ANNEX VII
IRRIGATION AND DRAINAGE

ANNEX - VII

IRRIGATION AND DRAINAGE

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IRRIGATION AND DRAINAGE

1. INTRODUCTION

The Sakae Krang river basin extends over the northwestern part of the Central Chao Phraya Plain with a total area of about 6,300 km^2. The river basin is bounded by the mountain ridges on the west, the Chao Phraya river on the east, the northern ridge of the Mae Wong river on the north and southern ridge of the Khok Khwai river on the south. Administratively, the basin is located within the jurisdictions of four provinces (Changwat), i.e., Khampheng Phet, Nakhon Sawan, Uthai Thani and Chainat.

Irrigation development in the Sakae Krang river basin has been commenced in late 1970s by RID. At present, there exist one large scale, five medium scale and 50 small scale irrigation projects in the river basin. The basin is graced with extended land resources quite suitable for agricultural production. Nevertheless, the land productivity is still low due to various constraints for agricultural development. The major constraints are as follows:

- Annual shortage and uneven seasonal distribution rainfall,
- Serious shortage of irrigation water resources in the dry season,
- Lack of perennial irrigation system,
- Improper water management,
- Improper application of agricultural inputs, and insufficient and improper control of diseases, insects and rats, and
- Insufficient agricultural supporting services.

In order to solve the above constraints, the optimum development plan should be formulated through sufficient understanding and grasp of present conditions in the basin and technical and economical considerations and examination to them.

In this ANNEX, irrigation and drainage aspects for the optimum development are discussed laying emphasis on the irrigation and drainage water requirements and planning and design of project facilities.

2. EXISTING IRRIGATION PROJECT

2.1 General

As stated in CHAPTER 1, there exist one large scale irrigation project, five medium scale irrigation projects and 50 small scale irrigation projects in the Sakae Krang river basin. These projects have mainly been implemented during the recent 5 years by RID in response to the local people's request in the basin. The location map of existing irrigation projects is shown in Fig. VII-1.

2.2 Large Scale Irrigation Project

The Thap Salao Irrigation Project is the only large scale irrigation project in the basin (see Table VII-1). The irrigation service area of 88,000 rai (14,080 ha) is located in the southeastern part of the basin and extends west to east along the both banks of the Thap Salao river which is the main water source of the project. The major facilities of the project comprise a diversion weir constructed across the main stream of the Thap Salao river and main and lateral irrigation canal system. At present, the project is suffering from irrigation water shortage. The main reasons are as follows:

- There exist three local-made weirs which cover the areas of 35,000 rai (5,600 ha) in total.
  Much irrigation water to the areas is taken without proper water management.

- Since 1970, the upstream area of the project was rapidly opened from the forest to the agricultural land. Consequently, the run-off phenomena from the basin upstream of the project were severely changed. No stable perennial flow is presently expected.

For solution of water shortage problem, RID intends to implement the Thap Salao Dam Project.

2.3 Medium Scale Irrigation Project

(1) Wang Kun Pao and Khun Lard Boriban Regulators

There exist two channels to divert the water of the Mae Wong river. These channels were constructed by farmers themselves more than 20 years ago. After construction of these channels, much water of the Mae Wong river was diverted through these channels to outside of the Mae Wong river basin. Subsequently, downstream areas of the Mae Wong river were suffered from irrigation water shortage. In resoponse to the farmer's request downstream of the Mae Wong river, RID constructed the regulators at the heads of these channels in 1975 to 1977, namely Wang Kun Pao Regulator and Khun Lard Boriban Regulator (see Table VII-1).

The Wang Kun Pao Regulator is located at the left bank of the Mae Wong river, 8 km downstream of the proposed Lower Mae Wong Dam. The Regulator covers the irrigation service area of 105,000 rai (16,800 ha). The Khun Lard Boriban Regulator is located at the left bank of the Mae Wong river, 40 km downstream of the proposed Lower Mae Wong Dam. The irrigation service area covered by the Regulator is 55,000 rai (8,800 ha). No records on diversion water amount from the Mae Wong river at both regulators are available.

