10. Construction Cost Estimates of Alternative Sites

10.1. Method of Cost Estimates

The Construction cost of each alternative plan was estimated based upon the quantities of construction works which were developed from the preliminary designs.

The quantities of construction works for each alternative plan were computed based on each respective layout without any estimates by interpolation or extrapolation. However, for the estimation of costs of the main electro-mechanical equipment including turbines, generators and power station equipments, a correlation curve between size and cost (using discharge for maximum output and effective head as parameters) was adopted for comparison.

The unit prices adopted including overhead charges were estimated based on the data collected locally in regard with actual construction costs, material costs and wages, and the prices obtained prior to such data collection were standardized at the level of the year 1979 by applying annual escalation rates of 5 % for the local expenditure portion and 8 % for the off-shore expenditure portion.

Details of the construction unit costs are shown on Table 10-2. The exchange rate between the local and U.S. currency is US$1.00 to M$2.21.

The estimated construction costs are classified into civil works, electro-mechanical equipment, engineering, administration and contingency. As the construction quantities are estimated only for the main items in the layout designs, contingency amounts to 10 % of the sum of civil works construction cost and electro-mechanical equipment construction cost; engineering cost and administration cost are each equal to 10 % and 2 % of civil works construction cost.

To provide for future changes in the construction quantities due to incompleteness of the adopted data of topography and geology and the layout designs, some contingency was added to the direct construction costs.

10.2. Estimated Construction Costs

Table 2-1-1 and 2-1-2 summarize the construction cost estimates of each alternative dam by site, according to the type of dam and height of dam, and Table 10.1. summarizes the construction cost estimates of the Tualang and J. Panjang Site developments including generating equipments.

Itemized quantities and unit costs of the Tualang and J. Panjang Plans are shown on Table 10-1.

10.3. Unit Costs of Civil Construction Works

The unit costs of civil construction works are shown on Table 10-2.

11. Benefits of the Project

11.1. General

Among benefits resulting from the development of the Project, power benefit, irrigation benefit, and flood control benefit are counted for positive benefits, and in case of the project to be developed at Tualang Site increments in construction cost for shifting Gua Musang - Kuala Keral Highway are counted for negative benefits.

The power benefit was calculated by the usual method of evaluation; the fixed cost and the variable cost of an alternative equivalent thermal power plant were adopted as power benefit.

A difference in production between the ultimate crop pattern fed with irrigation water supplied by this project and the existing crop pattern is adopted as the agricultural benefit.

The flood control benefit was calculated, on the basis of the survey results of flood damage records described in the ENEX Report "Kelantan River Basin Study" and based on the simulation of flood control effect by the reservoir on the overspill of the river flow.

As for negative benefits, the losses incurred upon the Aring, Lebir and Chalil Land Development Schemes and the reduction of forestry production due to the inundation were checked by multiplying the inundated area by the net annual production per unit area, using the values obtained from the Report "Ulu-Kelantan Land Development Scheme" prepared on March 15, 1979, assuming that the inundated area will not be recovered. This negative benefits, however, are not considered in benefit-cost analysis. The reduction of forestry production due to the inundation was checked by multiplying the net annual production per unit area by the inundated forest area which is the rest of the total inundated area minus the inundated area in the land development schemes. (see Table 11-1).

11.2. Power Benefit

For economic evaluation of a hydro power project, selection of an alternative equivalent power source is an important problem. Therefore, it is necessary to select the most common alternative power source having similar functions to the proposed hydro power project. Normally, oil-fired thermal power plant, or gas turbine or a combination of these plants are used for the alternative power source.

Assuming that the Lebir powerstation is finally operated as an intermediate peaking mode, the most suitable notional thermal alternative will be the combination of the steam plant operating with the capacity factor of 80% and the gas turbine with the capacity factor of 5%. This is one of the plans that NEB used in the economic review of the Trengganu Hydro-electric Project.

According to this NEB's plan, the scales of the thermal alternative of the Lebir project planned at the Jeram Panjang site are represented as follows.

Description of Power Plant	Capacity (MW)	Energy (GWh/a)	Capacity Factor (%)
Lebir project	151	426	32.3
Alternative steam plant	55	384	80.0
Alternative gas turbine plant	96	42	5.0

Used for this alternative are the capital cost and operating cost for the Pasir Gudang steam plant with 120 MW set and those of the gas turbine with 700 MW set. The latter is the converted costs of the gas turbine at a level of December, 1979, with a proper rate or price escalation of the capital and operating costs estimated by NEB at a level of January, 1978. These details are as shown in Fig. 11-1, Table 11-2.

The power benefit of the Lebir Project based on above notional thermal alternative are tabulated as follows, if it is divided into fixed cost and variable cost according to the interest rate.

Interest rate (%)	Fixed cost (M$/kW)	Variable cost (M$/kWh)
8	105.1	0.1010
10	115.1	0.1029
12	125.7	0.1051
14	136.8	0.1075
16	148.4	0.1101

Table 11-2 shows the annual cost of the alternative thermal power plant.

11.3. Agricultural Benefit

The reservoir on the Lebir River is planned to serve mainly for peak generation. The 6-hour peak discharge from the reservoir will become almost flat at the upstream end of the coastal area. This means that the future increase in demand for irrigation water in the Kelantan plains could be met by the discharge to be released for the power generation without re-regulation of the discharge. Although the catchment area of the reservoir corresponds to 20.5 % of the catchment area at the Gillemard bridge (2,480 km^2/12,100 km^2), the effect of flood control by the reservoir operation will be rather remarkable than expected. However, a surcharge due to temporary storage of flood discharge in the reservoir will rise the reservoir water level, resulting in the reduction of the area for land development in and around the reservoir.

Fig. 4-1 shows the irrigation and drainage projects under plan or in implementation for the coastal area along the Kelantan River. These projects are not directly related to the construction of the dam and the Kelantan band embankment, and these projects are implemented by the Drainage and Irrigation Dept. independently from the dam projects.

The agricultural benefit in the Kelantan plain attributable to the construction of the reservoir on the Lebir River is counted as a difference in the agricultural production between the cases with and without the construction of the reservoir. Accordingly, it is not necessary to include the construction costs of the irrigation and drainage projects in the evaluation of benefits of the dam on the Lebir River.

The increment in the agricultural benefit produced by the dam on the Lebir River is composed of (1) decrease in damages due to flood mitigation by the reservoir and (2) increase in the river discharge resulting from the operation of the reservoir.

The former includes damages to crops, private and public properties, losses due to suspension of commercial activities, costs necessary for refuge, loss of life, and also a decrease in agricultural production due to damage to irrigation facilities.

The latter is an agricultural benefit derived from the suppleanetal supply of irrigation water which would be made available by discharge for generation.

The benefits assumed in the report "Kelantan River Basin Study" are roughly classified into the following three items;

(1) Agricultural net production value

(2) Decrease in agricultural production due to lack of irrigation water resulting from a shortage in the discharge in the Kelantan River

(3) Flood damage to items other than crops.

Items (1) and (2) are counted as benefits of the Project and item (3) as a cost of the Project.

In addition to the above items, the following items counted in the report "Kelantan River Basin Study" are also related to the benefit calculation for the Project.

(1) Cost of maintenance of irrigation facilities (excluding drainage facilities)
(2) Cost of administration of agricultural development

The former including operation costs of irrigation pumps will increase according to an increase in the quantity of intaken water. However, this was disregarded in the report "Kelantan River Basin Study" because it will be very small. The latter includes costs for increased administration works due to an increase in irrigation water. However, the estimated increase in the cost will be very small and was also disregarded in the same report. Therefore, cost increases in the above two items are not taken into account in this preliminary report.

The agricultural net production value in the Kelantan River basin was obtained by deducting the gross production cost from the gross production value and was estimated by means of a special opportunity cost. The increment in the net production value viz. the benefit to be produced by the irrigation projects would be derived from such factors as improvement of planting patterns, increases in planted area and production, and decrease in flood damage.

The net production value without the reservoir on the Lebir River was estimated by calculating, first, the net production value without the irrigation projects and then adding the incremental net production value with irrigation projects. In this case, 15 to 25 years were adopted as the project maturity period from the completion of the projects to the gain of intended agricultural income. The report "Kelantan River Basin Study" mentions that a shortage in irrigation water may delay the achievement of targets by 6 years. Further, it estimates that the completion of the reservoir on the Lebir River with its flood control capacity may contribute to shortening* the above maturity period by one year.

* for reference

with the Dabong dam ------------- the maturity period shortened by 4 years

with the Kelantan River bands --- the maturity period shortened by 2 years

Estimation of the maturity period depends mainly on farmers' confidence in agricultural production. The same periods as adopted in the report "Kelantan River Basin Study" were used herein.

The program of the irrigation and drainage projects is shown in Fig. 4-2. The net production values of the projects Nos. 1 to 3 in the same figure are included in the total net production value without irrigation projects mentioned in the report "Kelantan River Basin Study". Those of the projects Nos. 4 to 13 are not clearly mentioned in the same report. Therefore, judging from the data available in Appendix 1 "Agriculture - Economics Data Base" and Appendix 4 "Catchment Area Model Computer Output" in the same report, the irrigation projects Nos. 4 to 13 were classified into four groups, and then respective net production values for each group were estimated. In this estimation, the completion time of project No. 5 was shifted to 1979 from 1980 as planned by the Government, then the projects Nos. 5 to 9 were put together in one group.

Table 11-3 shows the respective net production values of four groups of the projects. The maturity period of each project without flood mitigation were estimated to be 25 years for the project No. 4, 23 years for the project Nos. 5 to 9, 18 years for the project No. 10 and 15 years for the project Nos. 11 to 13, which are consistent to the figures mentioned in the report "Kelantan River Basin Study".

According to the program of the irrigation projects shown in Fig. 4-2, it is estimated that the Kelantan River basin will encounter a shortage in water supply around 1995. Considering the water demand after completion of project No.10, it is assumed that the situation of shortage in water supply will occur in and after 1996.

As this shortage in water supply will result in a decrease of farmers' confidential effect on improved agricultural methods, prolongation of the maturity period was estimated to be 6 years.

The operation of the reservoir on the Lebir River will be commenced in 1989 during the implementation of the above irrigation projects. Afterwards, the shortage in irrigation water would be solved in all, which may encourage farmers to promote agricultural development. The shortening of the maturity period by one year adopted in the report "Kelantan River Basin Study" is regarded as pessimistic, but this shortened period is also adopted in this report. Solution of the shortage in water supply and a feeling of some relief from floods would accelerate the growth of the net production value to be produced by the irrigation projects.

Damages to agricultural products which would be caused by drought discharge of the Kelantan River without any discharge regulation would be eliminated with the completion of the reservoir on the Lebir River. This is also one of benefits to the reservoir. As mentioned in the report "Kelantan River Basin Study", this benefit will reach the maximum value for an amount of M$40 x 10^6 in the year 2000 when all the irrigation projects are scheduled for completion.

The agricultural net production values with the dam on the Lebir River and without the dam are shown in Table 11-3 and Fig. 11-2.

As the result of the above study show, the flow of the future benefits in the Kelantan River basin by the development of the reservoir on the Lebir River is shown in Table 11-4. The total expected benefits for each year are obtained by subtracting the value "(D)-(C)" from the value "(B) - (A)".

11.4. Flood Control Benefit

Where the Project is given the function of flood control, the benefit of flood control was computed by using the result of the ENEX Study. This section discusses the effect of flood control of the Project.

Flood Mitigation Benefit

The mitigated volume of the peak flood at downstream was obtained in accordance with the volume of the reservoir in case of two flood control systems; one is natural control system by free overflow weir and the other manual control system by gate operation. In the report of "Kelantan River Basin Study", the amounts of flood damage have been integrated based on the past flood record for 27 years, from 1949 to 1975. The relation between the peak flood volume of the river and damage potential was prepared by using this record. From the above obtained mitigated volume and relation, the difference of damage was obtained in two cases with and without the Lebir dam, and was regarded as a flood control benefit.

Magnitude of Flood and Assessment of Damage

According to the report by ENEX, the flood control benefit is counted mainly from agricultural and social damages. The amounts of both damages are estimated on a yearly basis over a period of past 27 years as shown in Table 11-5 (Agricultural Damage) and Table 11-6 (Social Damage). These tables present annual flood damages in three different cases: A - without dam construction, B - Dabong Dam and C - Dabong and Lebir Dams respectively in the condition as of 1976 and in future condition.

It may be assumed from these tables that such large flood damage likely to affect the evaluation of the Project economy would take palace once a year and a major portion of total annual damage would result from the largest flood during the year. Simply on this assumption, the amount of flood damage in a year of heavy damage was calcualted on the basis of peak discharge at Guillemard.

In 1967 the peak discharge at Guillemard was 16,350 m^3/sec. This would be recuced to 12,150 m^3/sec. by constructing the Dabong Dam and further to 11,590 m^3/sec. by adding the dam on the Lebir River. Likewise, the peak discharge of 11,170 m^3/sec. in 1973 would be regulated to 9,920 m^3/sec. by the Dabong Dam and to 8,580 m^3/sec.

by the dam on the Lebir River. It is found that these peak discharges in 1967 and 1973 correspond to the amounts of damage in the same years given on Tables 11-5 and 11-6 respectively. Fig. 11-3 represents the evlation between peak discharge at the Guillemard Bridge and resultant damage on the coastal plain. According to Fig. 11-3, flood damage is zero with a peak discharge of less than 8,000 m^3/sec. An increment in the flood damage takes gentle curves after the peak discharge is beyond 15,000 m^3/sec. to 16,000 m^3/sec. level.

Flood Control Effect by the Dam on the Lebir River

Flood regulation by the dam was simulated for each flood of 100 year, 50 year and 20 year return periods, using the synthesized flood wave through hydrological analysis, and incremental discharges at Guillemard Bridge were calculated.

The crest elevation of free overflow weir on spillway is selected that the maximum flood water level in the reservoir can reach just a high water level assumed when the design floods at 1,000 year return period pass through the weir with various crest lengths. By this selection, twelve (12) different crest elevations are obtained from four (4) various crest lengths of 80 m, 120 m, 160 m and 200 m and three (3) assumed high water levels of EL.90 m, EL.80 m and EL. 70 m.

Fig. 11-4 shows each peak flood discharge at several probable flood occurrences at Guillmard Bridge regulated by above-mentioned free overflow weir. This Figure also shows the flood control effect in the case by the manual operation of the regulating gates. In this case the gate operation rule is to storage the water equivalent to the residual flood regulated capacity. The discharge volume is obtained by deducting the above regulated volume from the flood inflow to the reservoir. This discharge is divided into ten (10) ranges to form step inflow. Fig. 11-5 shows the relation between the discharge and reservoir water level in two cases of the manual regulation by the gate operation and the natural regulation by the free overflow for probable flood wave.

Estimation of the Flood Mitigation

The flood mitigation amount by each return period, scale and regulating method can be estimated from the relation between the peak flood inflow and the flood mitigation damage of the catchment area; and from the effect of the Lebir reservoir upon the flood peak inflow by each probable flood discharge at Guillemard Bridge. The following methods are adopted for converting this flood mitigation into the expected flood mitigation. (See Fig.11-6)

At first, the average value at the appropriate range of the flood discharge is regarded as a representative value, to which the flood mitigation amount is obtained. Then, probability of the flood occurrence in this range is obtained and it is multiplied by the above flood mitigation to estimate the expected value of the flood mitigation in this range. The expected valve of annual flood mitigation is obtained by summing up each expected value estimated. Table 11-7 shows the above-mentioned calculation process in the case of H.W.L. 90 m and spillway crest length 160 m. Table 11-8 shows the summary of the expected mitigation amount in each scale and control method.

11.5. Net Benefit of Land Development Scheme

Construction of the dam on the Lebir River will inundate portions of lands within the coverage area of land development schemes for Aring, Lebir and Chalil. Calculation was made for reference about the influence to be given by the Lebir Project on these schemes.

Among these schemes, the Aring Land Development Scheme has been studied in detail for its economic aspects and its cash flow showing both annual expenditures and incomes are available for this study. As for the other two schemes, the Lebir Land Development Scheme belongs to the Federal Land Development Authority, the same executing agency as for the Aring Scheme. Therefore, the cost and benefit of the land development scheme for Lebir are considered adequate based on the data obtained for the Aring Scheme. On the other hand, the Chalil Land Development Scheme is under a different executing agency and any data on the cost/benefit of the scheme were not available. However, a feature of the scheme is the development of similar items to other two schemes, namely rubber and palm oil. For convenience, the benefit accrued from the scheme is estimated in a similar manner.

The annual net benefit accrued from these land development schemes is obtained in such a way that the present worth of net income derived in the cash flow is spread equally over the life of the hydro power plant. As a result, the annual net benefit is computed at M$700 per hectare.

12. Economic Comparison of Alternative Sites

12.1. General Approach

At first, construction costs of dams for the three alternative sites were compared, because this project is mainly a dam construction whose construction cost will share 40 % to 50 % of the total construction cost of the Project in case any of the three sites is chosen. And as it is easily known that there is not so much difference in benefit between the developments of two downstream sites (Tualang and Jeram Panjang Site) and the benefit by the development of the upstream site (Kiak) is the lowest, a prospective result of comparison of the alternatives could be obtained to some extent only by comparison of construction costs of dams.

