At present the construction period of only about three years being likeliest, the second alternatives should be taken for the relocation, because it will be much time due to unexpected trouble in some cases for the related inhabitants to relocate even at the same time.

4.4 Public Health and Nutrition

Birth rate in Chachoengsao in 1990 of 13.35 per 1,000 is less than the previous year's. Death rate of the same year was 4.48 per 1,000 resulting in net growth rate of 8.8 per 1,000 while the previous year (1989) had net growth rate of 9.4 per 1,000.

Eminent endemic sickness/diseases are diarrhea, dysentery and food poisoning which are quite typical for coastal provinces. Poor environmental conditions favourable to diarrhea are as follows:-

(1) About 99 percent of surveyed population use rainwater for drinking, while 5 percent still have unsanitary water collection system.

(2) Only 26 percent of surveyed population have rainwater available all the year round.

(3) Domestic water comes from wells or canals without pretreatment as much as 99 percent.

(4) About 63 percent of surveyed population have fairly clean domestic water and only 28 percent have clean water.

(5) About 53 percent of surveyed population do not have garbage receptors while about 14 percent dispose of solid waste scatteringly on the ground. About 87 percent of the population burn garbage by themselves.

Diarrhea spreads in both dry and wet seasons, in dry season due to insufficient drinking/domestic water and in wet season due to extensive spreading of infectious germs along with water to those people who never treat their water before consumption. Such infection among children younger than 5 years old normally lasts long without correct medical treatment. It should be mentioned that in 1990 cholera infection occurred in

Chachoengsao originally as Vibrio-cholera Inaba and finally as V. C. Ogawa. This infectious disease spread acutely among construction workers generally living in poor environment in the Municipality of Amphoe Muang, Amphoe Ban Pho and Amphoe Bang Pakong. The spreading stopped in March but few cases were still reported many months thereafter.

Dengue haemorrhagic fever transmitted by mosquito Aedes aegypty generally occurred in Chachoengsao every other year. The disease became highly prevalent in the vicinity of damsite in 1989 especially in Amphoe Ban Pho, Amphoe Bang Pakong, Bang Khla and Amphoe Muang. This disease occurred again in 1990 and being continuously prevalent even after rainy season. This means that the mosquito A. aegyti can be culturing well in clean water all the year-round not limited only in rainy season. This conclusion matches well with the survey on sanitation in 1990 which found that only 41 percent of surveyed households had proper covering lids for rain-water jars.

Another infections disease transmitted by mosquito-culex is Japanese B. Encephalitis (JE.). This kind of mosquito transmits the infections virus from livestock to human beings. Even though the infection is quite low in Chachoengsao at present, the tendency of prevalence may increase in the future because of large number of pig farms in the province. Besides, the existing moving currents along canals and rivers as well as brackish water type are not quite favourable to this mosquito-culex.

Malaria transmitted by mosquito-Anopheles generally occurs in July to November. Most malarial patients are found coming from dense forest area in Amphoe Sanamchaiket. It should be emphasized that prevalence rate of malaria in the vicinity of damsite is not high but never becomes reduced and it is still considered as endemic disease.

Even though Opisthorchiasis has never been reported in Chachoengsao, it may become prevalent in future because surveyed population in five amphoes in the vicinity of damsite have habit of eating raw preserved fish which are intermediate host for liver fluke worms. In addition, the habit of defecation in the paddy fields may probably cause transmission of this disease during rice cultivation.

The EIA Report has concluded about impacts possibly occurring after the dam impoundment that sufficient availability of fresh water will be able to reduce prevalence rate of cholera and malaria. However, stagnant water in the impounding area which is the preferable growing condition for mosquito-culex may result in increased prevalence of Japanese Encephalitis. Also, more availability of fresh water is expected to enhance industrialization in the province, which may cause immigration of Northeastern workforces who carry liver fluke worms with them. Thus, higher prevalence of opisthorchiasis is likely to occur after the dam is operated.

In the area upstream of the diversion dam, factories location will be planned to be limited even in the future as water quality special conservation area. Therefore, there will be no inflow of laborers from the Northeast Region.

4.5 Recreation and Aesthetics

The EIA study team made a survey at the damsite and concluded that the damsite has never been developed for tourism. Tourist attractive spots are located in Amphoe Muang Chachoengsao, most of which are religious or historic places. The natural scenery of the Bang Pakong river is also attractive to some tourists, therefore, there are boat trip services along the river offered to interested tourists.

Some service business owners at the vicinity of damsite expected that the dam may be attractive to some tourists. Tourists also gave an interview that they want to visit the dam. Most of them want to see beautiful scenery. If the place is developed for tourism, other facilities may have to be provided, e.g. garden/park, toilets, restaurants, fishing area, security guards, etc. The upstream impounded basin will have stagnant water, therefore, it can be developed for water sports such as boat touring, water-skiing, fishing, etc. Upstream land area may become attractive to some investors to develop the place for tourism. However, green scenery along the river bank has to be reserved. In addition, pollution control must be very stringent for these places, otherwise, they may become pollution sources discharging waste into the impounded water.

CHAPTER 2. CONSIDERATION ON ENVIRONMENTAL MONITORING PROGRAM

The EIA Report has proposed monitoring program for eight environmental aspects, surface water quality, erosion and sedimentation, aquatic ecology and fishery, forestry, quality of water supply and land use.

Relevant monitoring program under RID's responsibility seems to be related to surface water quality, erosion and sedimentation and aquatic ecology and fishery. The remaining subjects will be responsible for by other government offices.

1. Surface Water Quality Monitoring

1.1 During construction

The EIA Report did not suggest to have monitoring during construction. However, monitoring of suspended solids of the supernatant flowing from the sediment holding basin is considered important.

Location	:	Supernatant flowing out of the sediment holding basin before discharging into the river
Parameter	:	Suspended solids
Frequency	:	Once every day during dredging of both ending joints of diversion canals to the river course
Remark	:	If SS in the supernatant exceeds 500 mg/l, mitigation has to be immediately applied such as increasing height of bund wall surrounding the sediment holding basin or increasing number of sediment holding basins so as to lengthen the sediment retention period.

1.2 During operation

The EIA Report proposed 11 monitoring stations in the Bang Pakong river and its tributaries. However, only six of them seem to be relevant to this diversion dam project and worth for monitoring. Altogether 25 parameters are suggested and considered suitable.

Monitoring program for surface water quality can be summarized as follows:-(See Fig. 4-2-1)

(1) Band Pakong river, upstream of Amphoe Bang Khla
(2) Bang Pakong river, upstream of damsite