(2) Khlong Nam Hom Irrigation Project

The Khlong Nam Hom area of 10,000 rai (1,600 ha) is located at the right bank of the Mae Wong river, middle part of the Mae Wong river basin (see Table VII-1). The main water source for irrigation is the Mae Wong river. The return flow from the small scale irrigation project areas along the left bank of the Khlong Pho river is used for augmentation of irrigation for the area. The major facilities of the project comprise a diversion weir constructed in 1975 to 1976 by RID and canal system constructed by farmers.

(3) Wang Rom Klao Irrigation Project

The Wang Rom Klao area of 12,500 rai (2,000 ha) is located at both banks of the Sakae Krang river, 10 km downstream of confluence of the Mae Wong and Khlong Pho rivers (see Table VII-1). The main water sources are the Mae Wong, the Khlong Pho and the Huai Thap Salao rivers. The major facilities of the project consist of an earth fill dam, spillway, intake structures and canal systems constructed by farmers.

(4) Khlong Yang Irrigation Project

The Khlong Yang area of 7,500 rai (1,200 ha) is located at the right bank of Huai Thap Salao river, 7 km upstream of confluence of the Huai Thap Salao and Sakae Krang rivers. The water source is the Huai Thap Salao river. The main facilities of the project consist of a diversion weir, 3 intake structures and canal systems. These facilities were constructed in 1950 to 1954 and deteriorated at present. Rehabilitation works are required.

2.4 Small Scale Irrigation Projects

There exist small scale irrigation projects of 50 in number (see Table VII-2). The total irrigation service area of all projects is 256,600 rai (41,050 ha) which consist of 60,500 rai (9,680 ha) of the Mae Wong river basin, 53,800 rai (8,600 ha) of the Khlong Pho river basin, 66,500 rai (10,640 ha) of the Thap Salao river basin and 75,800 rai (12,130 ha) of the Khok Khwai river basin, respectively. Most of the projects were consturcted by RID in 1980 to 1984 and have canal systems constructed by farmers.

2.5 Pump Irrigation Services from RID

RID Regional Office VII provides pump irrigation services with free charge for the farmers who have rainfed paddy field along the rivers and streams in the basin. About 35 portable pump units are usually used for such services. The regulations of the services are as follows:

- Operation hours of pump unit are 22 hrs/day,
- Irrigation service period is 120 days, and
- The regulations limit farmers receiving the service for only one crop season, wet season or dry season.

The Regional Office VII uses the budget of 1 to 1.5 x 10^6 Bahts/ years for the services.

3. SELECTION OF PROJECT AREA

3.1 Basic Concepts on Irrigation and Drainage Development

In order to realize the concepts for agricultural development, the following basic concepts for irrigation and drainage development are envisaged in conformity with the concepts for water resources development.

a) First priority for irrigation development would be given to the supplemental irrigation for wet season paddy in the existing irrigation areas.

b) Possible further extension of irrigable area would be examined taking the topographic and soil conditions into consideration. If the exploited water resources are available, eitherthe supplemetanl irrigation for the wet season paddy in the above extension area or the irrigation for dry season crop in the existing irrigation area would be considered.

c) The natural streams in the basin would be used for drainage as many as possible. The collector drains would be provided for proper drainage in each scheme.

3.2 Mae Wong River Basin

As stated in Chapter 1 of this ANNEX, there exist smale and medium scale irrigation projects along the Mae Wong river, which cover the irrigation service area of 230,000 rai (36,800 ha) in total. Most of existing irrigation areas have an intake weir or regulator and irrigation canal system constructed by farmers. These irrigation areas would be incorporated into the development plan. Other than the existing irrigation areas, there are following three potential areas, in where the paddy cultivation is made under rainfed condition:

a) Potential area fo 30,000 rai (4,800 ha) on the right bank in the upstream reach of the Mae Wong river

b) Potential area of 20,000 rai (3,200 ha) on the right bank in the middle to downstream reach of the Mae Wong river, and

c) Potential area of 18,750 rai (3,000 ha) on the left bank in downstream reach of the Mae Wong river.

