CHAPTER V PROJECT IMPLEMENTATION AND OPERATION

CHAPTER V PROJECT IMPLEMENTATION AND OPERATION

5.1 Project Organization

5.1.1 Executing Agency

RID, which is responsible for the overall planning, programming and execution of all major flood control and irrigation projects in the country, would be the Executing Agency for the implementation of the Project, with the assistance and cooperation of other Government agencies concerned in their respective fields.

In 1972, RID was transferred from the Ministry of National Development to the Ministry of Agriculture (the existing Ministry of Agriculture and Cooperatives) be responsible for both the construction and development stages of irrigation projects. RID is a large organization with about 8,900 officers, 39,200 permanent employees and 100,000 temporary employees. The Department is organized into a large number of administrative and technical divisions. Key technical and administrative staff would be assigned to the Project from their parent divisions.

The project organization will operate essentially as an independent division of RID but the line divisions would provide special technical support in certain fields like surveys, agricultural extension, marketing, operation and maintenance. A Director General of RID would be appointed as Project Director, and he would be responsible for overall direction of the Project within RID and coordination with other Government agencies and Departments. A Project Director would be in charge of RID's activities on the Project.

5.1.2 Project Office

A Project office will be established in the Project area reorganizing the existing Mae Kuang Project Office. A fully qualified and experienced engineer of a high rank at RID will be appointed as full-time Project Engineer.

The Project office would be adequately staffed for efficient Project implementation. In addition to RID, representatives of concerned agencies will be seconded to the Project Office, if required. These representatives will maintain technical liaison with their parent agencies. This organizational structure is the same as that adopted for implementation of major on-going irrigation projects at present. The Project Engineer would have the responsibility for ensuring timely preparation of specifications, calling for and evaluation of tenders, and negotiation and execution of contracts with the assistance of the consultants. Figure 5-1 illustrates the structure of the Project Office for implementation.

5.2 Construction Method and Schedule

5.2.1 Mode of Construction

Two modes of construction such as force account base and contract base have been studied. Construction works under the two modes are as follows:

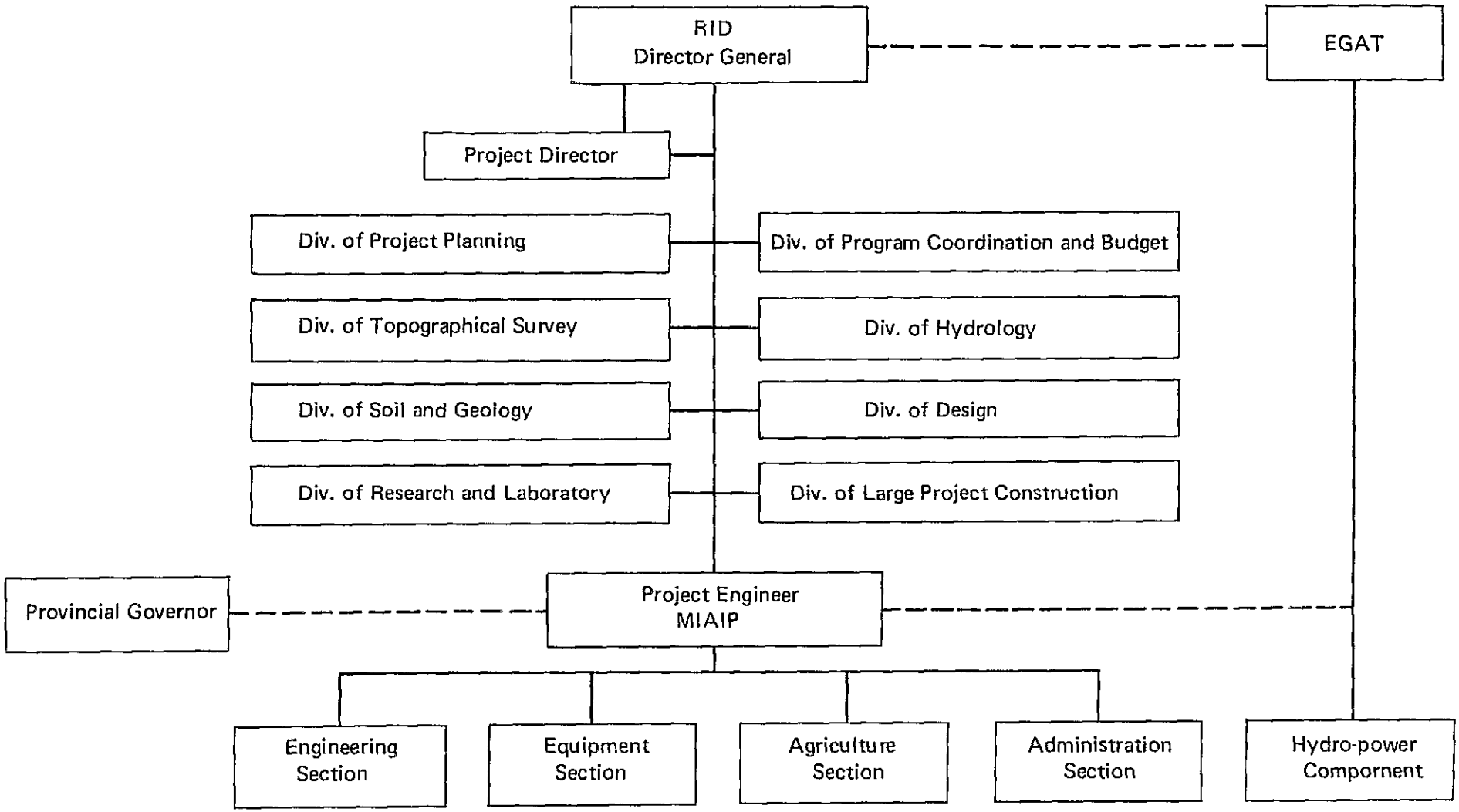
Mode of Force Account (Table 4-17)	Force Account: Construction Works Items	Left Saddle Dam	
		Main Dam	
		Right Saddle Dam	
		Spillway	
		Left Main Canal	(0 - 6.3 km)
		Right Main Canal	(0 - 9.5 km)
	Contract: Construction Works Items	Left Main Canal	(6.3 - 72.0 km)
		Right Main Canal	(9.5 - 15.4 km)
Mode of Contract (Table 4-18)	Contract: Construction Works Items	Main Dam	
		Right Saddle Dam	
		Spillway	
		Left Main Canal	(6.3 - 72.0 km)
		Right Main Canal	(9.5 - 15.4 km)
	Force Account: Construction Works Items	Left Saddle Dam	
		Left Main Canal	(0 - 6.3 km)
		Right Main Canal	(0 - 9.5 km)

5.2.2 Construction Method

a) Dam

Construction method of the dam can be almost same as what has been taken at the works of the Left Saddle Dam. Meanwhile, the fol-

FIGURE 5-1 PROPOSED ORGANIZATION CHART FOR PROJECT IMPLEMENTATION



lowing conditions should be considered beforehand in order to prevent and solve the future problems on the construction method.

Temporary Diversion: For the Main Dam construction, the temporary river diversion will be provided using the river outlet of which discharge capacity is only about 17 cu.m/sec under the water head of four to five meters. This amount is equal to the flood discharge of a 20-year return period in the dry season (December to March). Therefore, the embankment works in the wet season can be done only at high place where not to be flooded.

Outlet Works: Three outlet works would give many pieces of geological information to the coming dam works or would be big obstruction of that. And the back-fill works along the outlet is one of the most important works.

Stripping: Stripping depth at Left Saddle Dam was 0.75 meter on an average, while it shall be three meters on average and about eight meters maximum at Main Dam and one meter on an average at Right Saddle Dam.

Cut-off Trench (Core Trench): Size of trench has been planned to be six meters in width in the design by RID, but it will be widened as follows; 26 meters for Left Saddle, about 70 meters for Main Dam and 18 meters for Right Saddle.

Foundation Tretment: The new estimation of this works is also bigger than the original.

Core Embankment: For collection of core materials, the digging method should make the materials better in both quality and quantity.

Rock Embankment: For collection of rock materials, quarry sites in large scale such as by Bench Cut Method are required.

b) Irrigation Facilities

The construction areas are divided into three areas, that is,

Existing Irrigated Area, Left Bank Highland and Downstream Areas, and Right Bank Area. Furthermore, the Left Bank Highland and Downstream Area will be divided into Highland Area and Downstream Area, because of the following;

i) To be independent of each main canal route and its network;

ii) To complete the works efficiently in a short term, especially in Left Bank Highland and Downstream Area because Left Main Canal is extremely long.

The priority of the construction of irrigation networks in the area is as follows:

Priority 1: Left Bank Highland and Downstream Area
Priority 2: Existing Area
Priority 3: Right Bank Area

In deciding the above priority, the following have been taken into account;

i) Left Bank Highland and Downstream Area is such a large area;

ii) Irrigation water can be supplied from the reservoir to the area and Existing Irrigated Area, even though Mae Kuang Dam is under construction, on the other hand,

iii) Right Bank Area will be unable to use the irrigation water untill the complement of the dam works.

In principle, after clearing is completed, excavation and embankment works will start from the upstream side in each area according to the proposed cross section. Careful compaction is required at the embankment portion to avoid seepage or crumbling down.

5.2.3 Construction Schedule

Figure 5-2 shows the implementation schedule for the Project. It includes items of final design and procurement of construction equipment at the same time of Left Saddle Dam works.

5.3 Operation and Maintenance of the Project

5.3.1 Executing Agency and Organization

Existing Operation and Maintenance Office, RID, located at Amphoe Doi Saket covering 7,000 ha (43,750 rais) of irrigated area within single Amphoe Doi Saket would probably take over the responsibility for operation and maintenance of extended area now under consideration of construction.

The said extended area covers across the boundary of not only inside the Changwat Chiang Mai Administration but also even part of Amphoe Muang Lamphun. In context of complexity of Administrative Zone which should be covered by the O & M office, the O & M office should be better reorganized especially to have enough capacity to have good contacts with governmental agencies concerned at all defferent level of administrations. Under such presumable circumstance, it is suggested that:

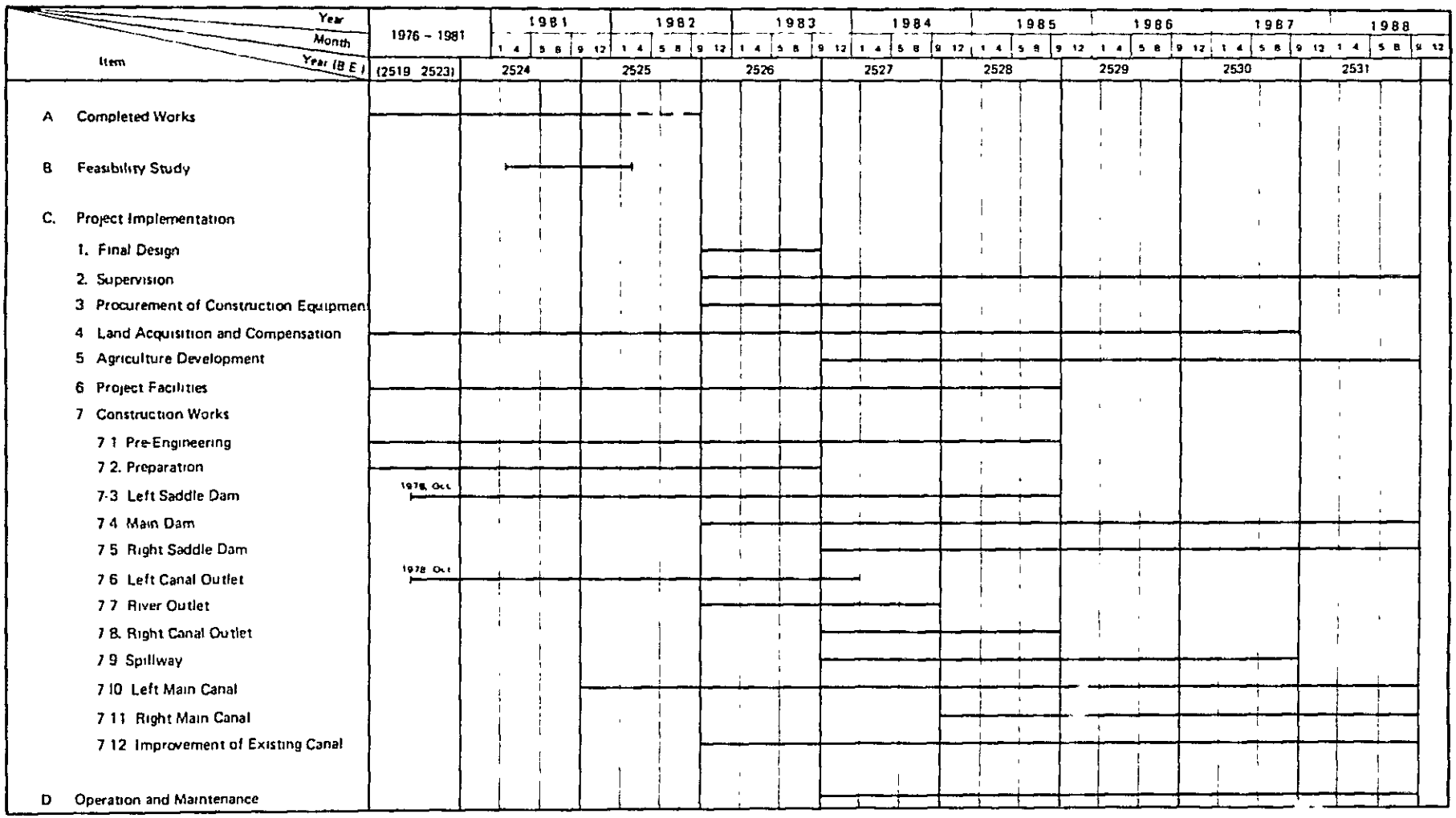
i) The head of O & M office has to be graded up to have good contact with Kaset Changwat at least.

ii) Special Liaison Unit responsibility of which is to have close contact with other governmental agencies concerned is needed to be created and attached to O & M office.

iii) Number of professional staffs of O & M office is required to be increased in well-balanced proportion with coverage of area.

iv) Number of Zone man (six Zone men are now posted to cover the irrigated area in the Existing Irrigated Area should be increased in same manner as well as in case of

FIGURE 5-2 IMPLEMENTATION PROGRAMME FOR THE PROJECT



professional staff of the O & M office. More intensified number of Zone man should be assigned to Left Bank Highland and Downstream Areas due to difficulty of their operational duties.

5.3.2 Function of Operation and Maintenance Office

The present O & M office, RID located at Amphoe Doi Saket will, in principle, be responsibility O & M works in future. The more complicated procedure, however, would be required among governmental agencies concerned and farmers.

Suggested procedure for water supply from the O & M office is such manner as described below:

i) Water supply plan is to be established by the O & M office, year by year based on storaged water depending upon weather conditions in the year.

ii) O & M office, first of all, informs the office concerned at Changwat level of available water supply as soon as possible.

iii) The offices concerned at Changwat level would make their own shares of water supply informed from the O & M office in consultation each other.

iv) In the case of Changwat Chiang Mai which has three Amphoes covered by the Project Area, offices concerned at Changwat level would make shares of water supply to each Amphoe involved in the irrigation project in consultation offices concerned in Amphoe level.

v) Other performers carried out now for distribution of water supply from RID canals to so called "Swan" could be applied enough as well.

vi) It would be better that coming O & M office would take over responsibility of maintenance of both main canals and

laterals instead of only main canals of existing O & M office. However, it seems to be a unexpected kind of constraint which must be over come.

5.3.3 Operation and Maintenance Costs

The operation and maintenance costs are summarized as follows;

Annual Operation and Maintenance Cost

Item	O & M Cost (฿ '000)	(฿/ha)
1) Salary and Wages	4,914	245.7
2) Equipment Operations	6,687	334.4
3) Materials and Supplies	6,819	341.0
4) Administration and General Expenditure	2,074	103.7
Total	20,494	1,024.8

Note: Detailed estimate is given in Appendix J-1.

5.4 Consulting Services

The Consultant's services for the implementation of the Project include those for final design and supervision of the project.

The Consultant's services are divided into the following three stages;

i) The final detailed design of the project as well as the preparation of tender documents. It will cover a 172 man-month period, 127 man-month for foreign consultants and 45 man-month for local consultants, starting from October 1982. The following highly qualified experts will be employed;

- Team Leader
- Hydrologist
- Irrigation Engineer
- Engineering Geologist

- Soil Mechanical Engineer
- Design Engineer (Dam, Canal, Structure, Power, Architecture)
- Mechanical Engieer (Equipment, Power-Plant)
- Construction Planner
- Cost Estimator
- Specialist for Tender Documents
- Specifications Writer
- Agronomist
- Economist
- Surveyor

ii) Tendering, construction supervision and training of local counterpart personnel in all aspects of the Project activities. The service period would cover 481 man-month, 238 man-month for foreign Consultants and 243 man-month for local Consultants, from October 1982 to December 1988. The required experts are as follows;

- Team Leader
- Project Engineer
- Dam Engineer
- Canal Engineer
- Egnineering Geologist
- Soil Mechanical Engineer
- Mechanical Engineer (Equipment, Power Plant)
- Economist
- Surveyor

iii) Supporting services and management. It will start from June 1985 and cover 119 man-month, 45 man-month for foreign Consultants and 74 man-month for local Consultants. The following highly qualified experts will be engaged;

- Agronomist
- Extension Service Expert
- Water and Farm Management Expert

The Terms of Reference for the Consultant's services and the proposed schedule for them are given in Appendix J-2.

