/ℓ. The TP in 1988 was low at below 0.15mg/ℓ. However, it was high in 1989 and 1984 at 0.15~0.30mg/ℓ. We propose a standard level of TN less than 0.7mg/ℓ and TP less than 0.1mg/ℓ.

The study results up to this point are arranged and shown in Table S9.33. The water quality standards given are as stated above forever going to be tentative figures and, according to future data, will require adjusting.

Table S9.31 Water Quality Standard for the Public Waters in Japan (Health Items)

item	unit	standard value
cadmium	mg/ℓ	below 0.01
cyarogen	mg/ℓ	undetected
organic phosphorous	mg/ℓ	undetected
lead	mg/ℓ	below 0.1
chromium	mg/ℓ	below 0.05
arsenic	mg/ℓ	below 0.05
mercury	mg/ℓ	below 0.0005
alkyl mercury	mg/ℓ	undetected
PCB	mg/ℓ	undetected

Table S9.32 Water Quality Standard for the Public Waters In Japan (Living Environment Items)

Parameter / Type	Use Type Adaptability	Standard Value				
		pH	COD	SS	DO	Coliform Group Num.
AA	Potable Water I Pisciculture Natural Conservation and All Use below A	More than 6.5 Less than 8.5	Less than 1 mg/ℓ	Less than 1 mg/ℓ	More than 7.5 mg/ℓ	Less than 50 MPN /100mℓ
A	Potable Water II, III Pisciculture II Bathing and All Use below B	More than 6.5 Less than 8.5	Less than 3 mg/ℓ	Less than 5 mg/ℓ	More than 7.5 mg/ℓ	Less than 1,000 MPN /100mℓ
B	Pisciculture III Industrial Water I Agricultural Water and All Use below C	More than 6.5 Less than 8.5	Less than 5 mg/ℓ	Less than 15 mg/ℓ	More than 5 mg/ℓ	Less than 5,000 MPN /100mℓ
C	Industrial Water II Environmental Conservation	More than 6.0 Less than 8.5	Less than 8 mg/ℓ	No flowting rubbish	More than 2 mg/ℓ	–

* This standard is applied to Lake and Marsh which volume is more than $10^7 m^3$.

Table S9.32 Water Quality Standard for the Public Waters in Japan (Living Environment Items)

Type	Use Type Adaptability	TN	TP
I	Natural Conservation and Uses below II	less than 0.1mg/ℓ	less than 0.05mg/ℓ
II	Potable Water I , II , III (Except Special Case) Pisciculture Bathing and below III	less than 0.2mg/ℓ	less than 0.01mg/ℓ
III	Potable Water III (Special Case) Use below IV	less than 0.4mg/ℓ	less than 0.03mg/ℓ
IV	Pisciculture II Use below V	less than 0.6mg/ℓ	less than 0.05mg/ℓ
V	Piscicul ture III Industrial Water, Agriculture Water Environmental Conservation	less than 1mg/ℓ	less than 0.1mg/ℓ

(Note)
- Potable Water I : possible for drinking by simple purification method as filtration etc.
- Potable Water II , III : possible for drinking by ordinary purification method as settling, filtration and others
- Pisciculture I : suitable for fishes living in oligotrophic lake type water as kokanee
- Pisciculture II : suitable for fishes living in oligotrophic lake type water as salmon, ayu and others
- Pisciculture III : suitable for fishes living in eutrophic lake type water as carp, crucian and others
- Industrial Water I : possible to use by ordinary purification method as settling and others
- Industrial Water II : possible to use by high grade purification method as chemicals pouring and others
- Environmental Conservation: Living environment in which people feel no unpleasant

Table S9.33 Tentative Water Quality Standard for Lake Ypacarai

pH	COD	DO	Fecal col.	TN	TP
6.5~8.5	less than 20mg/ℓ	more than 7.5mg/ℓ	less than 1,000 MPN/100mℓ	less than 0.7mg/ℓ	less than 0.1mg/ℓ

CHAPTER IV

WATER QUALITY IMPROVEMENT TECHNIQUES APPLICABLE TO THE BASIN

4.1 Water Quality Improvement Techniques for Lake and River and Their Evaluation

Table S9.41 classifies the techniques for improving water quality which is possible today according to technical principle and place of execution. The cost investment pattern for each technique is also shown (whether it requires high initial cost or high running cost), as well as the construction time required, scale-up possibility, stability as a water treatment technique, and the precedence in Japan.

This table evaluates techniques that are strictly applied in Japan; however, looking at the pollution generation and discharge conditions in the Ypacarai basin, some of these techniques obviously will not apply. For example, most households in the Lake basin area do not use phosphorous detergent and most farmer do not use an excessive amount of fertilizer or insecticide. Thus, at present, it is not necessary to examine restrictions on the use of phosphorous detergents or reduction of farm-related load. Also, fish breeding is not done in the region, so any related countermeasures do not need to be examined.

Although there will be high expenditure on facilities construction, water technologies that are unstable or relatively new and unproven should not be applied to the Ypacarai basin.

Moreover, even though there is a great deal of development taking place flourishing natural environment is still remaining in the Lake basin. Thus purification techniques that utilize the soil and vegetation should be applied positively.

Taking into account the considerations mentioned above, Table S9.42 lists the selected water quality improvement techniques which are applicable to the Lake basin. In Chapter 5, techniques related to utilization and conservation of the land in this table will be examined. In Chapter 6, techniques related to laws and regulations will be examined. In this chapter, we will primarily

examine the techniques focused on the equipping of facilities, their advantages and disadvantages, problems with their application, and effect on the environment.

Further, there is a possibility that the quite new water quality improvement techniques suitable to the pollution mechanism of Lake Ypacarai and the socioeconomic condition of the Lake basin will be developed, and such technical development is rather important.

4.2 Techniques Applicable to Generation and Discharge Sources

It goes without saying that the reduction of generation and discharge amount of pollutants at its sources is most effective to prevent water pollution. Many techniques exist for point sources, but there are very few effective techniques for non-point sources.

4.2.1 Reduction of Pollution Load Generation from Point Sources

(1) Regulations on the locating of industries and dwellings

As was stated in Chapter 2, the percentage of industrial waste in the generated loads at the point sources is extremely high. However, if industry were moved outside of the basin and/or no new industry were allowed to move into the area, industrial pollution would surely be reduced. However, if these types of measurements were implemented, the possibilities arise that the working population would be reduced, there would be a drop in district income, and regional economic development would be damaged. Thus, since industry presently exists in the area, this report proposes the mandatory installation of a waste water treatment system, as described in subchapter 4.2.2. Also, for new factories, it is necessary to ensure that only industries which produce little discharge (industries that do not use much water) are permitted to be established.

The chaotic and unregulated construction of dwellings has lead to increasing erosion and waste water, which contributes to deteriorate water quality in the rivers and lake. It is necessary to make a regional development plan in which bedroom towns of the metropolis are set

outside the Lake basin. In addition, any further housing development in this area should comply with strictly enforced laws in such areas as drainage installation for rain water, asphalt roadways, creation of green areas, and installation of simple communal sewage treatment plant etc.

(2) Improving the industrial production process in factories

In every type of industry, the production of high concentration waste water is defined in one or more ways. For example, in slaughterhouses, there is a lot of bloodletting, and a substantial flow of blood. At present, this blood flows as it is into the river. However, it would be advisable to consider catching this blood in a receptacle and using it along with entrails in foodstuff or manure.

There are other sources of high concentration waste water. In alcohol processing plants they come from the final distillation process; in starch processing plants, they come from the processes of protein liquid separation, washing filtration and dehydration after elutriation, and in meat processing plants, from the processes from defrosting to boiling.