Total development area is tabulated as follows.

Existing Irrigation Area	Rainfed Area	Total
230,000 rai	68,750 rai	298,750 rai
(36,800 ha)	(11,000 ha)	(47,800 ha)

The location map of irrigation development area in the Mae Wong river basin is shown in Fig. VII-2.

3.3 Khlong Pho River Basin

There exist small scale irrigation projects in the Khlong Pho river basin, which have the irrigation service areas of 53,800 rai (8,600 ha) in total. Other than these existing irrigation projects, a medium scale irrigation project, the Wang Rom Klao, is located at just downstream of the confluence of the Mae Wong river and the Khlong Pho river. The Wang Rom Klao has the irrigation service area of 12,500 rai (2,000 ha) and is originally irrigated by using the water from the Khlong Pho, because no available water from the Mae Wong can be expected. Accordingly, the Wang Rom Kao would be incorporated into the irrigation development plan for the Khlong Pho river basin.

The Khlong Pho river basin has the following potential areas, in where farmers enjoy the rainfed paddy cultivation:

a) Potential area of 18,750 rai (3,000 ha), which extends on both banks in the upstream reach of the Khlong Pho river,

b) Potential area of 12,500 rai (2,000 ha) on the left bank in the middle reach of the Khlong Pho river, and

c) Potential area of 14,400 rai (2,300 ha) on the right bank in the downstream reach of the Khlong Pho river.

Total development area is summarized below.

Existing Irrigation Area	Rainfed Area	Total
56,300 rai	45,650 rai	101,950 rai
(10,600 ha)	(7,300 ha)	(17,900 ha)

The location of irrigation development area in the Khlong Pho river basin is shown in Fig. VII-2.

4. IRRIGATION AND DRAINAGE WATER REQUIREMENTS

4.1 Irrigation Water Requirements

4.1.1 General

Irrigation water requirements under the following two conditions are calculated:

a) Irrigation water requirements under the present condition are estimated based on the present cropping pattern in order to grasp the areas actually irrigated through the present water balance calculation.

b) Irrigation water requirements under the with-project condition are estimated based on the proposed cropping pattern in order to determine the project scale.

The calculation of irrigation water requirements is made on monthly basis through the following procedures:

a) Estimation of consumptive use of water by crop,

b) Estimation of percolation rate for paddy crop,

c) Estimation of water requirement for nursery and land preparation for paddy crop,

d) Estimation of effective rainfall, and

e) Estimation of diversion irrigation water requirement based on the overall irrigation efficiency.

4.1.2 Consumptive use of water by crop

(1) Cropping patterns

The cropping patterns for both present and with-project conditions are shown in Fig. VII-3 and Fig. VII-4, respectively.

(2) Potential evapotranspiration (ETp)

Since no data on the field measurement of consumptive use of water by crop are available in the Sakae Krang river basin, the consumptive use of water is estimated based on the potential evapotranspiration made by the authorized method.

The FAO Group on Crop Water Requirement recommends the following prediction method:

a) Blany - Criddle,

b) Radiation,

c) Modified Penman, and

d) Pan evaporation.

Among the above methods, it is said that the modified Penman method would offer the best results, if accurate climatic data are available. The modified Penman method is widely used in Thailand as well as the Asian countries.

Climatic data for about 30 years are available at Nakhon Sawan. Calculation of the potential evapotranspiration is made by the modified Penman method based on the climatic dat at Nakhon Sawan. The estimated potential evapotranspiration is shown in Table VII-3.

(3) Crop coefficient (Kc)

According to the Chao Phraya - Meklong Basin Study made by Acres International Limited, Canada, the crop coefficient in the Chao Phraya - Meklong Basin has been evaluated using evapotranspiration measurement at Samchock Experimental Station as shown below.

Crop	Month				
	1st	2nd	3rd	4th	5th
Transplanted (local)	0.85	1.02	1.03	0.93	0.81
High Yield Varieties	1,00	1.30	1.32	0.87	-
Field Crops	0.30	0.50	1.00	0.80	-

These figures are used for estimation of consumptive use of water by crop.