CHAPTER VI ECONOMIC JUSTIFICATION AND FINANCIAL ANALYSIS

CHAPTER VI ECONOMIC JUSTIFICATION AND FINANCIAL ANALYSIS

6.1 Introduction

The economic justification of a project is to assess the net benefits passed on the society by the project. The assessment of the net benefits must encompass a wide variety of elements and at the same time must take the following items into consideration.

i) Not only direct benefit and cost but also even indirect benefit and cost if any must be included in the calculation.

ii) Latent value is utilized.

iii) Discounted cash flow method is utilized.

The economic justification is divided into two, namely: i) B/C ratio and ii) Economic Internal Rate of Return (EIRR). Presently, the Economic Internal Rate of Return is mainly used as the main indicator of the economic worth of a project. Economic Internal Rate of Return means that a particular rate of discount which will equate the present value of net economic benefits to that of the economic costs of the project.

A sensitivity test is conducted taking into account some "key factors" which may significantly affect the final outcome, such as i) the output, ii) the price of important output and input items, and iii) the foreign exchange rate in some special cases.

Economic justification and related studies for the Mae Kuang Irrigated Agricultural Development Project are conducted in accordance with the methodology mentioned above and that authorized by international lending agencies.

6.2 General

The economy of the Mae Kuang Irrigated Agricultural Development area is less developed than central parts of Chaing Mai valley, and development of the area is given priority by the Government, in line with the emphasis concurrently on integrated rural and agricultural development.

The Project is intending to develop 20,000 ha of the field for the stabilization of the agricultural production, the creation of the employment opportunities and the improvement of the living environment for a higher living standard of farmers. To achieve the object, the construction of Mae Kuang dam and its related facilities is required. Construction works of the Project consist of Mae Kuang dam and reservoirs, main canal and related facilities. The investment for the Project is surely justifiable in terms of the net value added to the national and regional economy, the benefits to farm families and other socio-economic benefits.

6.3 Economic Justification

6.3.1 Economic Costs

The economic costs of the Project are estimated at 2,521,441 million Bhat at 1980 prices which includes the total investment cost except the allowance for land acquisition, taxes and duties and price escalation. Operation and maintenance costs (17,420,000 Baht per year from 1991/92 onwards) are calculated separately.

6.3.2 Economic Benefits

a) Major Direct Benefits

The major direct benefits to evolve from the Project will be substantial increase in agricultural production and the resulting in the increased income and employment opportunities for some 14,300 farm families. Apart from the agricultural benefits, benefits derived from flood control, power generation, etc. are considered as direct benefits.

b) Agricultural Benefits

As mentioned above, the agricultural benefits are the major direct benefits derived from the Project. The agricultural benefits attributable to the Project are mainly in the form of incremental agricultural production less incremental costs, both of which are calculated on the basis of economic value from the viewpoint of national and regional economy.

The increase in agricultural production will be mainly due to i) increase in cropping intensity from 113 percent without the Project to 200 percent with the Project at full development; ii) higher annual average yields of paddy from 3.4 tons/ha to 4.6 tons/ha in the wet season, and to 4.4 tons/ha in the dry season resulting in paddy production of about 100,000 tons per year when the Project area is fully developed in 1995/96 and onwards; and iii) application of multi-cropping systems.

The Project will, when fully developed, generate agricultural incremental net benefits of 610,504,000 Baht per year. The annual agricultural benefits and related data are shown in Table 6-1. Basic data utilized in the calculation of agricultural benefits are shown in Appendix K-3.

c) Flood Control Benefit

The Project Area suffers from flood damages at the rate of about two years in every three years. The provision of the Mae Kuang dam under the Project would mitigate the flood damages to a great extent. A series of flood control computations is conducted as stated in 4.2.7 b) - Food Control Computation.

A result of the computation clarified that the annual average flood mitigation comes up to 18.38 million Baht as shown in Table 4-10. The fl-od control benefit is so little when compared with the agricultural benefit, therefore, it is not taken into account in the benefit calculation.

d) Hydropower Generation Benefit

The small scale hydropower generation plan is proposed in this Project. However, the hydropower generation study will be separately made by EGAT after this Study in the near future. Therefore, a very preliminary study has been conducted as described in the section of 4.2.8 - Hydropower Generation Plan.

A result of the study has revealed that the annual electric energy generation is estimated at 16.3 GWh in case of alternative-2 as shown in Table 4-13. The hydropower generation benefit is not considered in this economic analysis due to the above-said reason.

6.3.3 Economic Internal Rate of Return

On the basis of quantified economic benefits and economic costs mentioned above, the Economic Internal Rate of Return (EIRR) of the Project is estimated at 17.7 percent. The EIRR is calculated on the general assumptions of i) a project economic life of 50 years; ii) a projected paddy price of 5,900 Baht per ton; and iii) an agricultural development period of five years after completion of the project works. (In this period, the period necessary for "Longan" cultivation is not included; and iv) a seven-year construction period.

In general, these assumptions are considered to be reasonable. Summary of economic benefits and costs of the Project are shown in Table 6-2[1/]. Detailed data concerned are shown in Appendix K-3.

6.3.4 Sensitivity Test

Sensitivity tests are carried out to determine the effects of various conditions on the EIRR. The results of the tests are given

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1/ In case of force account basis with on-farm development. EIRRs and related data of the alternative cases, namely i) contract basis with on-farm development, ii) force account basis without on-farm development, and iii) contract basis without on-farm development, are shown in Appendix K-5.

below and indicate that the EIRR is satisfactory under the varying assumptions:

Assumption	EIRR (%)
i) Reduction in respective unit prices of all crops by 10 percent	15.7
ii) Reduction in respective unit yields of all crops by 10 percent	15.7
iii) Two years delay in construction period	15.2
iv) Cost increase of 20 percent	15.3

6.3.5 Other Socio-Economic Impact

In addition to the increase of agricultural production, flood control and hydropower generation, the Project will have significant socio-economic impact on employment, income distribution, political stability, fresh water fisheries and environment as mentioned below separately.

a) Employment Opportunities

Inhabitants in the Project Area will benefit directly from an increase in employment opportunities in agriculture, transportation and marketing after completion of the Project, and even during the construction period.

Increased agricultural production in the Project Area will result from the introduction of improved varieties of paddy, selected profitable upland crops and more intensive land use, which will make possible the double cropping of some 20,000 ha, almost all of the entire cultivated area after project development.

Farm labor requirements in the Project Area at full development will increase by over 50 percent. However, the annual available agricultural labor force will increase from an estimated 30,000 persons in 1981 to only about 42,000 persons in 1995, or by 40 percent.

Table 6-1 Income[1/] With and Without the Project

(Unit: ฿'000)

No.	Year	Present	Without Project	With Project						
		Income from Crops	Income from Crops (A)	Left Bank Area (B)	Existing Area (C)	Right Bank Area (D)	Sub-total (E)=(B+C+D)	Resettlement Area[2/] (F)	Total (G)=(E+F)	Difference (H)=(G-A)
1	1981/82	19,660	19,660	2,163	6,881	10,616	19,660	0	19,660	0
2	1982/83	19,660	19,660	2,163	6,881	10,616	19,660	6,674	26,334	6,674
3	1983/84	19,660	19,660	2,163	6,881	10,616	19,660	10,546	30,206	10,546
4	1984/85	19,660	19,660	2,163	174,195	10,616	186,974	11,347	198,321	178,661
5	1985/86	19,660	19,660	2.163	178,446	10,616	191,225	12,548	203,773	184,113
6	1986/87	19,660	20,249	26,227	189,066	166,918	382,211	13,349	395,560	375,311
7	1987/88	19,660	20,249	33,948	197,564	189,014	420,526	13,349	433,875	413,626
8	1988/89	19,660	20,249	50,863	206,061	258,265	515,189	13,349	528,538	508,289
9	1989/90	19,660	20,249	57,806	212,434	277,085	547,325	13,349	560,674	540,425
10	1990/91	19,660	20,249	67,242	212,434	297,898	577,574	13,349	590,923	570,674
11	1991/92	19,660	20,840	70,635	212,434	311,225	594,294	13,349	607,643	586,803
12	1992/93	19,660	20,840	75,691	212,434	325,882	614,007	13,349	627,356	606,516
13	1993/94	19,660	20,840	76,799	212,434	326,768	616,001	13,349	629,350	608,510
14	1994/95	19,660	20,840	77,353	212,434	327,211	616,998	13,349	630,347	609,507
15	1995/96	19,660	20,840	77,907	212,434	327,654	617,995	13,349	631,344	610,504
50	2030/31	19,660	20,840	77,907	212,434	327,654		13,349	631,344	610,504

1/ Incomes here represent value net from production costs.

2/ Net benefits obtainable from 450 ha of the proposed resettlement area located outside of the Project area.

Table 6-2 Summary of Economic Benefits and Costs of the Project[1/]

(Unit: ฿ '000)

No.	Year	Benefits	Investment Cost	O&M Cost	Total Cost	Net Flow (Incremental Cost	Present Worth Discounted at 17%	Present Worth Discounted at 18%
1	1981/82		149,385		149,385	-149,385	-127,679	-126,604
2	1982/83	6,674	566,866		566,866	-560,192	-409,220	-402,330
3	1983/84	10,546	692,869		692,869	-682,323	-426,042	-415,262
4	1984/85	178,661	542,853		542,853	-364,192	-194,369	-187,850
5	1985/86	184,113	330,591		330,591	-146,478	-66,809	-64,026
6	1986/87	375,311	132,941		132,941	242,370	94,476	89,774
7	1987/88	413,626	105,936	13,501	119,437	394,189	131,344	123,736
8	1988/89	508,289	-34,281	15,957	-18,324	526,613	149,979	140,079
9	1989/90	540,425		17,194	17,194	523,231	127,354	117,989
10	1990/91	570,674		17,298	17,298	553,376	115,102	105,750
11	1991/92	586,803		17,420	17,420	569,383	101,236	92,183
12	1992/93	606,516		17,420	17,420	589,096	89,543	80,824
13	1993/94	608,510		17,420	17,420	591,090	76,785	68,744
14	1994/95	609,507		17,420	17,420	592,087	65,722	58,321
15	1995/96	610,504		17,420	17,420	593,084	56,284	49,523
	↓	↓		↓	↓	↓	↓	↓
50	2030/31	610,504		17,420	17,420	593,084	237	178
	Total						113,342	-52,789

1/ All in constant prices in 1980.

$$E\ I\ R\ R = 17\% + \frac{113,342}{113,342 + 52,789} \times 1\% = 17.7\%$$

While much of the increased farm labor requirements will come from the existing farmers, landless laborers and/or under-employed laborers also will benefit significantly by the creation of more jobs.

Employment opportunities in marketing and transport will increase significantly in parallel with the increased paddy production, particularly when the market volume will exceed about 100,000 tons per year at full development of the Project.

For the construction of the Project, labor requirements of 200,000 man-days are estimated. It will provide significant employment opportunities during the early stage of construction.

b) Income Distribution

The per capita income gap between Chiang Mai city and the Project Area is very significant under the present condition that migration from the latter to the former has occurred.

Without the Project, the rural income situation would not be remarkably improved and the above-mentioned income gap would east continuously. With the Project, farm income will greatly increase and such gap of income disparity is believed to be narrowed. As a result of an increased agricultural production and income with the Project, farmers' demand and purchasing power for industrial goods both for living items and farm inputs will increase accordingly.

In parallel with the increase of income, farmers' living conditions would be substantially improved, and more and better food will be available also at the farmers' level.

c) Political Stability

After full development of the Project, the political stability of the area might be much improved through the banding together of associations for the operation and maintenance of various facilities including irrigation.

Change or shift from subsistence farming to a more intensive cropping system farming will increase political stability in addition to cash farm income and regional benefits. Further political stability would also result from the increase of commercial goods consumption and the improvement of services.

6.3.6 Environmental Impact

a) General

Environmental assessment is one of the newest science branches. It is necessary to give considerations to environment in planning development projects. It should always be remembered that development, which intends to achieve better living conditions, could cause negative outcome. They might be found during implementation of a development project or long after it is completed sometimes even 10 to 20 years later. In recent years, environmental problems are found throughout the world as a result of failure to consider negative aspects of development in eagerness to pursuit positive aspects only.

The purpose of the Mae Kuang Irrigated Agricultural Project is to develop farmlands integratedly. In contrast to urban development, an agricultural development is regarded as the intensification of land utilization with no environmental disruptions. Certainly, agriculture may protect environment, and farm land may provide green if proper farming techniques are applied. But, even an agricultural development project could cause a rapid change in ecology. In such cases, it is not entirely free from environmental problems. Even agriculture might adversely affect environment if it is not seriously taken into consideration.

b) Environmental Problems Derivable from Development

It is difficult to foresee environmental changes exactly and in detail since they are normally very diversified in case of a large scale development in tropical and sub-tropical zones. Consequently, it is important to identify during the feasibility study stage and

after the stage possible environmental changes in order to provide necessary countermeasures. The environmental impact which might be encountered in the Project Area is mainly divided into three, namely; a) physical and chemical, b) ecological, and c) socio-economic problems.

(1) Physical and Chemical Problems

Presently, there is no large storage reservoir in the Project Area, and the agricultural production is almost limited to the wet season operation. In order to promote the integrated agricultural development, the Mae Kuang Project is planned to provide annual reservoir diversions of an average of 229 MCM of water mainly for irrigation purpose.

The Mae Kuang Project Area is subject to the monsoon climate of the Southeast Asia. According to our field survey and our engineering experiences, any serious environmental impact is not considered to be derivable from construction of dam and reservoirs in this area. It is noted, however, that some limited local effects on temperature, humidity, wind speeds, etc. would be brought at certain places in and around the Project Area from the prospective changes of land use patterns. In addition to the limited local effects mentioned above, water quality impacts are also noticeable.

Of the major water quality impacts derivable from the project implementation, the deterioration of reservoir water is one of the most important. Generally, reservoir water quality is apt to deteriorate in the first few years of impounding owing to degradation of organic matter.

Besides reservoir water quality, it must be noted that changes in quality of irrigation return flow would produce certain serious impacts on domestic use of water and/or fish-farm operation. This is mainly due to the presence of insecticides. In applying agro-chemicals including insecticides, such chemicals will be allowed

only if the toxicity is lower than the permissive value and it does not remain behind. Furthermore, the quantity applied at a time and the number of applications will be controlled. Special considerations must be given to when and how they should be applied.

(2) Ecological Problems

The following ecological changes are expected to take place as a result of development.

° Shift from the natural ecosystem centered around tropical rain forests to agricultural ecosystem centered around cultivation of crops, seen from the vegetation standpoint.

° Shift from wet soil ecosystem characterized by reductive condition in lower land to dry soil ecosystem by oxidized condition, especially during the wet season, seen from the soil-water standpoint.

° Change of ecosystems, seen from the living of wild animals and wild vegetation.

The above-said ecological changes might result in the following problems.

i) Loss of forests resulting in degeneration of land

ii) Soil erosion and land slide

iii) Water pollution and soil contamination

iv) Impact to freshwater fisheries, forestry and wild animal and vegetation

The main items are explained as follows:

i) Loss of Forest

Forests are formed over a long period of time. Once they are cleared, it is not easy to restore them in a short period of time.

Compared with swamp forests, development of hillside forests into farmlands is not desirable in terms of efficient utilization of natural resources and conservation of environment. Indiscriminate clearing of forests could result in degeneration of land or decrease of soil fertility.

ii) Soil Erosion and Land Slide

Since farmlands in the Project Area are normally level or only slightly undulating there will be almost no possibility of erosion and land slide except for slopes along roads and waterways. Therefore, adequate protection work will be required for slopes.

iii) Water Pollution and Soil Contamination

Sources of environmental pollution possibly involved in the Project Area will be agricultural input like agro-chemicals and fertilizer in addition to effluent from various factories, sewage from housing and livestock excreta. Contaminants from factories will be discharged mainly in the form of waste water, and cause soil contamination as well as water pollution. As mentioned in (1) Physical and Chemical Problems said above, water pollution derived from the application of agro-chemicals would produce certain serious impacts on freshwater fish culture. Therefore, special attention must be given to the control.

In the Project Area, there is no plan or rearing a large number of animals on pasture. Excreta of livestock, leftover feed and waste water will be recycled and treated within the farm management.

iv) Impact to Freshwater Fisheries, Forestry and Wild Animal and Vegetation

In the Project Area, freshwater fisheries have not developed so much. In parallel with the development of water resources available for fish culture, freshwater fisheries are expected to develop remarkably in the near future. As mentioned repeatedly, it is

expected that agricultural input like agro-chemicals will be utilized widely and in large quantities compared with the present conditions resulting in change of ecosystems.