In the next step, cost-benefit analyses of alternative plans for each of the two sites (Tualang and Jeram Panjang) were carried out to screen out the optimum plan.

In the final step, the internal rate of return for the selected optimum plan was calculated to examine the feasibility of the Project by comparing with the investment opportunity cost.

12.2. Comparison of Alternative Sites

Tables 2-1-1 and 2-1-2 show the construction costs of dams, concrete dams or fill dams, for three alternative sites at the maximum resevoir water levels of EL. 90 m and EL. 70 m. For the Jeram Panjang site and the Tualang site, fill-type dams are adopted for the saddle dams because the fill-type dam was found to be more economical after comparison with the concrete dam.

Fig. 12-1 illustrates the results of the above comparison. According to this Fig. 12-1 at the high water level of

EL. 70 m the concrete dams are lower in cost than the fill-type dams except Jeram Panjang site and the Tualang site is the lowest and the Jeram Kiak site is the highest. While, at the maximum water level of EL. 90 m, the concrete dam is lower in cost than the fill-type dam for the Tualang site, and on the contrary the fill-type dams are more economical for the Jeram Panjang site and the Jeram Kiak site. The Jeram Panjang site has the highest priority and the Jeram Kiak the lowest.

Comparison of alternative sites only by the construction costs of the dams indicates that the Jeram Panjang site with construction of a fill type dam is most economical, the Tualang site the second, then the Jeram Kiak site the third.

This figure shows that at the Tualang site, the concrete dam is more economical than the fill-type dam at any water level of the reservoir. However, at the Jeram Panjang Site, the concrete dam is more economical, if the dam is designed with the maximum water level of 70 m, and the fill-type dam is a little bit more economical if the maximum water level is 90 m. Therefore, it is necessary to adopt a suitable type of the dam for the Jeram Panjang Site according to the dam height adopted.

Comparison of the alternative sites by the construction costs of the dams has resulted in selection of the Tualang site, but it cannot be concluded yet only by making a comparison of the costs of the dams that the Tualang site has an advantage over the Jeram Panjang site because problems such as relocation of the highway bridge still remain unsolved.

At this stage, the Jeram Kiak site was excluded from the comparison for the following reasons. The construction cost of the Jeram Kiak site is estimated to be about twice as much as those of the other two downstream sites, in either case of the maximum water levels being 70 m or 90 m. The difference in cost exceeds

M$140 x 10^6. The catchment area of the Jeram Klak site is smaller by 7.6 % than those of the downstream sites and the reservoir capacity and inflow are also smaller. Because of a smaller capacity of the reservoir, benefits of generated energy and water supply for irrigation are smaller than those of the downstream sites.

12.3. Comparison of Sizes

Table 2-2 shows the results of comparison of the Tualang site and the Jeram Panjang site when two sites are developed at the maximum water levels of EL. 90 m, EL. 80 m and EL. 70 m, on the condition that the reservoir operation will be done in such a way that the cost-benefit ratio is maximized.

Table 2-2-1 shows the calculation result of B/C and B-C setting spillway length H.W.L. at 90. In this calculation, the overflow weir width is used as a variable. The output study is made by regarding this crest elevation as a normal operating water level. From this study, maximum output and annual generated energy are obtained so that power benefit can be a maximum. As a result, B/C values indicate around 1.32. in the overflow weir widths from 80 m to 200 m, which means almost no difference in values, but surplus benefit (B-C) values show the maximum in the overflow range of 160 m. From the above calculations, the most appropriate crest length of free overflow was fixed at 160 m.
Table 2-2-2 shows the values of B/C and B-C obtained by changing the dam scales. It also includes for reference, the values of B/C and B-C estimated in the case of adopting the gate operation rule mentioned above, and in case of adding the agricultural benefit. In this estimation, the larger the values of B/C and B-C become, the more the dam scale increases. It reveals that larger scale dam will be more advantageous.

The values of B/C and B-C in the case of manual operation for flood control are better than those in case of the natural control by the free overflow weir. Thus, detailed investigations will be required in the near future.

Furthermore, as the result of adding the annual agricultural benefit of M$14.26 million, B/C will increase from 1.32 to 1.63, at H.W.L. of EL.90 m. In this case, B-C will also almost doubled from Malaysian Dollars 14.93 million to 29.19 million which shows high economic feasibility of this project. For example, the annual agricultural benefit of Malaysian Dollars 14.26million, if it is converted into the ultimate cropped pattern, is equivalent to 6.3% of the total agricultural annual benefit of coastal area.

Table 2-2-3 shows the values of B/C and B-C in case of adopting the gate operation by which a few more profit can be obtained, assuming that concrete gravity dam is constructed at Tualang Site. Same as the Jeram Panjang Site, the values of B/C and B-C at Tualang Site will be more advantageous when the dam scale increases. At H.W.L. of EL. 90 m, B/C value will be the biggest of 1.18, which is pretty smaller than the B/C value of 1.32 at the Jeram Panjang Site.

Fig. 2-2 is a summary of the above results. As shown in this figure, these values being restricted by the topographical and geological conditions of the proposed project sites, they are the largest at H.W.L. 90 m. Between the two, the Jeram Panjang site will be more profitable from the economic view-points.

12.4. Economic Feasibility of the Project

As mentioned in the previous article, compared to the alternative thermal plant, B/C value of the Lebir project which is summed up by power benefit and flood mitigation benefit, shows 1.32, in case of the discount rate of 8%, and in this case the internal rate of return is calculated at about 11%. If the agriculture benefit is added, B/C value amounts to 1.63 and the internal rate of return will approach about 13%.

For this calculation, an official selling price of the cheapest Arabian light crude oil as of December 1979 is adopted, but actual oil prices per barrel are various at the oil price zones, and all these prices are rather higher than the price adopted here. For example, some oil price indicates US$10.00 per barrel as highest. These oil price conditions suggest that the values of B/C and B-C adopted be fairly conservative. If crude oil price is 16.7% higher than the adopted one or equal to US$28.00/ barrel, the same price as the official selling price by the Arabian light in May, 1980, the B/C value will go up from 1.32 to 1.50, and the internal rates of return will also amount to about 12.6% without agro-benefit, and 14.5% with agro-benefit.

Therefore, even in case of the most conservative fuel price in December, 1979, the internal rate of return will reach about 13% with agro-benefit, which shows good viability of the Lebir Project from the economic view-points.

13. Construction Schedule for Implementation

From an economic point of view, the development of the Jeram Panjang site at the maximum water level of EL. 90 m was selected as the optimum plan for the Lebir Hydroelectric Development Project.

This Chapter describes the construction schedule for implementation of the selected plan.

After the preliminary investigation stage of the feasibility study, more detailed studies including field investigation works would be carried out to examine more precisely the feasibility of the Project. The final conclusion on the feasibility will be issued in end 1982. Afterwards, it is scheduled that about 36 months will be necessary to prepare the detailed design together with the preparation of tender documents then call tenders and award contracts for construction works. Accordingly, the start of construction works is scheduled from the beginning of 1986.

In the first year (1986), the access road will be repaired and newly constructed. At first, the access road route, which is branched from the logging road running toward the south, and goes over the small mount and finally reaches the dam through the right bank ridge of the main dam, will be constructed within a month after commencement of the construction work.

Excavation of the diversion tunnel entrance will be started immediately after completing this access road, and then, tunnel excavation will follow. All of the excavation access road, and 60% of the concrete lining will be completed by the end of the first year. In addition to the diversion tunnel, the works which should be done within the first year are the preparatory works such as camp and housing, power and communication, plant and equipment and also stripping of the main dam. In the second year (1987), construction of the most main structures will be started. Among these works, main works are the stripping and foundation excavation. For the dam construction, the 2nd cofferdam will be completed. In the latter half of the year the banking and foundation grouting for the main dam will be started as well as the construction of the saddle. The concrete works which should be completed within this year are only the concrete lining of the diversion tunnel. Concrete works for the spillway, penstock and powerhouse will be started in this year, but most of these works will be carried out in the next year.

In the 3rd year (1988), most of the civil works will be completed except for the powerhouse, and the works related to switchyard and main equipment, and as soon as entering the rainy season of November, the ponding will be started.

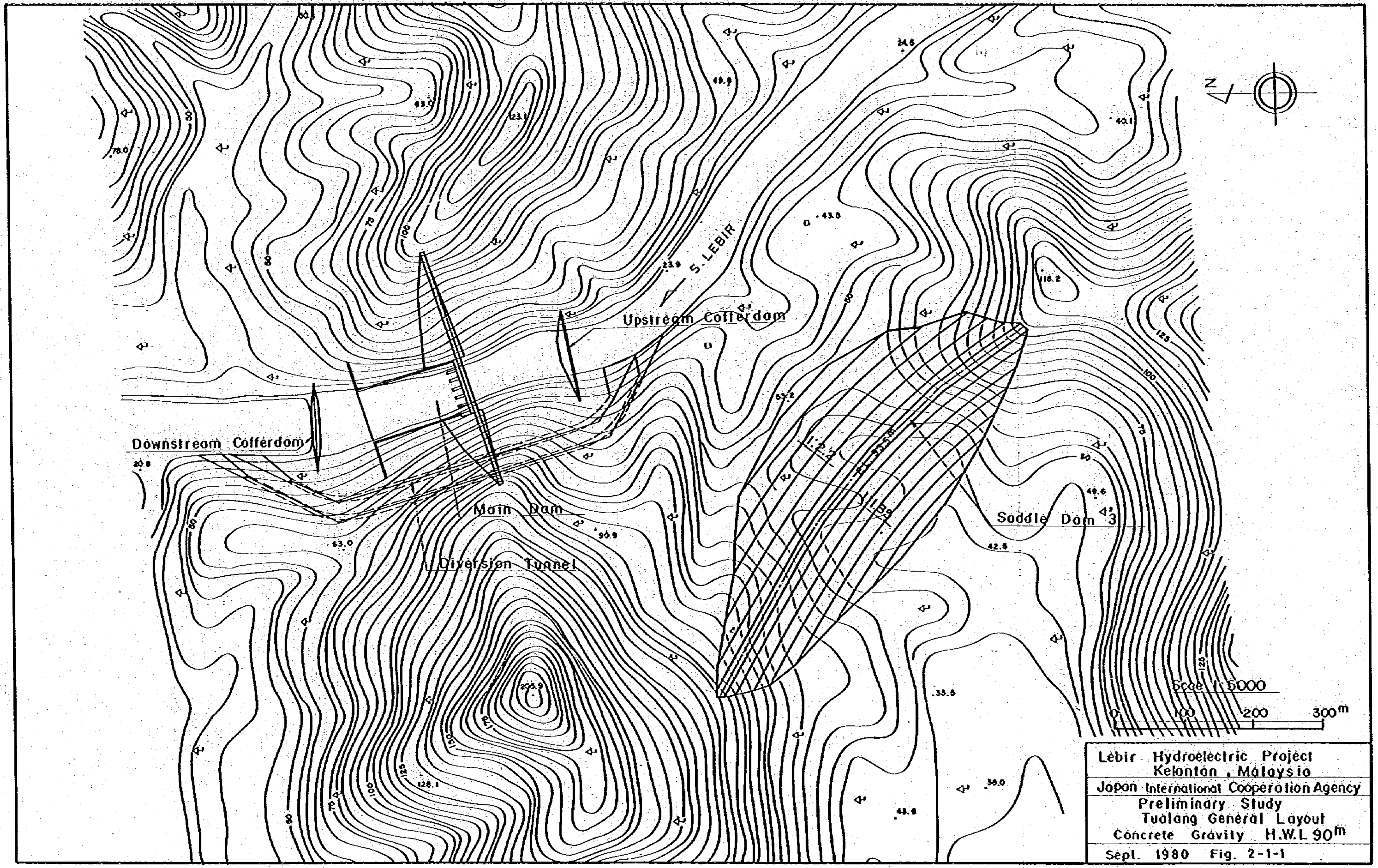
The main dam with embankment volume of 5.2 million m^3 is scheduled to be completed in 20 months. It seems not so tight schedule. The ponding of the reservoir will be started from November, 1988, and it will take nearly one year to have the reservoir volume of 3,100 million m^3 at H.W.L. 83.8 m. The trial operation will be started at the beginning of December, 1989. The Construction of the powerstation, main equipment and switchyard will be completed during the ponding period.

According to the above construction schedule, the construction period of the Project to be developped at Jeram Panjang Site will be from the beginning of 1986 to the beginning of 1990 when the commercial operation is to be started.

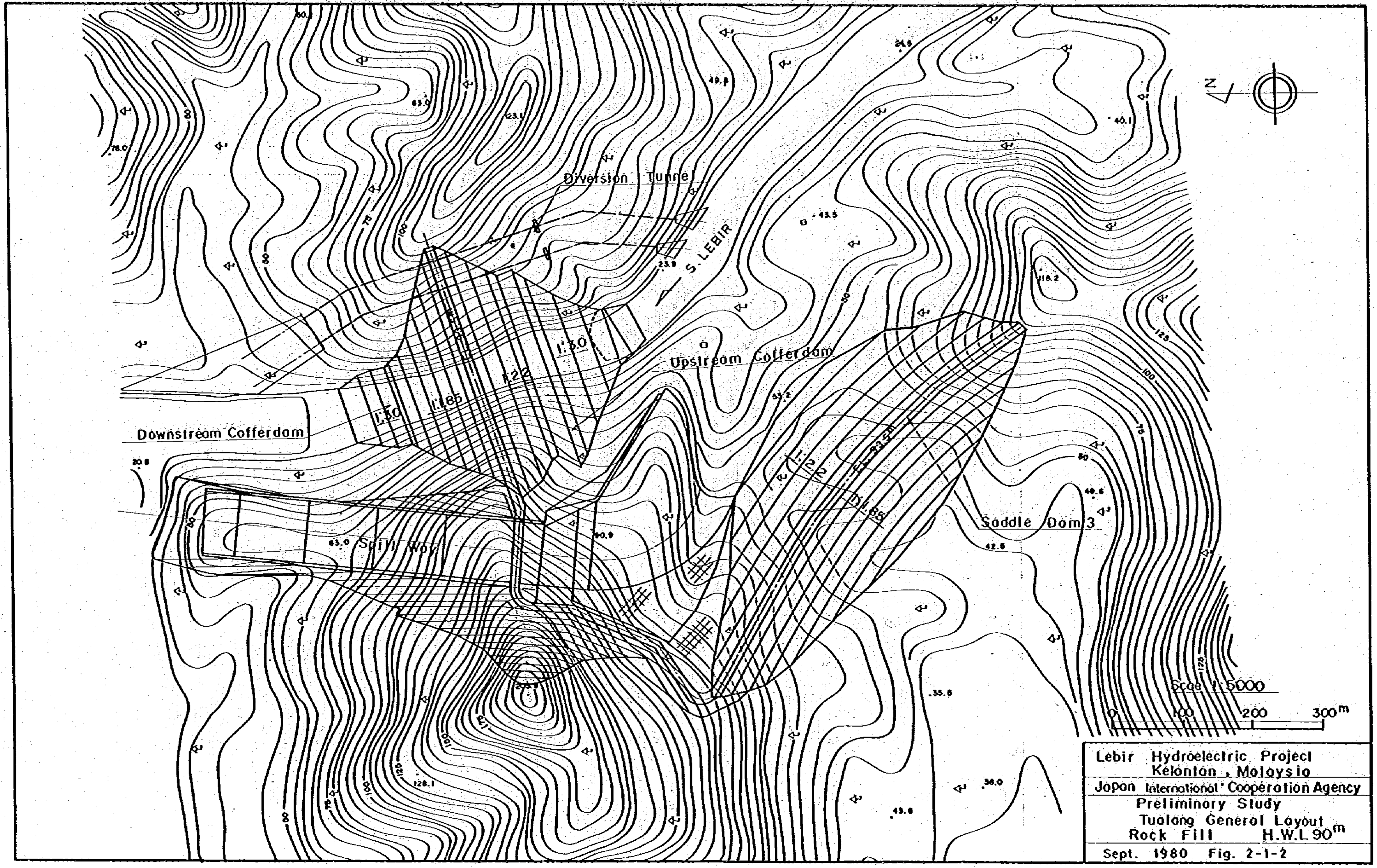
Fig.13-1 shows the above time schedule in the bar chart by main items of construction works. And Fig.13-2 also shows same kind of time schedule of Tualang Site construction works.