(4) Consumptive use of water by crop (Cu)

The consumptive use of water by crop is calculated by the following formula.

$$Cu = Kc \cdot ETp$$

where, Cu : consumptive use
Kc : crop coefficient
ETp : potential evapotranspiration

4.1.3 Percolation rate (P)

The percolation rate of 1.0 mm/day is incorporated in the calculation of irrigation water requirements for paddy crop, in due consideration of textural profiles of representative soil extending over the river basin.

4.1.4 Water requirement for nursery and land preparation (Wℓ)

The area required for nursery bed covers about 6 % of the cropping area. Nurseries are operated in the same area and during the same period as land preparation. Accordingly, it can be assumed that nursery water requirement is covered by supply water for land preparation.

The following figures are assumed for land satulation and ploughing, and standing water prior to transplanting.

Soil satulation	140 mm
Standing water	40 mm
	180 mm

Duration of land preparation = 30 days

The land preparation requirement is estimated by using Zijlstra and Van de Goor formula.

$$Wl = a \cdot \frac{e^{\frac{a \cdot T}{b}}}{e^{\frac{a \cdot T}{b}} - 1}$$

where, Wl : water requirement for land preparation (mm/day)

a : value of open water evaporation and percolation

b : quantity of water needed for soil satulation and standing water (mm)

T : duration of land preparation (day)

Estimated water requirement for land preparation varies from 270 mm to 300 mm.

4.1.5 Effective rainfall (Re)

The effective rainfall is estimated by using the relationship curve between total and effective monthly rainfall derived from the Chao Phraya - Meklong Basin Study as shown Fig. VII-5. This curve was worked out through the simulation of field water levels in the present agricultural practice condition with minimal storage of field in the Chao Phraya - Meklong Basin. The effective rainfall estimated by this curve shows rather conservative figures than that by the "effective rainfall chart made by RID shown in Fig. VII-6. The effective rainfall for upland crop is estimated by the above RID's chart.

The monthly rainfall data at Thap Than station were used for estimation of effective rainfall.

4.1.6 Net water requirement and diversion water requirement

The net water requirement is calculated using the following formula:

Paddy

$$Wn = Cu + P + Wl - Re$$

Upland crop

$$Wn = Cu - Re$$

where, Wn : net water requirement
Cu : consumptive use of water
P : percolation rate
Wl : water requirement for land preparation including nersery requirement
Re : effective rainfall

The diversion water requirement is calculated by the following formula:

$$Dw = Wn \times \frac{100}{E}$$

where, Dw : diversion water requirement
Wn : net water requirement
E : overall irrigation efficiency

Generally, the irrigation losses added to the net water requirement are the diversion water requirement. The irrigation losses consist of conveyance loss on the irrigation canal and application loss of the field. Factors affecting conveyance loss are size of the irrigation service area, canal lining and the technical and managerial facilities of water control on the canals. The application loss to the field is primarily affected by method and control of operation, the type of soils, length of field canals, size of the irrigation block, etc.

The following overall irrigation efficiencies are assumed for calculation of diversion water requirement.

Present condition

Paddy	:	45 %
Upland crop	:	40 %

With-project condition

Paddy	:	55 %
Upland crop	:	45 %

The calculated irrigation water requirements for the present conditions and with-project condition are shown in Table VII-4 to Table VII-6, respectively.

4.1.7 Unit design irrigation requirement

As shown in Table VII-6, the peak unit irrigation requirement for with-project condition varies from 0.547 ℓ/sec/ha to 1.080 ℓ/sec/ha. The peak unit irrigation water requirement with 5 year's return period is estimated at 0.9 ℓ/sec/ha. The unit design irrigation requirement is determined at 1.0 ℓ/sec/ha taking an allowance of 10 %.