Most of forest resources grown in and around the proposed reservoirs will be reserved excluding those to be inundated after construction of the Project. The environment surrounding the dam and reservoirs will be changed owing to the construction of such facilities. Accordingly, some changes in the ecosystem are expected though limited local effects.

Wildlife in the Project Area and its surrounding is believed to be quite a few in number. Adverse impact due to the change of ecosystems is relatively negligible.

(3) Socio-Economic Problems

The Mae Kuang dam and reservoirs are planned to be constructed for the development of the Project Area. This is expected to have a large impact on the two systems in terms of flood control in the wet season and water use in the dry season.

In the plan, the existing flood damage will be almost controlled, and even during the dry season various kinds of crops are expected to grow. Substantial rainfed or partially-irrigated parts of the Project Area are presently rice monocropped only in the wet season, because rainfall or irrigation supply is too uncertain to adopt conventional double cropping systems. After completion of the Project, such situations would be remarkably improved.

While the Project will improve the economic conditions including the above matter in the area, health conditions of the people living in the area will also be impacted in one way or another. In some areas health and sanitation of local residents will be enhanced, but the conditions could get worse in certain areas, unless appropriate measures are taken.

6.4 Financial Analysis

6.4.1 Revenue and Expenditure of Typical Farm Budget

The financial analysis of the Project is made from the farmers' viewpoint. In order to estimate the farm budget under the future with-project conditions, the analysis is made on 1.4 ha-farm-unit. Typical farm budgets are shown in Table 6-3.

After the irrigation development, the annual gross return in farm production by farmers is expected to increase due to the increase in unit yield of crops year by year. The return will be at its maximum starting from the fifth year and onwards after irrigation development was completed. Annual gross return from crop production in and after the fifth year of irrigation development applying intensive cropping systems is estimated at about 27,000 Baht per farm household on an average.

On respective farms, advanced farming practices will be introduced for profitable farm management. Accordingly, the funds necessary for the performance of such farm activities will necessarily be more when compared to those for primitive methods. The farming expenditure increases with the advanced farming and is at a maximum in and after the fifth year in case of ordinary crop cultivation.

Capacity to pay which is calculated by deducing labor costs from actual net return can be estimated at 20,510 Baht on an average. From the capacity to pay, the farmer must pay the annual O & M cost. According to the calculation, the O & M cost (in a narrow sense) is estimated at 1,435 Baht per farm household. Therefore, about 19,600 Baht of net profit will be reserved even after payment of O & M cost.

6.4.2 Repayment of Construction Cost

The project costs will be made available through loan arrangements by the Thai Government. The foreign currency portion is to be raised by a proposed loan from some of international lending agencies, and the local currency portion should be of the government security.

The loan must be repaid either by public funds or by project beneficiaries. To meet the repayment obligation satisfactorily, first of all, a policy for the Project should be established by the Government in the most feasible way.

Irrigation revenues as a financial source for the repayment of construction costs come from the incremental net returns in agricultural products derivable from the Project. In some developing countries, no charge or little charge is levied on farmers to recover the construction costs for such irrigation facilities according to the national policy to promote the advanced agriculture.

Taking cost recovery in Thailand as an example, necessary charge is levied on all of the project beneficiaries even though they are small-scale farmers. According to the report[1/], direct charges to be collected from the paddy farmers concerned are as follows:

- RID's actual operation and maintenance costs of 400 Baht per hectare for the main system and 100 Baht per hectare for on-farm development facilities.

- An annual charge of possibly 1,620 Baht per hectare for paddy farmers with on-farm development over a 12-year period, resulting in recovering 50 percent of the on-farm development costs at an annual rate of 12 percent interest.

Consequently, in view of the difficulties of complete repayment by public funds, a great part of the loan should be repaid from the project beneficiaries at least.

Based on the above-said example and the actual status in the Mae Kuang Project Area, direct charges to be collected from the farmers of beneficiaries are worked out as follows:

1/ "Greater Mae Klong - Malaiman - Irrigation Project Feaasibility Study", RID, King of Thailand, March 1980

- Actual operation and maintenance costs of 1,435 Baht per one unit farm of 1.4 ha for the main system and on-farm development facilities.

- An annual charge of possibly 5,368 Baht per one unit farm of 1.4 ha for farmers with on-farm development over a 12-year period including a two year grace period, resulting to recover all of the on-farm development costs at an annual rate of 12 percent interest.

Table 6-4 shows the result of calculating on-farm development cost recovery mentioned above.

Besides construction costs, the initial farm input is required for smooth management of agricultural development. In general, it is impossible to expect a large amount of return from the agriculture during the initial stage even though it is advanced. In Thailand, the entire cost incurable for project implementation will be born, usually, by the Government and/or any international lending agencies. Therefore, in the financial analysis on the part of farmers, apart from the above-said loans, the evaluation is conducted to treat such costs if it were due to a long-term loan advanced instead of beneficial farmers.

In the Project, the initial input for agriculture is to be paid for year after year as the production cost and, accordingly, it does not necessarily require long-term loans for their annual application. Under the financial system established in Thailand to facilitate for small-scale farmers, fertilizers, agro-chemicals, seeds, etc. are provided in kind as a part and parcel of loans for crop cultivation, livestock rearing and others. In our estimation of agricultural production cost, therefore, 10 percent of such costs were appropriated for interest payable. Consequently, the works supposed to be undertaken by long-term repayment on the part of the farmers would be:

Construction Cost: ฿4,084,728,000

Of the above, foreign currency portion:

฿1,698,341,000 (US$84,917,000)

Initial Input for Agriculture: None

In securing the above-said amount money required for the execution of the development work, the following loan facilitation could possibly be arranged:

Repayment Plan

Repayment Conditions	Average Annual Interest Rate	Repayment Period
Unredeemable for the first ten years	three percent	30 years

The trial calculation for repaying the above-said foreign currency portion is conducted under the conditions of unredeemable for the first ten years, three percent of average annual interest rate and 30 years of repayment period. Table 6-5 shows the result.

Table 6-3. Financial Typical Farm Budget (1.4 ha-unit farm)

Cropping Systems	Unit Yield (ton/ha)	Unit Price (฿/ton)	Unit Gross Value (฿/ha)	Pro-duction Cost (฿/ha)	Unit Net Value (฿/ha)	Net Value (฿/1.4ha)	Ratio	Actual Return (฿/1.4ha)	Hired Labor Cost (฿/1.4ha)	Capacity to Pay (฿/1.4ha)
Type I										
(1) Rice(w)[1/] +	4.6	3,800	17,480	7,653	9,827	13,758	2/3	9,172	1,834	7,388
Groundnut(d)[2/]	1.9	5,700	10,830	5,093	5,737	8,032	2/3	5,355	803	4,552
Sub-total										11,890
(2) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	1/3	4,586	917	3,669
Tobacco(d)	1.3	30,180	39,234	18,596	20,638	28,893	1/3	9,630	1,444	8,186
Sub-total										11,855
Total										23,745
Type II										
(1) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	2/3	9,172	1,834	7,338
Groundnut(d)	1.9	5,700	10,830	5,093	5,737	8,032	2/3	5,355	803	4,552
Sub-total										11,890
(2) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	1/3	4,586	917	3,669
Garlic(d)	3.5	10,500	36,750	20,426	16,324	22,854	1/3	7,617	1,143	6,474
Sub-total										10,143
Total										22,033
Type III										
(1) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	2/3	9,172	1,834	7,338
Groundnut(d)	1.9	5,700	10,830	5,093	5,737	8,032	2/3	5,355	803	4,552
Sub-total										11,890
(2) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	1/3	4,586	917	3,669
Vegetables(d)	6.0	2,100	12,600	6,439	6,161	8,625	1/3	2,875	431	2,444
Sub-total										6,113
Total										18,003
Type IV										
(1) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	1/2	6,879	1,376	5,503
Soybeans(d)	1.8	5,450	9,810	4,650	5,160	7,224	1/2	3,612	542	3,070
Sub-total										8,573
(2) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	1/2	6,879	1,376	5,503
Sweet corn(d)	1.2	2,200	2,640	1,165	1,475	2,065	1/2	1,033	155	878
Sub-total										6,381
Total										14,954
Type V										
(1) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	2/3	9,172	1,834	7,338
Soybeans(d)	1.8	5,450	9,810	4,650	5,160	7,224	2/3	4,816	722	4,094
Sub-total										11,432
(2) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	1/3	4,586	917	3,669
Garlic(d)	3.5	10,500	36,750	20,426	16,324	22,854	1/3	7,617	1,143	6,474
Sub-total										10,143
Total										21,575
Type VI										
(1) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	2/5	5,503	1,101	4,402
Rice(d)	4.4	3,800	16,720	7,329	9,391	13,147	2/5	5,259	1,052	4,207
Sub-total										8,609
(2) Rice(w) +	4.6	3,800	17,480	7,653	9,827	13,758	3/5	8,255	1,651	6,604
Soybeans(d)	1.8	5,450	9,810	4,650	5,160	7,224	3/5	4,334	686	3,684
Sub-total										10,288
Total										18,897
Type VII										
(1) Soybeans(w) +	1.8	5,450	9,810	4,650	5,160	7,224	2/3	4,816	722	4,094
Groundnut(d)	1.9	5,700	10,830	5,093	5,737	8,032	2/3	5,355	803	4,552
Sub-total										8,646
(2) Soybeans(w) +	1.8	5,450	9,810	4,650	5,160	7,224	1/3	2,408	361	2,047
Tobacco(d)	1.3	30,180	39,234	18,596	20,638	28,893	1/3	9,630	1,444	8,186
Sub-total										10,233
Total										18,879
Type VIII										
(1) Soybeans(w) +	1.8	5,450	9,810	4,650	5,160	7,224	1/2	3,612	542	3,070
Groundnut(d)	1.9	5,700	10,830	5,093	5,737	8,032	1/2	4,016	602	3,414
Sub-total										6,484
(2) Longan(perennial)	3.8	19,000	72,200	13,315	58,885	82,439	1/2	41,220	6,183	35,037
Sub-total										35,037
Total										41,521

Table 6-4 Cost Recovery for On-Farm Development Cost

(Unit: Baht/one farm household with 1.4 ha unit farm)

No.	Year	Capacity to Pay 1/	O&M Cost	Net Profit	Construction Cost	Interest	Total Loan	Repayment	Surplus	Accumulated Surplus
1	1981/82									
2	1982/83					-฿24,180-				
3	1983/84									
4	1984/85									
5	1985/86									
6	1986/87									
7	1987/88									
8	1988/89	16,718	1,314	15,404		2,902	27,082		15,404	15,404
9	1989/90	17,867	1,416	16,451		3,250	30,331		16,451	31,855
10	1990/91	19,028	1,425	17,603		3,640	28,602	5,368	12,235	44,090
11	1991/92	19,606	1,435	18,171		3,432	26,666	5,368	12,803	56,893
12	1992/93	20,324	1,435	18,889		3,200	24,498	5,368	13,521	70,414
13	1993/94	20,417	1,435	18,982		2,940	22,070	5,368	13,614	84,028
14	1994/95	20,464	1,435	19,029		2,648	19,350	5,368	13,661	97,689
15	1995/96	20,510	1,435	19,075		2,322	16,304	5,368	13,707	111,396
16	1996/97	20,510	1,435	19,075		1,956	12,892	5,368	13,707	125,103
17	1997/98	20,510	1,435	19 075		1,547	9,071	5,368	13,707	138,810
18	1998/99	20,510	1,435	19,075		1,089	4,792	5,368	13,707	152,517
19	1999/00	20,510	1,435	19,075		575	0	5,369	13,706	166,223

1/ The term "Capacity to Pay" means the amount remaining to operate after all costs except for water charges.

Table 6-5 Annual Loan Repayment Schedule for Entire Project Area of 20,000 ha

(Unit: ฿ '000)

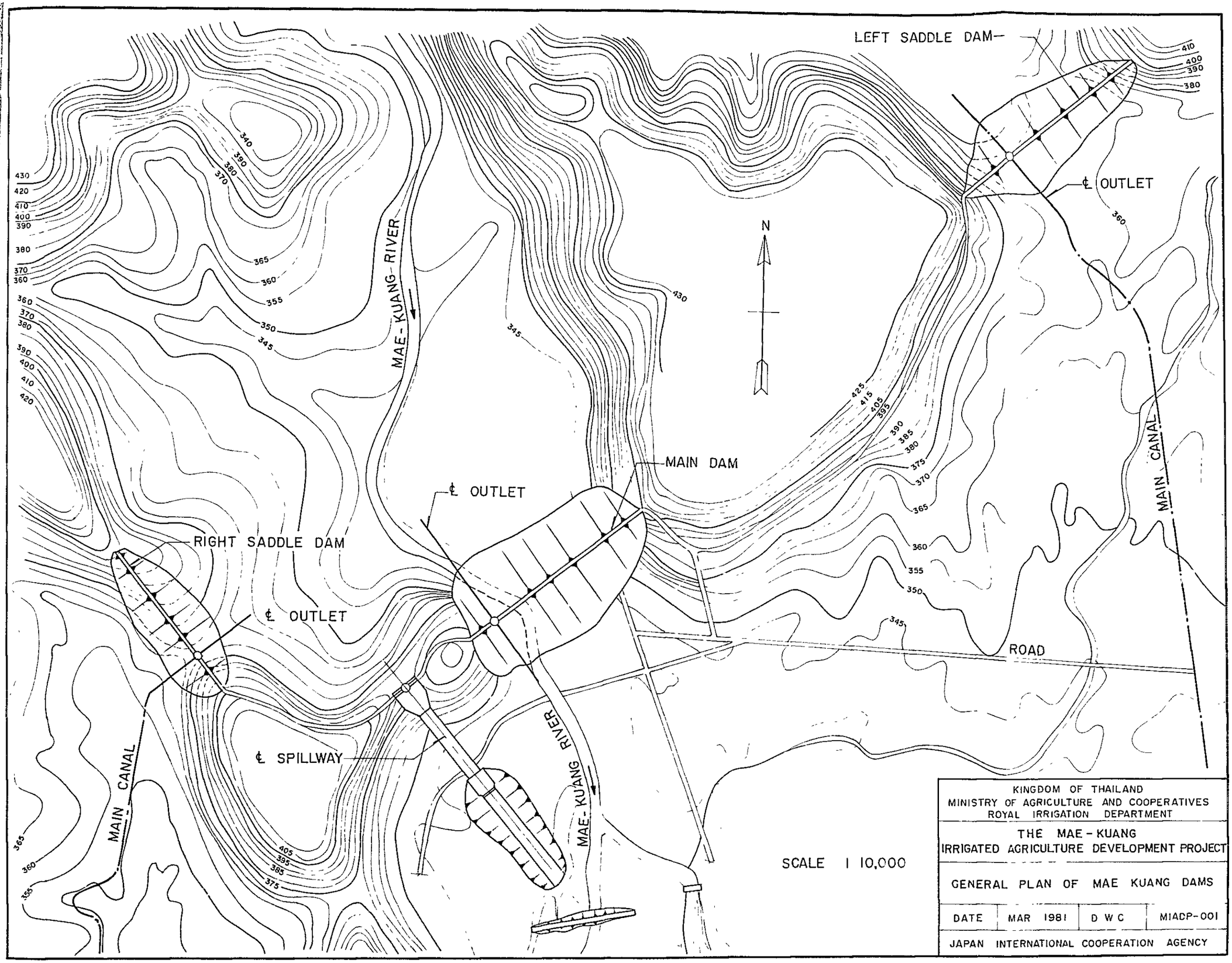
No.	Year	Capacity to Pay	O&M Cost	Net Profit	Construction Cost	Interest	Total Loan	Repayment	Surplus
1	1981/82								
2	1982/83								
3	1983/84				-฿1,698,341-				
4	1984/85								
5	1985/86								
6	1986/87								
7	1987/88								
8	1988/89	238,831	18,773	220,058		50,950	1,749,291		220,058
9	1989/90	255,253	20,228	235,025		52,479	1,801,770		235,205
10	1990/91	271,829	20,351	251,478		54,053	1,885,777		251,478
11	1991/92	280,084	20,494	259,590		55,673	1,911,483		259,590
12	1992/93	290,342	20,494	269,848		57,344	1,968,887		269,848
13	1993/94	291,677	20,494	271,183		59,067	2,027,989		271,183
14	1994/95	292,344	20,494	271,850		60,840	2,088,790		271,850
15	1995/96	293,011	20,494	272,517		62,664	2,151,458		272,517
16	1996/97	293,011	20,494	272,517		64,544	2,215,995		272,517
17	1997/98	293,011	20,494	272,517		66,480	2,282,400		272,517
18	1998/99	293,011	20,494	272,517		68,472	2,197,488	153,413	119,104
19	1990/00	293,011	20,494	272,517		65,925	2,110,000	153,413	119,104
20	2000/01	293,011	20,494	272,517		63,300	2,019,887	153,413	119,104
21	2001/02	293,011	20,494	272,517		60,597	1,927,071	153,413	119,104
22	2002/03	293,011	20,494	272,517		57,812	1,831,470	153,413	119,104
23	2003/04	293,011	20,494	272,517		54,944	1,733,001	153,413	119,104
24	2004/05	293,011	20,494	272,517		51,990	1,631,578	153,413	119,104
25	2005/06	293,011	20,494	272,517		48,947	1,527,112	153,413	119,104
26	2006/07	293,011	20,494	272,517		45,813	1,419,512	153,413	119,104
27	2007/08	293,011	20,494	272,517		42,585	1,308,684	153,413	119,104
28	2008/09	293,011	20,494	272,517		39,261	1,194,532	153,413	119,104
29	2009/10	293,011	20,494	272,517		35,836	1,076,955	153,413	119,104
30	2010/11	293,011	20,494	272,517		32,309	955,851	153,413	119,104
31	2011/12	293,011	20,494	272,517		28,676	831,114	153,413	119,104
32	2012/13	293,011	20,494	272,517		24,933	702,634	153,413	119,104
33	2013/14	293,011	20,494	272,517		21,079	570,300	153,413	119,104
34	2014/15	293,011	20,494	272,517		17,109	433,996	153,413	119,104
35	2015/16	293,011	20,494	272,517		13,020	293,603	153,413	119,104
36	2016/17	293,011	20,494	272,517		8,808	148,998	153,413	119,104
37	2017/18	293,011	20,494	272,517		4,470	0	153,474	119,043