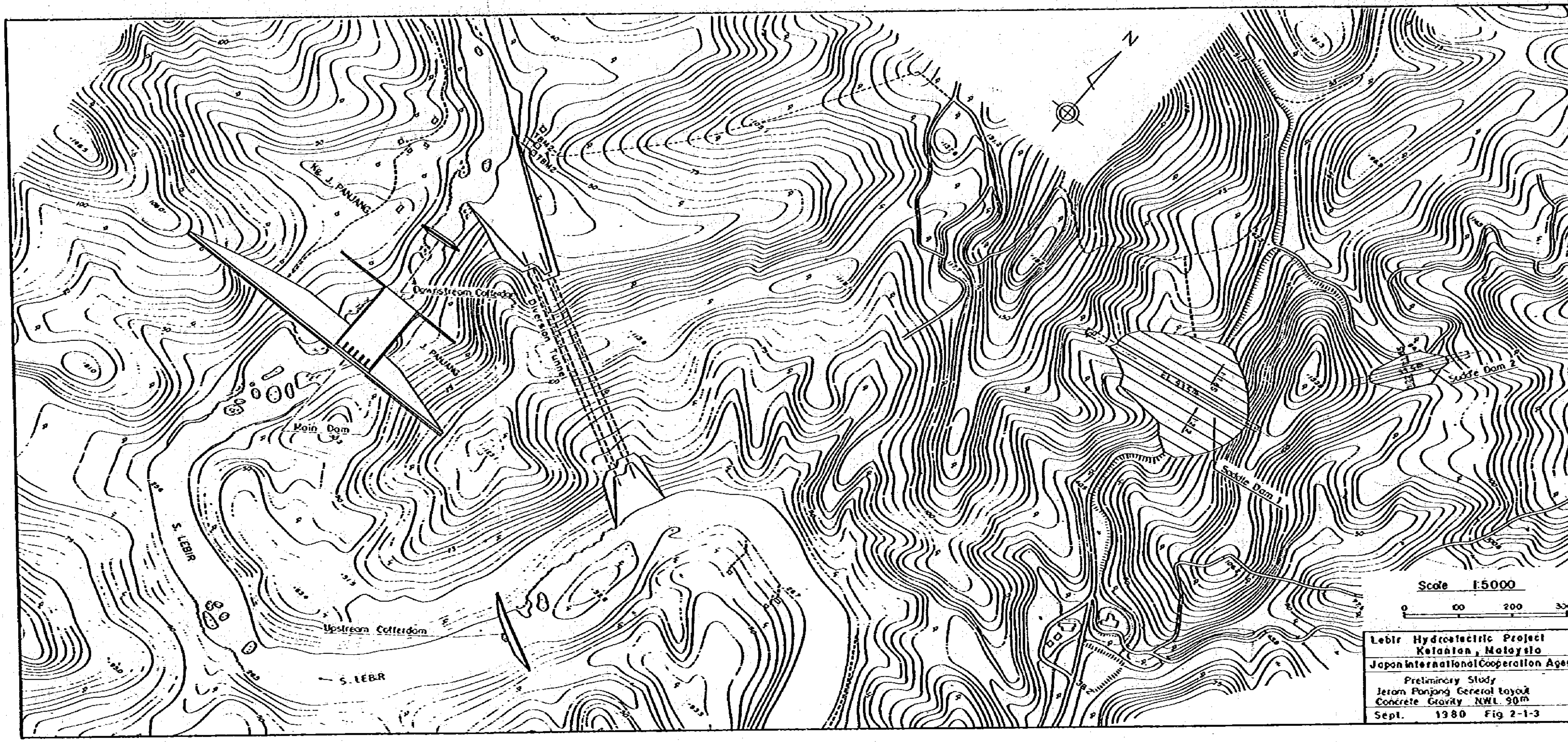
Appendix

Figures and Tables

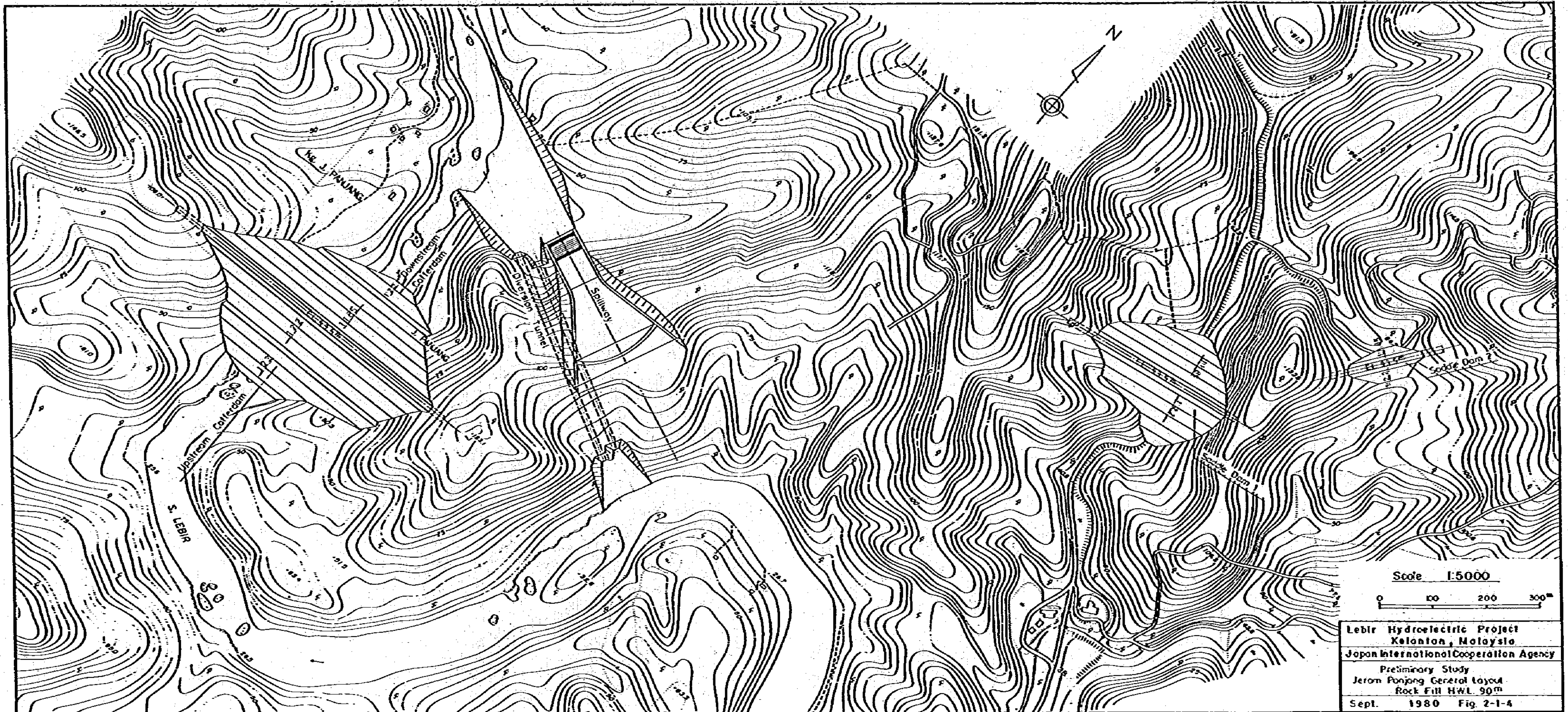


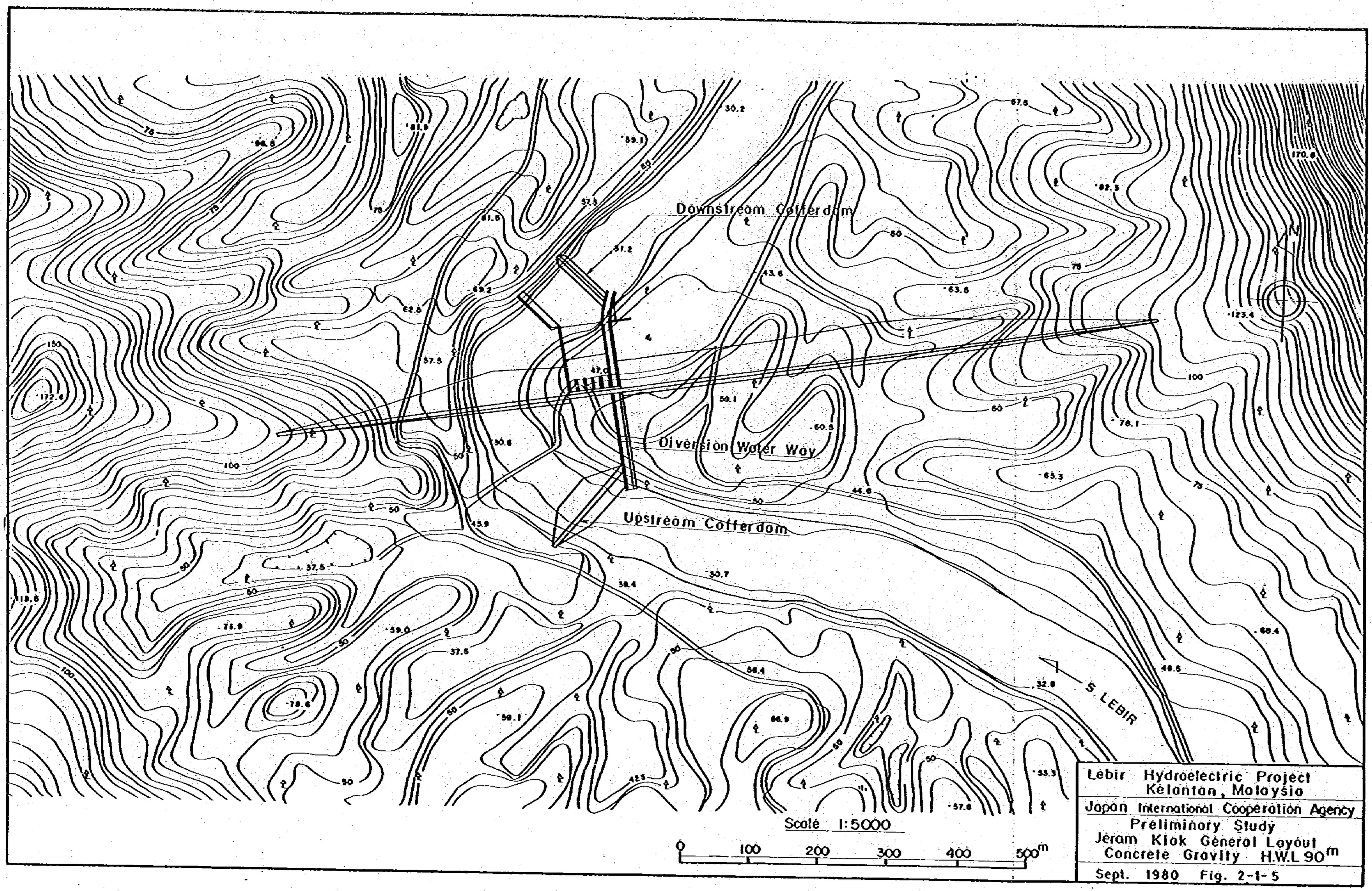
S. LEBIR
Upstream Cofferdam
Downstream Cofferdam
Main Dam
Diversion Tunnel
Saddle Dam 3
Scale 1:5000
0 100 200 300m
Lebir Hydroelectric Project
Kelantan, Malaysia
Japan International Cooperation Agency
Preliminary Study
Tualang General Layout
Concrete Gravity H.W.L 90m
Sept. 1980 Fig. 2-1-1


Diversion Tunnel
S. LEBIR
Upstream Cofferdam
Downstream Cofferdam
Spill Way
Saddle Dam 3
1:30
1:22
1:85
1:30
Scale 1:5000
0 100 200 300m
Lebir Hydroelectric Project
Kelantan, Malaysia
Japan International Cooperation Agency
Preliminary Study
Tualang General Layout
Rock Fill H.W.L 90m
Sept. 1980 Fig. 2-1-2



Lebir Hydroelectric Project Kelantan, Malaysia		
Japan International Cooperation Agency		
Preliminary Study Jeram Panjang General Layout Concrete Gravity NWL 90m		
Sept.	1980	Fig 2-1-3


N
Upstream Cofferdam
Downstream Cofferdam
Diversion Tunnel
Spillway
S. LEBIR
Saddle Dam 1
Saddle Dam 2
Scale 1:5000
0
100
200
300m
Lebir Hydroelectric Project
Kelantan, Malaysia
Japan International Cooperation Agency
Preliminary Study
Jeram Panjang General Layout
Rock Fill HWL 90m
Sept. 1980 Fig. 2-1-4



Lebir Hydroelectric Project
Kelantan, Malaysia

Japan International Cooperation Agency

Preliminary Study
Jeram Kiak General Layout
Concrete Gravity H.W.L 90m

Sept. 1980 Fig. 2-1-5

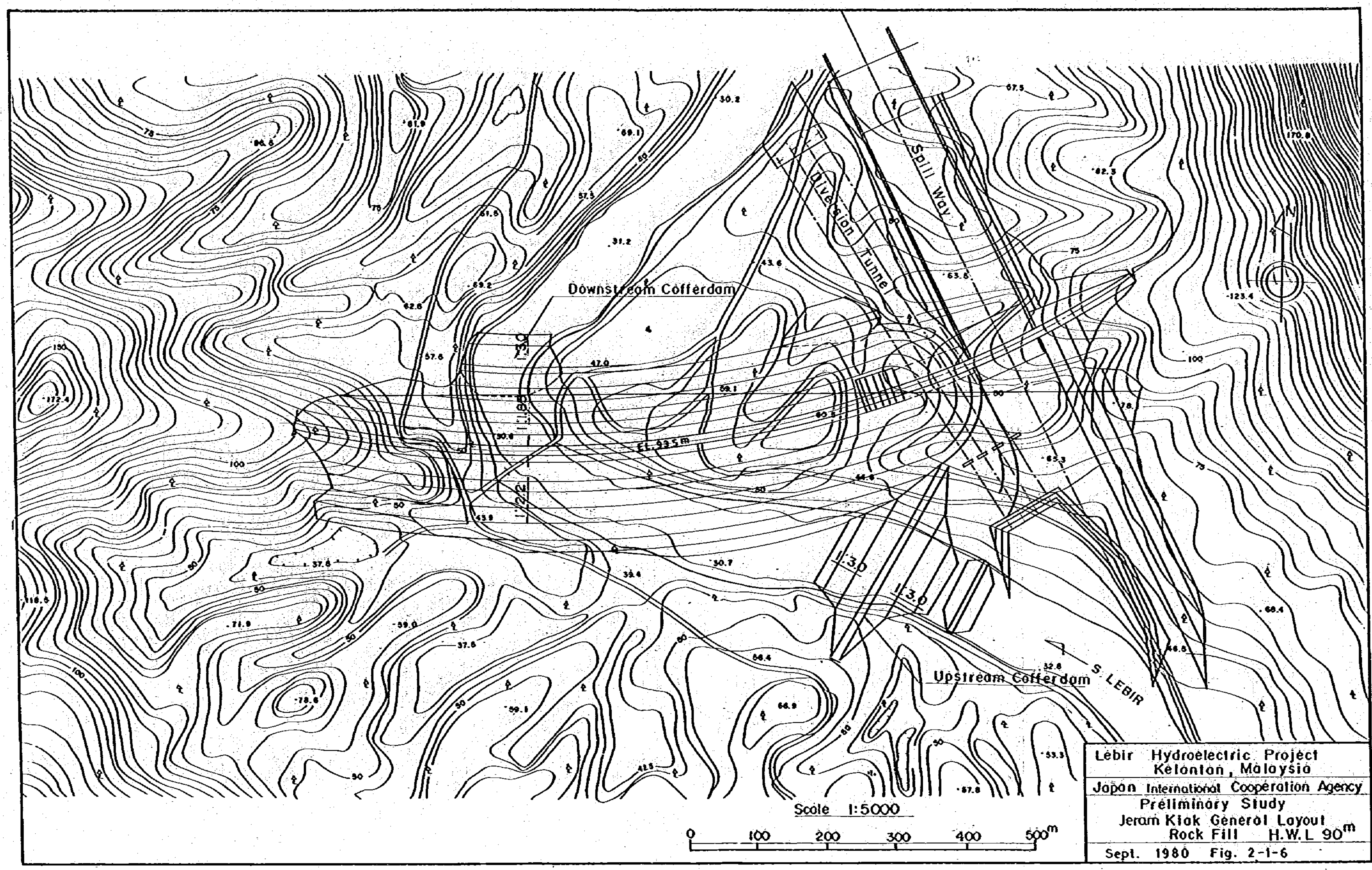

Spill Way
Diversion Tunnel
Downstream Cofferdam
El. 93.5m
1:3.0
1:1.85
1:2.2
1:3.0
1:3.0
Upstream Cofferdam
S. LEBIR
N
Scale 1:5000
0 100 200 300 400 500m
Lebir Hydroelectric Project
Kelantan, Malaysia
Japan International Cooperation Agency
Preliminary Study
Jeram Kiak General Layout
Rock Fill H.W.L 90m
Sept. 1980 Fig. 2-1-6