4.2 Drainage Water Requirement

4.2.1 Present drainage condition

There exist no artificial drainage facilities in the Sakae Krang river basin. The natural streams formed in the basin are used for drainage. It was found through the field survey that there are no serious drainage problems in the upper and middle part of each sub-river basin. Only lowlying areas downstream of the Sakae Krang river, the Thap Salao river and the Khok Khwai river are inundated with the excess water of rainfall.

4.2.2 Standard for drainage plan

Taking the present drainage condition into consideration, the following basic concept for drainage development in the basin is envisaged in conformity with the concepts for irrigation development:

- The natural streams in the basin would be used for drainage as many as possible. The collector drains would be provided for proper drainage in each scheme.

The drainage water requirement is estimated in accordance with the following design standard which is generally applied to drainage plan in the humid Asian countries such as Thailand, Philippines, Malaysia and Indonesia:

a) Return period fo design rainfall is five years,

b) Design rainfall is of three days - consecutive rainfall,

c) Design rainfall shall be drained off for three days,

d) On-field storage of an average surcharge of 75 mm.

4.2.3 Drainage water requirement

Design rainfall is determined based on the daily rainfall records at Thap Than.

Three days - consecutive rainfall with return period of five years	170 mm

Unit drainage water requirement is calculated by using the following formula.

$$q = \frac{(R-h) \times 10^{-3} \times 10,000 \times 10^{3}}{86,400 \times d}$$

where, q : unit drainage water requirement (ℓ/sec/ha)

R : design rainfall (mm)

h : on-field storage of an average surcharge (75 mm)

d : allowable duration of inundation (3 days)

Unit drainage water requirement is determined at 3.67 ℓ/sec/ha.

5. PLANNING AND DESIGN OF PROJECT FACILITIES

5.1 General

The general features of each high priority project are to irrigate the area of 298,750 rai (47,800 ha) for the Lower Mae Wong and Upper Mae Wong Projects and the area of 101,950 rai (17,900 ha) for the Khlong Pho Project. The facilities required for the Project are intake weir, irrigation and drainage canals and their related structures.

For the planning and design of the project facilities, the following topographic maps are available.

(1) Topographic maps on a scale of 1/10,000 with a contour interval of 1.0 m

The maps cover only a part of upstream reaches of the Mae Wong and Khlong Pho river basins.

(2) Topographic maps on a scale of 1/50,000 with a contour interval of 20 m

These maps cover the whole Sakae Krang river basin.

A layout planning of main canal and lateral is made for both the Mae Wong and Khlong Pho river basins by using the topographic maps on a scale of 1/50,000. However, the scale and contour interval of the topographic map used for the layout planning are not sufficient to estimate the construction cost of irrigation facilities. Consequently, the model area located in the upstream reach of the Mae Wong river, where is covered by the topographic maps on a scale of 1/10,000 with a contour interval of 1.0 m, is selected for above purpose.

The planning and design of irrigation facilities for the model area are made to mainly estimate the work quantities and the construction cost (see Table VII-7).

5.2 Planning and Design of Irrigation Facilities for Model Area

5.2.1 Intake weir

The hydrological, geological and topographical conditions at the proposed intake weir site are not investigated yet at this moment. Planning and design of intake weir for the model area is made referring the existing intake weirs on the Mae Wong river.

An intake weir of ogee type would be constructed for the model area to divert the irrigation water to the area. The weir would be 4.5 m high and 35 m long including the scouring sluice portion. In the right end of the weir, a scouring sluice with 2 sets of gate, 2.0 m wide and 2.0 m high, would be provided so that the deposited sand can be flashed down. The scouring gate would be operated by man power.

An intake structure would be constructed on the right bank. The intake gates would consist of 3 sets of slide gate, each 2.0 m wide and 1.8 m high, which would be operated by man power. The intake discharge is estimated at 7.4 m^3/sec at maximum.

The layout of proposed intake weir is shown in Fig. VII-7.

5.2.2 Irrigation canal system

(1) Layout planning of irrigation canal

A layout planning of irrigation canal is made on the topographic map on a scale of 1/50,000. The topographic map on a scale of 1/10,000 prepared by RID is used for this work. In the planning the following matters are taken into consideration.