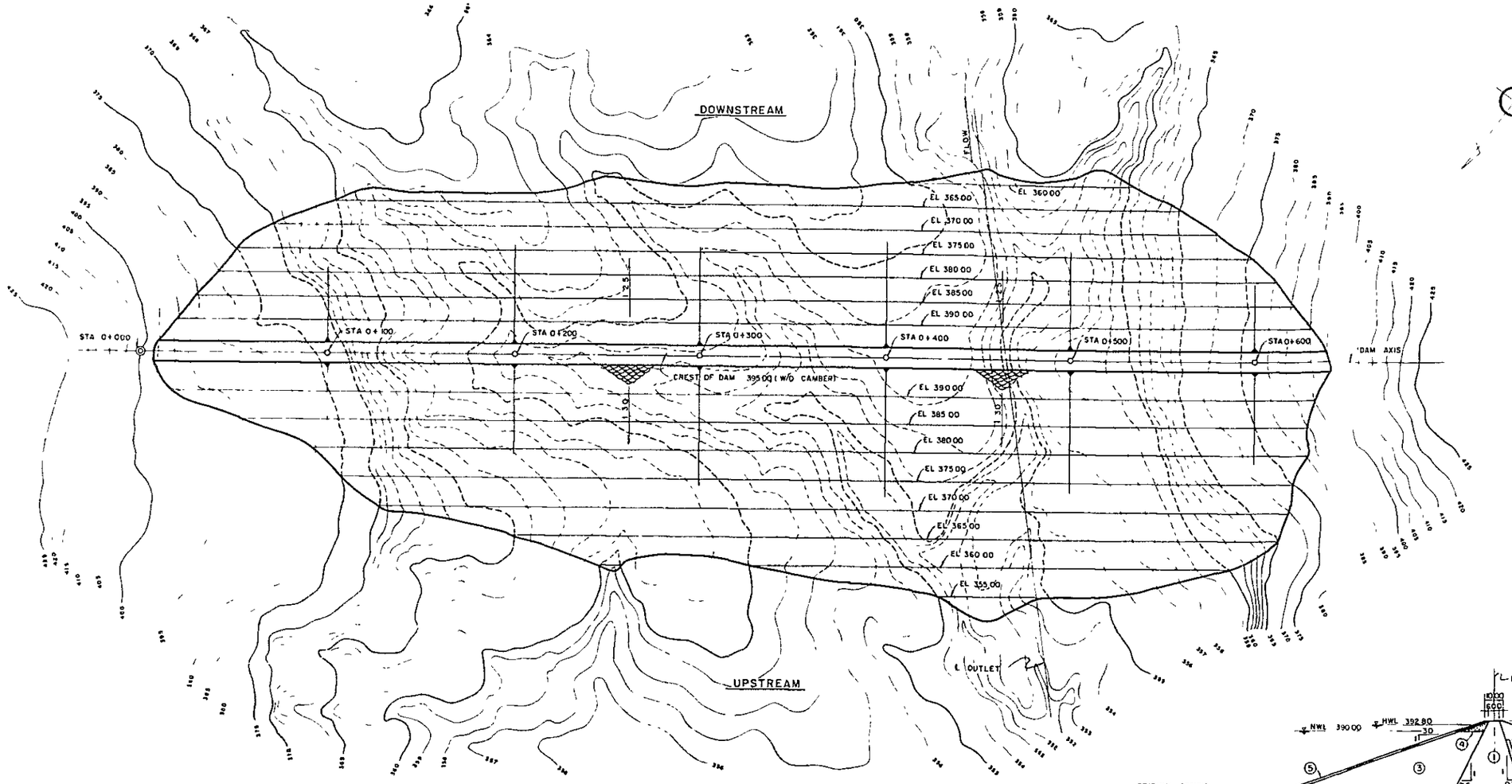
Note: 1. Calculation for loan repayment is limited to the foreign currency portion.

2. The term "Capacity to Pay" means the amount remaining to operate after all costs except for water charges.

3. Repayment conditions: unredeemable for the first ten years, three percent of average annual interest rate and 30 years of repayment period.

LIST OF DRAWINGS


LEFT SADDLE DAM
MAE-KUANG RIVER
MAIN DAM
℄ OUTLET
℄ OUTLET
RIGHT SADDLE DAM
℄ OUTLET
℄ SPILLWAY
MAIN CANAL
MAE-KUANG RIVER
ROAD
MAIN CANAL
N
SCALE 1 10,000
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT
THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT
GENERAL PLAN OF MAE KUANG DAMS
DATE
MAR 1981
D W C
MIADP-001
JAPAN INTERNATIONAL COOPERATION AGENCY



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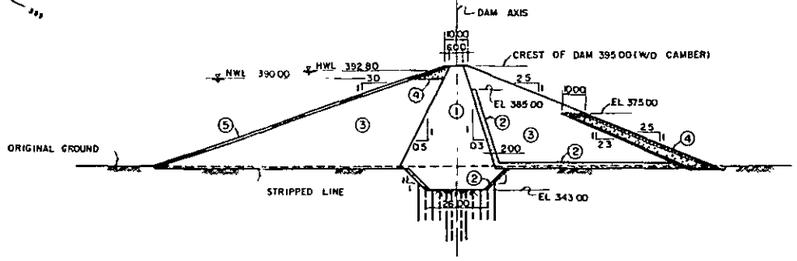

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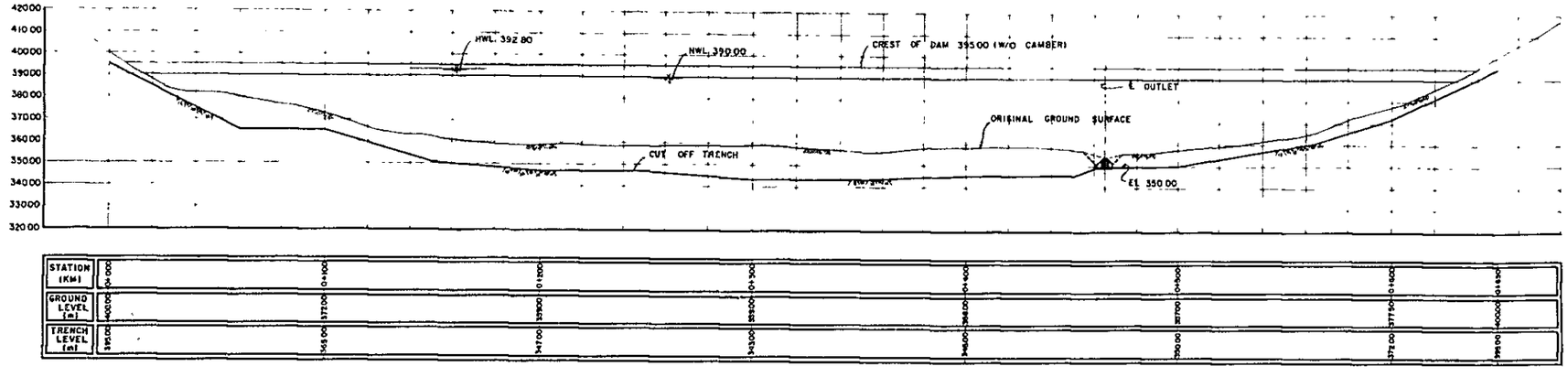


PROFILE
SCALE { HORZ 1:1,000 / VERT 1:1000

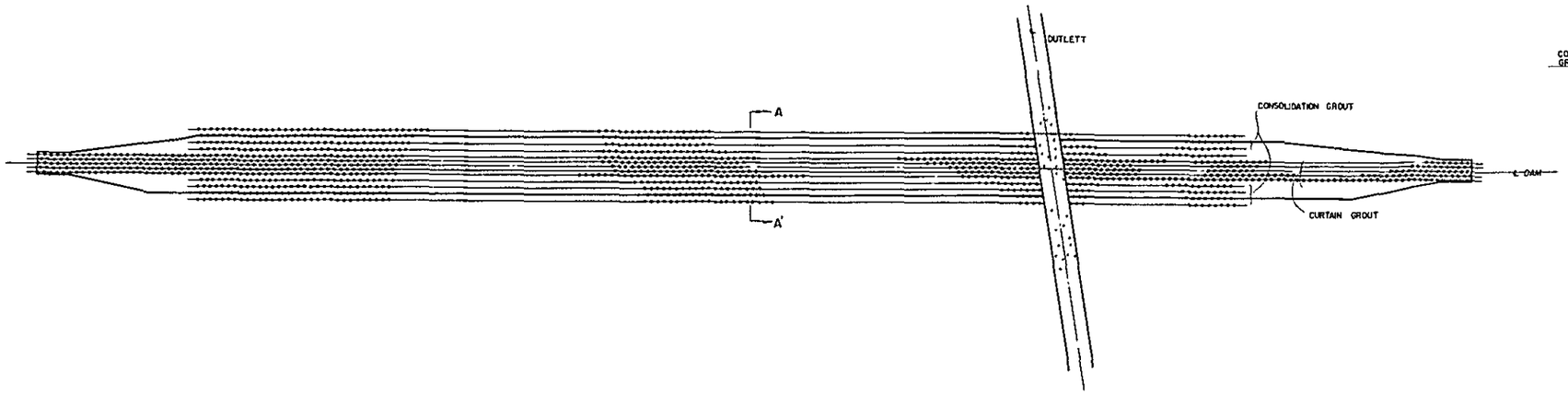
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

LEFT SADDLE DAM
PLAN, PROFILE AND SECTION

DATE	AUG 1981	DWG	MIADP-002

JAPAN INTERNATIONAL COOPERATION AGENCY



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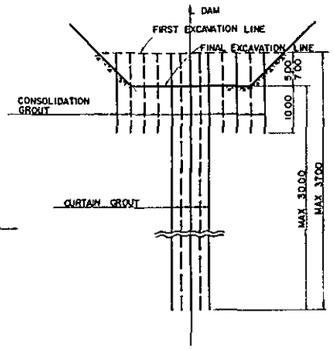

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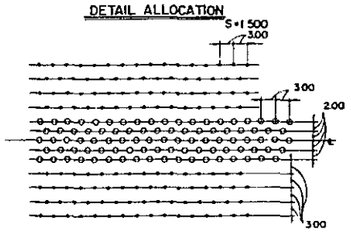
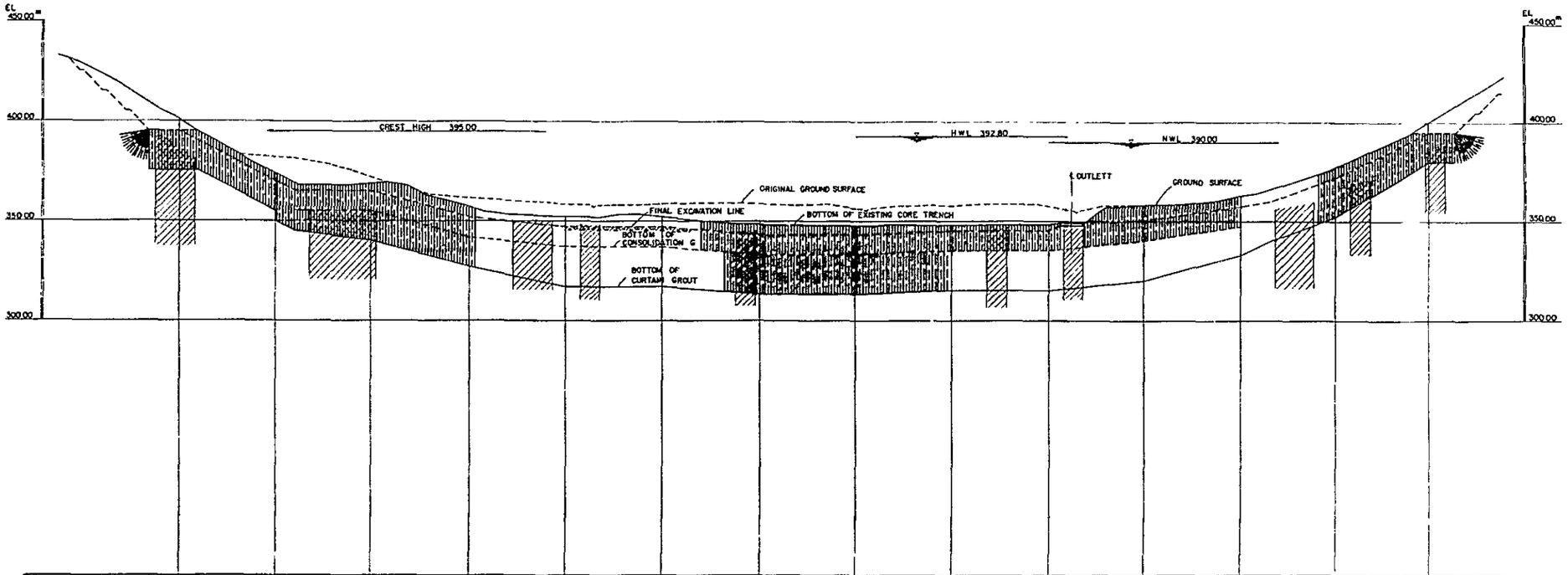
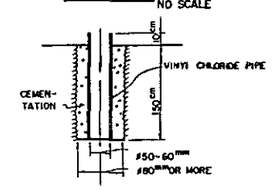




STATION NO.	-15	NO. 0	+10	NO. 1	+10	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 8	NO. 9	NO. 10	NO. 11	+15	NO. 12	NO. 13	+15
(1) GROUND LEVEL	404.60	400.00	399.50	381.60 (1252.00)	381.10 (1250.39)	372.30 (1221.50)	361.30 (1185.30)	354.40 (1162.40)	354.40 (1162.33)	338.70 (1110.70)	334.30 (1096.70)	337.90 (1108.60)	337.50 (1107.20)	358.00	361.50	365.80	377.25	400.00	404.80
CORE TRENCH LEVEL	395.00	395.00		370.00	365.00	365.00	358.00	347.00	347.00	343.00	343.00	345.00	345.00	350.00	357.50	360.00	368.00	395.00	395.00
BOTTOM OF GROUT CURTAIN	375.00	375.00	375.00	335.00 (335.00)	335.00 (335.00)	340.00	327.00	317.00	317.00	313.00	313.00	315.00	315.00	320.00	333.00	338.00	348.00	390.00	390.00

(1) ( ) : ELEVATION OF EXISTING CORE TRENCH

GROUT PIPE NO SCALE



1. EVERY GROUT HOLES NEED A GROUT PIPE.
2. CURTAIN GROUT SHOULD BE DONE USING STAGE GROUT METHOD
3. CONSOLIDATION GROUT SHOULD BE DONE USING NIPPLE GROUT METHOD
4. PRE-TEST HOLES & CHECK HOLES ARE NEGLECTED IN THIS DRAWING
5. EVERY DRILLING & GROUTING WORKS SHOULD BE PERFORMED FROM GROUND SURFACE OR FIRST EXCAVATION LEVEL