It is necessary to revise the production processes in other industries in order to clarify the generating point of high concentration waste water. In addition, for the places which are generating high concentration waste water, we must grapple with developing technology that reduces the generated load.

4.2.2 Reduction of Pollution Load Discharge from Point Sources

(1) Establishment of a treatment system for waste water from industrial pollution sources

As was stated previously, nearly all the existing industries in the Lake basin are discharging waste water without taking measures to treat it. Thus, since the greatest contribution to pollution at point sources comes from industry, establishing treatment systems for industrial waste water is an urgently required measure in the fight for preserving water quality.

In the Lake basin, there are four large-scale oil refineries. These plants represent 40 to 80% of the total industrial related discharge load.

At CAPSA, which has originally a high level of production, in 1979, a chemical treatment plant with a treatment capacity at 5m^3/h of high concentration waste water, was established. However, due to partial hinderances, it is out of operation. Also, at ACEITERA, there is a chemical treatment plant (the layout of which is unknown), however, it only operated for a short time following its birth, and has since been out of operation. It is necessary to put plants like this back into operation as soon as possible.

Futher, even if the CAPSA plant for high concentration waste water was pit in operation, as the amount treatable at this plant is only 50% of the total load, lagoon should be established for low density waste water which could be "treated" and then discharged. We strongly feel that guidance is necessary for the isntallation of chemical plants and lagoons similar to those at CAPSA at the vegetable oil refineries without any treatment facilites.

Small- and medium-scale factories other than the plant oil refining factories, should at least install facilities for simple processing such as oxidizing ponds.

Other than vegetable oil refineries, most of small- and medium-scale factories are processing the agricultural and livestock products, thus the resulting waste water is rich in organic substances. Consequently, it is desired to establish treatment plants with principally lagoon-type treatment facilities.

As for lagoons, for low concentration waste water, aerobic lagoon treatment (oxidation pond) is applied, and for high concentration, anaerobic lagoon treatment. A combination of the two gives a high treatment capacity. The cost for these two types of lagoon treatment is low and maintenance is easy, because there is no need for special machine installation is easy, because there is no need for special machine installation nor energy, as they borrow the biological energy. But aerobic lagoon needs wide space and anaerobic lagoon generates offensive odor. Thus after considering the various factories' location and conditions, these should be installed.

In this study, an oxidation pond model plant for a butchery was constructed and its purification capacity was examined. However, the results obtained were not good due to the large amount of blood that was contained in the source water. Yet, if we look at the achievements of the many examples of this application in the United States, the BOD removal ratio is, on average, 80 to 95% in the case of oxidation ponds, anaerobic lagoons are at 50~70%. Consequently, as a treatment method for waste water rich in organic substances, it is easy to operate and quite effective.

(2) Establishment of treatment systems for waste water from tourism pollution sources

Most of the facilities related to tourism such as hotels and clubs have installed storage tanks and septic tanks, however there are many where the conservation management is not appropriate. The load proportion from tourism sources is very small, however, since many of these facilities are located near the lake shores, in cases where processing facilities are not functioning effectively, the polluted water is allowed to flow directly into the lake. However, based on various ways in which the lake functions as a business resource, it is imperative that there is adequate conservation management of these facilities. Consequently, a detailed investigation should be made concerning the proper management of the treatment facilities and if there were any problems therein they would be improved without delay.

(3) Improvement in the treatment system for domestic waste water

In the zone under study, there is only sewage system in parts of San Lorenzo and Luque. In other areas, both urban and rural, domestic waste water is treated with infiltration tank. In particular, in urban areas, there is no space for infiltration tank replacement and the problem of ground water contamination occurs. Unless some drastic and effective steps are taken to alleviate this problem, grave risks may be faced.

Although it has been hoped to construct sewerage and sewage treatment plant to treat the domestic waste water, no actual estimates or schedules have been planned, due to a sparity of finance. CORPOSANA plans to construct sewerage and sewage treatment plants in the areas

where water works is completed. However, since many of the areas are suffering from financial problems, a schedule has not yet been established. In addition, San Lorenzo sewage treatment plant (an oxidation pond supports a population of approximately 15,000) has not been in operation for the past two years due to lack of support management funds (This sewage treatment plant was repaired and began operating again in December 1988). There are also problems in other areas like San Bernardino where underground sewages cannot be installed, because the ground is too hard and the ground water level is too shallow. Looking at the situation, even in urban areas, the widespread use of sewerage systems and equipping of sewage treatment plants will presumably take a long time.

Until the sewerage facilities are set up, it is necessary, in particular, to give plenty of thought to domestic waste water treatment methods in urban areas. One method, which was experimentally tested on-site during this study, is the introduction of soil absorption treatment system. In this study's testing, there were almost no effects from the removal of N and P because of the soil characteristics at the installation location; whereas COD and BOD removal rate was high at approximately 90%. Moreover, the possibility of groundwater pollution when effecting treatment in shallow areas as opposed to infiltration tanks was lower and there was no foul odor development. Consequently, in the urban areas, as infiltration tanks have just reached a point of unusuability, it is desired to make the transition to soil absorption treatment. As there is more space needed for soil absorption treatment system than for infiltration tanks, an effective approach would be to establish this at several house units.

It is necessary to put some thought into the use of cesspit emptier for raw sewage collection for where the soil absorption treatment is inadequate due to soil characteristics and groundwater level. However, in this case, raw sewage and other waste water would be separated, and an infiltraton tank and, separately, a storage tank for raw sewage would need to be installed. Moreover, there would also be the necessity of having a treatment faiclity for the content collected by the cesspit emptiers.

4.2.3 Reduction of Generation and Discharge Load from Non-point Sources

(1) Prevention of direct flowing of cattle evacuations into the rivers around the grazing lands

Grazing lands represent a large area within the Lake basin, where primarily cattle graze. Based on the number of domestic animals, the amount of load generation by them can be greater than human waste. Judging from the extensive pasturage, the load generation per unit area cannot be considered a problem.

In the contaminated material from the grazing land that enters the lake (including the swamp area), the COD is estimated to reach approximately 20%, the TN approximately 30%, and the TP approximately 30%. As the major portion of pollutants from the grazing land flows into the river in a non-decomposed state in flood time, measures that prevent these non-decomposed evacuations from flowing into the rivers in flood time are necessary.

As a countermeasure, borders on the banks of the rivers and lake must be established within which grazing would be prohibited. In this area, the building up of the low bank and green belt should be considered. It would be more effective, if inside this low bank, drainage ditch were constructed, and the polluted water which flows from the grazing land was directed into lagoons.

(2) Prevention of soil runoff from the cultivated lands

Cultivated lands are currently being furrowed on slopesand this causes erosion in the rainy season. To make matters worse, the low productivity of the acid soil is still more dropping.

In the cultivated lands, basic countermeasures to prevent the erosion of soil is contour cultivation. However, if this is to be used in the Lake basin, large scale readjustment is necessary. The implementation of this will take a long time. We are considering the planting of grass for use as an earth supporting system parallel to the contour lines.

To prevent soil runoff from the cultivated land without restoring to an earthworks method, the use of organic material to increase the

permeability and anti-erosion would be effective. As described in 4.5, if the supplying of sludge compost is possible, this problem could be solved. Also, in the case of soil poor in organic substances which is distributed in the Lake basin if the slope is more than 15 degrees, then it is said that the erosion becomes notable. Thus in the future, land use restrictions should be implemented so that there is no development in districts where the land slopes.

(3) Prevention of erosion in residential zones and of roads

As was previously stated, forest land and cultivated land in the Lake basin is rapidly being converted to land for dwellings and roads. Much of the forest and cultivated land is sloped, thus the top soil is being eroded because of the leveling work done for the construction of dwellings. In order to prevent this, construction methods must be studied.