(3) Bang Pakong river, downstream of Amphoe Muang in front of Wat Sothorn

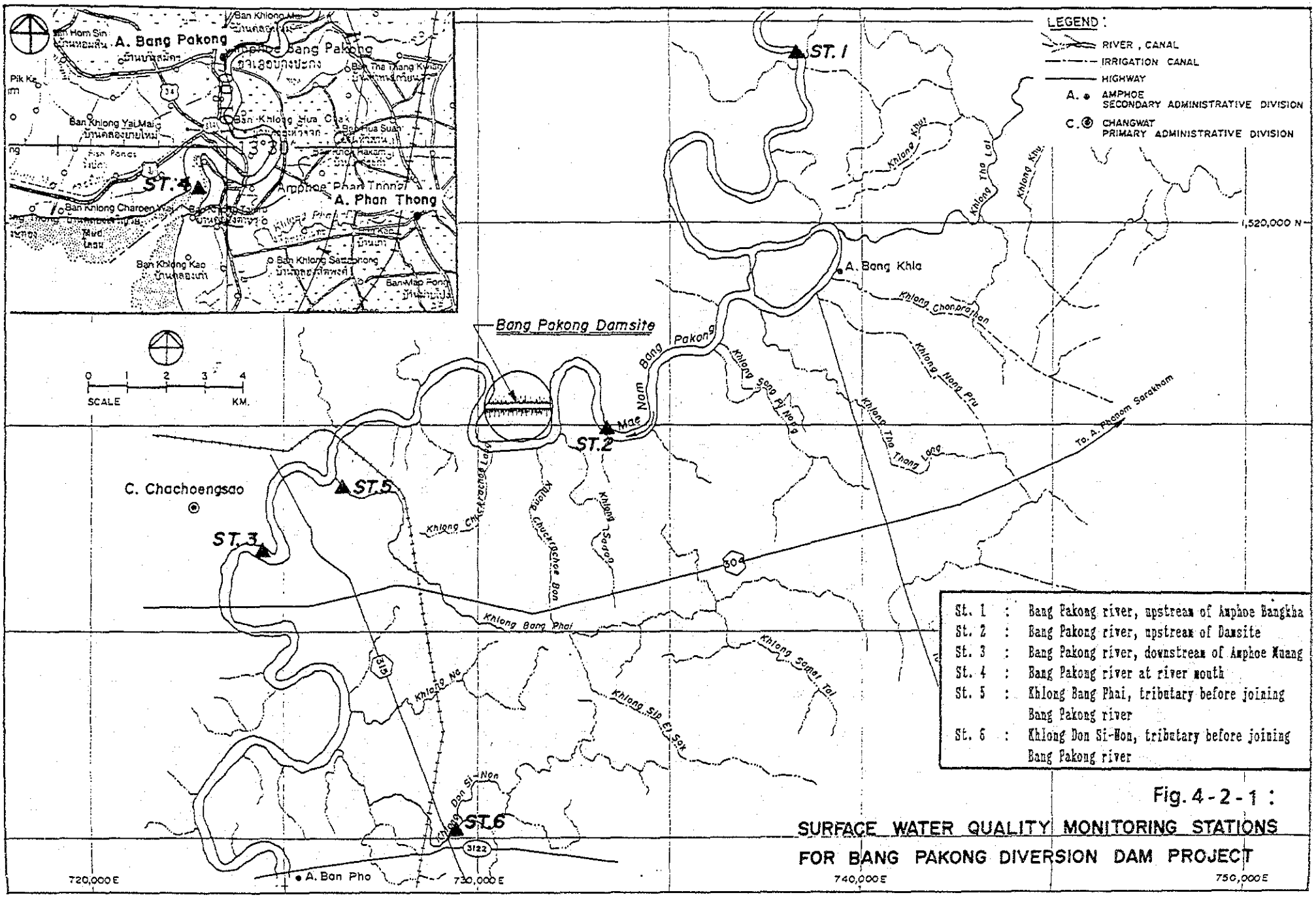
(4) Bang Pakong river at river mouth

(5) Khlong Bang Phai tributary before joining Bang Pakong river

(6) Khlong Don Si-Non tributary before joining Bang Pakong river

Station No. 1-4 are aimed at monitoring the changing of water quality in the Bang Pakong river after the dam is operating. Especially station No. 4 will be able to point out accumulation of pollutants discharged from downstream factories. Stations No. 4 and No. 5 are tributaries receiving runoff from the left bank irrigable area and discharging it into the downstream river course. Water quality in these tributaries may improve or even become worse depending on whether there is changing of agricultural activity in the vicinity or not.

Sampling depths and sampling time	:	Mid depth sampling is recommended for all parameter except coliforms at surface level. Sampling should be made during low tide for stations located in the downstream river course, i.e. stations No. 3 and No. 4.
Parameters	:	25 parameters including temperature, pH, salinity, turbidity, SS, electrical conductivity, DD, BOD, alkalinity, hardness, ammonia, nitrate, phosphate, fecal coliforms, total coliforms, SAR, fluoride, cyanide, iron, nickel, Manganese , lead, mercury, chromium and cadmium.
Frequency	:	Three times per year in April, September and December. After the first three years of



St. 1	:	Bang Pakong river, upstream of Amphoe Bangkha
St. 2	:	Bang Pakong river, upstream of Damsite
St. 3	:	Bang Pakong river, downstream of Amphoe Muang
St. 4	:	Bang Pakong river at river mouth
St. 5	:	Khlong Bang Phai, tributary before joining Bang Pakong river
St. 6	:	Khlong Don Si-Non, tributary before joining Bang Pakong river

Fig. 4-2-1 :
SURFACE WATER QUALITY MONITORING STATIONS
FOR BANG PAKONG DIVERSION DAM PROJECT

impoundment, all recorded data should be evaluated to identify impacts due to the diversion dam on water quality such that mitigative measures and monitoring program can be adjusted immediately. Comparison of surveyed data with those investigated by other government agencies should also be conducted. For example, if any of heavy metals is not detectable throughout the monitoring period, monitoring in the following years can be neglected.

2. Erosion and Sedimentation

2.1 Monitoring of suspended solids (SS)

Location : 5 stations (See Figure 4-2-2)

(1) Ban Pan just downstream form the confluence of Nakhon Nayok and Prachinburi rivers.
(2) Ban Leam Sai about 10 km downstream from station 1.
(3) Ban Klauy about 10 km downstream from station 2.
(4) At Amphoe Bang Khla.
(5) At damsite in the upstream impoundment.

Parameter : Suspended solids

Frequency : Once every month in dry season during the first two years after the dam starts operating.

2.2 Monitoring of sedimentation along the river banks

This can be achieved by erecting scales to detect sedimentation at the inner concave meandering and straight river portion close to above five stations proposed for monitoring of SS. Detection should be made monthly continued for at least 5 years after impoundment.