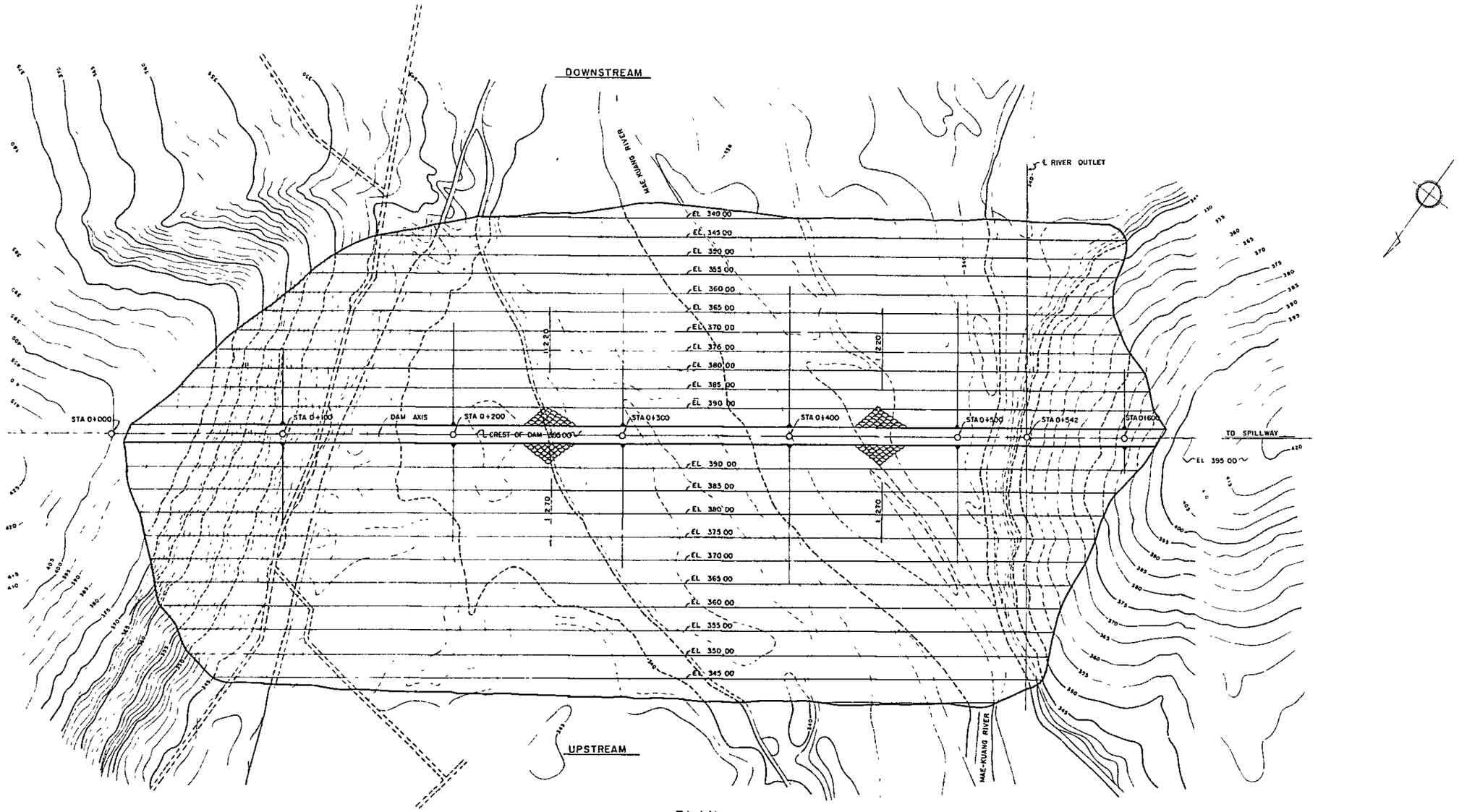
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

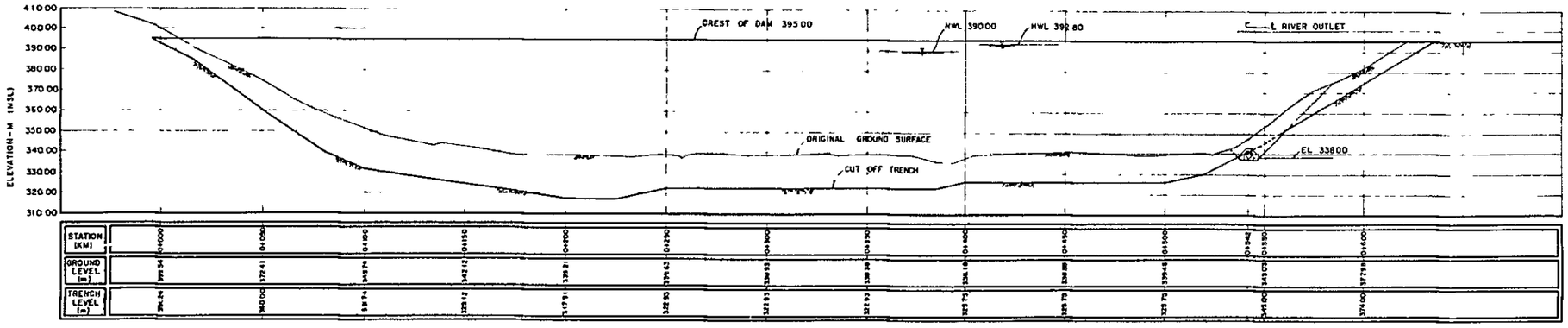
# LEFT SADDLE DAM
# PLAN OF FOUNDATION TREATMENT
S=1:1000

DATE	AUG 1981	DWG	MIADP-D03

JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN
SCALE 1 1,000



PROFILE
SCALE { HORZ 1 1000 / VERT 1 1,000

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

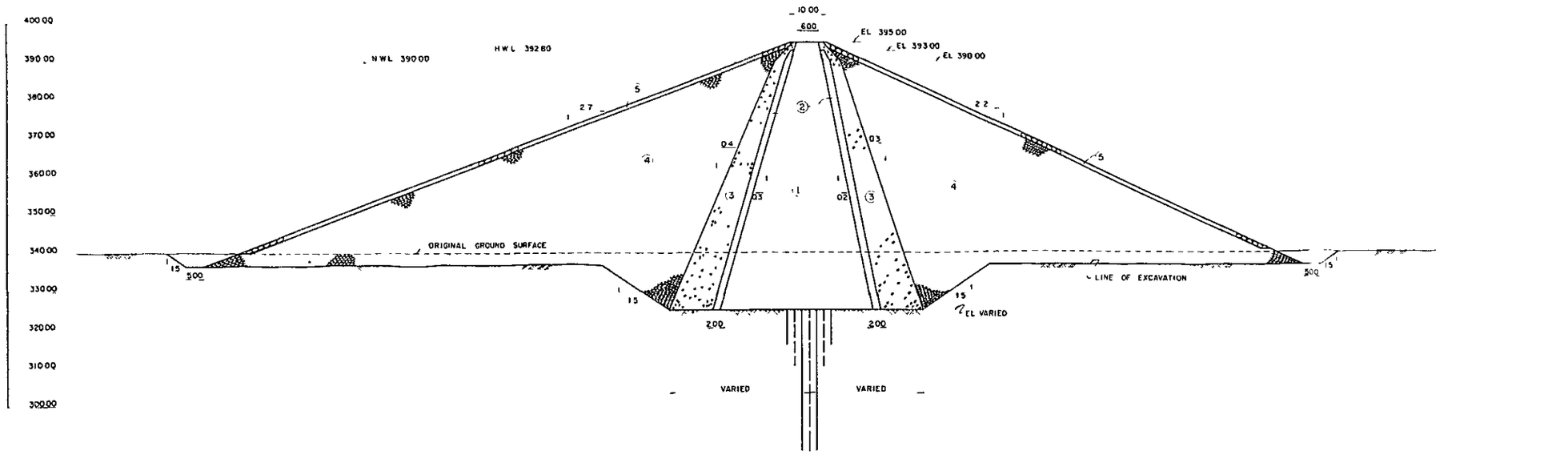
THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

MAIN DAM
PLAN AND PROFILE

DATE	AUG 1981	DWG	M1ADP-004

JAPAN INTERNATIONAL COOPERATION AGENCY

NO	ZONE
1	CORE
2	FILTER
3	TRANSITION
4	ROCK
5	RIP RAP

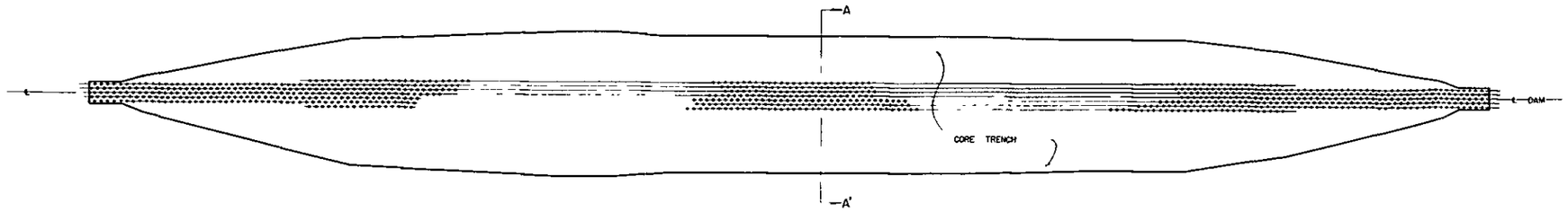


TYPICAL SECTION

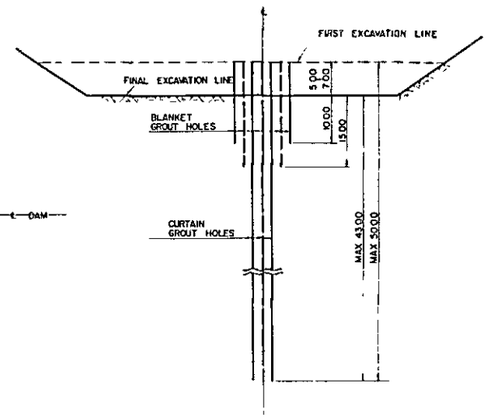
SCALE 1:500

0 10 20 30 40 50 METERS

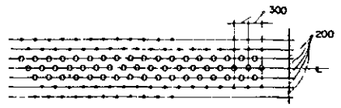
KINGDOM OF THAILAND MINISTRY OF AGRICULTURE AND COOPERATIVES ROYAL IRRIGATION DEPARTMENT	
THE MAE-KUANG IRRIGATED AGRICULTURE DEVELOPMENT PROJECT	
MAIN DAM TYPICAL SECTION	
DATE: AUG 1981	DWG: MIADP-005
JAPAN INTERNATIONAL COOPERATION AGENCY	



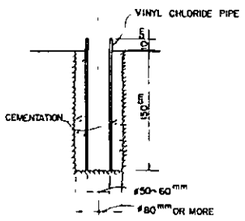
A-A' SECTION
S=1 500

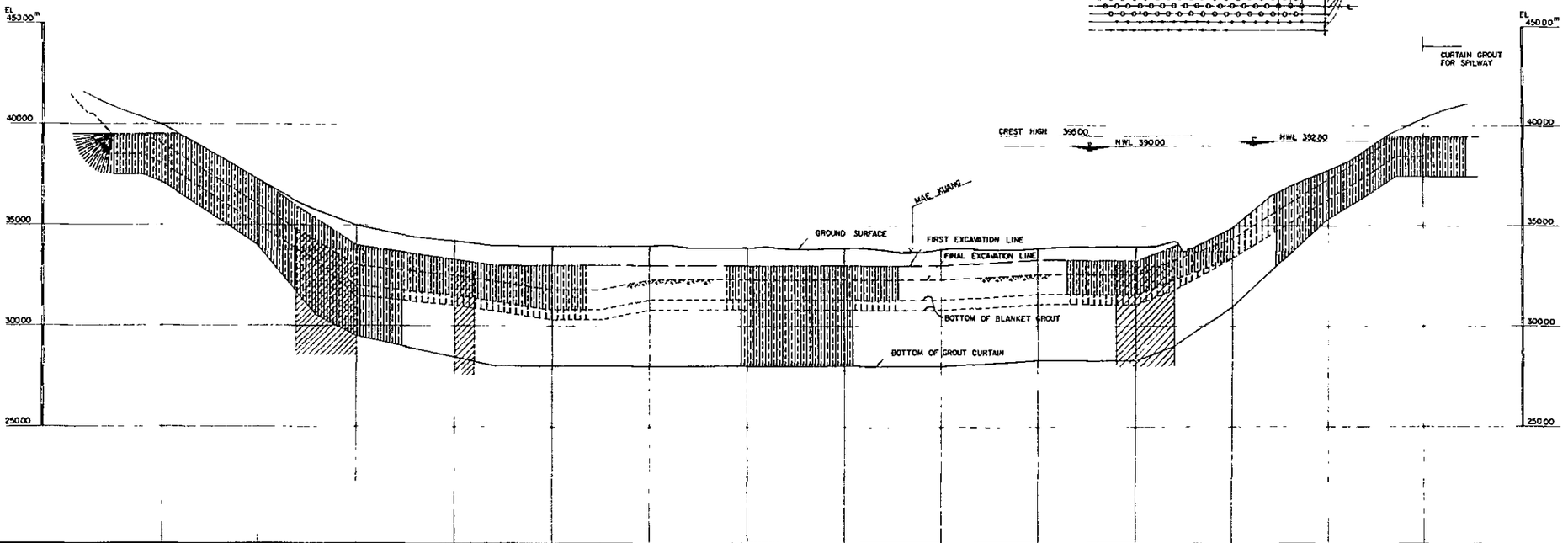


DETAIL ALLOCATION
S=1 500



GROUT PIPE
NO SCALE





STATION NO.	NO 0-25	NO 0-10	NO 0	NO 1	+30	NO 2	NO 3	+20	NO 4	NO 4+25	NO 5	NO 6	NO 7	NO 8	NO 9	NO 10	+20	NO 11	NO 12	+35	NO 13
GROUND LEVEL	408.80	400.00	400.00	372.30	357.20	349.40	342.10	339.20	339.30	339.00	339.00	338.70	338.40	338.10	338.50	339.50	342.00	348.90	376.00	397.40	403.80
CORE TRENCH LEVEL	395.00	395.00	390.00	340.00		330.00	325.00		318.00	318.00	323.00	323.00	323.00	323.00	328.00	326.00		344.00	374.00	395.00	395.00
BOTTOM OF GROUT CURTAIN	375.00	375.00	371.00	340.00	325.00	295.00	284.00	280.00	280.00		280.00	280.00	280.00	280.00	283.00	283.00	290.00	310.00	334.00	375.00	375.00
FAULT TREATMENT																					