The majority of roads other than the main highways which connect large cities are not paved with asphalt. Thus if there is a heavy rain, a great deal of run-off occurs and a deep waterway is created which erodes the gutters already dug. In rural areas erosion is started by the tracks made by the cattle trucks and entire streets becomes deeper than the shoulder of the road. When it rains, it becomes a path for sand and mud flow. In order to prevent this, along with either paving the roads with concrete or spreading gravel, it is necessary in construct drainage ditch and begin reforestation alongside the roads.

(4) Prevention of earth and sand runoff from clay, stone and gravel quarries

In the western area of Lake Ypacarai, there is a good layer of white clay from the Silurian strata and the river bed of the Yuquyry River contains black clay of the Quaternary Age. These clays have been exploited for use in folk crafts and bricks.

In addition, on the east side of the lake in the Los Altos mountain range, white sandstone from the Paleozoic Age is in high demand as ornamental rock for construction and is being exploited. The hexagonal shaped sandstone in Aregua and San Lorenzo and the igneous rock

cropping out within the basin are exploited as materials in civil engineering projects due to their hardness.

Also, in the western area of the basin, conglomerate from the Cretaceous Period is widely distributed and is exploited as a source of gravel because of its low concretion.

The distribution of the clay, stone and gravel open quarries described above are shown in Fig. S9.41. The vegetation cover has been lost in the quarry areas in the hill and mountain regions. Steep slopes have formed which result in huge quantities of earth and sand runoff in flood time. To prevent this, the earth supporting systems should be built and grit chambers installed in the quarry areas.

(5) Prevention of river bank erosion

There are extremely few areas where revetments have been built on the rivers in the basin. This is desirable from the standpoint of the scenery and ability to enjoy the water. However, depending on the location, when there is a flood a lot of erosion takes place on the both sides of the river and a great deal of sand and mud run-off occurs. Among the rivers in the Lake basin, particularly the branches flowing into the left bank of the Pirayu River suffer lateral erosion remarkably. In this type of area, revetments of concrete or stone are necessary. Moreover, it is effective to stabilize the river bed by installation of a debris barrier on the downstream side.

4.3 Techniques applicable for Inflow Rivers

Three ways to seduce the effuent load in the siners are ① seduction of the siver water flowing into the Lake during flood time when the sun-off load is large, ② building of a by-pass and diverting the siver water for purification, and ③ removal of sludge and garbage which has accumulated on the bottom of the river.

1) Installation of a flood control canal

Many people live in the Yuquyry River basin and in addition, a majority of the industrial pollution sources are located there. Thus the water quality at normal water level is quite a bit worse than other rivers.

Moreover, when it rains, the flow amount increases substantially and the load which has accumulated in the river bottom during the normal water level moves downstream all at once. In addition, since the households and factories also discharge polluted water that has accumulated within the area at one time, the load amount which flows into the river is extremely large in flood time. Though the effect by this load on the lake water quality is reduced by the purification capacity of the marsh, to cut the inflow load is desirable for the conservation of the marsh.

Thus, if in the Yuquyry river a flood control canal between an appropriate point on the side of the river which enters the marsh and the Salado River is created, and if the river water during flood time were diverted directly into the Salado by diversion dam, then there would be substantial reduction of the load amount which flows in the marshes and river.

In the Yuquyry River, the flow amount peaks is 0.5~1.0 day after a rain; however the flow speed does not change substantially. Also, the water quality in flood time, if the SS is excluded, does not change substantially from the normal water level. Thus, we believe that when the water level is high and the diversion dum are opened, the load amount which flows into the lake can be reduced systematically. During the normal day with the water flowing in normal river course, the lake water level should not drop due to insufficient inflow of water.

However, the installation of this type of flood control canal should be seriously studied from the standpoint of such problems as selection of a route, construction methods and cost. In addition there is the problem of the effect that it would have on the environment of the marshes downstream on the Salado River.

2) Contact oxidation ditch

A human-built canal which is installed as a river by-pass canal is filled with gravels and cobbles. Microorganisms attach themselves to the rocks and purify the polluted water. This technology has a major advantage in that its maintenance is easy and furthermore, the system is

able to cope with the fluctuation of load. But it requires a sizable amount of space.

3) Removal of sludge and garbage from the river beds

The waste water from the vegetable oil refineries and food processing plants is discharged into the rivers and canals, thus sludge is accumulating in the water flow route. As a result, there are places where methane and sulfuric hydrogen gases are forming. Also, where the river flows through urban areas, there are many places where garbage which has been thrown in and pollutants decomposing give off a foul odor. This type of sludge and garbage is not simply a source of bad water quality and stench, but it is also blocking the water flow and spoiling the beautiful scenery.

Consequently, contaminated mud and garbage need to be removed from the rivercourse, however, even presently, due to a lack of district funds, even normal waste collection and disposal in cities is not sufficiently carried out. Moreover, most waste disposal plants in the basin becomes landfill for flat plains, thus leading to a worsening of the surrounding environment. In order to insure funding sources, collection regulations need to be fully carried out, as well as, the installment of waste disposal plant at former quarries.

4.4 Measures Applicable within the Lake

(1) Treatment of garbage and pollutants on the lake shores

Garbage and pollutants dumped directly into the lake from its shores directly affect water quality and the ecology because they are in no way purified by the rivers. The tourist and recreation spots of San Bernardino and Aregua and the swimming area of Aregua have a conspicuous amount of garbage scattered around them. In San Bernardino, filth are often thrown into the drainage canal.

Consequently, these garbage and filth treatment is desired, however, there is still a problem of waste and contaminated mud treatment within the rivercourse. Waste disposal in San Bernardino

occupies a large part of the district budget, thus calling for new waste disposal plant to be set up.

(2) Removal of dead algae and dead aquatic plants

Living algae and aquatic plants contribute to the purification of water; however, they constitute organic pollution when they are dead. The area near the egress to the Salado River has a high concentration of COD throughout the year when compared to other points of the lake. This seems to be so because aquatic plants and algae are carried by the wind and current to this area where they settle and rot. The algae and aquatic plants which have floated to the egress to the river block the water flow out of the lake. This is a cause of flooding in the lake shore and a lengthening of the retention time.

Aquatic plants are distributed widely along the shores, however, since the plants do not die at a fixed time, from the point of labor and cost, removal which covers the entire area is difficult. Thus, we propose that the implementation of a plan for determined removal of drifting algae and water grass in the area around the mouth of the Salado River would be very effective.

(3) Dredging of sludge from the bottom of the lake

It goes without saying that the foundation of water quality pollutant prevention is countermeasures against pollution generation and discharge sources. In the enclosed area where there is already a certain level of organic material and nutrient salts, there are some cases where the water quality will not improve even if the load is reduced, because the internal production is not weakend due to the load elution from the bottom mud of the lake. There are many cases where even if the load flowing in is reduced, the water quality will not improve.

Other than the elution in the lake, another cause of the worsening of the water quality in the lake would be the stirring up of the bottom mud due to the shallowness of the water. Consequently, bottom mud removal is thought to be effective for the improvement of the water quality, however, for the cost involved here, the effectivity is extimated to be short. Moreover, dredging work brings along with it the problems of the treatment of the removed sludge and the development of turbidity.

Therefore, it is necessary to conduct testing in order to determine the suitability of execution.