Fig. 2-2 Benefit/Cost Analysis

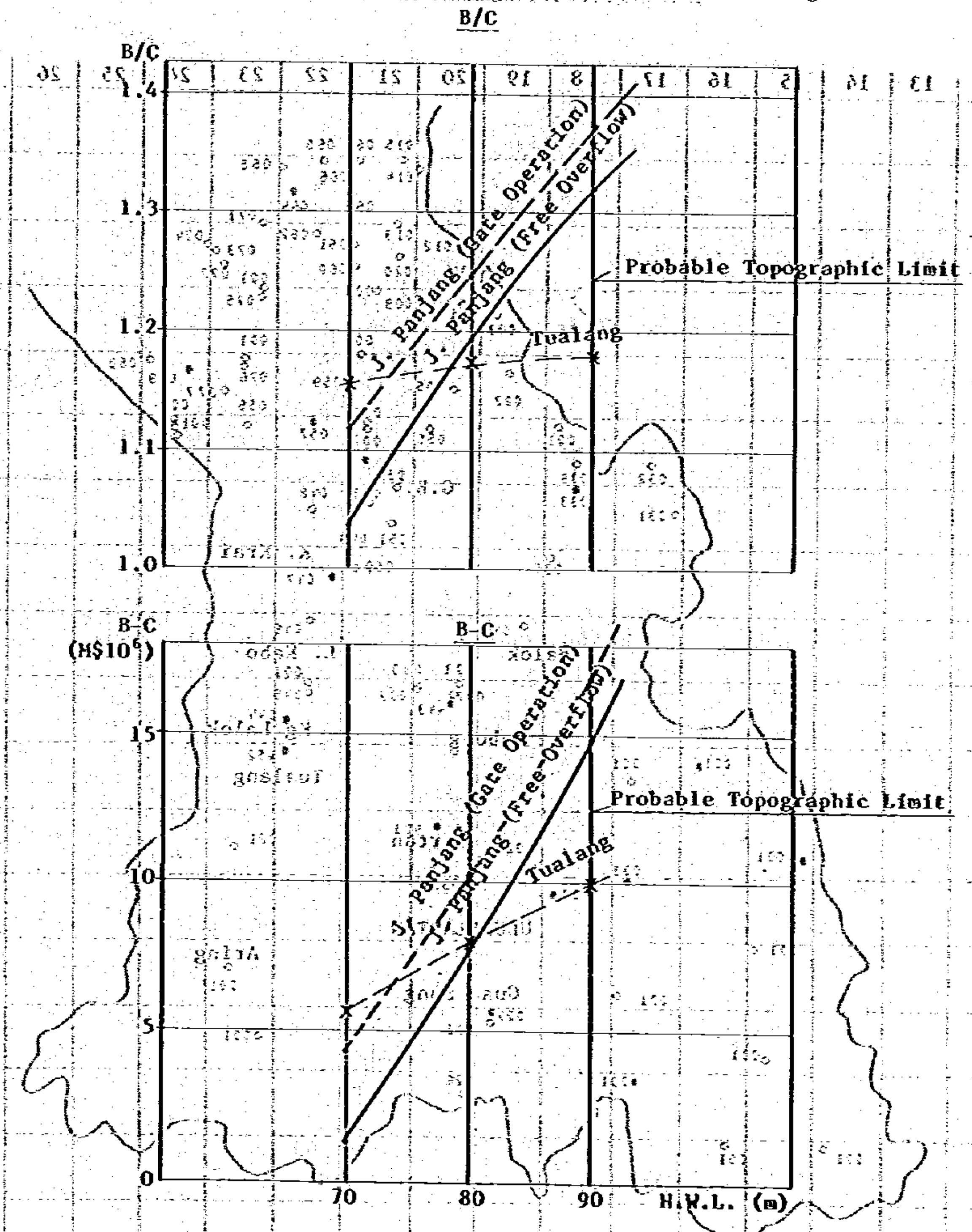


Fig. 3-1 Number and Location of Stations

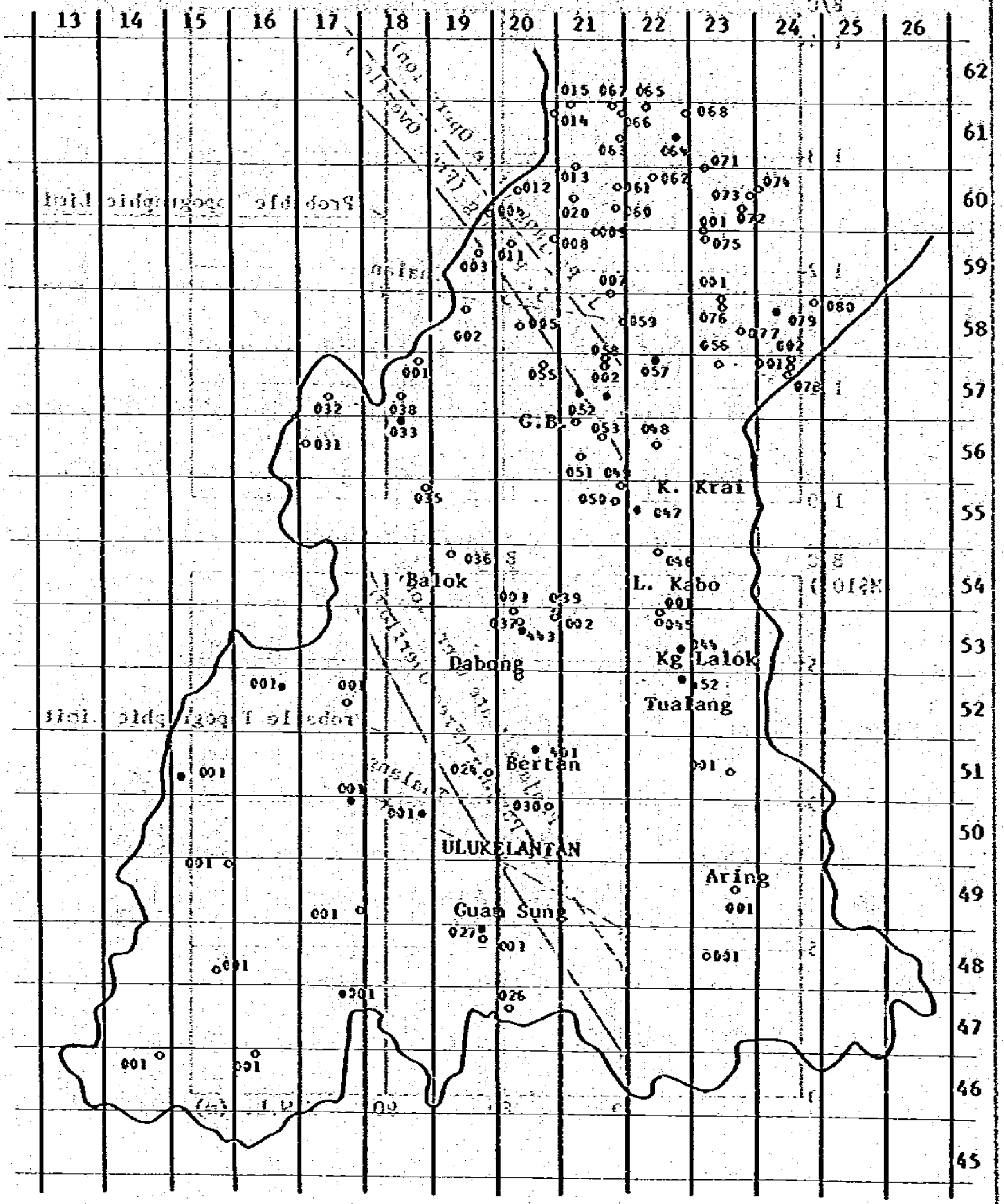


Fig. 4 - 1 Irrigation Projects (Existing and Proposed)

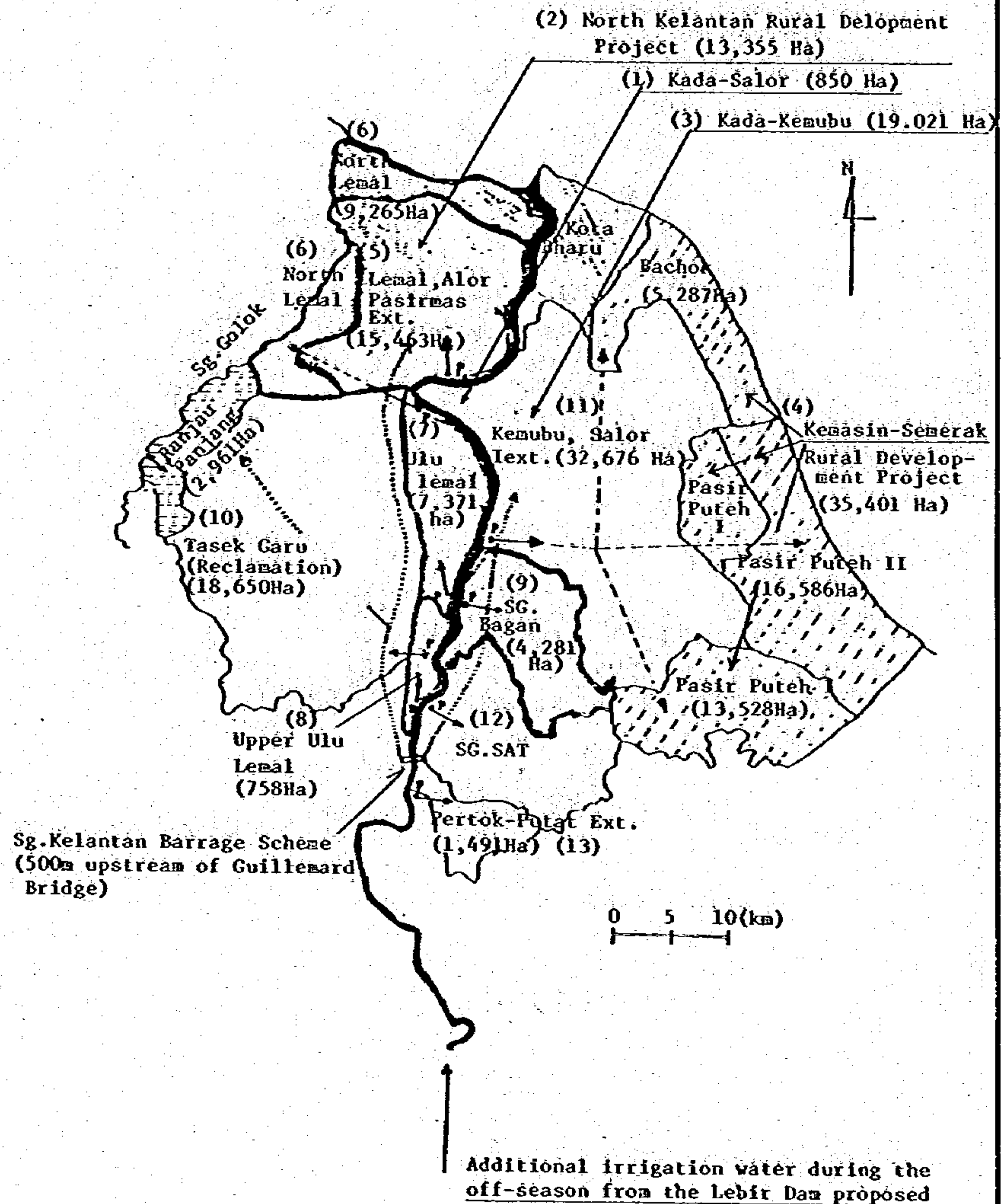


Fig. 4 - 1 Irrigation Projects (Existing and Proposed)

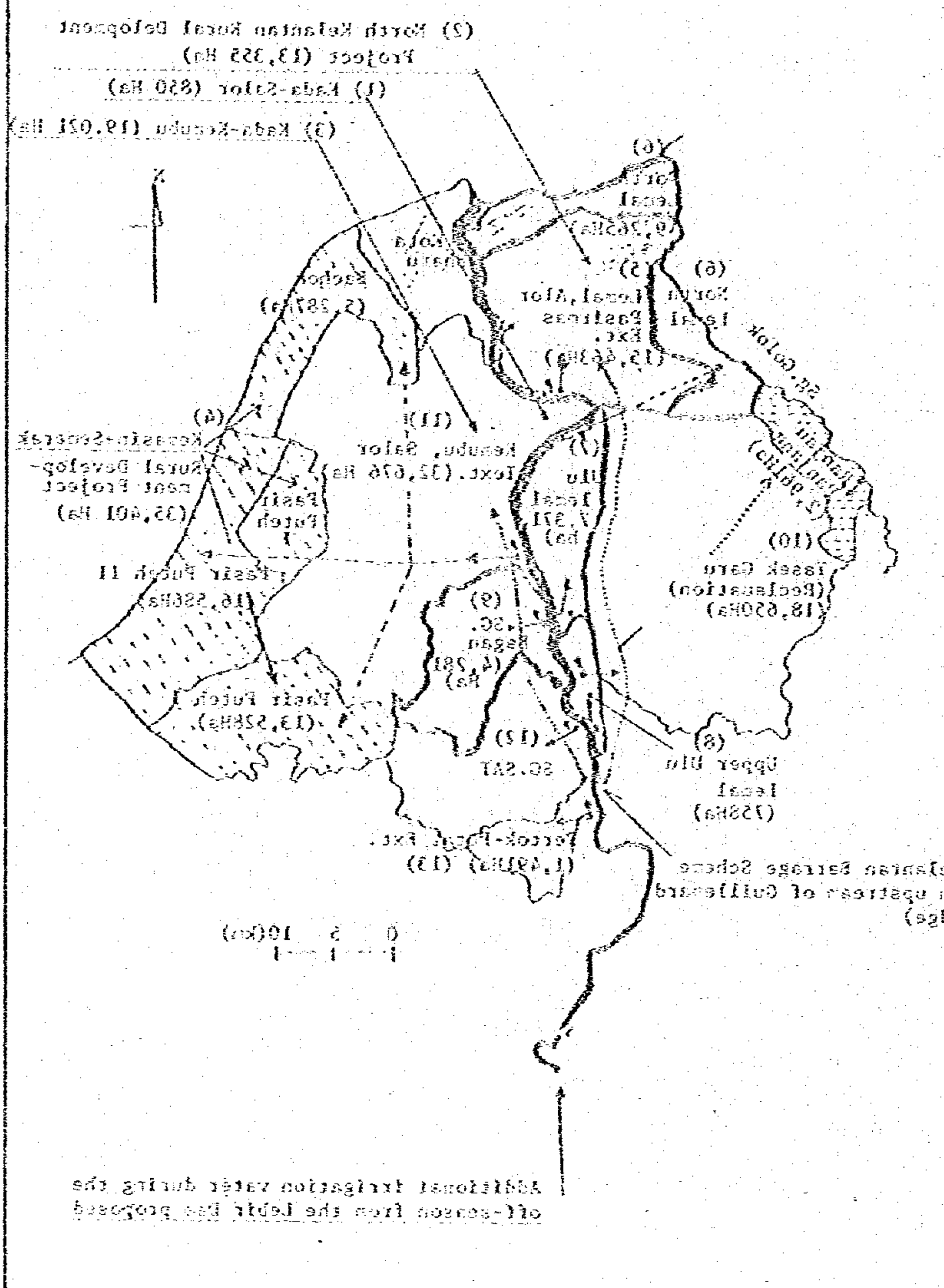
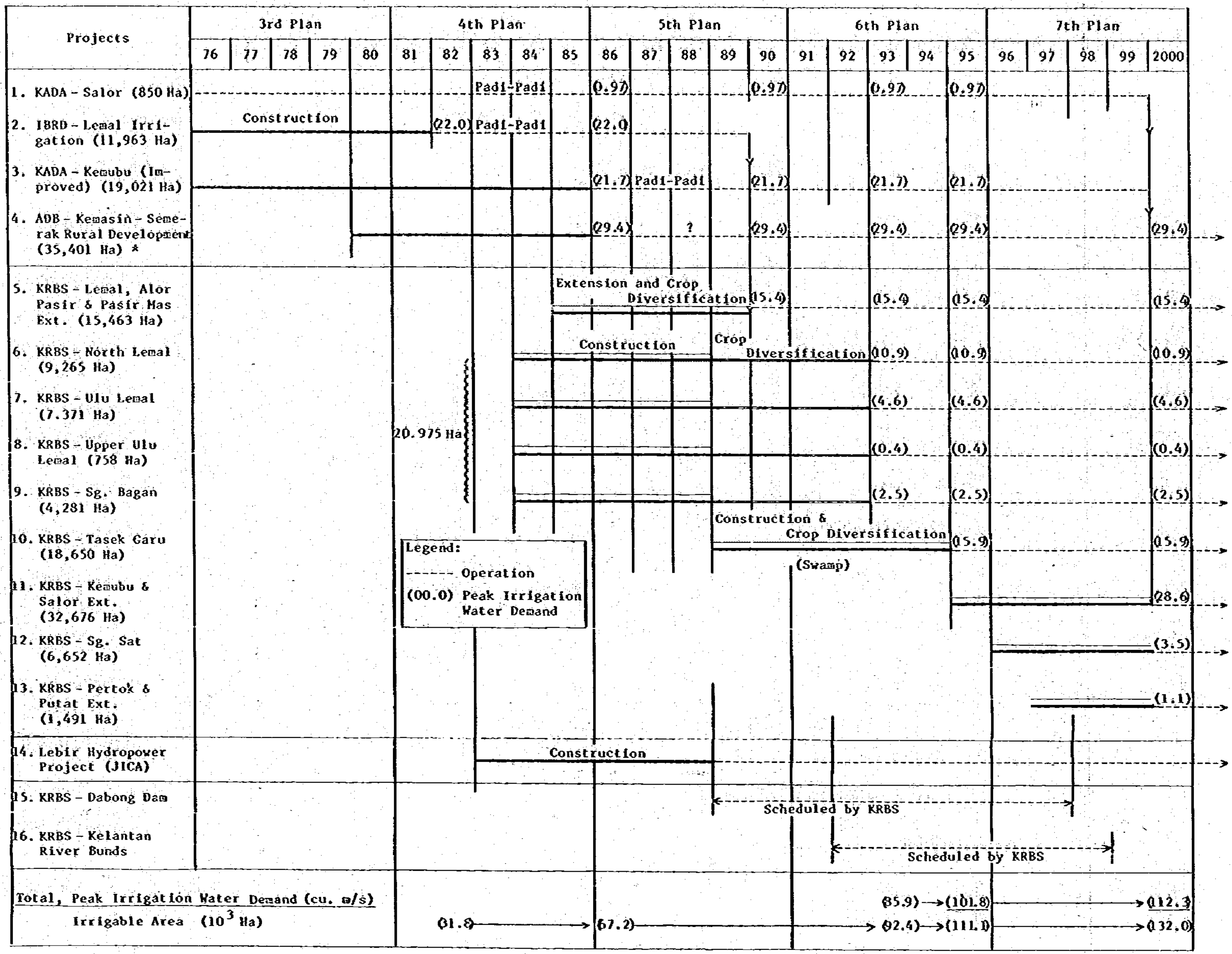
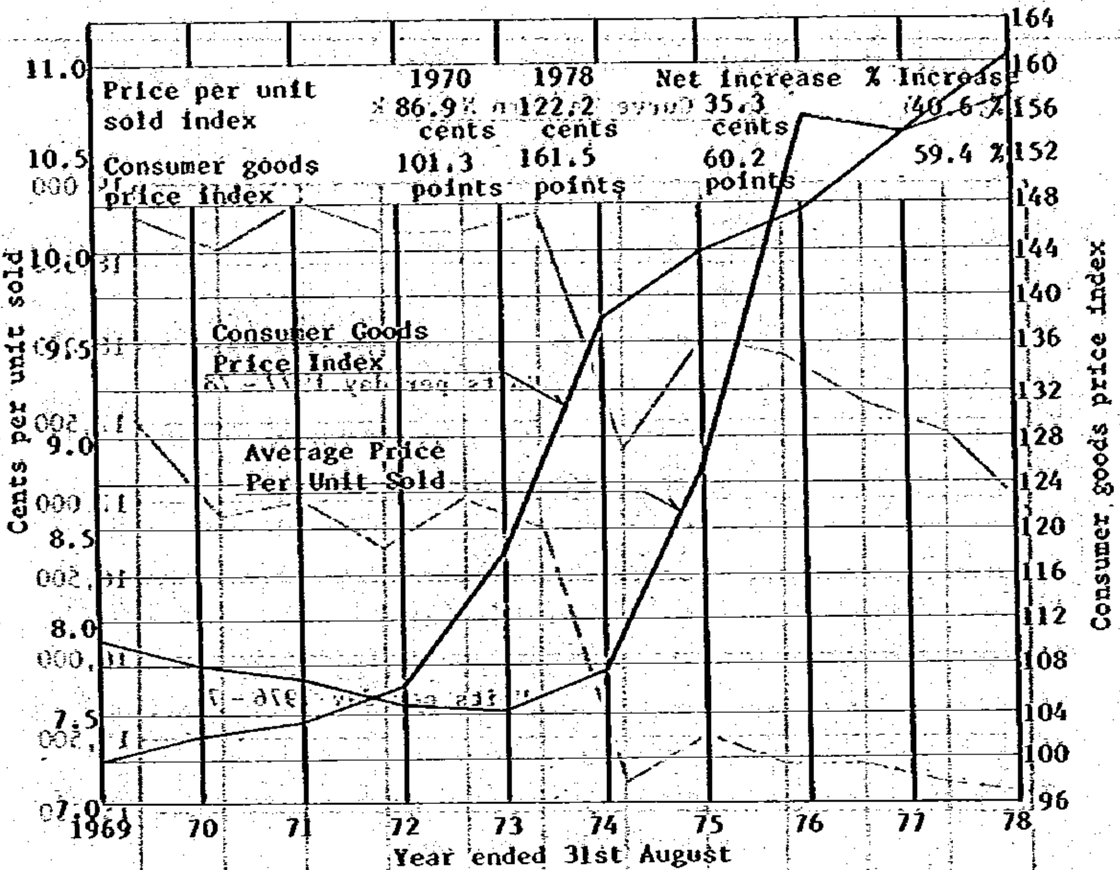