1 EVERY GROUT HOLES NEED A GROUT PIPE

2 EVERY GROUTS SHOULD BE DONE USING STAGE GROUT METHOD EXCEPT HOLES LESS THAN 10 METERS IN DEPTH

3 THE HOLES LESS THAN 10 METERS IN DEPTH SHOULD BE GROUTED USING HIPPLE GROUT METHOD

4 PRE-TESTING HOLES & CHECK HOLES ARE NEGLECTED IN THIS DRAWING

5 EVERY DRILLING & GROUTING WORKS SHOULD BE PERFORMED FROM GROUND SURFACE OR FIRST EXCAVATION LEVEL

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

THE MAE-KUANG IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

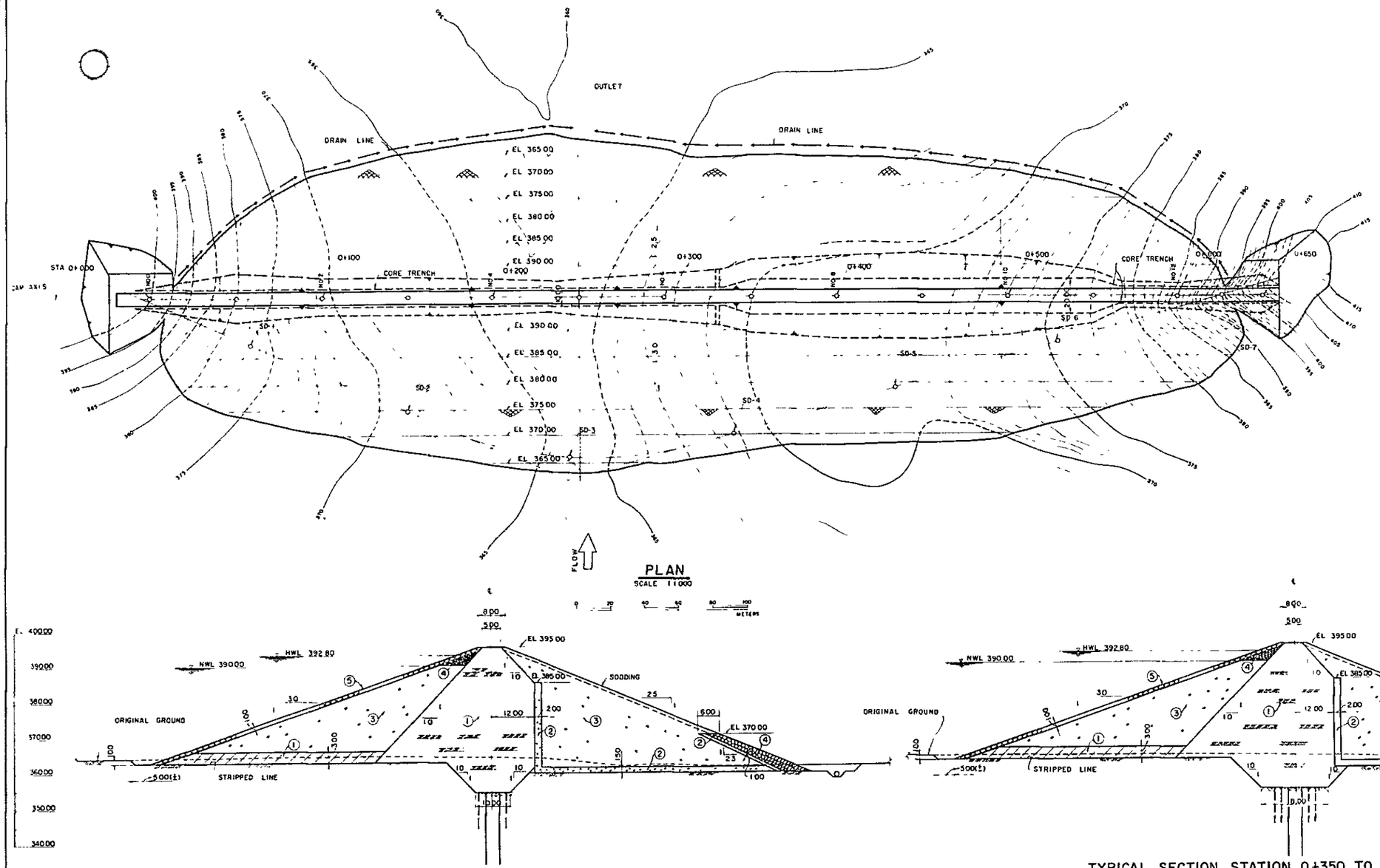
MAIN DAM

PLAN OF FOUNDATION TREATMENT

S=1:1000

DATE	AUG 1981	DWG	MIADP-006

JAPAN INTERNATIONAL COOPERATION AGENCY

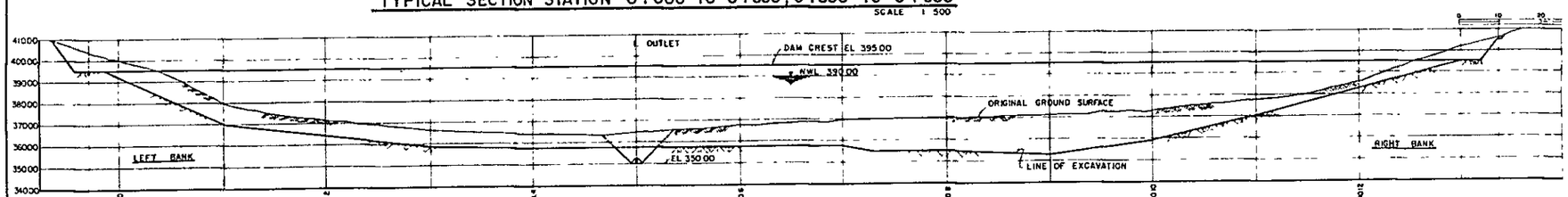


PLAN
SCALE 1:1000

TYPICAL SECTION STATION 0+000 TO 0+350, 0+550 TO 0+650
SCALE 1:500

TYPICAL SECTION STATION 0+350 TO 0+550
SCALE 1:500

1	CORE
2	FILTER
3	RANDOM
4	ROCK
5	RIP RAP



STATION (KM)	0+000	0+050	0+100	0+150	0+200	0+250	0+300	0+350	0+400	0+450	0+500	0+550	0+600	0+650
GROUND LEVEL (m)	400.00	378.50	371.00	366.00	364.00	364.00	367.40	369.50	370.00	370.50	372.00	377.50	386.00	401.60
TOP OF EXCAVATION (m)	392.00	370.00	364.50	359.00	357.90	357.50	357.50	357.50	354.80	352.50	359.00	370.50	382.00	395.00

PROFILE ALONG ℄ OF CORE TRENCH
SCALE 1:1,000

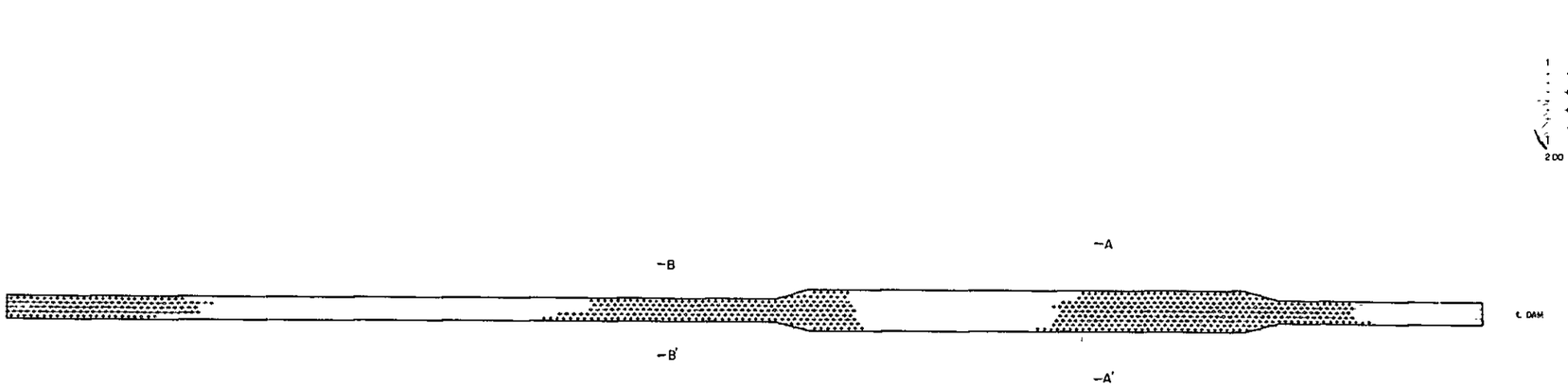
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

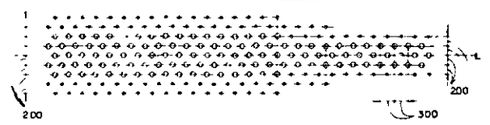
RIGHT SADDLE DAM
PLAN PROFILE AND TYPICAL SECTION

DATE	AUG 1981	DWG	MIAOP-007

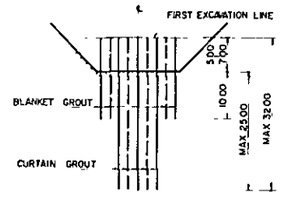
JAPAN INTERNATIONAL COOPERATION AGENCY



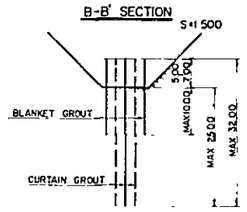
DETAIL ALLOCATION S=1:500

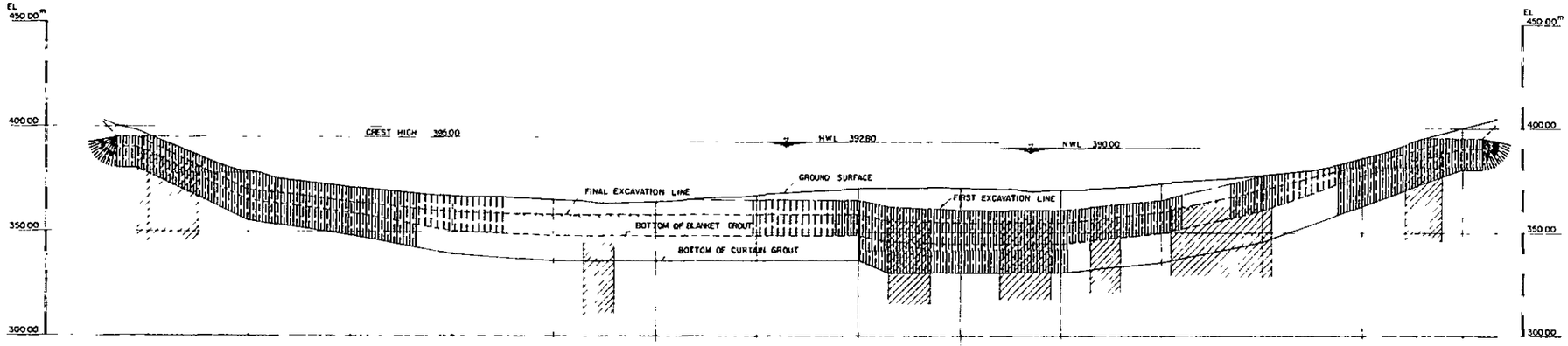


A-A' SECTION S=1:500 (NO 7~NO 11)



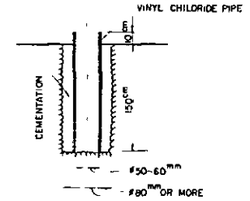
B-B' SECTION S=1:500





STATION NO	-15	-5	NO 0	NO 1	NO 2	NO 3	NO 4	NO 5	NO 6	NO 7	+15	NO 8	NO 9	NO 10	NO 11	NO 12	NO 13	+10
GROUND LEVEL	395.00		398.10	378.50	371.10	369.00	365.00	364.40	367.40	370.50	370.82	370.70	369.70	371.00	377.10	385.20	399.70	
CORE TRENCH LEVEL	355.00	355.00	352.50	370.00	364.00	359.00	358.00	358.00	358.00	358.00	355.00	354.00	354.00	355.00	370.00	382.00	395.00	395.00
BOTTOM OF GROUT CURTAIN	340.00		382.00	355.00	349.00	339.00	336.00	326.00	336.00	338.00	330.00	330.00	330.00	335.00	345.00	362.00	380.00	380.00
FAULT TREAT-MENT																		

GROUT PIPE NO SCALE



1. EVERY GROUT HOLES NEED A GROUT PIPE
2. CURTAIN GROUTING SHOULD BE DONE USING A STAGE GROUT METHOD
3. BLANKET GROUTING SHOULD BE DONE USING A RIPPLE GROUT METHOD
4. PRE-TEST HOLES & CHECK HOLES ARE NEGLECTED IN THIS DRAWING
5. EVERY DRILLING & GROUTING WORKS SHOULD BE PERFORMED FROM GROUND SURFACE OR FIRST EXCAVATION LEVEL

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

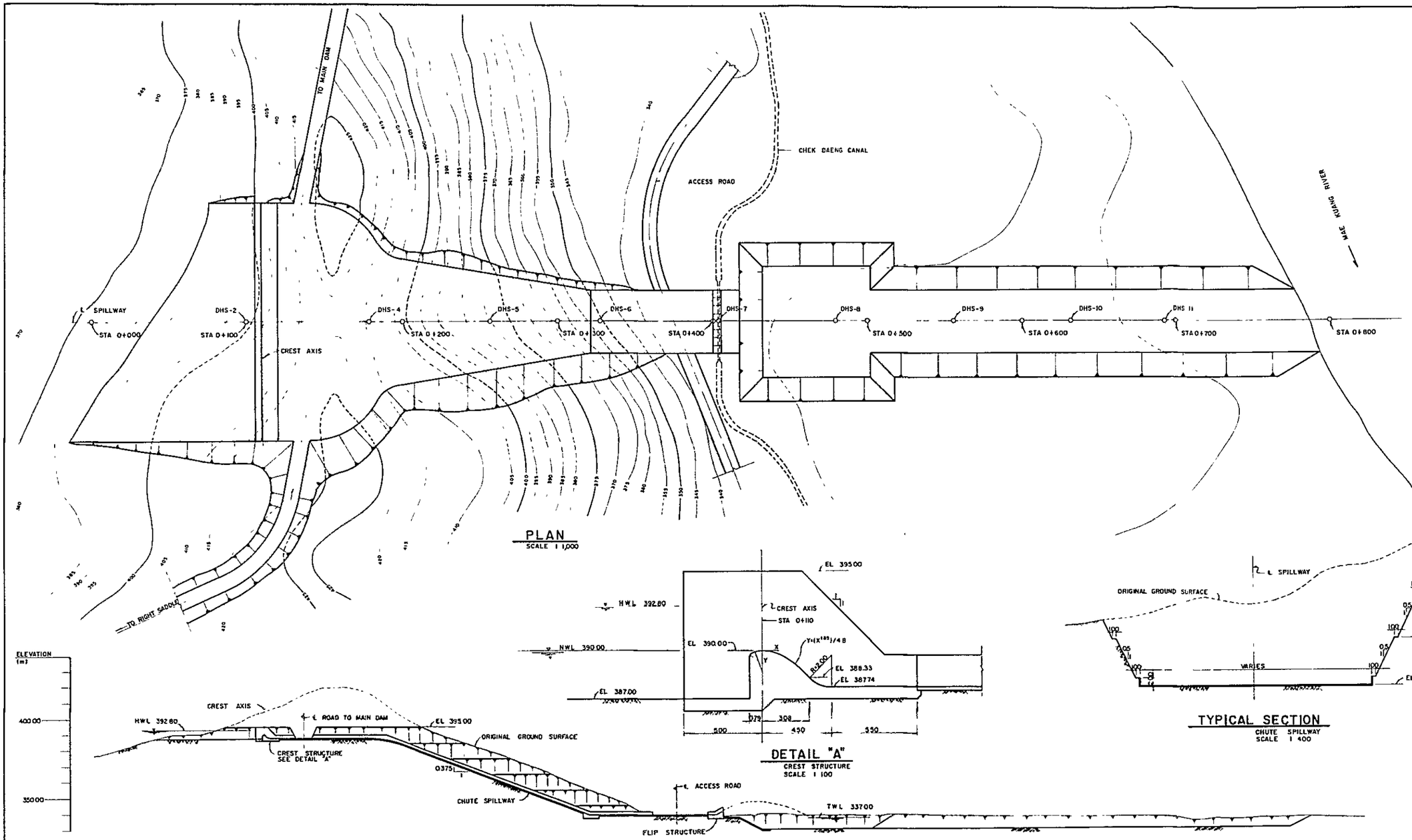
THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

RIGHT SADDLE DAM
PLAN OF FOUNDATION TREATMENT

S=1:1,000

DATE AUG 1981 DWG MIADP-008

JAPAN INTERNATIONAL COOPERATION AGENCY



PLAN
SCALE 1:1,000

DETAIL "A"
CREST STRUCTURE
SCALE 1:100

TYPICAL SECTION
CHUTE SPILLWAY
SCALE 1:400

STATION (KM)	0+000	0+100	0+110	0+140	0+170	0+200	0+230	0+260	0+290	0+300	0+320	0+360	0+400	0+500	0+600	0+700	0+800
APRON ELEVATION (m)		390.00	387.69	387.43	384.00	372.75	361.50	350.25	339.00	339.00	339.00	339.00	339.00	330.00	330.00	330.00	
APRON WIDTH (m)		150	150	130	60	70	60	50	40	40	40	40	40	70	40	40	

PROFILE
SCALE (VERT 1:1,000
HORZ 1:1,000

0 20 40 60 80 100 METERS

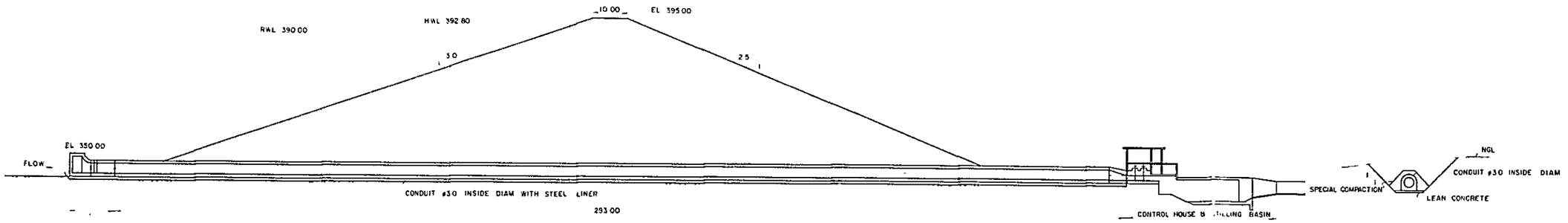
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