(4) Establishment of a water gate at the egress to the Salado River

This is a measure getting the hint from the clarifying of the lake water following the heavy rains from Jan. 13~16, 1988 and the resulting raise in water level. A water gate is to be established at the egress to the Salado, the lake water outflow will be freely stopped, after the water level rises the water gate will open and then the lake water and bottom mud will be flushed out. As the regular meteorological and hydraulic observation and the water quality survey had not yet begun in January 1988, there is not dependable data enabling the explanation of this phenomenon, however, the amount from 2 or 3 rainfall occurences a year (based on data from observation outside the Lake basin, the estimated value for 4 days is 150~200mm) was contrasted the past largest increase in water level. (2.60m above the datum level by Navy record). Then, after the removal of aquatic plants at the egress to the Salado River on Jan. 20, the water level rapidly decreased and the water was purified. Consequently, the clarifying of the water was due less to the dilution by the rain, than by the flushing out of bottom mud which contained a large portion of the pollutants.

As the lakeside was submerged in January following the rise of water level up to 2.60m, it is necessary to excavate at the egress to the Salado River (during the Jan. 1988 survey, the water depth was 85cm), and to install a water gate. Moreover, water bloom developed in Feb.~March 1988, following the purification of the water and there is also a possibility of problems in clarifying and foul odors arising from the sewage. Consequently, apart from the basic study concerning the pollution mechanism in the lake, it is necessary examine the possibility of executing hydraulic model experimentation or on-site experimentation.

4.5 Techniques for Sludge Treatment

As has been shown before, there are many types of techniques for treating and purifying water, however , inevitably, in one form or another, sludge is produced from the water treatment facilities. Due to the fact that there

is no sludge treatment facility at the San Bernardino purification plant, the sludge generated from filtration is sent back into the lake, Although outside the basins, even at the public alcohol distillery at Troche, the large quality of sludge produced from the waste water treatment facilities piles up and is neglected and then is discharged when there is rainfall. If the sludge that once removed were returned to the river or the lake, the effect of waste water treatment reduce by half. Therefore, sludge treatment techniques need to be applied.

The easiest method of treating sludge is after several days of sun-drying, to bury it in the ground, however, during drying foul smelling water is released, thus it is necessary that in the wide range surrounding the treatment facilities, there be no inhabitants and that the location be easy for the transporting of the matter.

Sludge which is generated by treatment plants is rich in organic materials, nitrogen and phosphorous which can be reused in the agricultural industry. If it does not contain any heavy metals or toxins, the sludge can be concentrated and dried for fertilizer for agricultural purposes. Also, the sludge can be dried and mixed with lime which is the only mineral resource in Paraguay, and used as acid soil improvement material. Consequently, if sludge could reach a state of unified amount guarantee, compost producing plants could be set up.

As was stated before, the productivity of the soil is low because of the lack of organic material in the sandy and highly acid soil in the Lake basin and it erodes easily when it rains. If there were a system for selling low cost sludge compost to the farmers in the Lake basin, we believe we could kill two birds with one stone by making use of the sludge and improving the productivity of the soil.

There are many methods for the production of compost, however as high technology is needed for maintenence, the desired method is one which might even be slightly inefficient, but which uses the hands of the people for its carrying out.

Table S9.41 Water Quality Improvement Techniques Applicable to Lake and Marsh

Location	Principle	Water Quality Improvement Techniques	Cost Investment Pattern	Construction of Facilities		Possibility of Scale-up	Stability as Water Treatment Technology	Precedence in Actual Scale in Japan
				Necessity	Construction Period (years)			
Within Basin	Location Regulation	Location Regulation	–	No	–	–	–	Yes
	Basin Change	Diversion of Channel	I	Yes	5~10	Yes	–	Yes
	Reduction of Generated Load	Limit Use for Detergent Cont. OP	–	No	–	–	–	Yes
		Rationalization of Water Utilization	–	No	–	–	–	Yes
	Reduction of Point Source Discharged Load	Effluent Regulation	–	No	–	–	○	Yes
		Sewage Treatment	I+R	Yes	5~10	Yes	○	Yes
		High-level Sewage Treatment	I+R	Yes	5~10	Yes	○	Yes
		High-level Raw Sewage Treatment	I+R	Yes	5~10	Yes	○	Yes
		Purification Tank (for Raw Sewage)	I	Yes	1~3	No	△	Yes
		Purif. Tank (for Domestic Waste W.)	I+R	Yes	2~5	No	△	Yes
	Reduction of Non-poin Source *1 Discharged Load *2	Reduction of Load from Agriculture						
		Reduction of Non-specific Load						
Inside Inflow Rivers	Prevention against Inflow Load in Flood Time	Flood Control Reservoir	I	Yes	1~5	Yes	△	
	Direct Purification	River bypath through Marsh	I	Yes	1~3	Yes	△	
		Soil Absorption Treatment	I	Yes	1~3	No	△	Yes
		Infiltration Channel	I+R	Yes	I+R	No	△	
		Filtration (upward)	I	Yes	1~5	No	△	
		Settlement of Floating Substances	I	Yes	1~5	No	△	
		Contact Oxidation Channel	I	Yes	1~5	No	△	Yes
		Direct Aeration	I+R	Yes	1~5	No	△	
		River Water Treatment Plant	I+R	Yes	1~10	Yes	△	
	Removal of Retaining Load	River Bed Dredging	R	Yes	1~5	Yes	△	Yes
Within Lake and Marsh	Reduction of Load Generated within Lake and Marsh	Dredging	I+R	Yes	1~5	Yes	○	Yes
		Bottom Mud Coverage (by lake internal material)	I	No	–	Yes	△	
		Bottom Mud Coverage (by lake external material)	I	No	–	Yes	△	
		Nutrient Salt Inactivation Treatment	R	No	–	No	△	
		Countermeasure for Pisciculture	–	No	–	–	–	Yes
	Control of Eutrophication (Countermeasure against Stratification) (Change of Hydrographic Conditions) (Reduction of Nutrient Salt Concentration) (Control of Biofacies) (Removal of Algae)	Measures at River-Month	I	Yes	3~5	Yes	△	
		Lake Separation	I	Yes	5~10	Yes	△	
		Utilization of Floating-leaf Plants for Treatment	R	Yes	1~3	No	×	Yes
		Removal of Algae	R	Yes	1~3	No	×	Yes
		Treatment of Inceticide and Herbicide	R	No	–	No	×	Yes
		Control of Ecosystem	–	No	–	–	×	
		Water Inflow for Purification	I+R	Yes	5~10	Yes	○	Yes
		Artificial Lake Water Circulation	I+R	Yes	3~5	No	△	
		Aeration of Deep Water Layers	I+R	Yes	3~5	Yes	○	
		Circulation Treatment of Lake Water (Pumped type)	I+R	Yes	3~5	Yes	△	
		Injection of Purifier into Shallow Water	I+R	Yes	1~5	Yes	△	
		Increase in Underground Water Inflow	I+R	Yes	3~5	Yes	△	
		Selective Effluent of Deep Water	I+R	Yes	3~5	Yes	△	
	Preservation of the Lake Shore Environment	Beach type Lake Shore	I	Yes	1~10	Yes	×	
		Shore with Vegetation	I	Yes	1~10	Yes	×	

*1 Method for Agricultural Load Reduction
(Reasonable Use of Fertilizer, Change of Planting Crops, Change of Chemical Fertilizer, Compost Making, Improvement of Agricultural Method)

*2 Method for Non-specific Load Reduction
(Control of Logging, Forest Management, Cleaning of Road Surface, Measure against First Flushing, Infiltration Land

Legend

I : Initial Cost Type
R : Running Cost Type
I+R: Combined Type

× : Not reliable
△ : Not fully evaluated
○ : Stable

Ministry of Construction (1987)
Development of Synthetic Water Control Technique for Lake and Marsh (in Japanese)

Table S9.42 Water Quality Improvement Techniques Applicable to the Lake Ypacarai Basin