Fig. 4-2 Sequence of Development - Irrigation and Lebir Hydropower

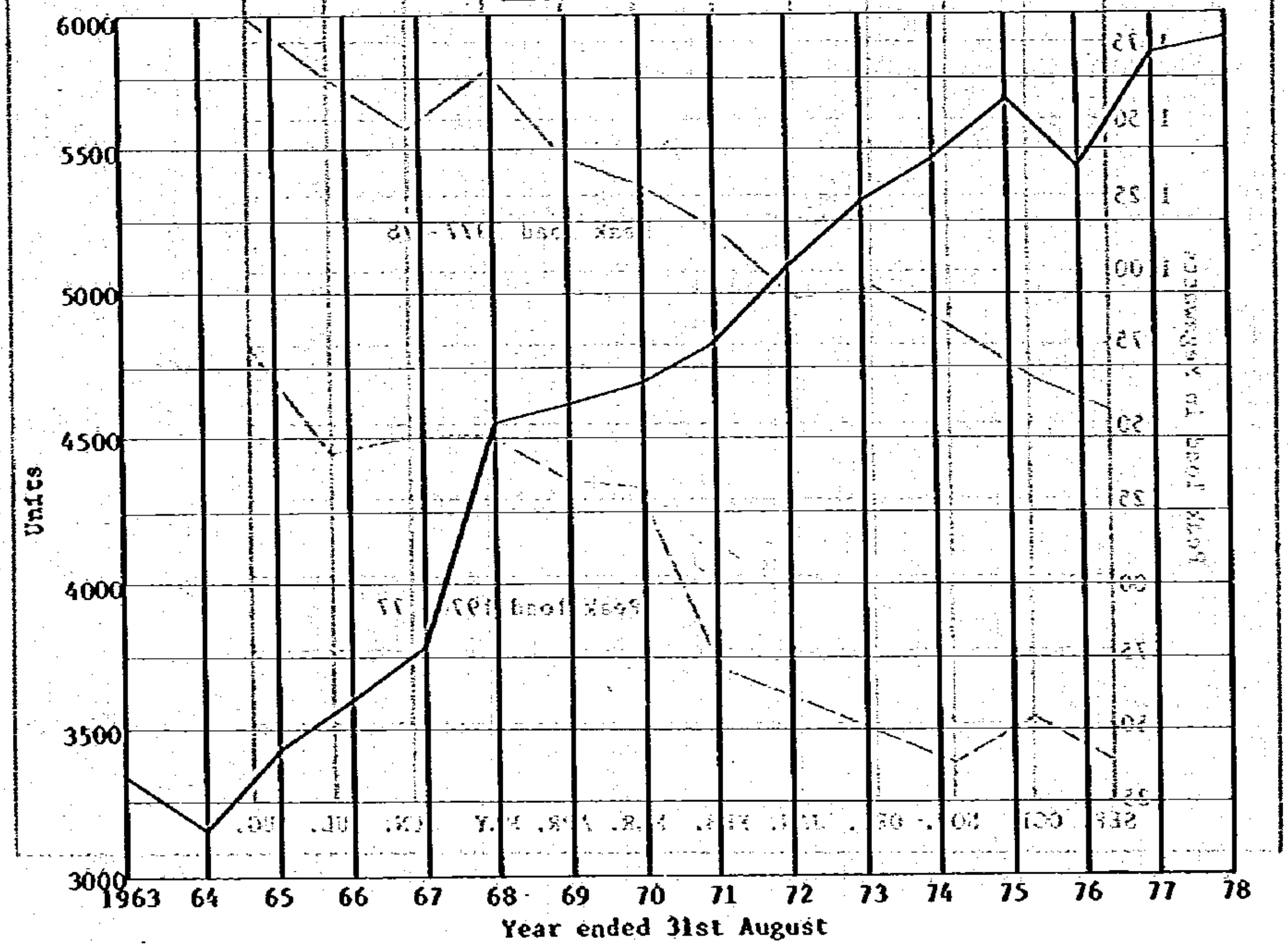


* Includes the KRBS Projects for irrigation (Bachok and Pasir Puteh, Stages I & II) and for drainage (sq. Machang Diversion, Lower Sg. Kemasin, Upper Sg. Semerak Diversion and Lower Sg. Semerak).

Fig. 4-3 Average Price Per Unit Sold in Comparison with Consumer Goods Price Index