SPILLWAY
PLAN, PROFILE AND TYPICAL SECTION

DATE	AUG 1981	DWG	MIADP-009

JAPAN INTERNATIONAL COOPERATION AGENCY

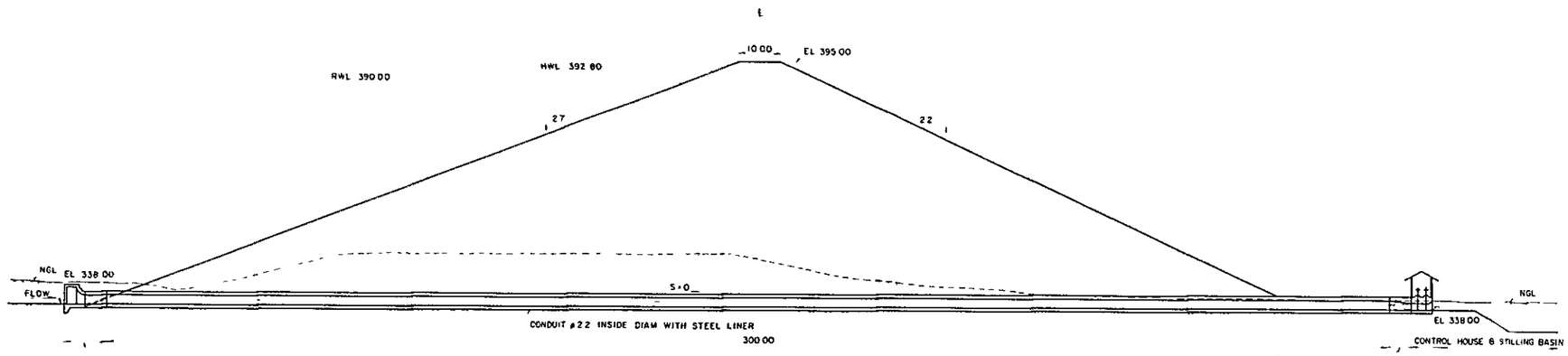


CANAL OUTLET OF LEFT SADDLE

SCALE 1:500

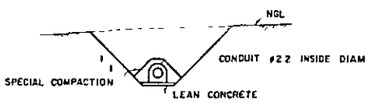
TYPICAL CROSS SECTION

SCALE 1:500



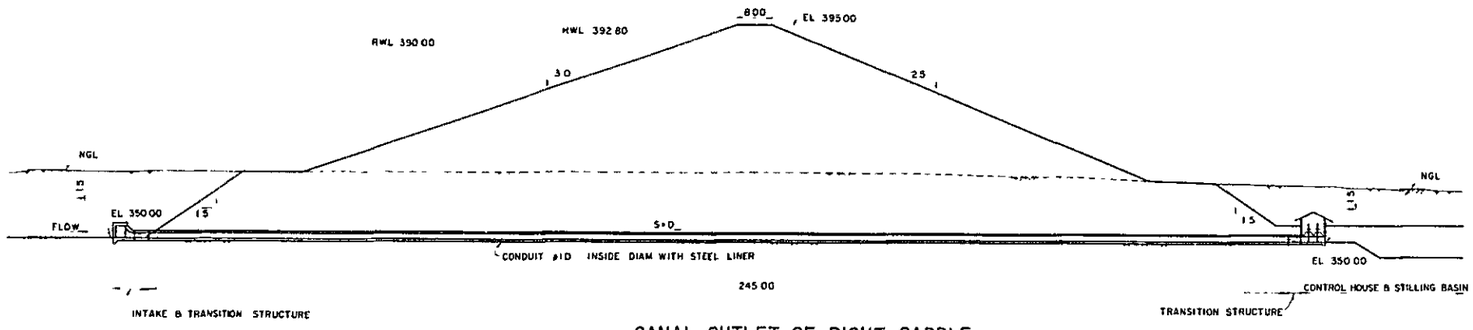
RIVER OUTLET OF MAIN DAM

SCALE 1:500



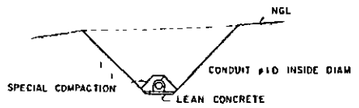
TYPICAL CROSS SECTION

SCALE 1:500



CANAL OUTLET OF RIGHT SADDLE

SCALE 1:500



TYPICAL CROSS SECTION

SCALE 1:500

0 10 20 30 40 50 METERS

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

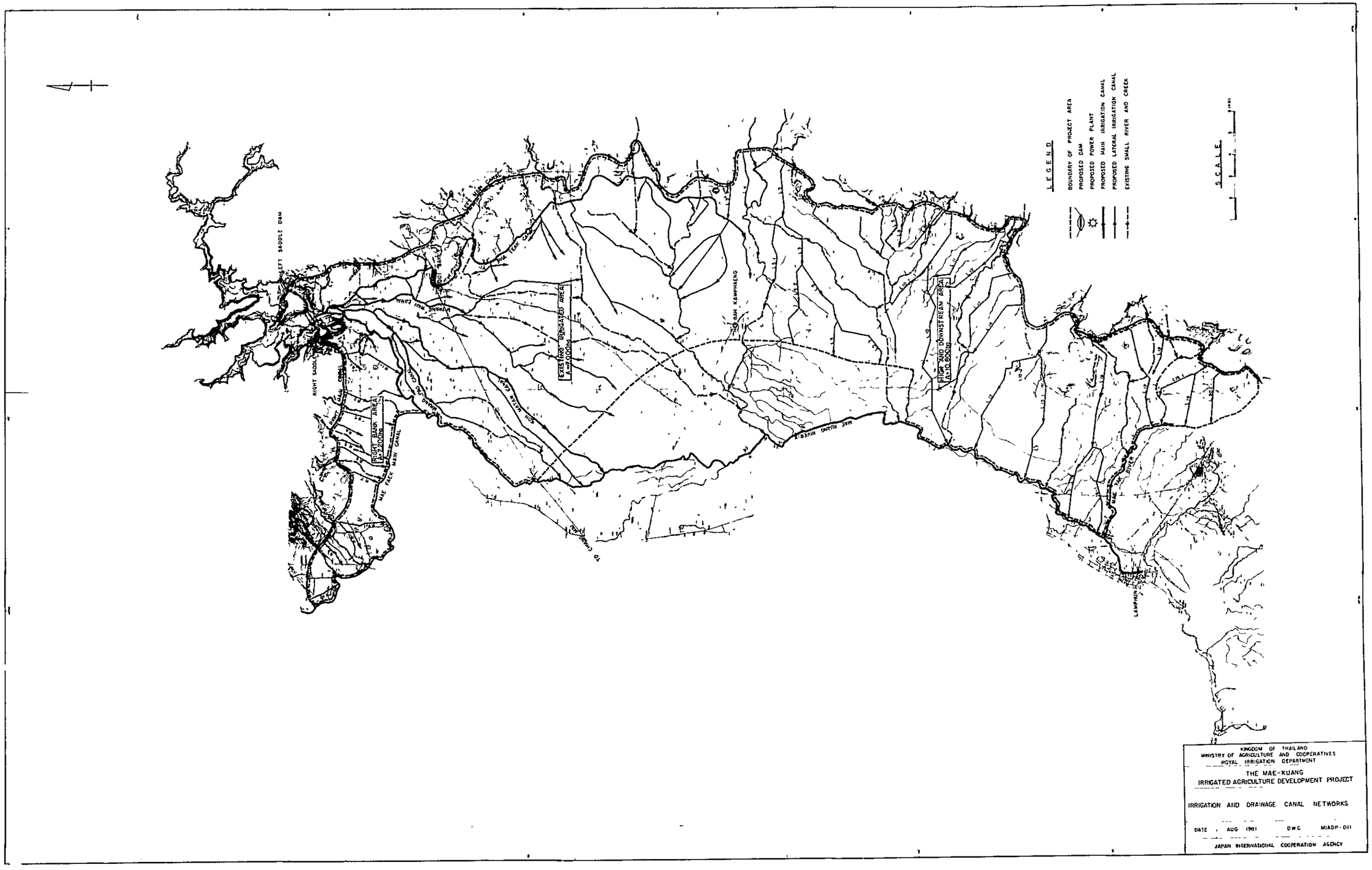
THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

OUTLETS

AT LEFT SADDLE, MAIN DAM AND RIGHT SADDLE

DATE AUG 1981 DWG MIADP 010

JAPAN INTERNATIONAL COOPERATION AGENCY



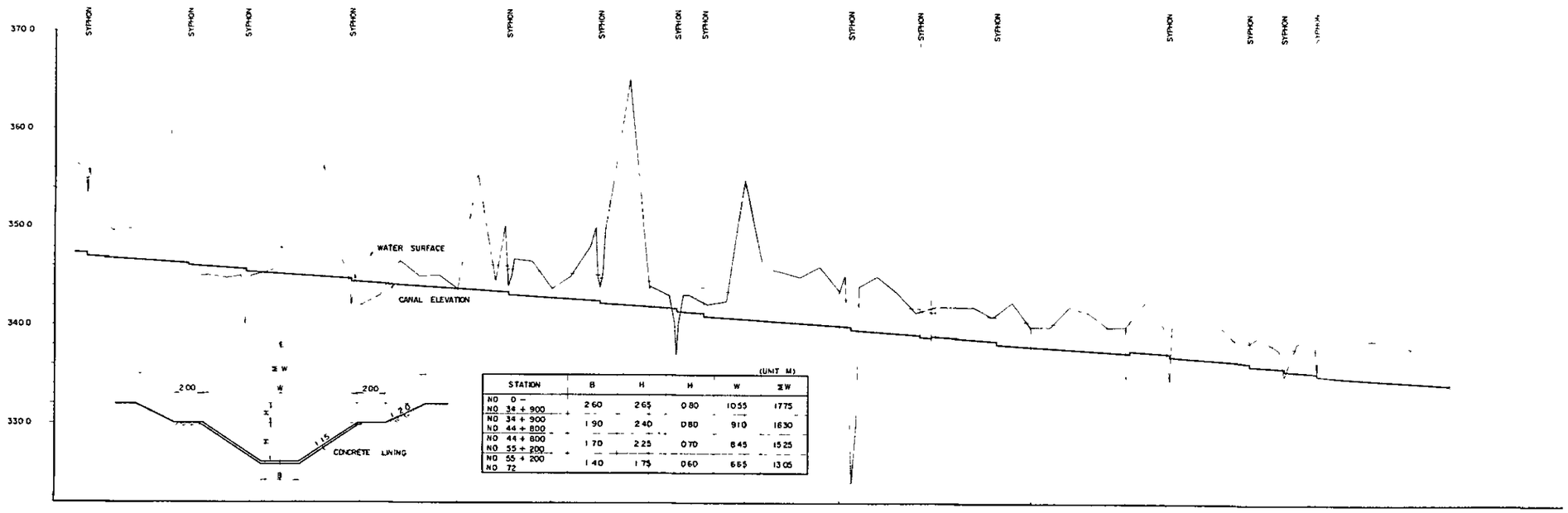
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

THE MAE-KUANG IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

IRRIGATION AND DRAINAGE CANAL NETWORKS

DATE : AUG 1991 DWG MIADP-011

JAPAN INTERNATIONAL COOPERATION AGENCY



(UNIT M)

STATION	B	H	H	W	ΣW
NO 0 – NO 34 + 900	2.60	2.65	0.80	10.55	17.75
NO 34 + 900 – NO 44 + 800	1.90	2.40	0.80	9.10	16.30
NO 44 + 800 – NO 55 + 200	1.70	2.25	0.70	8.45	15.25
NO 55 + 200 – NO 72	1.40	1.75	0.60	6.65	13.05

HYDRAULIC GRADIENT

1/8,000

DISCHARGE (CU M/SEC)

Q 10.800 — Q=8.019 — Q=5.758 — Q 2.780

STATION	DISTANCE	ACCUMULATIVE DISTANCE	GROUND ELEVATION	CANAL BED ELEVATION	WATER SURFACE
NO 0	0	0	356.7	347.22	349.45
NO 0 + 650	650	650	356.7	347.22	349.45
NO 1	1.000	1.650	352.1	346.93	349.28
NO 2	1.000	2.650	349.6	346.80	349.45
NO 3	1.000	3.650	349.9	346.68	349.33
NO 4	1.000	4.650	358.0	346.55	349.20
NO 5	1.000	5.650	360.0	346.43	349.08
NO 6	1.000	6.650	347.9	346.00	348.65
NO 7	1.000	7.650	345.0	345.88	348.53
NO 8	1.000	8.650	344.8	345.75	348.40
NO 9	1.000	9.650	342.5	345.63	348.28
NO 10	1.000	10.650	345.3	345.50	347.98
NO 11	1.000	11.650	346.0	345.08	347.85
NO 12	1.000	12.650	348.5	344.95	347.73
NO 13	1.000	13.650	356.1	344.83	347.60
NO 14 + 500	1.000	14.650	346.5	344.70	347.48
NO 15	1.000	15.650	342.0	344.58	347.35
NO 15	1.000	16.650	343.0	344.45	347.23
NO 17	1.000	17.650	346.5	344.33	347.10
NO 18	1.000	18.650	345.0	343.90	346.55
NO 19	1.000	19.650	345.1	343.78	346.43
NO 20	1.000	20.650	343.0	343.65	346.30
NO 21	1.000	21.650	355.5	343.53	346.18
NO 22 + 730	1.000	22.650	344.5	343.40	346.05
NO 23	1.000	23.650	346.7	343.31	345.96
NO 24	1.000	24.650	346.5	342.85	345.50
NO 25	1.000	25.650	343.8	342.73	345.38
NO 26	1.000	26.650	345.0	342.60	345.25
NO 27 + 500	1.000	27.650	348.0	342.48	345.13
NO 28	1.000	28.650	344.0	342.41	345.06
NO 29	1.000	29.650	365.0	342.08	344.70
NO 30	1.000	30.650	344.0	341.93	344.58
NO 31 + 400	1.000	31.650	343.1	341.80	344.45
NO 32	1.000	32.650	343.2	341.68	344.33
NO 33	1.000	33.650	342.2	341.63	344.28
NO 34 + 900	1.000	34.650	342.5	341.35	343.90
NO 35	1.000	35.650	355.0	341.15	343.80
NO 36	1.000	36.650	346.0	340.85	343.48
NO 37	1.000	37.650	345.5	340.60	343.25
NO 38	1.000	38.650	345.0	340.58	343.23
NO 39	1.000	39.650	346.0	340.45	343.10
NO 40 + 600	1.000	40.650	345.0	340.33	342.98
NO 41	1.000	41.650	342.0	340.20	342.85
NO 42	1.000	42.650	345.0	340.08	342.73
NO 43	1.000	43.650	343.5	339.95	342.60
NO 44 + 200	1.000	44.650	341.5	339.83	342.48
NO 45	1.000	45.650	342.0	339.70	342.35
NO 46	1.000	46.650	342.0	339.58	342.23
NO 47	1.000	47.650	342.0	339.45	342.10
NO 48 + 200	1.000	48.650	341.0	339.33	341.98
NO 49	1.000	49.650	342.5	339.20	341.85
NO 50	1.000	50.650	340.0	339.08	341.73
NO 51	1.000	51.650	340.0	338.95	341.60
NO 52	1.000	52.650	342.0	338.83	341.48
NO 53	1.000	53.650	341.5	338.70	341.35
NO 54	1.000	54.650	340.0	338.58	341.23
NO 55 + 200	1.000	55.650	340.0	338.45	341.10
NO 56	1.000	56.650	342.5	338.33	340.98
NO 57 + 300	1.000	57.650	340.0	338.20	340.85
NO 58	1.000	58.650	340.0	338.08	340.73
NO 59	1.000	59.650	341.0	337.95	340.60
NO 60	1.000	60.650	340.0	337.83	340.48
NO 61 + 900	1.000	61.650	338.0	337.70	340.35
NO 62	1.000	62.650	339.0	337.58	340.23
NO 63 + 300	1.000	63.650	337.8	337.45	340.10
NO 64	1.000	64.650	338.4	337.33	339.98
NO 65 + 400	1.000	65.650	338.8	337.20	339.85
NO 66	1.000	66.650	338.2	337.08	339.73
NO 67	1.000	67.650	338.4	336.95	339.60
NO 68	1.000	68.650	338.7	336.83	339.48
NO 69	1.000	69.650	338.5	336.70	339.35
NO 70	1.000	70.650	338.0	336.58	339.23
NO 71	1.000	71.650	337.0	336.45	339.10
NO 72 (E.P.)	1.000	72.650		336.33	338.98

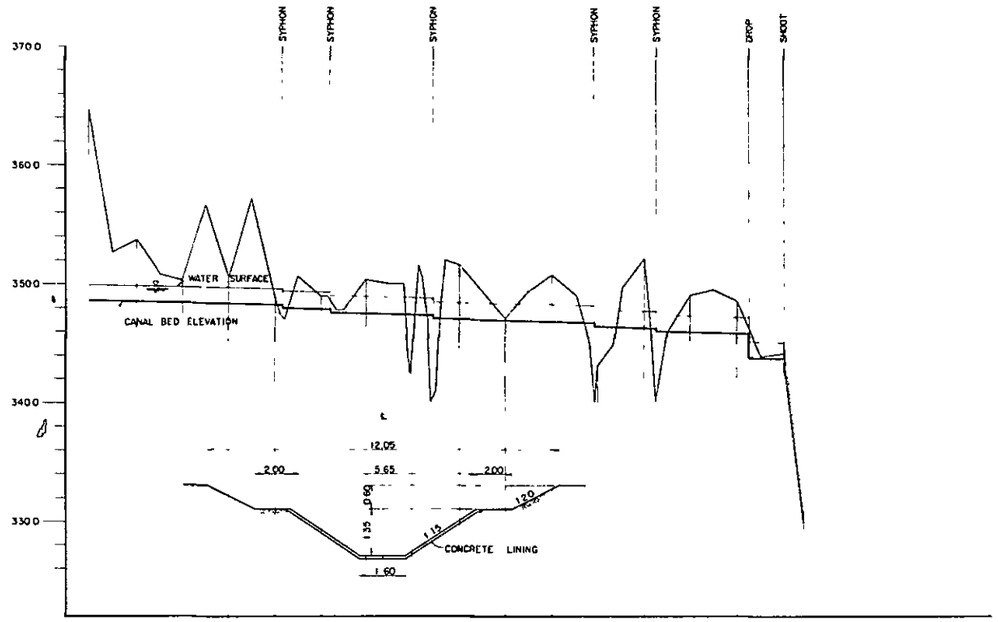
KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