Application site	Contents of Load Reduction	Technology of Water Quality Improvement
Sources of load generation and discharge	Reduction of the quantity of generated load from point sources	· Regulation on the localization of industries and dwellings★ · Improvement in industrial production process (include recovery of valuable materials)
	Reduction of the quantity of discharge load from point sources	· Establishment of industrial waste water treatment system Big industry: High grade treatment (Chemical treatment plant)● Lagoon● Functional recovery of existing facilities● Small and average industries: Lagoon● · Right maintenance of waste water treatment system belonging to tourist installation● · Establishment of domestic waste water treatment system (urban area) Promotion of sewage work and sewage treatment plant★ Changing infiltration tank to soil absorption treatment system● Introduction of raw sewage collection system by cesspit emptier■ Function improvement of existing sewage treatment plant (San Lorenzo)◆ · Establishment of sludge treatment plant◆
	Reduction of the quantity of generated load from non-point sources	· Planned land use considering water quality conservation★ · Forest conservation (Regulation of deforestation, Forest management)◆ · Forest expansion★ · Prevention of the direct disposal of cattle evacuation into the rivers (Establishment of prohibited grazing zones, Reforestation of the river banks)★ · Prevention of soil erosion in cultivated land (Contour cultivation, Organic soil)★ · Prevention of erosion of residential zones and road (Construction chutes)◆ · Prevention of sediment discharge from quarries (Ditches for sedimentation, Containment wall)◆ · Prevention of river bank erosion◆
Inflowing rivers	Reduction of inflow load in flood time	· Establishment of flood control channel (waters below the Yuquyry)■
	Raise the purification effect in river beds	· Contact oxidation ditch (Rivers within urban zone)■
	Elimination of the accumulated load within river beds	· Elimination of sludge and garbage from river beds (urban zone)●
Within the lake	Reducdtion of load at the mouths of rivers	· Conservation of marshes (Yuquyry and Pirayu downstreams) · Widening of marshes (Pirayu mouth surroundings)★
	Reduction of direct inflow from the coast	· Elimination of garbage from the lake shores● · Conservation of lakeshore vegetation●
	Restrain internal production load	· Elimination of dead algae and dead aquatic plants ●
	Restrain ellution load from bottom materials	· Installation of a sluice at the mouth of Salado River ■

●: to execute as soon as possible ◆: better to execute within two to three years ★: better to execute within five to ten years ■: to judge its applicability after the feasibility study

CHAPTER V

LAND IMPROVEMENT PROJECT TAKING INTO ACCOUNT WATER QUALITY CONSERVATION

5.1 Land Use Planning Requirements

According to Figure S9.51, as for the pollution load amount streaming into the lake (the region including marshes), the non-point sources represent 31% of the COD, 55% of TN, and 70% of TP; moreover, because , the pollution load of generation and discharge vary highly according to the rainfall runoff pattern and the way of land use, appropriate planning for land use in the basin is necessary to reduce the pollution load from the non-point sources.

Presently, there are no concrete plans, neither on the part of the central government nor each district for the proper use of the land in the Ypacarai basin. From the point of view of water quality conservation, the drawing up of such a plan at the earliest possible moment is desirable, however, the informations related to the current land use of the Lake basin, land use demand in future, the grade of living environment desired by inhabitants etc. At present, it is difficult to make a well-grounded land use plan because of lacking those informations. Thus, we just propose a basic concept shown by Fig. S9.52 as an example.

5.2 Basic Land Use Concept of the Lake Basin

(1) Urban Zone

Within the next twenty years, the Lake Ypacarai region will become urbanized, considering its distance from Asuncion, according to real estate agents. National route No.2, heading north from Asuncion, is also in the planning stages, thus the urbanization to Limpio is inevitable. Therefore, on the assumption that these areas will be urbanized, it is urgently necessary to establish basic living facilities in order to ensure the best maintenance of the urban environment, including the quality of its water.

That is to say, it is necessary to take the following points into consideration : road pavement in order to prevent sand and mud runoff accompanied with housing land development, improvement of a drainage channel and small rivers involving the establishment of a settling basin and a regulating reservoir; greenization of the housing land ; regulation of domestic waste water discharge ; establishment of waste disposal facilities : completion of sewerage, etc. Moreover, facing

the factories and the offices implanted in the area the establishment of drainage treatment facilities are required, and it is advisable not to approve the location of new factories which use a large amount of water.

(2) Agricultural Zone

Although there is till abundant cultivation done presently on the hilly areas in the Yuquyry basin, in the future, this should be regarded as an advantage for the so-called high consumption zone of the metropolitan area, in that these areas will answer the inhabitants' demand for fresh, good quality fruits and vegetables. However, in this area, basides the soil being sandy and acidic, thus presenting a low production potential, much of this soil runs off during rains. It is necessary to promote, therefore, an improvement of the soil by the introduction of sludge compost and the prevention of run-off by the establishment of proper constructions. Moreover, with the present situation, it is difficult to grow vegetables in the summer, due to the high temperatures and low rainfall. However, with the improvement in the river water quality, irrigation could be applied, thus presenting the possibility of stable vegetable cultivation.

Regarding the soil enrichment device, the sludge compost dosage and the sediment run-off measures, we think to provide the areas with a drainage channel for agriculture which will include plantings along the contour lines, a settling basin and a regulating reservoir installation. Furthermore, there is no particular problem concerning the agricultural chemical and fertilizer quantity used at the present time ; however, in order to avoid the use of strong agricultural chemicals of residual-prone types in the soil or excessive fertilizers in the future, there must be guidance and supervision.

(3) The Forest Zones

The mountain forests are effective in retaining rain water and in purifying the pollutants in rain water, and riverside forests are effective in the prevention of soil/sand and polluted matter inflow from both banks. Moreover, in the recreation zone vicinity, the existence of a temporary green belt is desirable, from the point of view of scenery and amenity.

Figure S9.52 illustrates clearly the high forest zone, where the goal is protection of water-head forests, the forest line zone, where the goal is for river water quality maintenance, and the green belt, where the goal is for the increase in the value of recreational zones. As stated in 1-1, in the Lake basin, as the decrease in forest zones is remakable, it is desirable to promote the reafforestation, particularly in some of the cultivation and pasture areas. If the afforestation is encouraged, the fact

that wood will appear to be of high value as a fuel resource must be a guarantee.

(4) Pasture Zones

Due to the weakness of the soil and the meagerness of the vegetation, the most effective use for land in the Pirayu basin, henceforth, is as pasturage. However, it is impossible to ignore the animal excretion which flows freely into the lake during rains as a cause of water quality contamination, therefore it is desirable to preserve the present riverside forest, as well as, on the inside of which, to establish a low embankment belt or a planted belt and to prohibit grazing in the vicinity.

(5) Recreation Zones

In the city of San Bernardino, located at the east of the lake, are concentrated, high-class, recreation facilities, such as hotels, clubs, villas and restaurants. However, as the planned facility expansion continues, the foreign tourists will likely be attracted if it were possible to enjoy the natural environment around the Salado River.

On the other hand, Aregua located at the west of the Lake was once the recreation center for the citizens of Asuncion, however, it is wanting in spit now. Aregue is located near Asuncion as well as it has a beach on the lakeshore suitable for bathing and also produces characteristic folkcrafts. Consequently, it is possible that this city will develop as the popular recreation base just differ from San Bernardino in its character.

Furthermore, as historically religious Ypacarai is a locational link for San Bernardino and Aregua and also the center for leather goods production, it presents a hidden possibility for new development as a tourist spot.

Here are thus presented three towns which could be joined as the lakeside recreational zone. However, in order to accompany recreational zone development with water quality conservation, it is necessary, for the water body and lakeside to be designated for public use, to select environmental monitoring specialists, and for the sewage, sewage treatment plant and waste disposal plant as forms of environmental conservation techniques, to establish the necessary basic facilities.