Units Sold Per Consumer



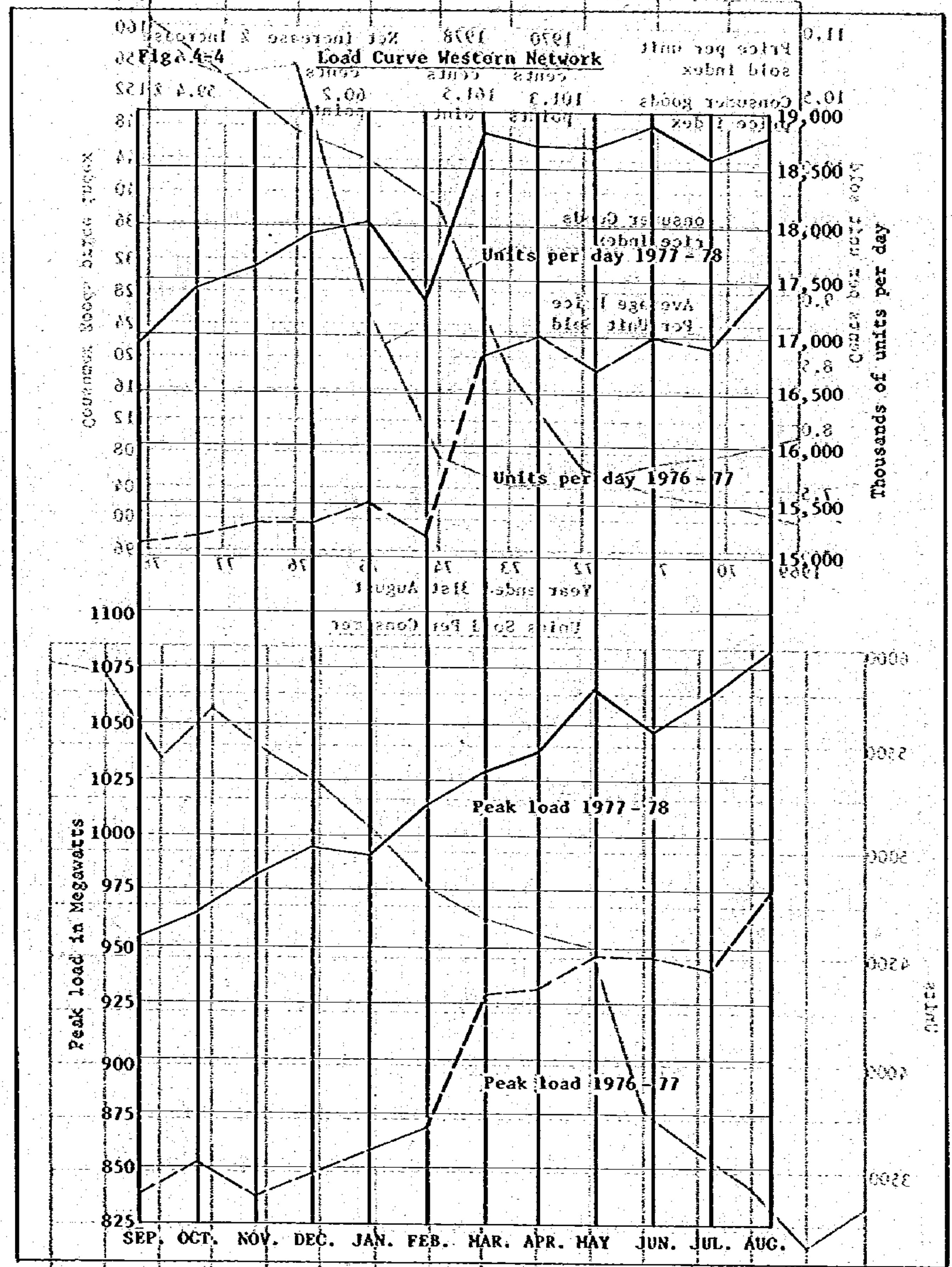


Fig.4-4 Load Curve Western Network

Fig. 4-5 Typical Daily Load Curves

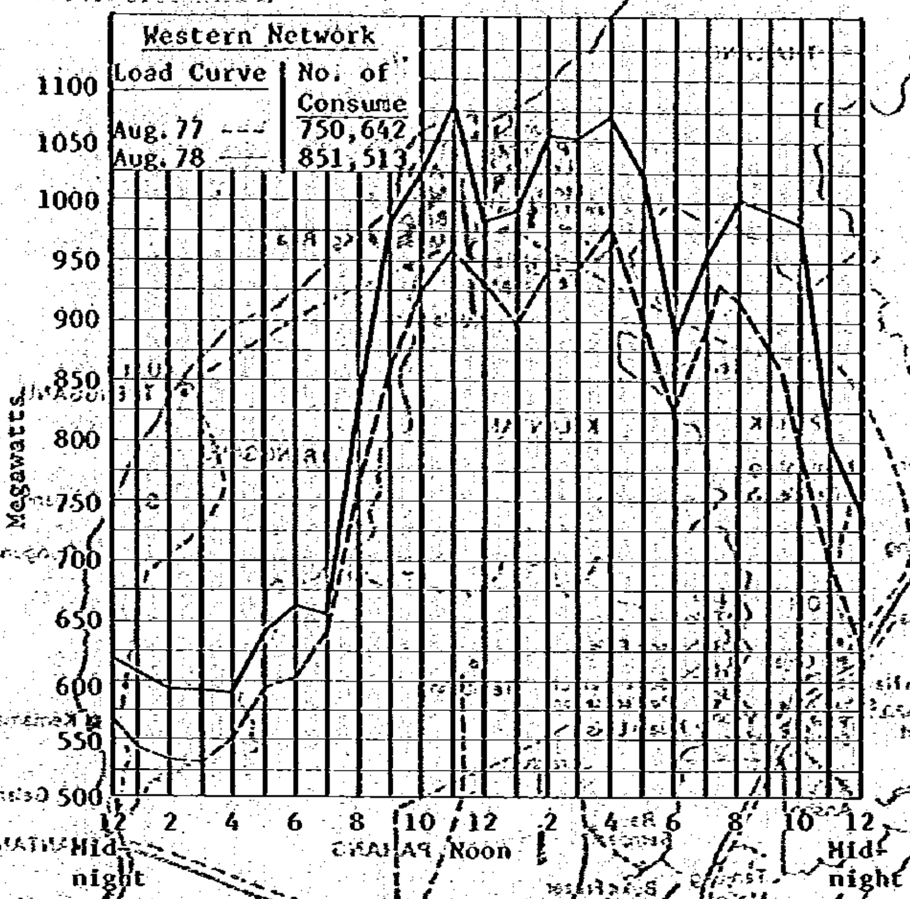


Fig. 4-6 Load Curve of Local Area

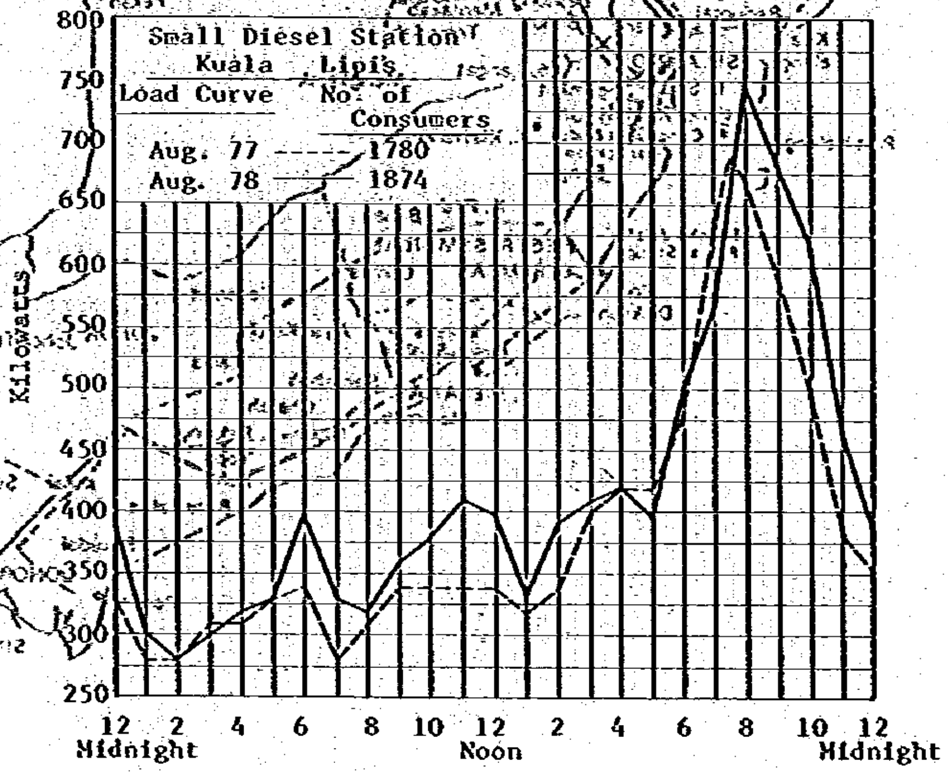
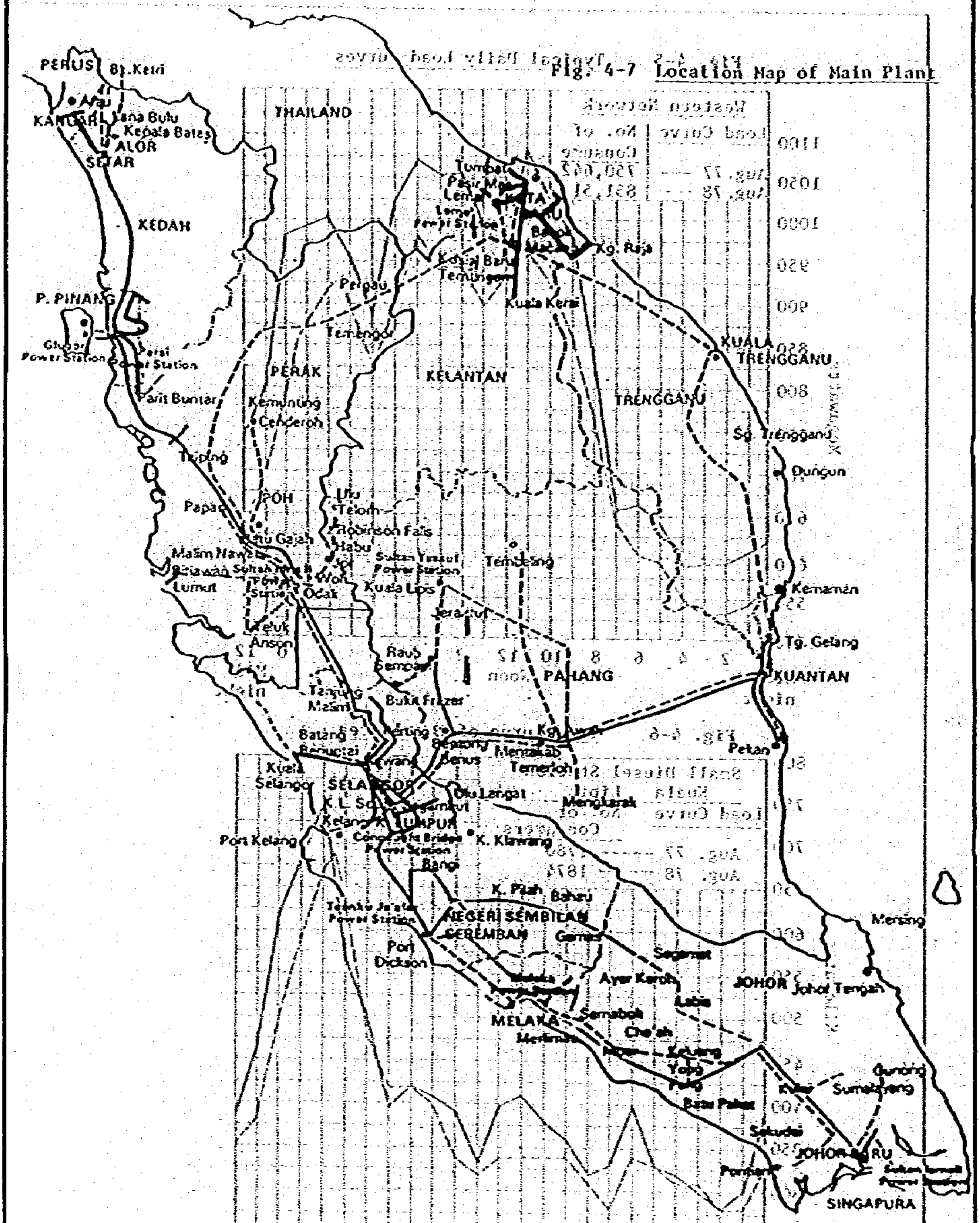


Fig. 4-7 Location Map of Main Plant



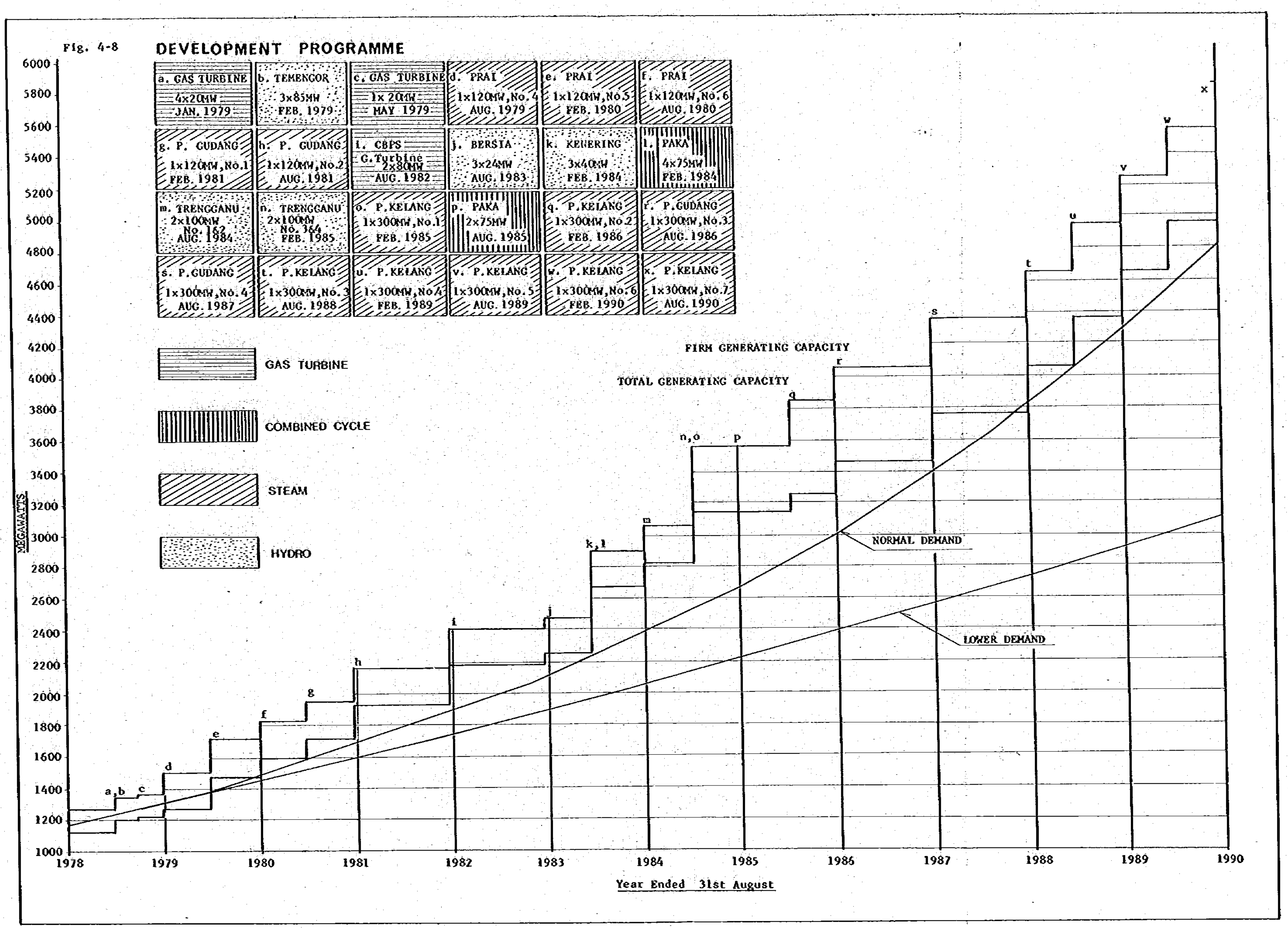


Fig. 4-8 DEVELOPMENT PROGRAMME

Fig. 6 - 1 Mean Monthly Rainfalls

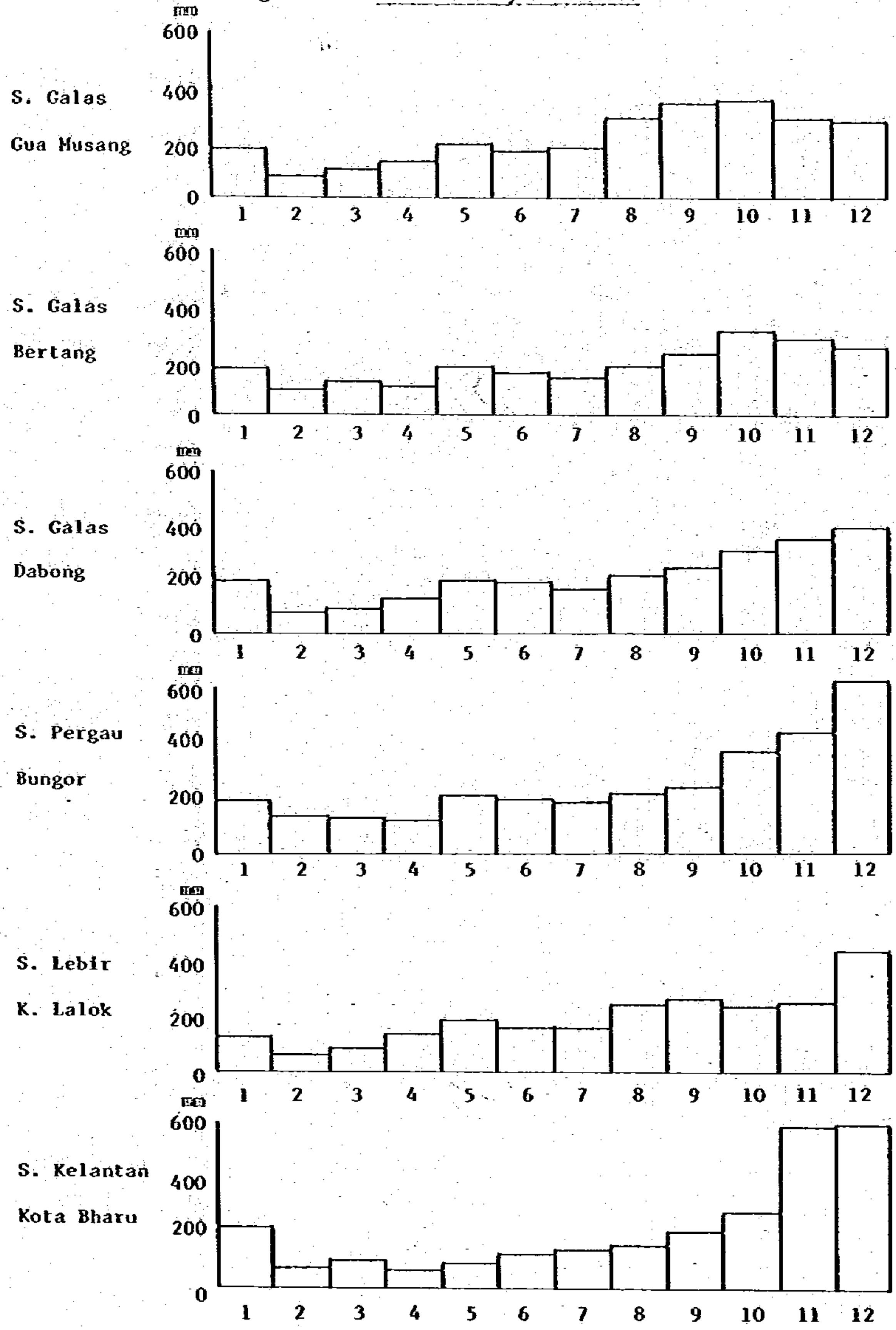


Fig. 6 - 1 Mean Monthly Rainfalls

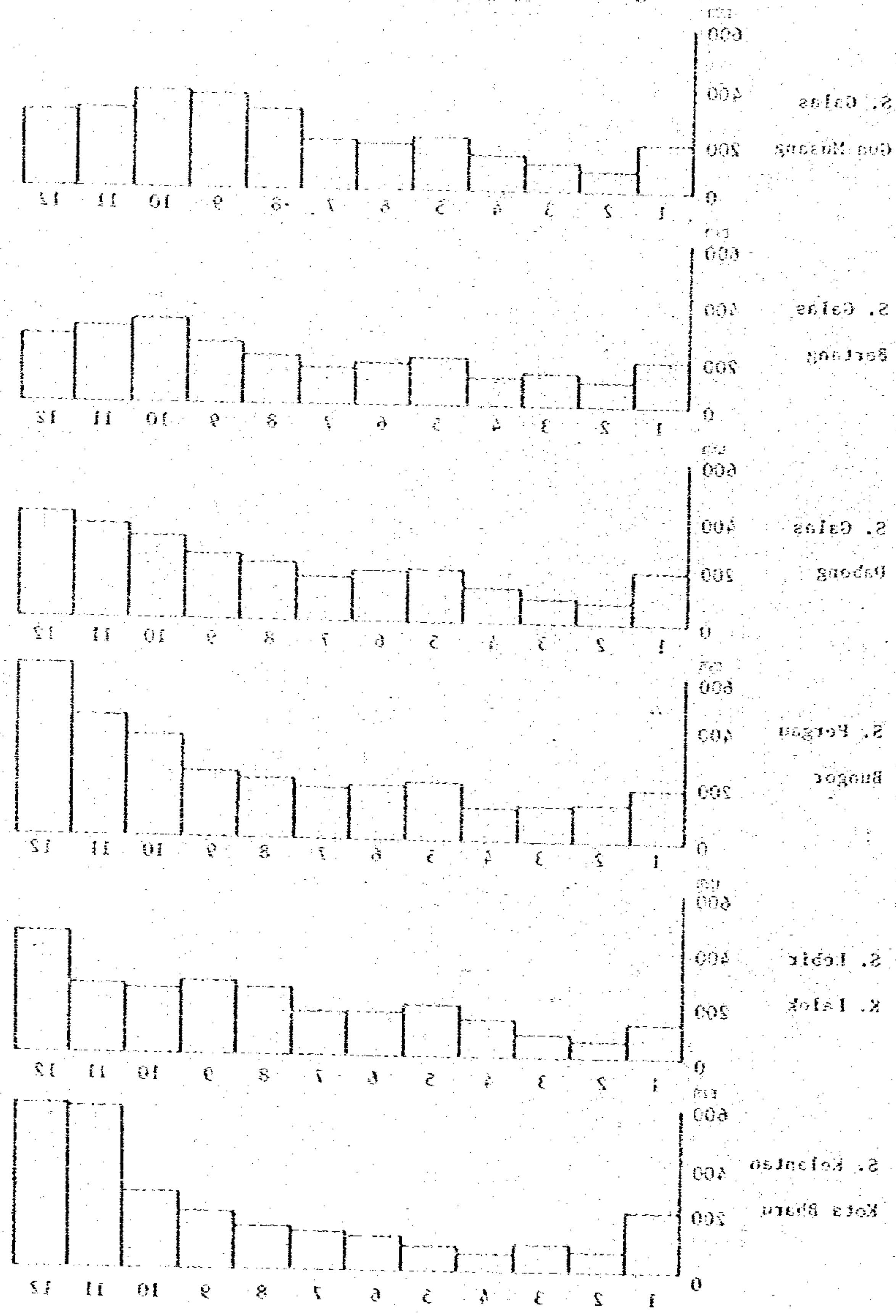


Fig. 6 - 2 Water Level - Discharge Curve (Tualang)