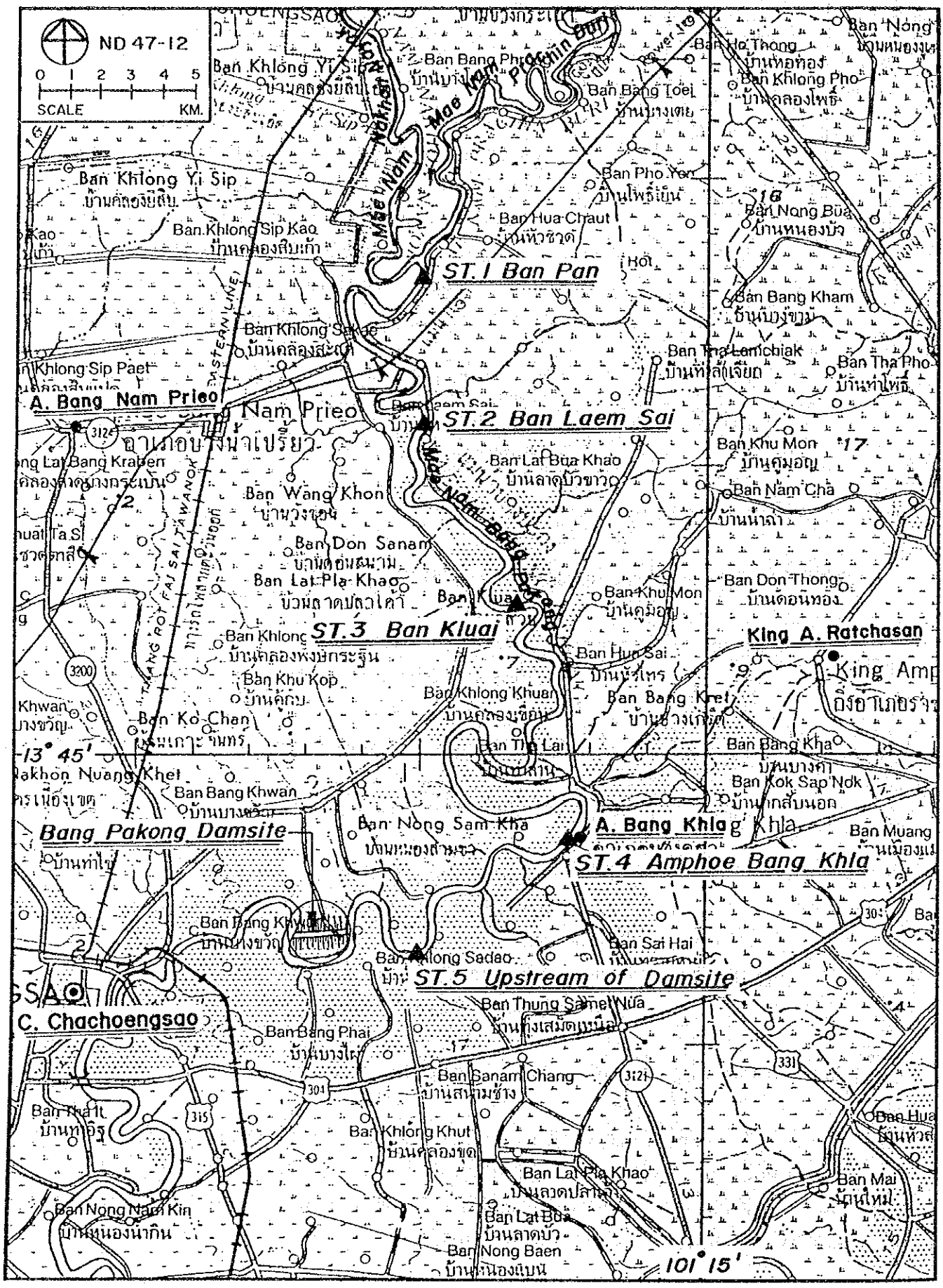


Fig. 4-2-2 : MONITORING STATIONS OF SUSPENDED SOLID

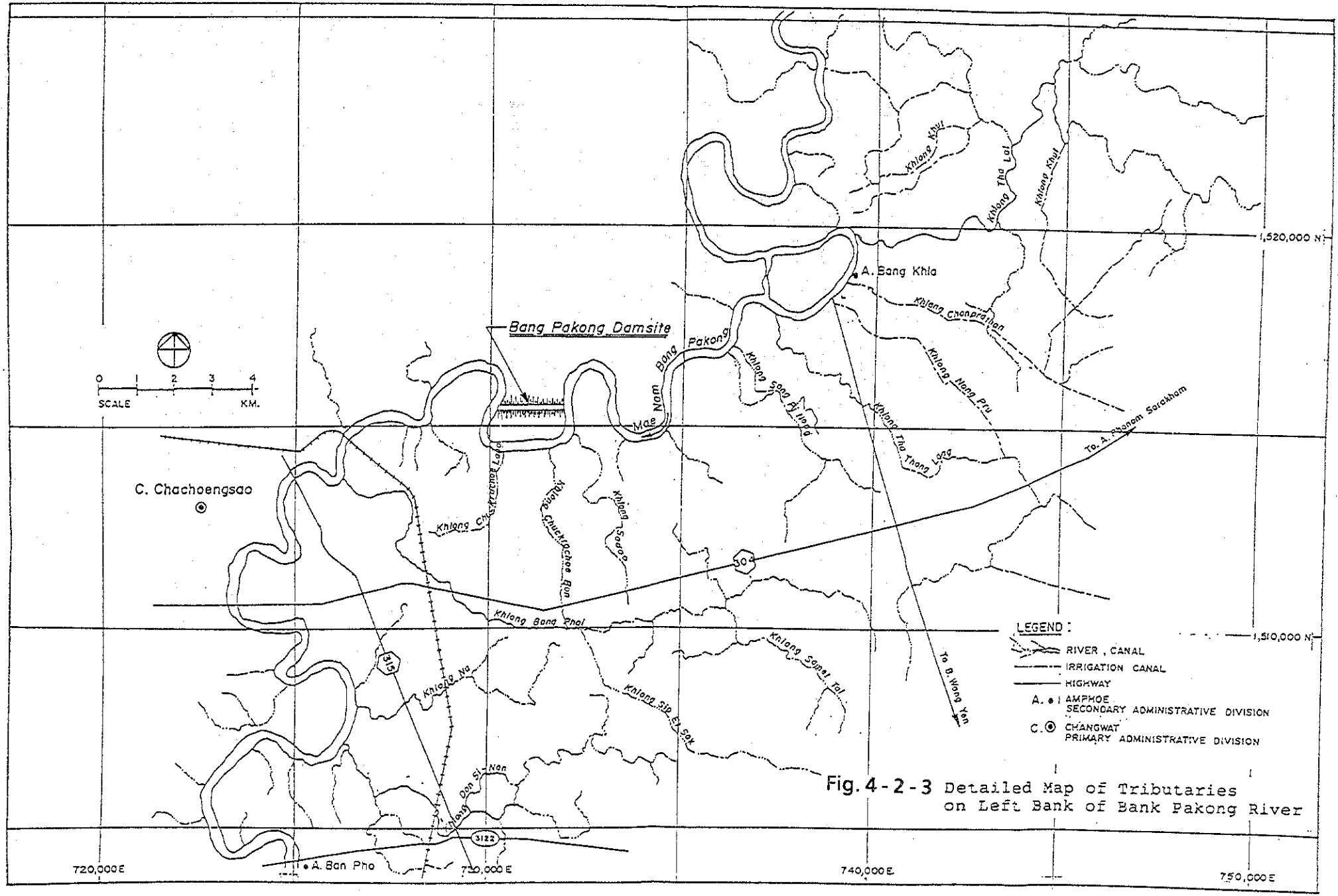


Fig. 4-2-3 Detailed Map of Tributaries on Left Bank of Bank Pakong River

2.3 Monitoring of river bank erosion

Ten locations of non-eroded river bank (outer concaved meandering) should be marked up starting at damsite up to Ban Pan and monthly checking should be made for 2 years after impoundment.

3. Aquatic Ecology and fishery

3.1 Planktons and benthos

Location : At 2 locations, e.e. stations No. 2 and No. 3 as designated for water quality monitoring which are:-
1) Bang Pakong river, upstream of damsite.
2) Bang Pakong river, downstream of Amphoe Muang in front of Wat Sothorn.

Parameters : Type, density and composition of:-
1) Planktons.
2) Benthos.

Frequency : Three times per year concurrently with water quality monitoring, i.e. in April, September and December. Post evaluation should be made after three year monitoring for further adjustment of mitigative and monitoring programs. Comparison of mitigative and monitoring programs. Comparison of RID data with investigation results by other government agencies is also recommended.

3.2 Aquatic plants

Location : Along upstream and downstream river course.

Parameters : type and density of aquatic plants.

Frequency : Three times per year concurrently with water quality monitoring. Post evaluation after 3-year investigation is recommended.

3.3. Fishery

Type and quantity of fish should be recorded by collecting data from existing fishing equipment available in the Bang Pakong river. Locations for collection of such data are recommended as follows:-

Location : Four stations:-
1) Upstream at Amphoe Ban Sang in Prachinburi province.
2) Upstream impoundment.
3) Downstream close to damsite.
4) Downstream at the river mouth, where there is push net.

Frequency : Once every year.

The monitoring programs in 5 other environmental aspects under the other governmental bodies' responsibilities than 3 aspects under RID's responsibility, which must be included in the EIA report, could not be collected this time. After receiving and reviewing them, a summary of the environmental impact monitoring program will be compiled in the final detailed design report.

4. Forestry and Wildlife

After the project completion, newly planted mangrove forest strips 20m wide along the downstream diversion canal banks and along the downstream Bang Pakong river banks should be monitored once a month for three years.

Suitable kinds of trees such as bamboo, brushwood, etc. should be planted along the upstream diversion canal to protect both the banks from erosion.

There is no problem on wildlife.

5. Land and Water Transportation

Connecting roads, a connecting bridge, extension roads across the closure dam and the entrance road No.3 will enhance a convenience of road transport between the left and right banks of Bang Pakong river.

After the project completion, the daily traffic should be observed once a month for three years for grasping the condition under which the roads and the bridge are used.

As for water transportation, small passenger boats which are at present the only water transport means along the Bang Pakong river will not be able to travel through the diversion upstream and downstream of the closure damsite.

After the project completion, daily small passenger boat operation condition (frequency, boat type, number of passengers, etc.) should be observed at the jetties once a month for three years.

6. Land Use and Agriculture

(1) The land of the left bank of the Bang Pakong river should be monitored at the same time as the commencement of irrigation water supply and repeated to be monitored every five years, for grasping the land use feature variation.

(2) For strong acid soil zone in the irrigation area on the left bank, land use investigation should be carried out just after the commencement of irrigation supply, and the monitoring be repeated in a dry season every five years.

(3) For salty soil zone in the lower irrigation area on the left bank, monitoring of the condition for agricultural production should be started just after irrigation water supply, and repeated in a dry and wet seasons every five years.

7. Socio-economy (Land Expropriation and Evacuation, etc.)

Movement of population, work force distribution in the benefited area should be investigated once a year after the project implementation.

Also the agricultural land area, the agro-production and the production value should be investigated once a year after the project implementation.

8. Public Health and Nutrition

The numbers of monthly outbreaks of sorts of diseases (Acute diarrhea, Vibrio-cholera, Dengue haemorrhagic fever, Malaria, Opisthorchiasis, Japanese Encephalitis, etc.) should be monitored continuously after the project implementation for grasping the outbreak tendency. In case the outbreaks remarkably increase, the countermeasures should be made at once by the specialists.

(Note) Sorry to say, since the monitoring program of items 4 - 8 in English in the EIA report could not be collected this time, they were presumed from the environmental impact mitigative measures in English collected from the report.

CHAPTER 3 SURVEY RESULT OF ENVIRONMENTAL CONSIDERATION (WATER QUALITY)

The final eia report had neither yet been completed by Kasetsart University at the commencement of the phase I field work for this detailed design study in October 1992, nor at the end of the phase II field work in March 1993. (The final report in Thai was sent to JICA main office in June 1993.)

At the stage of getting the draft final report in English, since it was judged that the contents were imperfect for making out the mitigative measures and monitoring program especially for water quality, the JICA Study Team carried out water quality analyses in cooperation with the Chemical Analysis Section, Research and Laboratory Division, RID, situated in Pakkred in surverbs of Bangkok.

1. Surveying Method

1.1 Fundamental way of thinking

There is very little data of water analyses in the catchment area of the diversion damsite on the Bang Pakong river. In particular, how saline water intrusion occurs, that is, how sea water reaches upstream cannot be grasped from the previous survey results of the Ministry of Science, Technology and Environment (MOSTE) and Kasetsart University, though it is regarded as very important.

The newer surveys and analyses of river water in the range which influences diversion dam construction were therefore carried out.

Next, the surveys on pig raising farms which had been regarded as the largest pollutant, fish ponds, factory sewages and a factory treating plating sewage were made. On the surveys, data which had not yet been publicized were eagerly collected, in spite of the complicated jurisdiction of water quality control in Thailand. These surveys were made not only in the catchment area of the Bang Pakong river but also out of the area for grasping existing condition of the factory sewages.

Ground water was surveyed using existing wells, not by newer boring tests.