(6) Conservation Zones

As stated in 1.3, the downstream swamp of the Yuquyry River contributes greatly to the removal of pollutants entering the lake. The purification efficacy of the downstream swamp of the Pirayu River is not yet understood as a fixed standard, however it is definite that it plays a

temporary role in the purification of the water. If these swamps were lost,the pollution in the lake would most likely rapidly progress. As for the swamp in the Salado River basin, there is much value in conserving it as a tourist resource, as it offers exceptional view and a spot for bird-watching. Consequently, it is desirable to designate the continuous swamp zone, extending from the Yuquyry downstream to the Salado basin, as a conservation zone and to prohibit any developmental activities which would deteriorate the zone's functions and reduce its natural value.

Other area conservation, particularly the water's edge of the lake and rivers and especially the marshes, requires special consideration. The aquatic plants on the water's edges weaken the strength of the waves breaking on the shore and prevent shore erosion. Also, due to their ability to absorb nutrient salts, they also help to purify the water. Furthermore, the aquatic plants clusters provide breeding places and refuges for the animals living on the water's edge, which is essential to make the biofacies abundant. The sandy beaches themselves primarily have a high capacity to purify water, and provide ground for recreational activities.

Fig. S9.53 illustrates the present status of Ypacarai lakeshore. There are few artificial structures and the natural conditions are well preserved; It is desirable to set up the environmental conservation zone between the recreatonal zone and the Lake and to prohibit the reclamation, construction of vertical revetment and abandonment of waste and filth strictly.

CHAPTER VI

WATER QUALITY CONSERVATION LEGISLATION

6.1 Legislation in Japan

As a reference, the elaboration of legislation over the water quality conservation in Paraguay, existing Japanese legislation will be outlined briefly.

Japanese environmental administration consists of pollution prevention and natural environmental conservation, and the legislative base is Basic Law for Environmental Pollution Control. This legislation defines as pollution that which, due to human activity, infringes on human health and the life environment; for activity, infringes on human health and the life environment; for example: air, water and soil pollution, noise, vibration, ground subsidence and foul odors. This legislation prescribes the items which need to be effected by enterprizer and national and local public bodies (establishment of environmental standards, regulations on pollution discharge and land use, establishment of pollution prevention planning, promotion of pollution prevention operations, training for those in charge of operations provision of an organization for those responsible, relief funds for victims of pollution, working out of complications).

The environmental standards by type of use body of public water body shown in Table S9.32 are shown within this legislation with the additional information that they are based on scientific criteria and that they require frequent revision.

As for the Law, in the beginning existed a prescription to bring into harmony environmental conservation and economic development. Nevertheless, this idea was lost in the struggle to further economic development at the expense of the environment. In a later addendum to this code, the necessity of protecting vegetation and other natural forms of life for environmental conservation was seen.

The concrete content of the various measures to be carried out within the Basic Law for Environmental Pollution Control is prescribed in its individual laws ; an example of one of those laws is the Water Pollution Control Law and it prescribes standards for effluent into public water bodies for factories and enterprises, penal regulations against this and establishment of daily monitoring

duties for effluence qulality which should be carried out by the former contributors. Under this law, it is made clear the necessity for regulations concerning the concentration of the effluence quality at the drainage outlet and concerning the total discharge load amount entering closed water bodies.

Besides this, as a regulation for the conservation of the entire environment including water quality, there is the Environmental Impact Evaluation System. This is aimed at the larger undertakings and is effected and permitted by the government. It includes evaluation and final determination of environmental effects preceding the execution of operations, based on the opinions voiced by citizens, which enables the implementation of regulations in advance.

Before assuring the approval of the execution of large undertaking operations following this regulation, preparation and commencement of an environmental impact statement is carried out which includes evaluation of predictions by the enterprises themselves, explanation to involved residents of the results of the investigation by the enterprises, and the chance for the residents and the chairperson of the municipality to offer contrasting opinions.

It is essential to carry out adequate land use in order to reduce the polluted matters from the non-point sources. Thus, for the promotion of these, there is the City Planning Law and Law for the Conservation of Green Belts around the National Capital Region . As for the districts needing to implement these laws, from the point of view of environmental conservation, instead of especially low evaluation of fixed property taxes, development should be prohibeted and as in the case of the landowner wanting to sell her or his land, the public body should be asked if it wants to buy it.

6.2 The Present Condition and the Problems of the Legislation System in Paraguay

As the Japanese code system shows in the preceding paragraph, it is necessary to make an effective code system in Paraguay in order to proceed in the prevention of water pollution. This is stated in the following: ① to decide on those responsible for monitoring the water quality, to identify the work required to be effectively carried out by those responsible, ② to indicate reliable data on water quality standards in public water areas and also on water quality

standards of drainage, ③ to establish the system of investigation in advance, at a public gathering, of behavior which influences the environment such as the discharge of pollutants, ④ to introduce preferential measures in order to proceed in planned land use and in the establishment of water purification facilities.

According to these points, the present conditions and problems in Paraguay will be shown to be the following.

1) Those responsible for water quality monitoring

The water quality in aquatic areas which are affected by an unspecified number of persons, grows worse generally, unless a public organization takes control of the situation. In Japan, rivers, lakes, ports and the coastal area are regulated as public water areas, and the water quality requires continuous monitoring by the heads of local public bodies. The results are required to be publicized.

On the contrary, in Paraguay, the idea of "public aquatic areas" has not been established yet and those responsible for rivers and lakes are not clearly designated. Although, where facilities exist, people are designated to run them (for example, for ports, it is ANNP who is responsible, for river bridges, it is the Department of Public Enterprise, and each district). However, there is no obligation to control the water quality nor other environments. Therefore, there could be situations in which rivers might be used for personal purposes or might be care lessly contaminated with garbage and polluted matters.

First of all, people responsible for the environment and for work to be undertaken have to be selected for the purpose of conservation of the whole environment, including the water quality in public aquatic areas.

Pollution sources also require people who can perform the function of monitoring the water quality. For factories and offices which discharge at least 50m^3/day, a person to monitor and carry out proper drainage treatment is necessary. What is desired is to establish schools for qualified trainees in the area of drainage treatment performed by the governmental agencies.

2) Establishment of water quality standards

As for the establishment of standards for the lake and inflowing rivers as public aquatic areas, the fundamental concepts are shown in the preceding paragraphs. It is hoped that the standards well be established as soon as possible according to the results of future investigations.

Specific water quality regulations on discharge need to be established, depending on the type of industry, after considering the water quality standards in the public aquatic area and the situation of the discharge of pollutants, as mentioned above. In order to regulate the water quality of drainage, there are two methods: to regulate only the concentration; or to regulate the total amount of the polluted matters discharged. One or both of these methods could be applied depending on the nation and the district. However, for closed type aquatic areas which promote easy accumulation of pollutants as compared to rivers and the sea,it is necessary to apply area wide total pollutant load control, as they would be the most effective.

3) The pre- and post-inspection systems with regard to the behavior of pollutant emission

As for the drainage of pollutants into the aquatic areas, there is the development land use which enhances the drainage from non-point sources and the establishment of factories and offices which increases the drainage from point sources.

In Paraguay, there are no goverment or districtions to regulate the use of land or the establishment of factories and offices. Therefore, in the Lake basin, development is going on at random in the form of the cutting down of forests and creating housing sights, which is unfavorable with regard to water quality conservation.

In a way, with regard to the pollution discharge, items of prohibition were elaborated in 1980, to include hygiene laws. However , the cases where this applicability was accepted, and prohibited pollution discharge loads, are few.