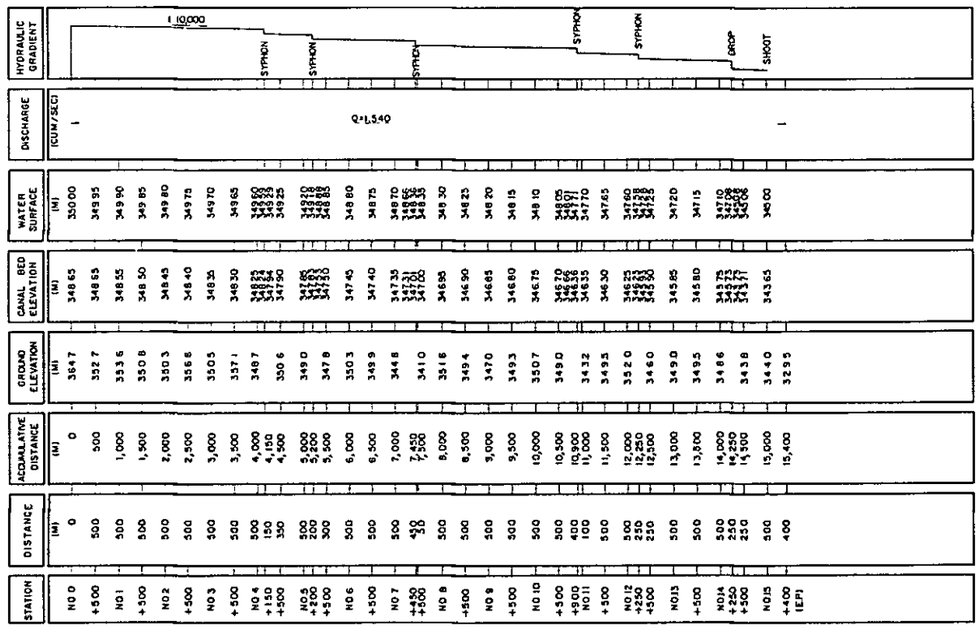
THE MAE-KUANG IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

PROFILE OF LEFT MAIN IRRIGATION CANAL

DATE AUG 1981 DWG M1ADP-012

JAPAN INTERNATIONAL COOPERATION AGENCY





STATION	DISTANCE (M)	ACCUMULATIVE DISTANCE (M)	GROUND ELEVATION (M)	CANAL BED ELEVATION (M)	WATER SURFACE (M)
NO 0	0	0	354.7	348.65	350.00
+500	500	500	352.7	348.65	349.95
NO 1	500	1,000	353.6	348.55	349.90
+300	500	1,500	350.8	348.50	349.85
NO 2	500	2,000	350.3	348.45	349.80
+500	500	2,500	356.8	348.40	349.75
NO 3	500	3,000	350.5	348.35	349.70
+500	500	3,500	357.1	348.30	349.65
NO 4	300	4,000	348.7	348.24	349.60
+150	150	4,150	350.6	348.24	349.55
+300	350	4,500	349.0	347.90	349.25
NO 5	300	5,000	347.8	347.65	349.20
+200	200	5,200	350.3	347.53	348.88
+100	300	5,500	347.8	347.30	348.85
NO 6	500	6,000	350.3	347.45	348.80
+500	500	6,500	348.9	347.40	348.75
NO 7	500	7,000	344.8	347.35	348.70
+450	450	7,450	341.0	347.31	348.66
+500	50	7,500	341.0	347.00	348.35
NO 8	500	8,000	351.8	346.85	348.30
+500	500	8,500	349.4	346.90	348.25
NO 9	500	9,000	347.0	346.85	348.20
+500	500	9,500	349.3	346.80	348.15
NO 10	500	10,000	350.7	346.75	348.10
+300	500	10,500	349.0	346.70	348.05
+900	400	10,900	343.2	346.56	347.91
NO 11	100	11,000	343.2	346.35	347.70
+500	500	11,500	349.5	346.30	347.65
NO 12	500	12,000	352.0	346.25	347.60
+250	250	12,250	346.0	345.93	347.28
+250	250	12,500	346.0	345.90	347.25
NO 13	500	13,000	349.0	345.85	347.20
+500	500	13,500	349.5	345.80	347.15
NO 14	500	14,000	348.6	345.75	347.10
+250	250	14,250	343.8	345.73	347.08
+250	250	14,500	343.8	345.71	347.06
NO 15	500	15,000	344.0	345.65	346.00
+400 (EP)	400	15,400	329.5		

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

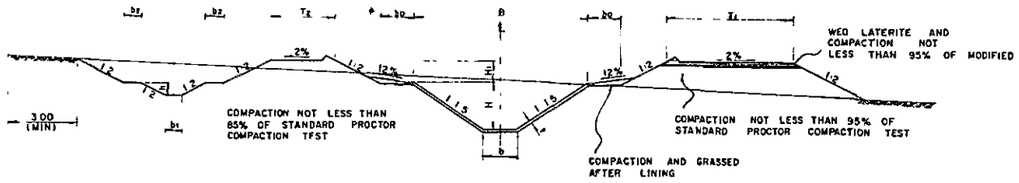
THE MAE-KUANG IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

PROFILE OF RIGHT MAIN IRRIGATION CANAL

DATE	AUG 1981	DWG	M1ADP 013

JAPAN INTERNATIONAL COOPERATION AGENCY

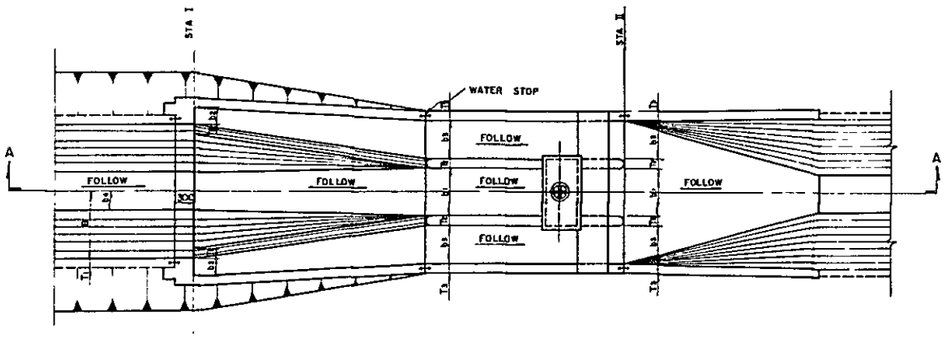
STANDARD CROSS SECTION OF CANAL AND ROAD



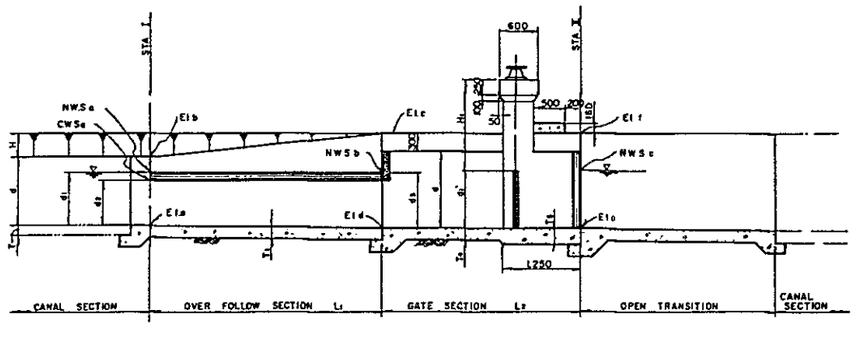
DIMENTION TABLE

NAME AND SECTION	TYPE	DESIGN DISCHARGE	V	b	B	H	H_1	t	bo	T_1	T_2	h	b_1	b_2
		cu m/sec	m/sec	m	m	m	m	m	m	m	m	m	m	m
LEFT MAIN CANAL NOO - NO6+280	1	10 800	0 895	2 60	10 55	2 65	VARIES	0 07	4 00	9 00	4 00	0 80	4 00	1 50
- NO34+900	1	10 800	0 895	2 60	10 55	2 65	VARIES	0 07	2 00	6 00	3 00	0 60	1 50	1 50
- NO44+800	2	8 013	0 839	1 90	9 10	2 40	VARIES	0 07	2 00	6 00	3 00	0 60	1 50	1 50
- NO55+200	3	5 758	0 769	1 70	8 45	2 25	VARIES	0 07	2 00	6 00	3 00	0 60	1 50	1 50
- NO72	4	2 780	0 639	1 40	6 65	1 75	VARIES	0 06	2 00	6 00	3 00	0 60	1 50	1 50
RIGHT MAIN CANAL NOO - NO15+400	1	1 540	0 505	1 60	5 65	1 35	VARIES	0 05	2 00	6 00	3 00	0 60	1 50	1 50
LATERAL		VARIES	VARIES	VARIES	VARIES	VARIES	VARIES	0 05 0 00	1 50	4 00	2 00	—	—	—

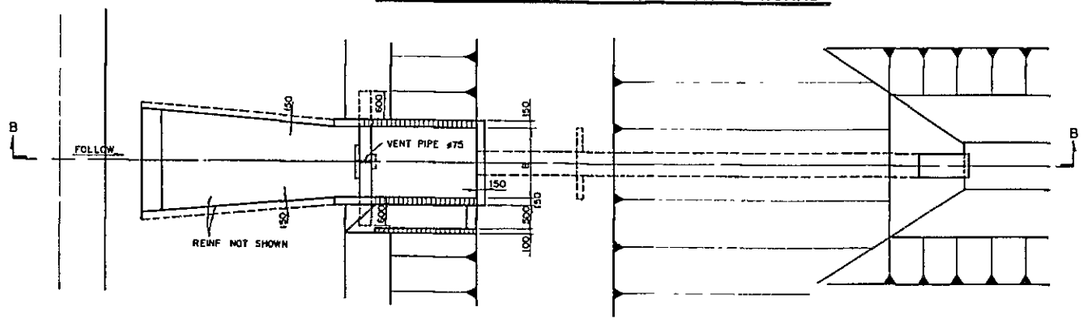
PLAN OF CHECK GATE



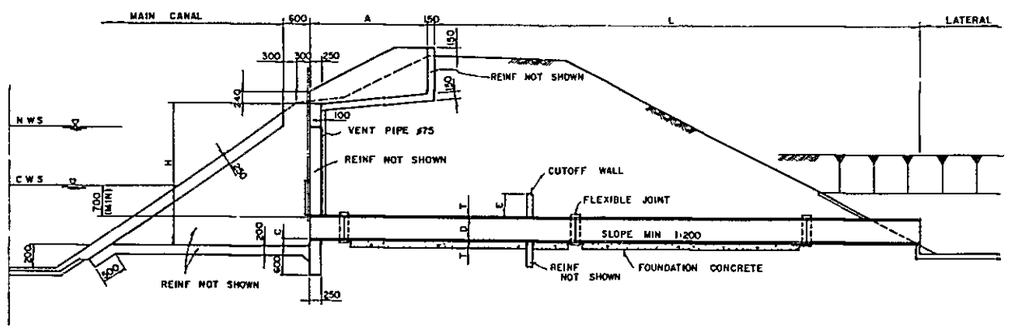
SECTION A-A



PLAN OF GATE-CONTROLLED DIVISION WORKS



SECTION B-B



NOTES

1 CHECK GATE

EACH DIMENSION MUST BE DESIDED BY CANAL SIZE AND HYDRAULIC CONDISION ESPECIALY FLOWING RUN-OFF FROA DRAINAGE AREA

2 GATE-CONTROLLED DIVISION WORKS

1) EACH DIMENSION MUST BE DESIDED BY CANAL SIZE , DIKE SIZE AND DIVISION DISCHAGE

2) CAREFUL COMPACTION IS REQUIRED AT THE BACK-FILLING POTION

KINGDOM OF THAILAND
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ROYAL IRRIGATION DEPARTMENT

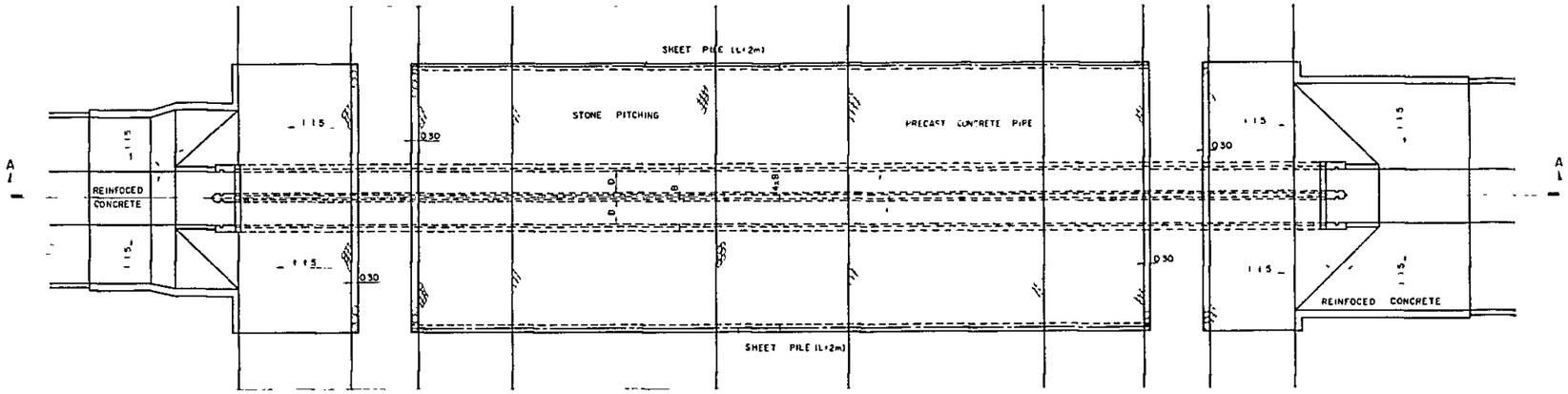
THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

MAJOR STRUCTURES IN IRRIGATION CANAL (1)

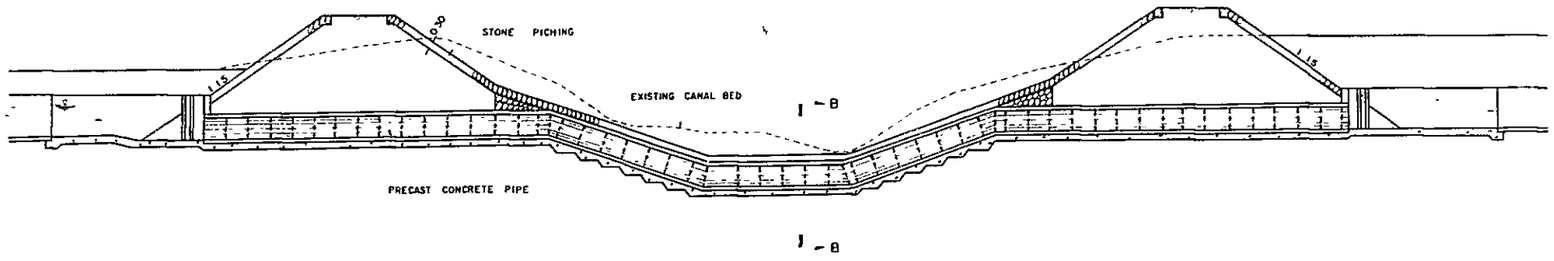
DATE	AUG 1981	D W G	MIADP-014

JAPAN INTERNATIONAL COOPERATION AGENCY

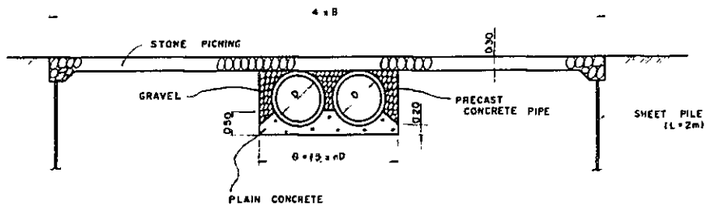
GENERAL PLAN OF SYPHON



SECTION A-A



SECTION B-B



NOTES

1. DIMENSION OF PRECAST CONCRETE PIPE MUST BE DECIDED BY HYDRAULIC CALCULATION BASED UPON DESIGN DISCHARGE
2. CAREFUL COMPACTION OF DIKE EMBANKMANT IS REQUIRED

KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

THE MAE-KUANG
IRRIGATED AGRICULTURE DEVELOPMENT PROJECT

MAJOR STRUCTURES IN IRRIGATION CANAL (2)

DATE AUG 1981 DWG MIADP-015

JAPAN INTERNATIONAL COOPERATION AGENCY