1.2 Survey spots and times

Fig. 4-3-1 shows the sketch of water sampling spots in the main river and tributaries of the Bang Pakong river. The surveys were made once in the tributaries from November 1992 till June 1993, and once a month in the main river from November 1992 till April 1993 and twice a month in June 1993. In the main river, the surveys were carried out at the surface and bottom layers according to the circumstances.

The sewages flowing into the Bang Pakong river were surveyed once each at the phase I and phase II field work times, both upstream and downstream of the diversion damsite.

The ground water were surveyed in the same way.

The facilities for treating injurious substance in Bangkok Metropolitan Circle were inspected, because no facilities was found in the catchment area.

1.3 Surveying items and analyzing method

(Refer to appendix)

2. Summary of Survey Results

(The details are shown on Appendix.)

2.1 River water quality

(1) Salinity

The analysed results of chlorine ion concentrations in December 1992, in January, March, and June 1993, are indicated on Fig. 4-3-2. As shown on the Fig. the saline water intrusion into the upper reaches of the river shows very regular pattern according to the distances from the estuary and the months when the samples were taken.

The chlorine ion concentrations on January 12, 1993 show a tendency of approximately linear reduction in the section from Chachoengsao Bridge (R1) upto Amphoe Bang Khla (R6).

The expression will be,

$y = -250x + 4,000$

where, y: C1 - concentration (mg/l)
x: Distance from R1 (km)

Similarly, the expression on March 9, 1993, will be,

$y = -130x + 13,500$

Also, the expression on June 8, 1993 will be

$y = -230x + 8,000$

It is assumed that the saline water intrusion nearly ceases on June 22, 1993. Accordingly, the expression will be,

$y = 300 - 500$, showing nearly a holizontal line.

Taking y as C1- concentration in sea water, the spot x will correspond nearly to the estuary. Besides, C1- concentrations of surface layers are not different from those of bottom layers at all the sampling spots. In some cases, the C1- concentration of surface layer is rather higher than that of bottom layer.

Judging from this fact in the Bang Pakong river, vertical intensive mixing of river water is acted by tidal movement, and saline water intrusion is advanced according to the river discharge reduction.

The difference of salinity at the uppermost spot (R6) from that at the lowest spot (R1) in the surveying range in March 1993 was about 60 percent of the difference in January 1993, because the salinity was raised up even at the uppermost spot (R6). The difference of salinity between them at the beginning of June 1993 just after a rainy season started, was almost the same as that in January 1993. It is not the same, however, that the salinity of the bottom layer is a little higher than that of the surface layer. As a result, it is recognized that the salinity gradient in time of saline water

intrusion is kept upto the upper reaches as it is, and saline water, after that, flows down regularly in laminar flow type.

Fig. 4-3-3 shows a variation of saline water intrusion with the lapse of time.

Fig. 4-3-4 shows a variation of saline water flowing down with the lapse of time.

The decisive difference between them, is that C1- concentration is raised up zero degree-logarithmically in the former case, but C1- concentration is lowered first degree-logarithmically in the latter case.

Within the range of the survey in a dry season, salinity rise by sea water intrusion results from river discharge reduction at the upper reaches.

On the other hand, salinity drop results from river discharge enlargement and diverting water amount at the upper reaches.

(2) Relation between salinity and electric conductivity

The salinity is one of the most important monitoring items. It will take much time and expenses for habitual analyses requiring high technic. In order to examine conveniently analysing way, the relation between C1- concentration and electric conductivity was studied using the instrument given by JICA.

Since C1- concentration widely ranges from 20 to 14,000 mg/l, the data less than 600 mg/l as allowable range for drinking water was summarized and shown on Fig. 4-3-5~1 as lower concentration part and on Fig. 4-3-5~2 as higher concentration part.

Judging from the Figures, C1- concentration and electric conductivity of this river water are evidently correlative.

In case of lower concentration,

Cl^- (mg/l) = 0.3 EC (μmho/cm) - 60

In case of lower concentration,

Cl^- (mg/l) = 0.34 EC (μmho/cm) - 780

(3) Turbidity

The turbidity of the river concerned is fairly high through the year. In a dry season, the turbidity of surface layer is temporarily lowered by co-agulating reaction due to sea water intrusion. The turbidity of the bottom layer is extremely high, however, not accompanied by organic pollution, but caused by inorganic matters.

According to the hearing survey from the farmers at the pumping station site, taking water is topped every year in time when turbidity is lowered, that is transparency is raised up.

After a dry season is over, that is, in time when transparency is lowered on the contrary, taking water is resumed. this face completely coincides with the pattern of the said sea water intrusion.

As a result of the survey conducted by JICA Study Team, it is found that the transparency at the limit is clearly increase, in case the limit of Cl^- concentration for drinking water is about 1,000 mg/l. The period will be from the middle of January till the middle of June. This period nearly coincides with the one judged by the farmers. The judgment that pollution progresses by reason of much turbid material, is not appropriate only in case of this river.

(4) Other water quality factors

In short, decisive polluting phenomenon cannot be found except for the above-mentioned salinity effect. Just after a dry season, river water detained at the upper reaches was not deteriorated by salinity, but seems to be rather somewhat less polluted.

2.2 Ground water quality

The five deep wells 70 to 114 m in depth in the area concerned were investigated. As a result, all the wells are not suitable for drinking because of chlorine ion or dissolved heavy metals, etc..

2.3 Sewage from pig raising farms

It was judged that under the existing condition, there is no particular problems at all.

2.4 Chicken raising farms and fish ponds

It was judged that there are no problems on sewage in the chicken raising farms and fish ponds.

2.5 Sewage from factories

The sewage from factories and the drainage from sewage disposal facilities surveyed by JICA Study Team exceeded the upper limit of the water quality standard values except a semi-official and private whisky factory. Although water analysis has not yet been carried out, great cares should be taken especially on injurious sewage disposal.

CHAPTER 4 ENVIRONMENTAL IMPACT MITIGATIVE MEASURES

As the results of EIA studies by RID and the JICA Study Team, the environmental impact mitigative measures are proposed as follows:

(1) All the catchment area of the Bang Pakong diversion dam should be designated as water source conservation area by the National Environmental Board (NEB). Consequently, RID has a right for water quality conservation as well as water utilization to contribute to environmental impact mitigation.

* As easily found out by observing the Chao Praya river and the canals in the Bangkok Metropolitan Circle, no function to force the people follow the standard is possessed by NEB, though the water quality standard has already been established at present. This proposal was made considering the existing condition in Thailand, since the development is entirely contrary to the environment conservation.

(2) For the enterprise discharges in the designated area, the Research and Laboratory Division, RID should have rights to make water quality analysis like MOI and to give an order of improvement, if a problem exists, and to let MOI order shutdown of operation, if no improvement is done.

* The ability of water quality analysis in Thailand is no enough humanly and materially. MOI having many rights, such as permission of factory construction, approval and inspection of drainage facilities, etc. it seems to be difficult to supervise environment conservation only in this designated area, the RID's function of water quality analysis, the best and largest in Thailand, in intended to be exercised.

(3) In order to reconfirm the hydrological influence of the Bang Pakong river (influence of river water level upon both the banks) after completion of the project, a hydraulic analysis should be applied. Using the results, embankment for preventing overflow will be re-examined and reconfirmed.

* In ETA report, embankments of 13 km on the left bank at the upper reaches and 15 km on the left bank at the lower reaches of the Bang Pakong

diversion dam are proposed. Particularly, the river water level at the lower reaches in a dry season should be examined.

(4) Livestock discharges should be controlled by MOAC and sewage sumps set-up be promoted. For newer pig raising farmers, oxidization pond construction, before pig raising starts, and removal of dry feces in a dry season should be conducted by themselves under the guidance of MOAC.

* As a result of the study by JICA Study Team, there is no problem on pig raising farm discharges at present.

The condition, however, will be changed, if water is taken from the Bang Pakong river even in a dry season, after completion of the project. This item is therefore propose, considering that MOAC has not controlled livestock discharge at all so far.

(5) For ordinary sewage in urban areas of Chachoengsao City and Bang Khla District, a simple sewerage works should be applied. As the works, simple lagoons (ponds) will be all right.

(6) The jetties should be constructed as landing sites at both the upper reaches and the lower reaches of the diversion damsite for securing the navigation.

CHAPTER 5 WATER QUALITY ENVIRONMENT IMPACT MONITORING PROGRAM AND ITS EXECUTION

Even though NEB designates this area concerned as water source conservation area, the Pollution Control Department (RCD) in the Ministry of Science, Technology and Environment (MOSTE) has had insufficient staff members in the existing water quality analysis system, and MOI will not be able to make factory discharges inspection.

The staff members in the Research and Laboratory Division, RID, will be more excellent than the ones in PCD and MOI. Accordingly, the water quality analysis for the project concerned should be made mainly by RID without relying upon the others. For the purpose, the instrument and the equipment as shown Table 7 should be newly provided in the Research and Laboratory Department, RID.