In order to improve this situation, at land development and factory and business locations, a system of advanced investigation and a system

of monitoring the protection of the conditions, from the time of the investigation, are necessary. Furthermore, especially in that which concerns large-scale development, it is necessary that, in advance, assessments are made of the possible effects on the environment and, from these results, that the nation and districts retain the jurisdiction to regulate their consequential development and establishment.

4) Introduction of various preferential items

In order to decrease the amount of drainage of polluted matters from the basins, it is necessary to use the land adequately, and also to establish various facilities for water purification and treatment. It is necessary to consolidate the preferential items concerning taxes and a system for the provision of assistance funds, before obliging factories and offices to construct those facilities, as the construction is costly.

Furthermore, to proceed with the land use plans according to water quality conservation, regulations are necessary; but in order for these regulations to be fully effective, a preferential tax system should be adopted which decreases the taxes of forests and marshlands which effectively purify the water.

CHAPTER VII

DIFFUSION OF THE CONCEPT OF WATER QUALITY CONSERVATION

7.1 Fundamental Outlines of Conservation

A basic thought existing in many countries, which represents the difficulty which lies in general environmental conservation, including water quality, is that "investing in environmental conservation brings an economic growth slowdown, thus, in order to improve the standard of living, the degradation of the environment must be withstood. Which is to say, environmental conservation and economic progress cannot stand side by side".

However, if the economy is raised and the standard of living improved, demand for a pleasurable environment will increase. The irreversibility of damage to the environment is certaomly possible. There are very few countries which have achieved a restoration of the environment after ignoring it for economic gains, without investing a large sum of money. Furthermore, before an improvement in the standard of living, human existence ruins the environment to an unforgivable extent, and in the case of some countries and regions, past land use also resulted in the remarkable degradation of neighboring countries and regions.

In order to avoid this kind of situation, all peoples and users must understand that, by and large, economic development and environmental conservation are not exclusive of one another, but that the environment is a great public resource whose use is not limitless. Finally, it must be understood that it is necessary for all users to contribute efforts to provide for the environment's long-term integrity.

Until recently, in Paraguay all factories and installations discharged their emissions directly into the rivers, causing eutrophication, despite the fact that by the 1970's, water quality in Asuncion's metropolitan area and its environs was frighteningly poor. Rivers had long since lost the ability to clean themselves. Ultimately, accounts have to be made of the mediu - and long-range harm that the city of Asuncion, with its 500,000 inhabitants, will inflict on an international river like the Paraguay.

The concern the people in Paraguay feel for water quality conservation is inadequate. Looking at this from anoter angle the guarantee, up to present, of a favorable water quality environment in this country is admirable; however there is a need to reform the up-to-now "throw it in the river and forget it" way of thinking, and to penetrate every level of the society with the above idea to bear the appropriate expenses and to carry out the maintenance of public property.

7.2 Principal Points of Diffusion by Sectors

The ideas expounded in the previous paragraph must be propagated in many forms and activities, and to many people. The following are the principal points of diffusion by sectors.

1) for Responsibilities of factories and offices

According to paragraph 1.2, 80 to 90% of pollution load discharge from point sources are industrial in origin and the great majority are discharged untreated. A part of discharge load is removed in the marshes, however, this is a serious situation which needs to be improved from the point of view of conserving the marshes themselves.

Although the discharge load from tourism sources is far less than industrial sourcess, they do so directly into the lake. Furthermore, because they depend so heavily on the environment itself, especially the lake, for their own well-being, they must necessarily bear a large part of the burden of keeping it alive.

Consequently, it is necessary to make recognize the followings against the responsibilities of factories and offices: they are the causative persons who make deteriorate the value of environment, that is the common property, and it is their duty to execute some countermeasures to reduce the discharge load as little as possible.

2) for Residents in the Lake basin

The residents along the basin have the duty to conserve the public heritage as a satisfying environment and simultaneously they have the right to use the environment in satisfactory ways. Although it is also important to realize these duties, it is also believed that one of the

reasons large factories are able to drain much foul-smelling waste water near cities is because general residents do not have a clear idea of the infringement on their rights which was explained above. In order to conserve the environment, the polluters must resolve to understand the necessity of regulations and penalties consequent to transgressions against them. The most important thing that remains above all is the insistence on the fact that every citizen must be conscious of her or his right to protect, maintain and thus enjoy the environment. For this to be realized necessitates that explanation of this concept of environmental conservation be diffused to all citizens in an easily understandable fashion.

3) for Public administration

Paraguay has yet to reach the level of environmental destruction that Japan, Europe or the United States has; nevertheless, neither does it pay much attention to conservation strategies. But the problem will continue to encompass a larger scope year after year.

MAG, MSPBS, MIC, MEC, MOPC, STP, the municipalities and other related offices must collaborate in planning and effecting conservation. Technical personnel from other offices must be included also if a specialized task force for administration of the environment is to be erected. Important is that related functionaries understand the significance and characteristics fundamental to the politics of environmental conservation and that they develop a general concern for the environmental problems they face.

4) for Students

Students of all levels have a role, now and in the future, whether as townspeople, functionaries or factory workers in solving environmental problems. Consequently, there should be a conscience raising in the direction of educating these young people and a determination of what themes should be included in the school curriculum concerning local as well as global environmental problems.

7.3 Methods of Diffusion

Taking into consideration methods of diffusion in various countries around the world, the following have been selected as most appropriate to the situation in Paraguay.

1) Distribution of pamphlets

Different editions of the results of this report may be disseminated in schools, public offices, churches, etc., which is the easiest way to begin diffusion.

2) Seminars and conferences

At schools, administrative organizations, churches and army bases, specialists on water quality conservation can somehow talk about the environmental problems , according to the ages and professions of the people. It would be highly effective to use video packages including the conclusion of this investigation.

3) Preparation of special television programs

Although it is difficult, specialized and costly, preparing television programs of this type would be very effective in transmitting the message of conservation and its significance. Perhaps negotiations could be made to obtain the contribution of existing films on this subject from foreign countries.

4) Marking a "Week for the Environment" and manufacturing posters saying the same

In 1972, in order to raise the consciousness of the world's people toward environmental issues, the United Nations established the annual "United Nations Environment Day" every year on June 5. Even in Paraguay on this day, districts deeply concerned with environmental problems hold symposiums, however the concern of the average citizen is still low. Henceforth, centering around this day, a week is hoped to be designated where many activities would be effected in efforts to deepen citizens' concern for environmental conservation.

5) Re-examination of environmental science within the school curriculum

Implementation of environmental science into the school curriculum, judged on a long-term basis, could be said to be the most effective way of deepening interest in environmental problems. In Paraguay, an environmental education curriculum that the Ministry of Education prepared in 1970 was adapted in 1986 to meet the teachers' needs. Presently, according to this curriculum, in history, society and hygiene courses, environmental education is systematically being carried out.

At this point an even more complete, more valuable curriculum on environmental education is desired, which, by involving the students in literally going out and performing the measuring and surveying, would establish an even more effective program. If this could reach point where the students would perform the work on a continual basis, the schools would then be playing a beneficial and essential role in environmental monitoring functions.

6) Establishment of water gardens

It is possible to build a park and recreational fields for the residents in the area where beatiful water is visible after passing through the marshes at the mouth of the Yuquyry. If we can stage expos where scientific and technical information can be obtained concerning water pollution and water purification, it will serve to raise the consciousness of the residents regarding water.

CHAPTER Ⅷ

FORTIFICATION OF THE AGENCIES RELATED TO WATER QUALITY CONSERVATION

8.1 Organization of the Administration of Water Quality Conservation in Different Countries

In 1970, the United States created the Environmental Protection Agency (EPA), charging it with the duty to fight against air and water pollution, abolish agricultural insecticides, radioactivity and other things. This agency is responsible for setting emissions standards and implementing measures against pollution for each state's government. The EPA, which is supported by a huge budget, in turn supports individual states economically in their fight for local conservation. In addition, EPA technical personnel conduct many extensive investigations, to identify environmental assailants.