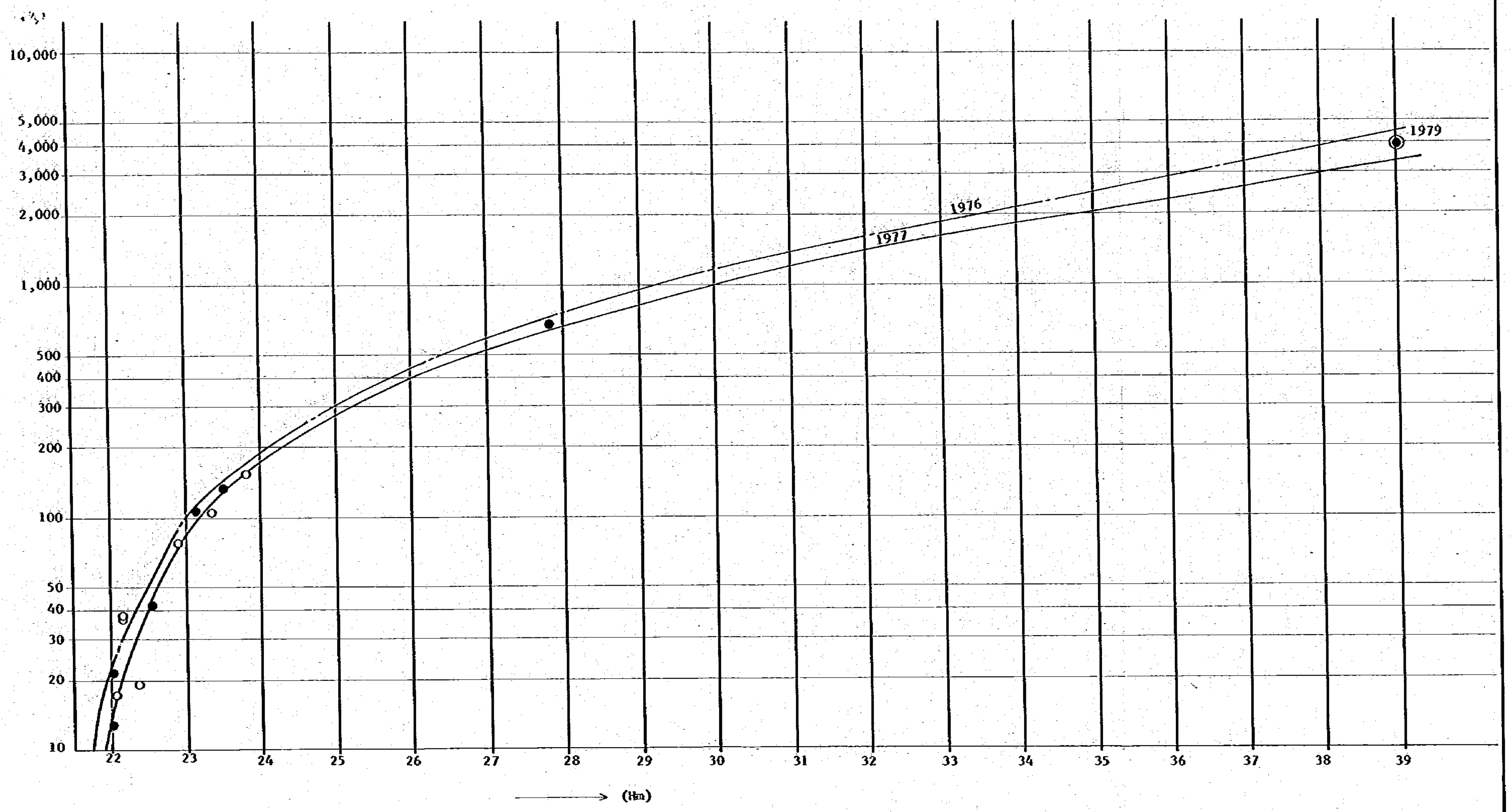


Fig. 6 - 3 Daily Discharge Cur

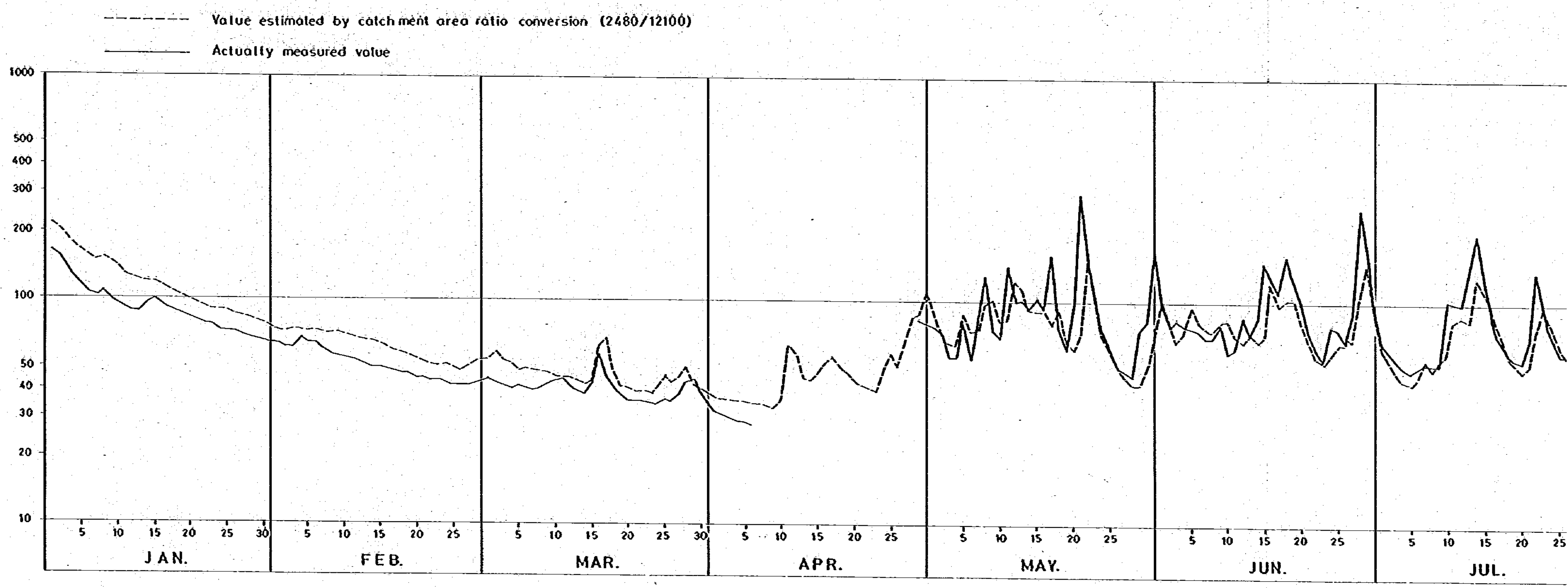


Fig. 6 - 3 Daily Discharge Curve at Tualang

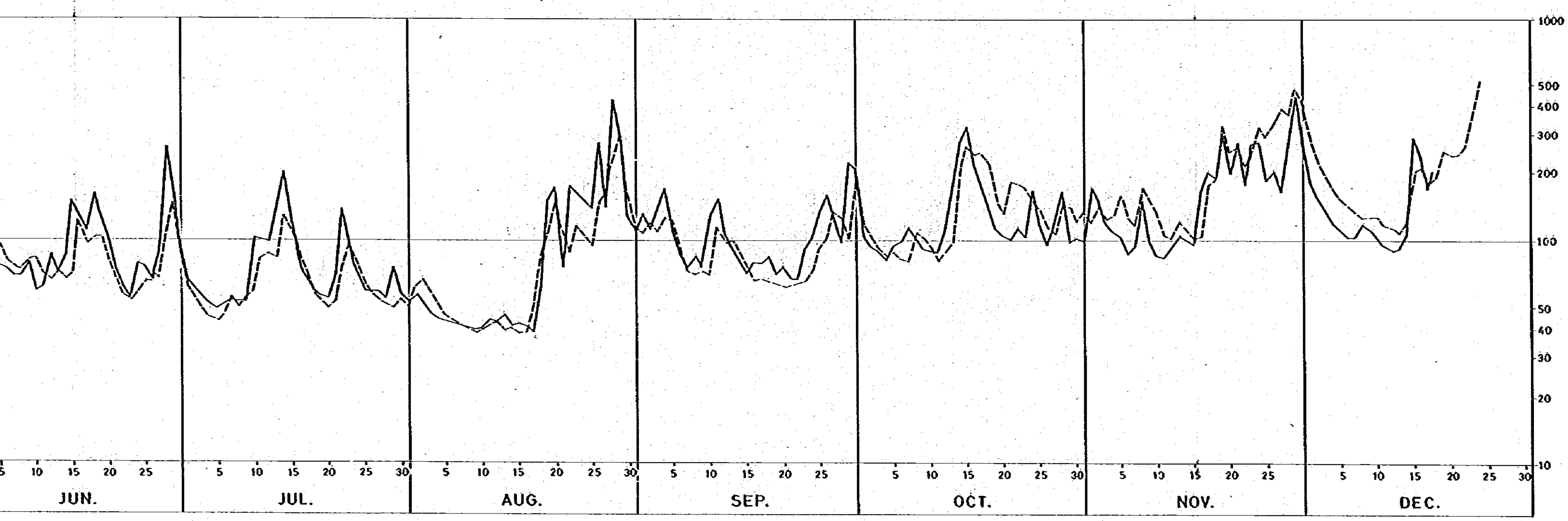
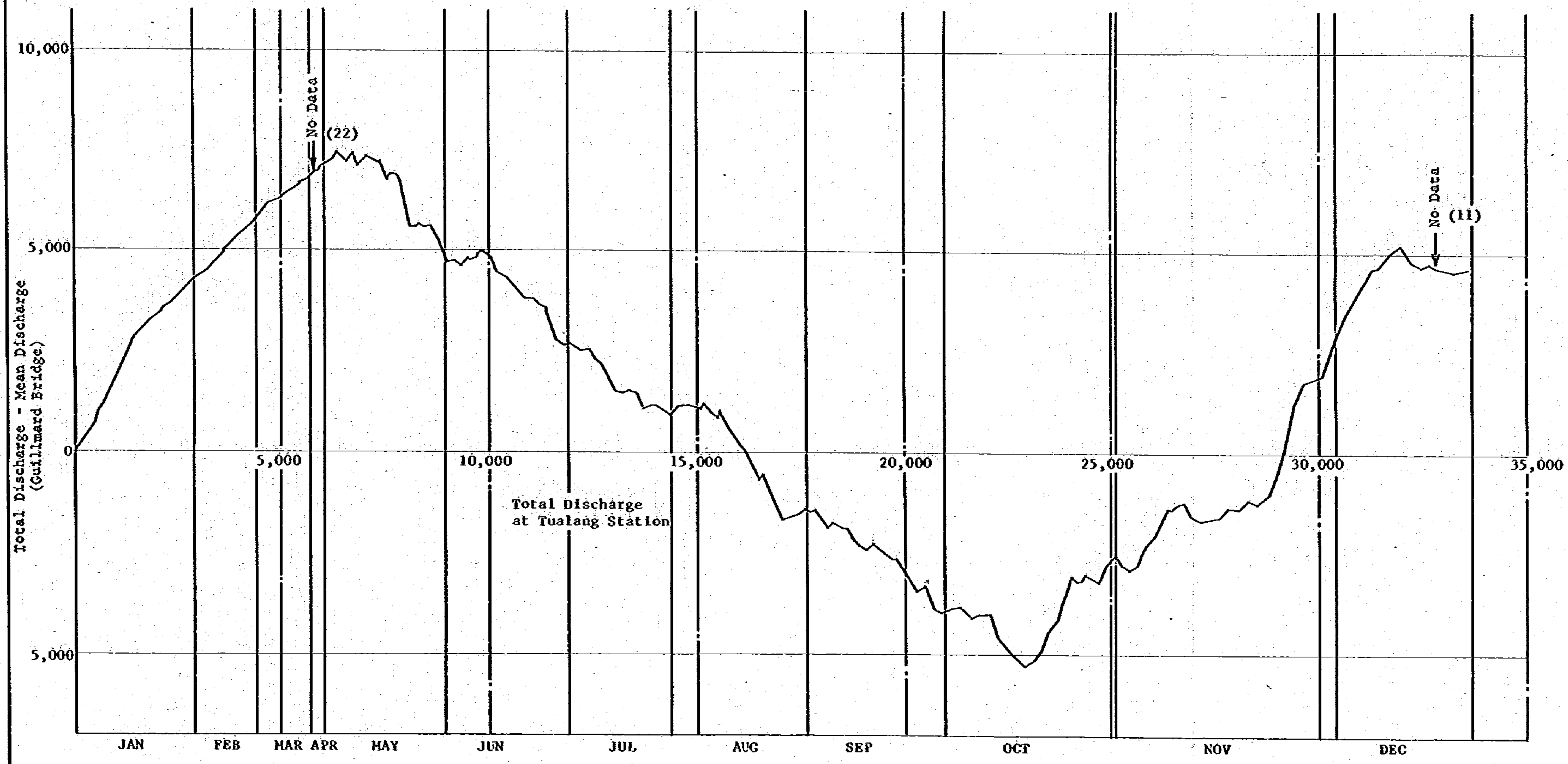


Fig. 6 - 4 Double Mass Curve



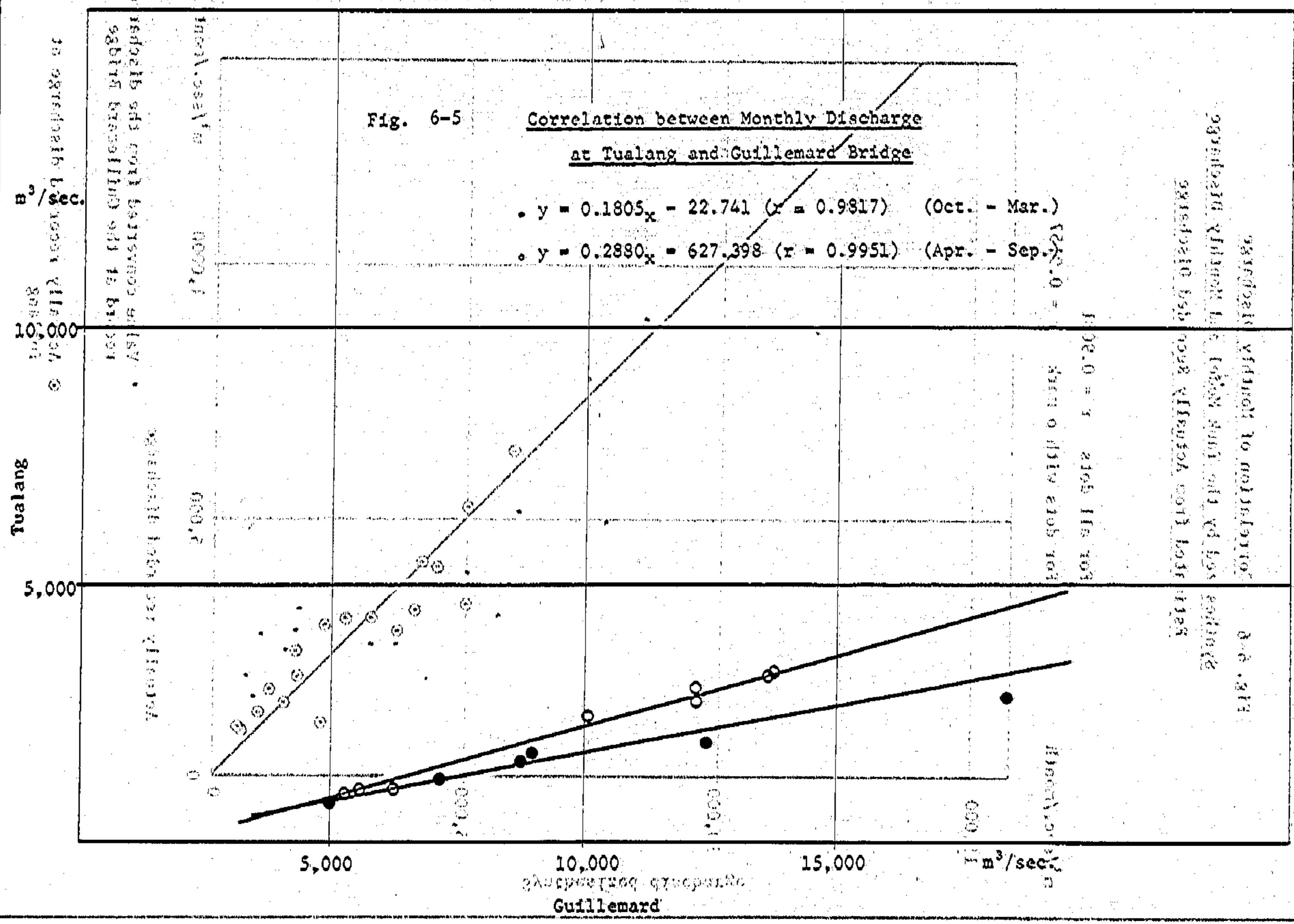


Fig. 6-5 Correlation between Monthly Discharge at Tualang and Guillemard Bridge

Fig. 6-6 Correlation of Monthly Discharge Synthesized by the Tank Model and Monthly Discharge Estimated from Actually Recorded Discharge