1. Monitoring Items

1.1 Ordinary monitoring for river water

The monitoring will be carried out at such three sampling points as R1, R2, and Rx shown on Fig. 4-3-1. The frequency and items are shown below.

The samplings will be carried out on the first Tuesday on October, January, April and July in a year.

The samplings will be made from the river water in surface and bottom layers. The following analyses will be made for six samples at the time of sampling, (water temperature, pH, electric conductivity, transparency and dissolved oxygen), judging from the existing technical and financial problems.

The following analyses in the laboratory will be made for the test samples mixed equal amount of water in surface layer with that in bottom layer, just after they are taken back to the Research and Laboratory Division, RID, according to the regulated water quality standard items and

environmental standard items for drinking water in Thailand, due to be established in the near future.

1.2 Monitoring for diversion dam control

The salinity intrusion will be monitored measuring water temperature, pH and electric conductivity at the jetty of the sampling point R1 shown on Fig. 4-3-1, every Tuesday from the beginning of a dry season until the time when the diversion dam gates are completely closed.C1- concentration will be calculated with the following expression.

In case of lower concentration,

$$Cl^-\ (mg/l) = 0.30\ EC - 60$$

In case of lower concentration,

$$Cl^-\ (mg/l) = 0.34\ EC - 780$$

where, EC: Electric conductivity (micro Siemens/cm) (μmho/cm)

This salinity is connected with the central control room to be indicated on the graphic panel. The values observed with salinity monitoring devices installed at the side of each water level meter on the left bank, will be used as the salinities just upstream and downstream of the diversion dam.

1.3 Monitoring for enterprise discharges

For the enterprise discharges in the catchment area, all the factories discharging sewage should be listed up and the water quality inspection be carried out once a year. The list concerned should be made out by the time of the diversion dam completion, upon deliberation with MOI.

The inspecting items are determined according to MOI's criteria. The factories with anxieties to discharge heavy metals, however, should be monitored carefully in particular.

Considering the existing condition of water quality monitoring in Thailand mentioned above, MOSTE, MOI and local consultants seem to have no capability of water sampling and water quality monitoring either, although RID has a capability of water quality analysis. Accordingly a support by Japanese consultants on hygienic engineering, whose country has advance countermeasures against public nuisance will be needed continuously, until the diversion dam is completed.

2. Environmental Consideration during construction Works

Basically the Japanese Study Team will agree to take into account the environment during construction works, following the Thai national ordinance and the recommendation in EIA report by Kasetsart University. They, however, will propose the newer recommendations based on their water analyses and fieldworks as follows:

All the spoil excavated from the diversion canal site should be filled into the existing old river course to be left after the diversion canal completion, that is, the section about 5km long between upper and lower reaches of the closure dam to be built, from the river bottom about 9m in water depth upto 3m in water depth. (for preventing river water from being polluted by stagnation.) The reason is as follows:

Due to the shallow river water depth of 3m, solar beams can easily reach down to the river bottom, water temperature is raised up, and oxygen is enough dissolved into water from the waters surface by waves made by winds and boats, and tidal movement. It will form good environment suitable for aquatic plants such as green algae which release oxygen by photo synthesis into the water in daytime. Under such circumstances, the river course will not be polluted but rather eventually purified. From a viewpoint of construction plan, (spoil banking plan and provision of spoil banking place), it was found out that overall practical use of the old river course was the best means ,too.

3. Technology Transfer on Environment of Water Quality

(1) Usage of instrument and equipment for water quality analysis donated by JICA, especially problems on measuring method of COD in

Thailand and examination of usability for COD meter donated by JICA were guided to the staff members in the Research and Laboratory Division, RID.

(2) Water sampling method

A new water sampler of better performance than that on the market was completed improving that by way of trial in the RID factory. The practical water sampling method was guided to them using this water sampler.

(3) Problems on BOD measurement

The RID's measurement requires a period of 5 days at 20 degree centigrade. These conditions are from JIS and ASTM standards. In Thailand, however, there have bee seldom surface river water at 20 degree centigrade. There were no surface river water at 20 degree centigrade for this time studying period. The research on establishing an analysing method under newer condition was therefore guided to them.

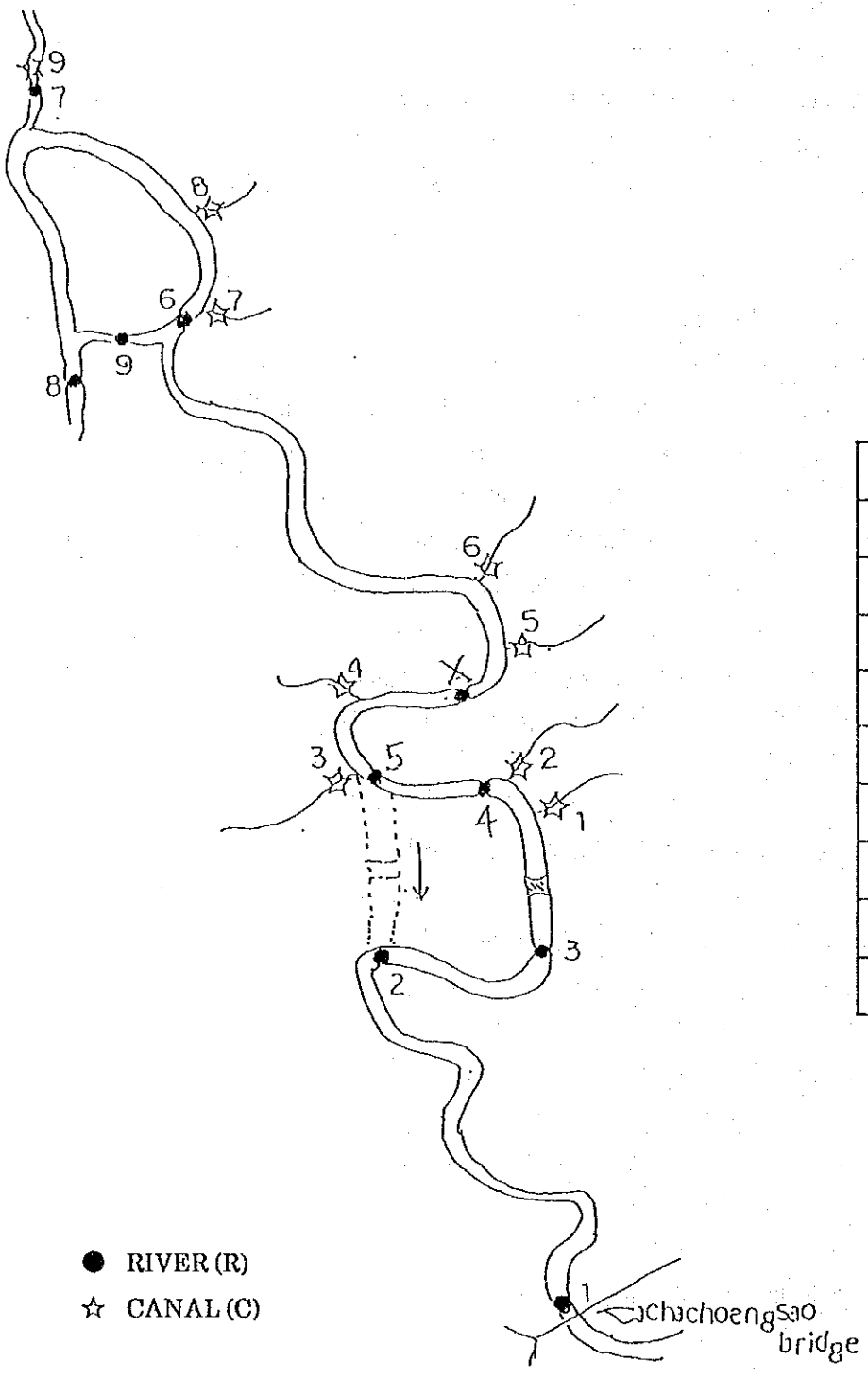
(4) Inspecting method for enterprise discharges

The essential points of the inspection method for respective factories were guided to them.

(5) Data arrangement and analysis methods

How to take significant figures and to round up figures by considering analysis precision were guided to them.