A Ministry of the Environment in England not only enforces environmental standards, but works toward the policy and planning of land use, authorizes residential constructions, implements water and sewerage services, disposes of waste, and works in the preservation of historical heritage and so on. The Water Management Authority, which is a part of this ministry and establishes water works and sewage works, controls industrial emissions and manages rivers by basin.

In West Germany, environmental protection was administered by the Ministry of the Interior, until many problems appeared including acid rain, contamination of the Rhine River, and the Chernobyl nuclear accident. Now, the Ministry of the Environment, Natural Protection and Nuclear safety is in charge. Also, the Federal Agency of the Environment exists to carry out scientific and technical investigations in order to support the policies of environmental conservation; it also prepares studies and instructions on air, water, waste, ecology and etc.

In France, the Ministry of the Environment, established in 1971, carries out investigation and compiles facts about the environment, and suggests measures against pollution, and for natural protection. Nevertheless, emissions

studies are conducted at individual factories by the Management of Construction or Industry of each region.

In Japan, in the same year as France, 1971, an Environment Agency was established, which makes single recommendations and proposals on basic policies related to pollution (air pollution, water pollution, soil pollution, noise pollution, vibration and ground subsidence, offensive odors) prevention and natural environment preservation, however, water conservation planning for each aquatic area is established by the local public body and measures are effected by each ministry bureau and the local public body.

8.2 Characteristics of the Organization for the Administration of an Environment Desirable for Paraguay

In order to formulate and implement a policy of conservation for a certain body of water, it is necesary to take measures at all stages, including the generation, discharge and introduction into the environment of waste, while considering the natural and socieconomic conditions of the environment. Therefore, it is desirable to create a body which administers and takes measures to protect basins, as England does, through the Water Authority.

To actually make an independent system and attempt to recommend measure operations entails problems: if there are overlapping projects and recommendations for various projects from differing sources, and conflict and contrast in existing governmental organizations, and no adjustment either of the budget or of the functioning of the administration, there will be little ensuing success for the measures.

Accordingly, it is hoped that the environmental administration agency will possess the authority to take the initiative in other administrative agencies' coordination and execution of policies related to this project. This would constitute the support for personnel and budget, by its position within the government.

In Paraguay, there is not yet an integrated agency which manages and sets policies for water quality conservation in the basins. As for administrative agencies closely related to water quality conservation, there is: SENASA, attached to MSPBS, for natural environmental conservation including

observation and guidance on industrial effluence and food sanitation, the carrying out of environmental conservation regarding air, water and soil, technical guidance on domestic sanitation management and the water supply for towns with populations lower than 4,000; CORPOSANA, which carries out sewer and domestic water supply for cities exceeding 4,000 in population; INTN, attached to MIC, which gives developmental guidance for industrial effluence treatment; Asuncion National University, which acts as a scientific research agency; and ANNP, which effects port construction and geological, hydrological and hydraulic research. Furthermore, other agencies closely related to water quality conservation are: MAG, from the aspect of farm soil conservation policies, agricultural chemicals and fertilizer use; MOPC, from the aspect of provision of roads, parks and green areas; and SFN, from the aspect of forest administration. Other than these, STP, from a socioeconomic aspect, makes proposals on policies related to environmental conservation, and MEC, plays a role in the diffusion of water quality conservation concepts.

Presently, the above agencies operate independently from one another. However, in order to fundamentally solve water pollution problems, while securing the cooperation of all the various agencies, it is necessary to create the above-mentioned independent agency, for central functioning and jurisdiction. Therefore, here we propose the establishment of "Lake Ypacarai Basin Management Authority".

This kind of agency, in any country, is directly attached to the government because it is necessary that the jurisdiction is fixed and the funding source be stable. However, only in the case of the Ypacarai water quality conservation policy, due to the existence of private enterprises which could immediately grapple these problems and the funding resources, they could form a foundation which could help in many fields. Moreover, from the point of view of the nature of these problems, as scientific research agency cooperation is indispensable an agency which facilitates participation from university researchers is hoped for. However, in the final stage, the selection of the nature of the agency still lies in the hands of Paraguayan jurisdiction.

8.3 Qualifications for Lake Ypacarai Basin Management Authority

Lake Ypacarai Basin Management Authority will be required to promote the followings: ① continuation of fundamental research, ② diffusion activities,

③ preparation of laws and regulations, ④ implementation of conservation measures, ⑤ development and application of relevant techniques, ⑥ guidance in monitoring for engineers and educational operations, ⑦ monitoring of water quality, ⑧ assurance of sufficient financial and human resources.

The fundamental survey described in ① has been fairly carried out in this project, however, as this only refers to a short period of 1 year, matters remain, such as the insufficient understanding of the actual situation and unsolved problem. ④ is described in detail in Chapter 4, however it is necessary to select those operations of the public sector. Then, ⑥, has as objective to raise the level of the environmental monitoring engineer. The following is a simple detailed description of the content of each of the above items.

① Promotion of basic research necessary for water quality conservation planning

a. Research for the clarification of pollution mechanism and water quality prediction

- study on lake and river water quality and bottom material quality
- observation of basin weather, river flow amount and lake water level
- testing on lake hydrology and pollution factors
- research on water quality prediction techniques

b. Research on the relationship between water quality and health and water use obstacles

- study on health hazards for those who use the lake and rivers
- data collection on the relationship between toxins and health hazards
- study on the relationship between lake water quality and purification plan filtration obstacles
- analysis of lake water quality and purification costs

c. Research on actual possibility of treatment/purification techniques

- study on the condition of production process and discharge treatment at factories and offices

- study on the condition of production activities and management at factories and offices
- selection of the most appropirate domestic waste water treatment methods per urban area
- investigation on the problems in the establishment of a flood control channel in the Yuquyry
- investigation on the problems in the establishment of a contact oxidation canal
- invetigation on the problems and testing of the establishment of a water gate at the egress to the Salado River

d. Establishment of land use planning

- study of actual conditions of land value and ownership
- study on land use demands
- verification of conservation areas

e. Establishment of water quality standards

- reinvestigation of public water body tentative water quality standards
- establishment of waste water standards

f. Cost benefit analysis for water quality conservation measures

- estimation of costs necessary for measures in each type of area
- economic evaluation on estimated exterior effects

② Promotion of diffusion activities

- preparation and distribution of pamphlets
- holding of lectures and research seminars
- preparation of special T.V. program
- reinvestigation of educational curriculum of environmental science
- establishment of a water garden

③ Formation of legislation and regulations

a. Legislation or public water body water quality maintenance and improvement

- verification of public water bodies
- verification of environmental monitoring systems
- verification of water quality standards and monitoring systems

b. Legislation on discharge control of pollutant

- investigation on waste water monitoring duties for factories and offices

- investigation on regulations on waste water standards and monitoring

c. Legislation on land use control

- investigation on pre- and post-inspection
- investigation on environmental impact assessment system

d. Regulations on taxes and assistance funds

- assistance funds and tax regulations on the establishment of waste water treatment facilities
- tax regulations on special land use

④ Promotion of water quality conservation measure opeations

- arrangement for sewage works and sewage treatment facilities
- arrangement for sludge and waste disposal plants
- arrangement for river (riverside forestry work, construction of revetment against erosion)
- treatment of river course polluted mud and garbage collection
- treatment of lakeside garbage and filth collection
- removal of dead algae and water grass in lake (around Salado mouth)

⑤ Promotion of development and guidance in water treatment/ purification techniques

- development and guidance for lagoon capacity techniques
- development and guidance for soil absorption treatment capacity techniques
- development of sludge compost techniques