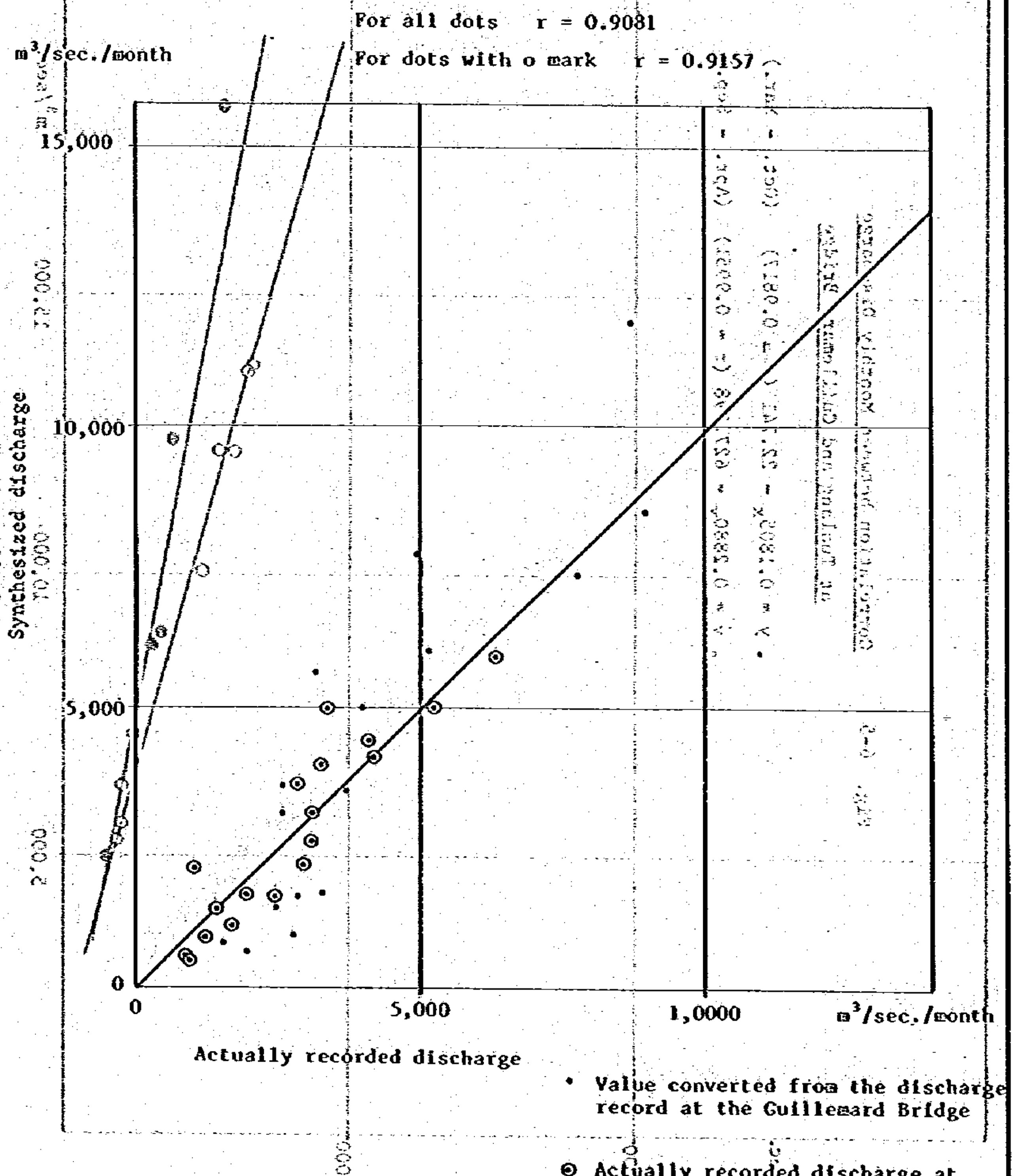


Fig. 6-7 Correlation of Peak Discharge at Tualang and the Guillemard Bridge

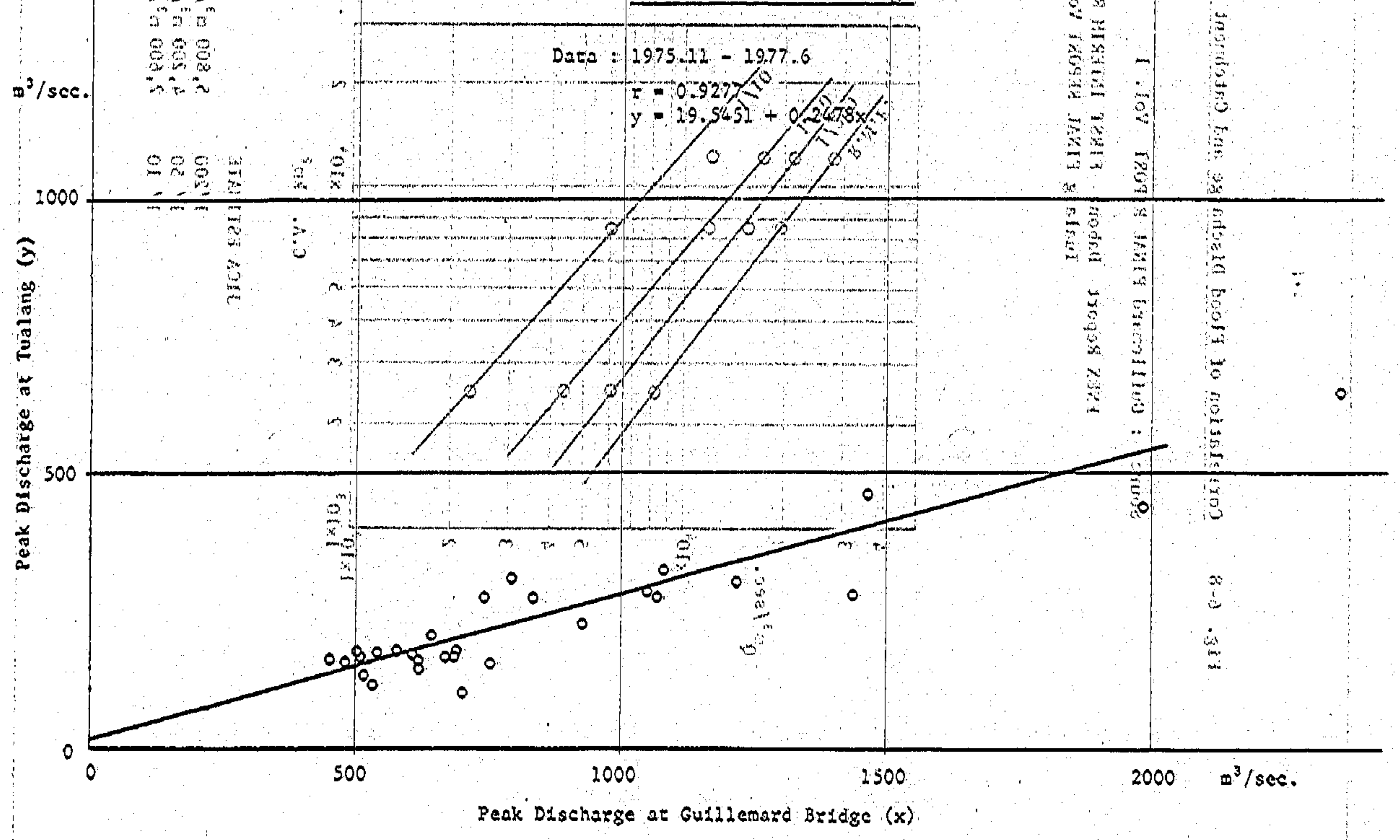
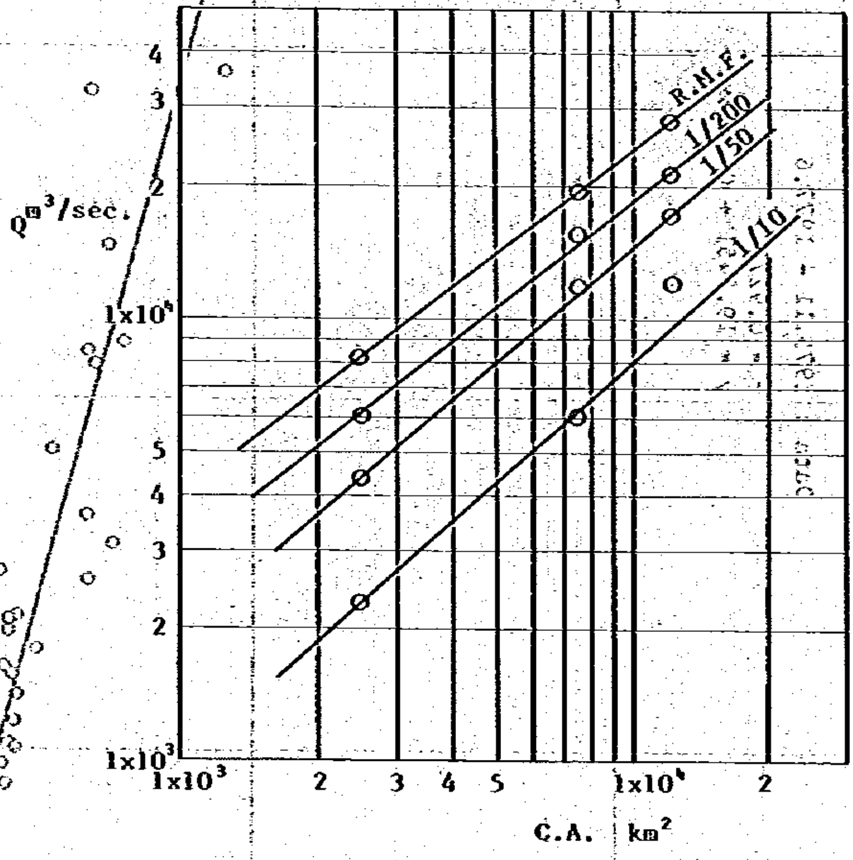


Fig. 6-8 Correlation of Flood Discharge and Catchment Area

Source : Guillemard FINAL REPORT Vol. 1

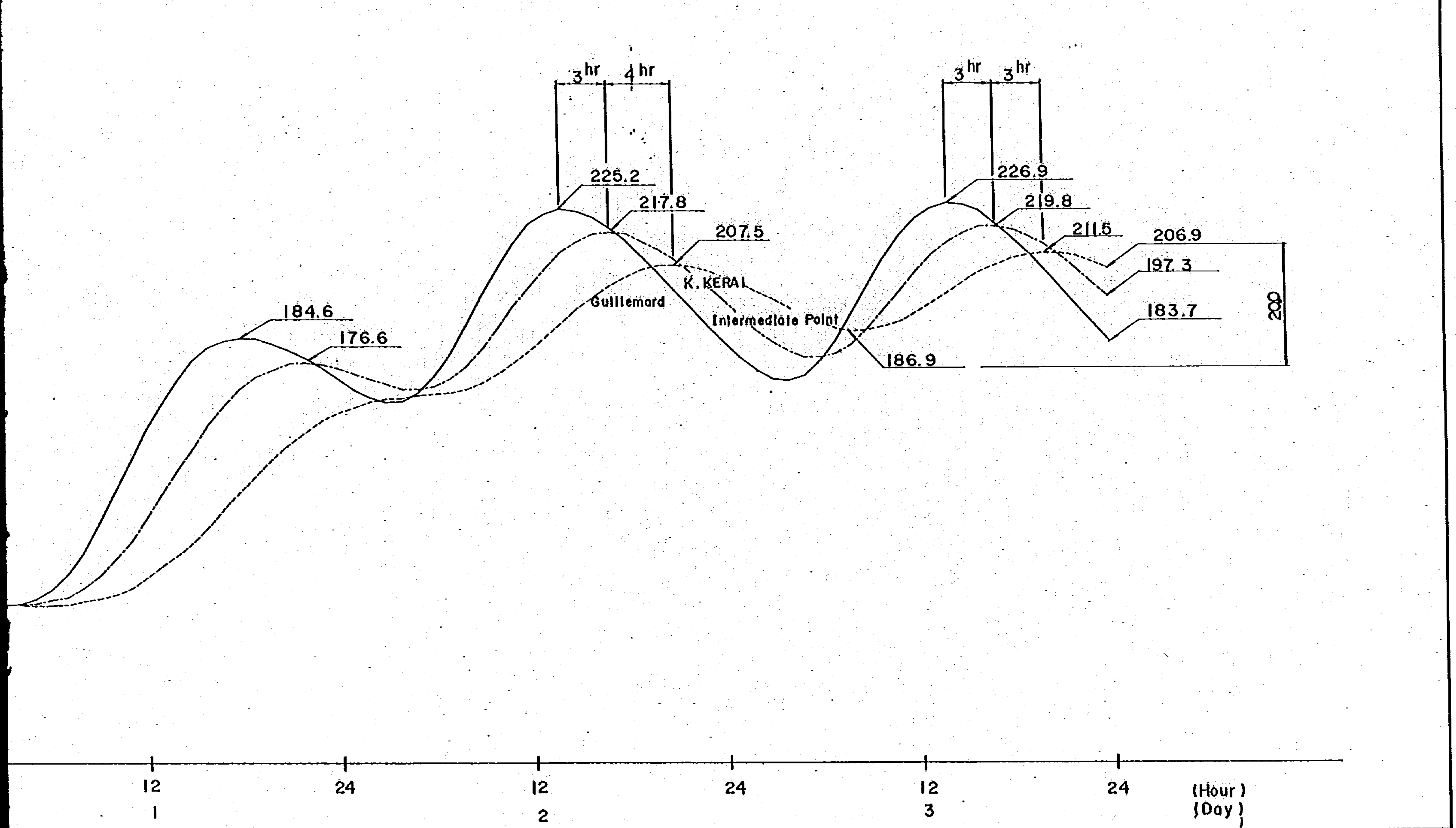
ENEX Report Dabong FIRST INTERIM REPORT P12
Tualang FINAL REPORT Vol. 3



JICA ESTIMATE

1/200	5,800 m^3/sec.
1/ 50	4,200 m^3/sec.
1/ 10	2,600 m^3/sec.

Fig 6-9 Discharge Fluctuation at the Guillemard Bridge QB = 100.0 m³/s



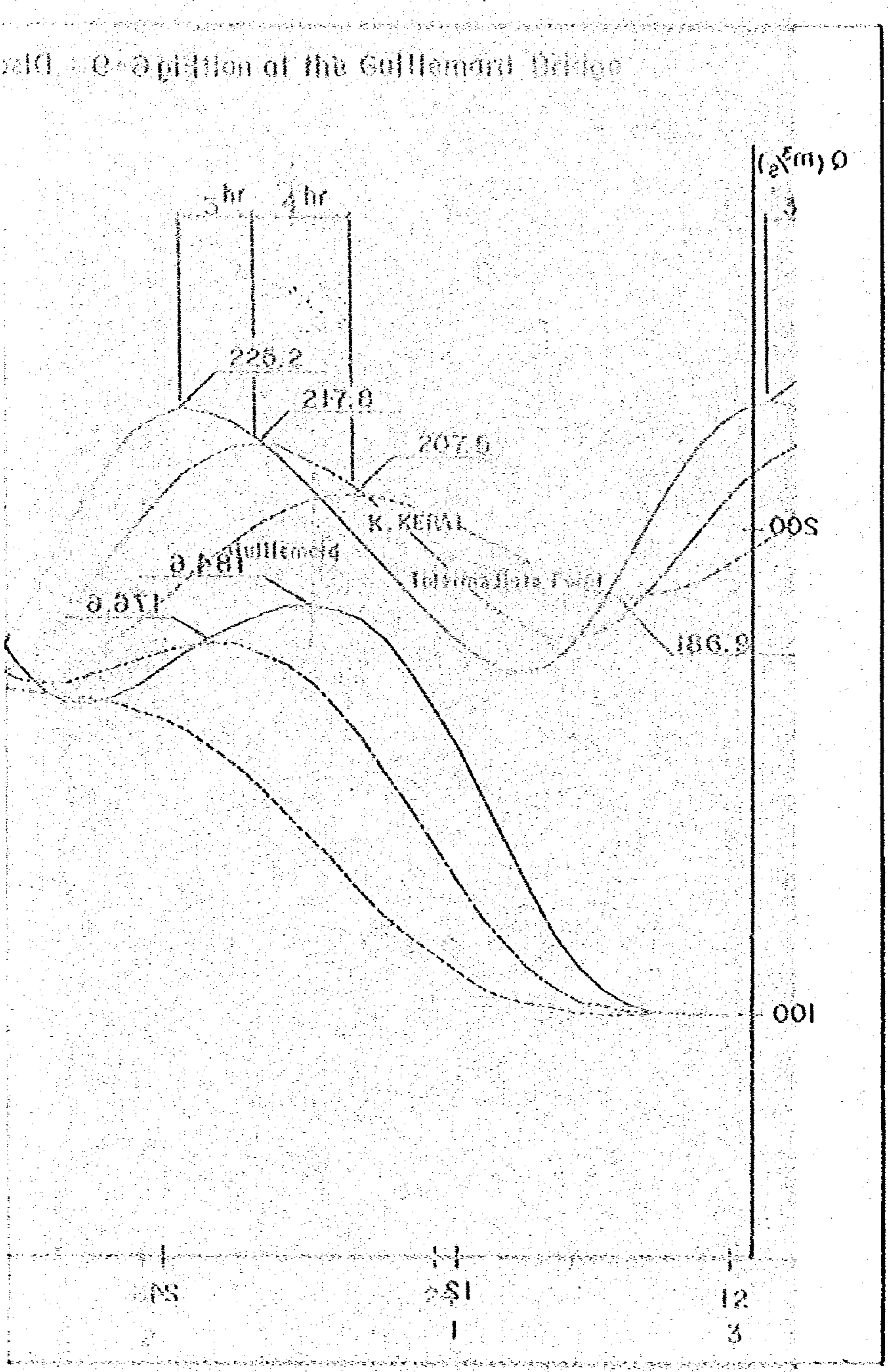


Fig. 7 - 1 Location of Water Quality Stations

(No. 642 and No. 652)