Fig. 4 - 3 - 1 WATER SAMPLING POINT



From the sea (km)	
R - 1	57.3
R - 2	65.0
R - 3	66.8
R - 4	68.8
R - 5	69.8
R - X	71.8
R - 6	78.8
R - 8	84.3
R - 9	79.3
R - 7	81.8

Fig. 4-3-2 Cl^- conc. Profile (1)

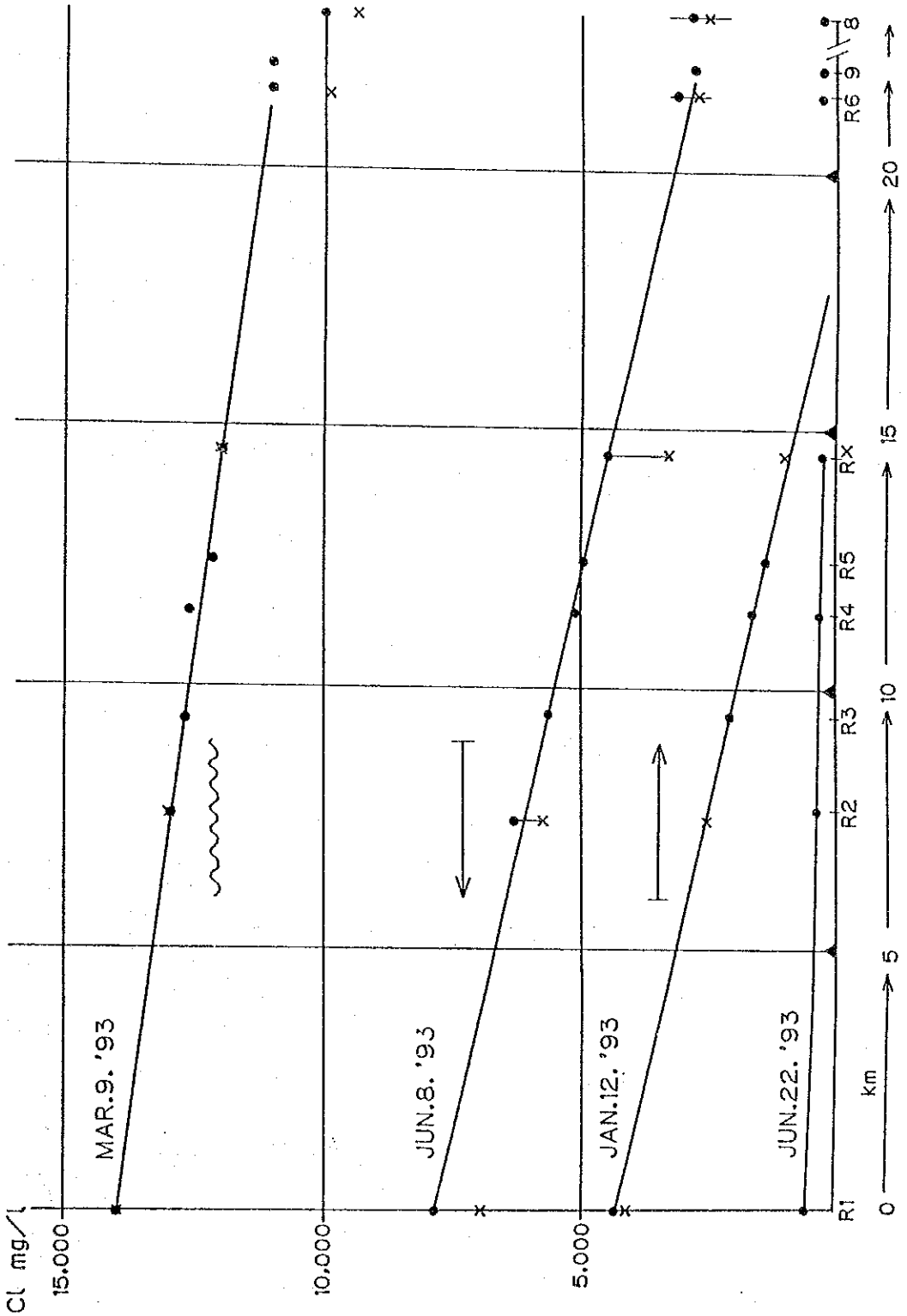
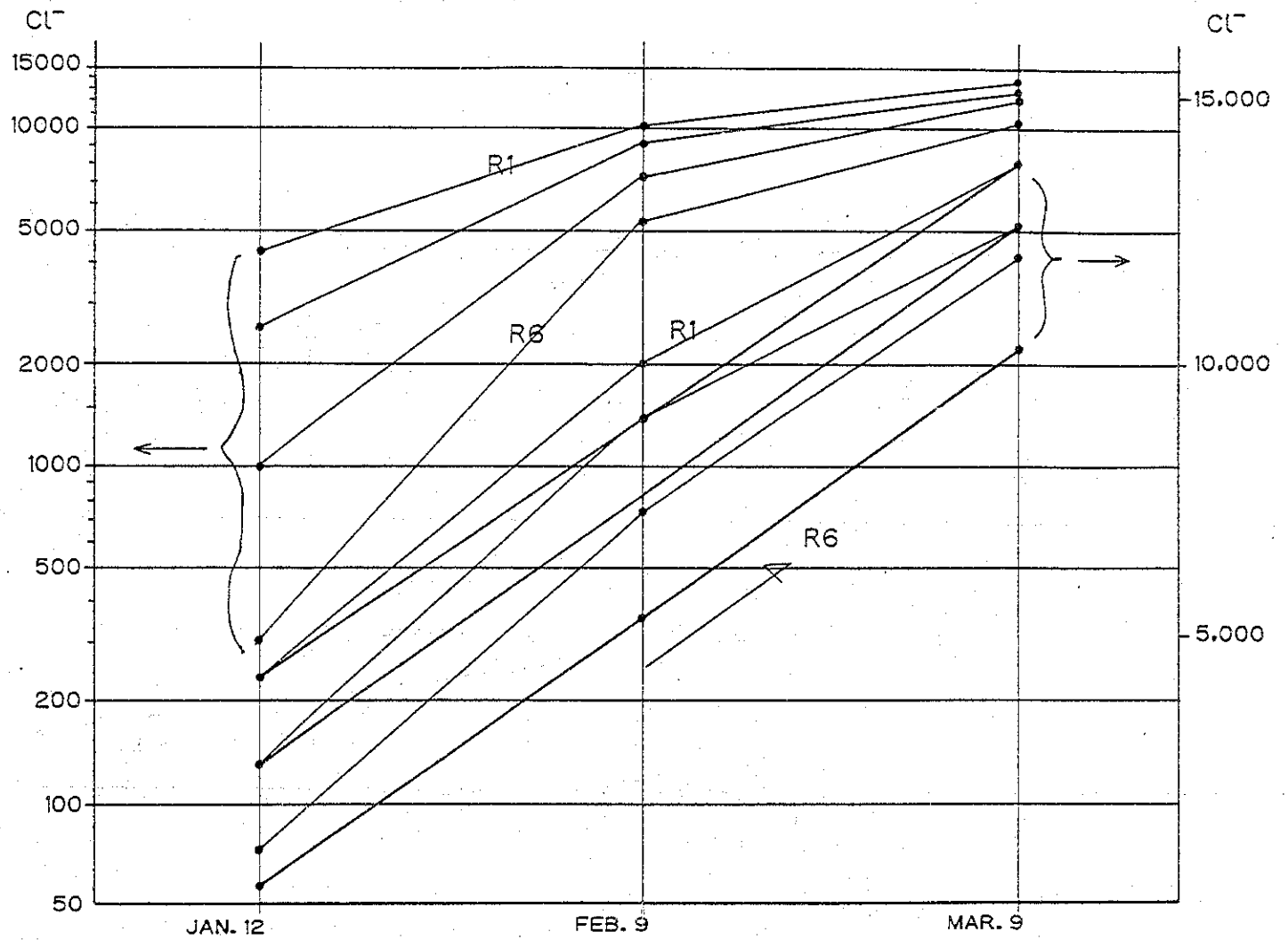


Fig. 4 - 3 - 3 Cl^- conc. Profile (2)



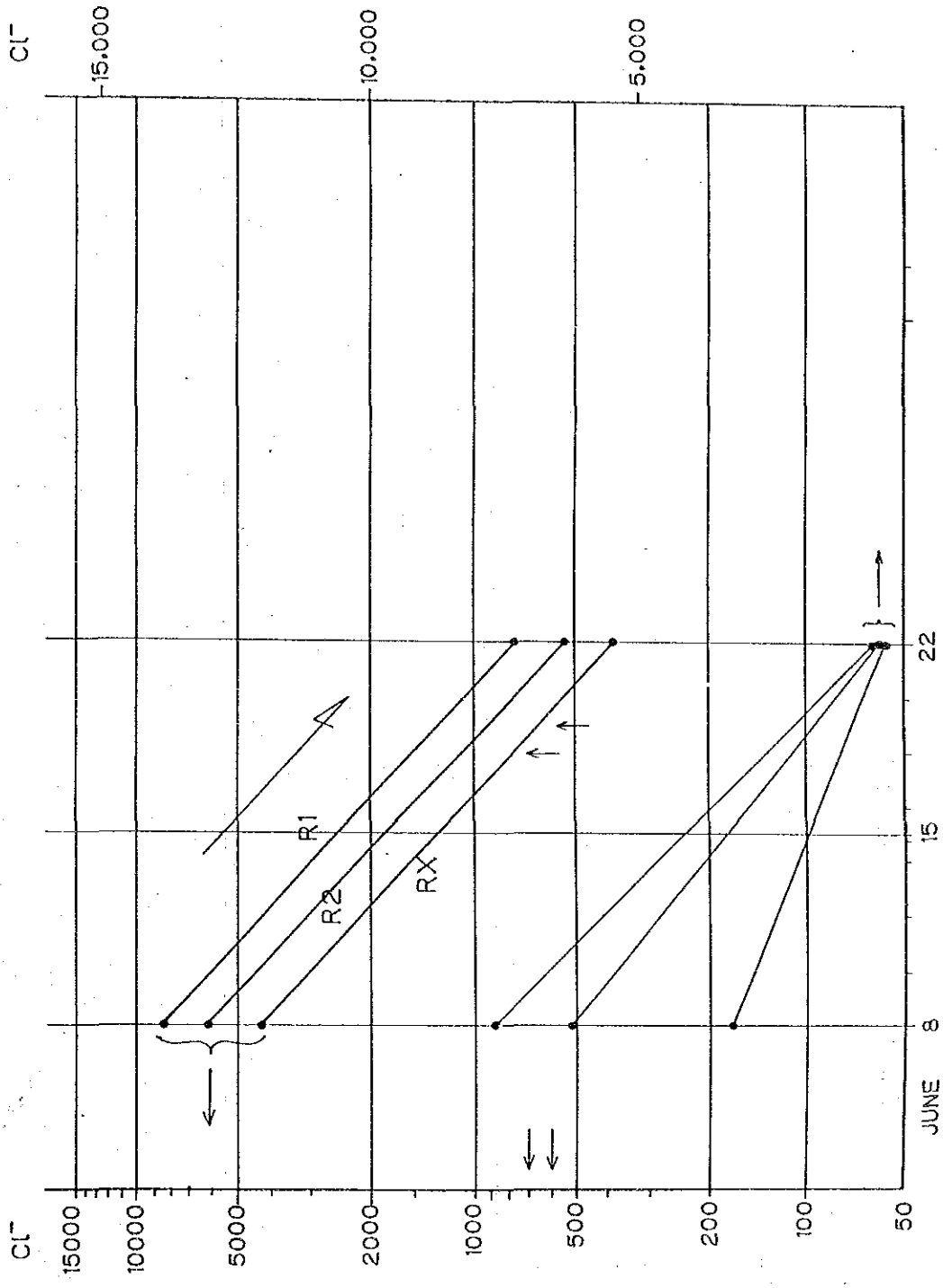


Fig. 4 - 3 - 4 Cl⁻ conc. Profile (3)

Fig. 4-3-5～1　　Cl^- vs EC (1)

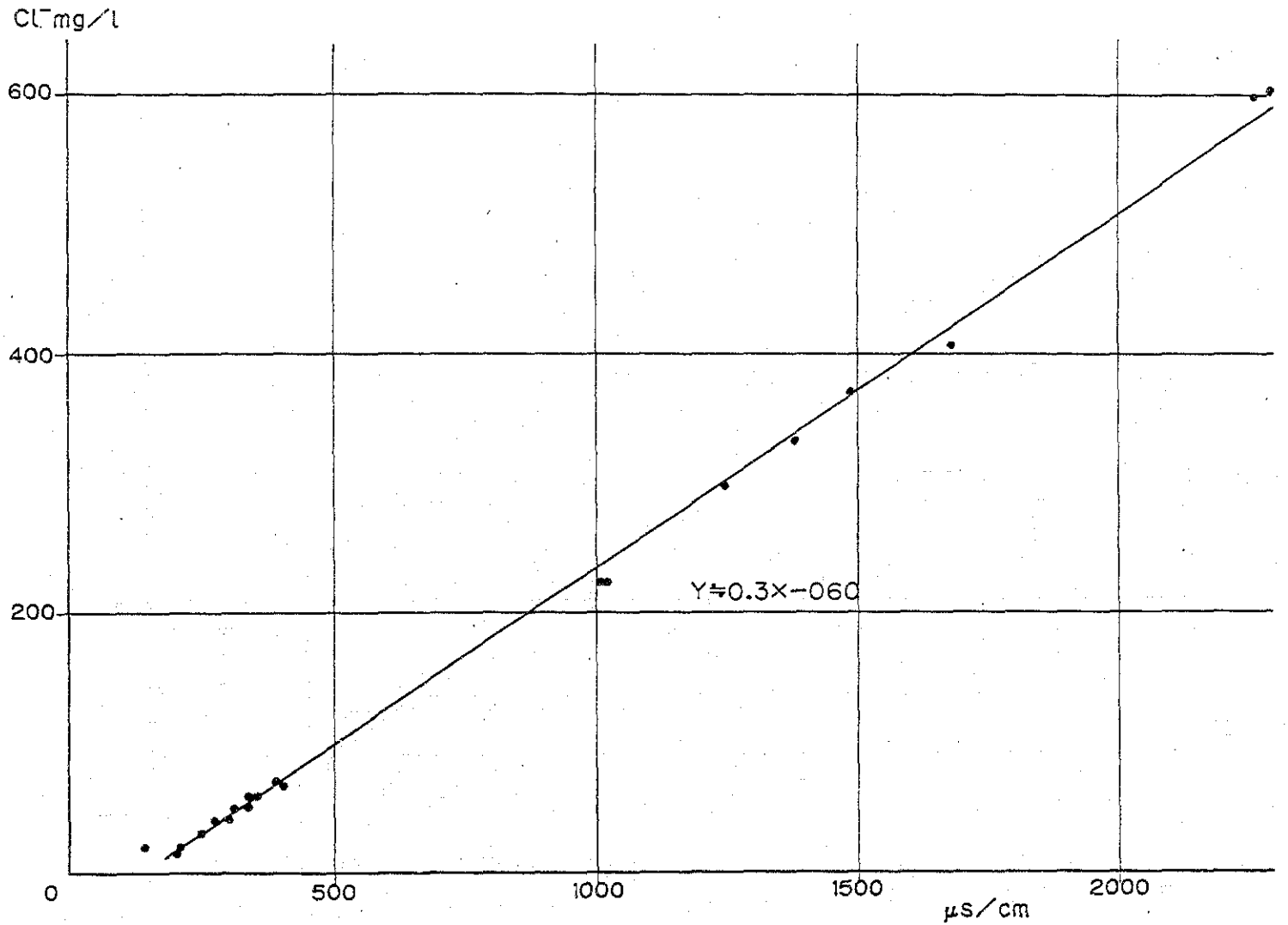


Fig. 4 - 3 - 5 ~ 2 Cl^- vs EC (2)

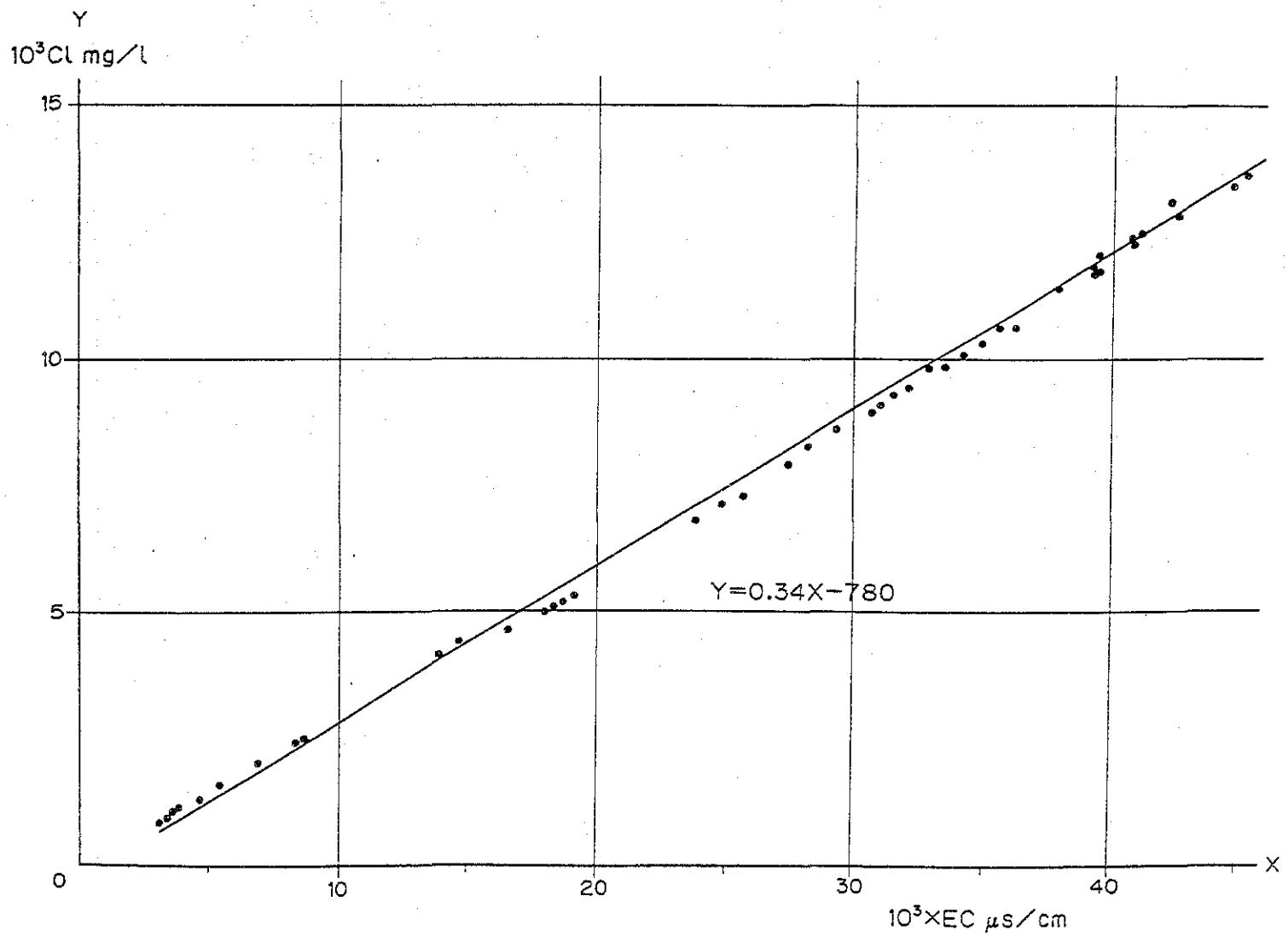


Table 7. Instrument list for Laboratory of RID

Name of Instrument	Cost/Unit (Baht)	Maker	Reason
1. Personal Micro Computer, Printer & UPS. (2 sets) CPU	83,000	Intel 80486 DX-50 Micro-processor	For Analyzed and Collected Data of Water Sample
Printer (Thai & English)	23,000	Epson Model lQ-1170	
Ups.	55,000	Quasar Micro Ups 7019 1 KVA	
2. Type writer 1 unit (Thai & English)	25,000	Olympia standard 200 BT.	For Printed Report
3. Kjeldahl Distillation 1 unit	120,000	Gerhardt macro 750 ml For 6 serial distillations	For Distilled Nitrogen
4. Kjeldahl Digestion 1 unit	58,000	Gerhaldt macro 750 ml For 6 digestions	For Digested Nitrogen
5. Mot-plate 1 unit	30,000	Gerhaldt Ceran-Mot plate C 450	For Digested Sample to Analyze total Phosphorus
6. Mot-plate 2 units	10,000	Gerhaldt 1701 EV1	For Boiled Distilled Water to Prepared Reagents
7. Oven 1 unit	75,000	WTB binder Type 240	For Dried SS, TS & TDS
8. Vacuum/ Pressure pump 1 unit	47,000	Millipore Cat.No.XX22050	For Filter SS
9. Balance 0.000g 1 unit	38,000	Sartorious BA 310 s.	For Weighted Chemical
10. Completely Fiber-glass Fume Hood 1 set	100,000	Major Products Size 150	For Absorbing Acid Vapour
Total	835,000		

TABLE 8

SUMMARY OF ENVIRONMENTAL MONITORING PROGRAM PROPOSED BY JICA STUDY TEAM

Environmental Resources	Location of Monitoring	Frequency	Remarks
1. Surface Water Quality			
1.1 Suspended Solids (SS) during construction - Temporarily banked spoil	- Supernatant flowing points out of sediment holding basin before discharging into the river.	- Once every day during dredging of both ending joints of diversion canals to the river course.	- If SS is found exceeding 500 p.p.m. mitigation has to be immediately applied to lengthen the sediment retention period, e.g. * increasing height of bund wall around the sediment holding basin, or * increasing number of sediment holding basins.
- Discharged spoil	- Lowest point of old river course	- Once every day during discharging spoil	- In calculation, such high turbidity as need environmental mitigative measures immediately never occurs (less than 100 p.p.m)
1.2 Ordinary monitoring for river water during operation - Temperature - pH - Electric conductiorty - Transparency - Dissolved Oxygen (DO)	- Three stations such as R1, R2 and RX in Bang Pakong main river (Fig. 4-3-1).	- 4 times a year (in Jan., April, July and Oct.) at the times of 6 water samplings from superficial and bottom layers.	- Chlorine ion concentration is converted from electric conductivity.
- Basic items for drinking water quality in Thailand - Basic items for environment in Thailand		- 4 times a year (in Jan., April, July and Oct.) for water samples for analyses mixed with water for superficial layer and bottom layer.	
1.3 Monitoring for diversion dam control - Temperature - pH - Electric conductivity	- Jetties at R1	- Once a week for a peroid from beginning of dry season till completion of gate closing.	- Chlorine ion concentration is converted from electric conductivity so as to monitor salinity intrusion. They will be indicated on graphic panel in central control room.
1.4 Monitoring for enterprise discharges - Items defined by MOI - Heavy metals with fear of being discharged	- All factories discharging sewage, listed up	- Water inspection once a year	

TABLE 8 (Cont'd)

Environmental Resources	Location of Monitoring	Frequency	Remarks
2. Erosion and Sedimentation (Only after impoudment)			
- Suspended solids (SS)	- Five station (See Figure 4): – 1) Ban Pan just downstream form the confluence of Nakhon Nayok and Prachinburi rivers. 2) Ban Laem Sai about 10 km downstream from station 1. 3) Ban Klauy about 10 km downstream from station 2. 4) At Amphoe Bang Khla. 5) At damsite.	- Once every month in dry season during the first two years after the dam starts operating.	
- Sedimentation along the river banks.	- Erecting detecting scales at inner concave meandering and straight river portion close to five stations above.	- Detection should be made monthly and continued for at least five years after impoundment.	
- Erosion along the river banks.	- Ten locations of non-eroded river bank (outer concaved meandering) should be marked up starting at damsite up to Ban Pan.	- Monthly checking at those locations should be made for two years after impoundment.	
3. Aquatic Ecology and Fighery (Only after impoundment)			
- Type, density and composition of plankton and benthos.	- Two stations, i.e. the same station no. 2 and 3 for surface water quality: – 1) Bang Pakong river, upstream of damsite. 2) Bang Pakong river, downstream of Amphoe Muang, in front of Wat Sothorn.	- Three times per year concurrently with water quality monitoring, i. e. in April, September and December.	- Post evaluation should be made after three year monitoring. Comparison of the data with investigation results by other government offices is recommended.
- Type and density of aquatic-plants	- Along upstream and down-stream river course	- Three times per year concurrently with water quality monitoring, i. e. in April, September and December.	- Post evalution should be made after three year monitoring
- Record of type and quantity of fish in Bang Pakong river	- Four stations: – 1) Upstream at Amphoe Ban Sang in Prachinburi province 2) Upstream impoundment 3) Downstream close to damsite 4) Downstream at the river mouth	- Once every yearly inter-viewing owners of fishing equipment already installed along the Bang Pakong river.	- Data on fishing activity in the Bang Pakong river can also be obtained from local fishery office.

TABLE 8 (Cont'd)

Environmental Resources	Location of Monitoring	Frequency	Remarks
4. Forestry and Wildlife			
- Mangrove forest strips 20 m wide	- Along downstream diversion canal and downstream main river from diversion dam	- Once a month for three years	
- Bamboo, bushwood etc.	- Along upstream diversion canal	- Once a month for three years	
5. Land and Water Transportation			
- Connecting roads, connecting bridge, extension roads across closure dam, entrance road No.3	- At connecting bridge	- Daily traffic once a month for three years	
- Small passenger boats	- At jetties of closure dam	- Daily condition (frequency, type, number of passengers, etc.) Once a month for three years	
6. Land Use and Agriculture			
- Land use feature	- Land on left bank of main river	- Every five years since commencement of irrigation water supply.	
- Strong acid soil zone condition	- Strong acid zone in irrigation area on left bank of main river.	- Every five years in dry season just after commencement of irrigation water supply.	
- Salty soil zone, for agro-production	- Salty soil zone in lower irrigation area on left bank of main river	- Every five years in dry and wet seasons, just after irrigation water supply.	
7. Socio-economy (Land expropriation and evacuation, etc.)			
- Population and work force distribution	- In benefited area	- Once a year after project implementation	
- Agricultural land area, agro-production area production value	- In benefited area	- Once a year after project implementation	
8. Public Health and Nutrition			
- Numbers of monthly outbreak of diseases *	- In benefited area	- Monthly, continuously after project implementation	- In case outbreaks remarkably increase, countermeasures should be made at once by specialists.

* (Acute diarrhea, Vibrio-cholera, Dengue haemorrhagic fever, Malaria, Opisthorchiasis, Japanese Encephalitis, etc.)

(Note) The summary of environmental monitaring program proposed by the JICA Study Team was made up based on EIA report by Kasetsart University and field survey results by the JICA Study Team.

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