(a) Canal alignment should be straight and short as much as possible.

(b) The existing irrigation canals are to be incorporated to the project canal system as much as possible.

(c) Embankment portion should be minimized as much as possible.

The layout of irrigation canal system is shown in Fig. VII-8.

(2) Design of irrigation canal

Design discharge

Based on the unit irrigation water requirement of 1.0 ℓ/sec/h the design discharges for the irrigation canals over the model area are calculated as shown in Fig. VII-9.

Linning of canal

All the main canals and laterals are lined with 10 cm thick plain concrete to protect seepage from the canal bank and bottom and the canal section against erosion.

Velocity

The maximum permissible velocity of concrete lined canals are determined at 1.5 m/sec. The minimum permissible velocity is determined at 0.5 m/sec so as not to induce the growth of aquantic plants and to deposit the sediments.

Roughness coefficient

The Manning formula is used for determination of hydraulic properties of canals. The Manning's roughness coefficient "n" is assumed at 0.015.

Freeboard and west bank

Freeboard is decided so as to absorb the fluctuation of water level due to the variation of actual roughness coefficient, conversion of velocity head to the statistic head and wave action caused by wind or regulating structure operation. The minimum freeboard is determined as follows:

Discharge (m^3/sec)	Minimum Freeboard (m)
Less than 2.0	0.15
2.0 - 7.0	0.20

The height of waste bank is determined to be 0.3 to 0.4 m for concrete lined canal.

Canal base width/water depth (B/h) ratio

The ratio of canal base width and water depth is determined as follows:

	B/h
- Concrete lined canal	1.0 - 2.0

Side slope

The side slope of canals is assumed at 1 : 1.5.

Considering above design criteria, the preliminary designs of main canal and lateral for the model area are made. The profile of main canal is shown in Fig. VII-10. The typical cross section of irrigation canal is shown in Fig. VII-11.

(2) Design of related structures

Many different types of canal structures are required in the irrigation canal system of model area to effectively and efficiently convey and regulate the irrigation water. The following canal structures are envisaged to be constructed for the model area.

Turnouts with check

These structures would be provided to divert water from the main canal or lateral to lateral or sub-lateral. The check would be provided to regulate the canal water surface upstream of the structure and control the downstream flow. The structure would comprise a reinforced concrete flume and transition with gradually varied section at both up- and downstream of the flume. The flume would be equipped with steel slide gate to regulate water surface in the canal.

Syphon

The main canal would cross over the many existing streams. The syphon structures would be provided at such crossing places. The structure would consist of inlet transition, cast-in-place concrete conduit with rectangular section and outlet transition.

Culvert

Culvert would be provided to convey irrigation water under roads. The culvert would consist of a rectangular reinforced conduit or a precast concrete pile and transition with gradually varied section at inlet and outlet of the conduit.

Sidespillway

The sidespillway would be provided to waste excessive water which may result from misoperation, heavy rainfall or floods caused by break of canal embankment. For the purpose mentioned above, the sidespillway would be constructed upstream of syphon structures.

5.2.3 Design of drainage canal system

(1) Layout planning of drainage canal

There exist many existing small rivers and streams. These rivers and streams would be used for drainage purpose as much as possible. Only collector drain would be provided in the model area so as to drain the excess water of rainfall to the existing rivers and streams. (See Fig. VII-8)

(2) Design of drainage canal and its related structures

According to the drainage water requirement estimated in Section 4.2, the unit design discharge is determined at 3.67 ℓ/sec/ha. Design discharge of respective drainage canals are calculated on the basis of the unit design discharge.

The related structures to the drainage canals include corss drains and culverts. They are planned and designed with the same principles as those of the related structures for irrigation canals.

The typical cross section of drainage canal is shown in Fig. VII-11.

5.2.4 Inspection road

For proper operation and maintenance of project facilities, well arranged inspection roads are of vital importance.

(1) Main inspection road

The main inspection roads are required for inspection, operation and maintenance of main canals. Considering the future increase of vehicles for the inspection and operation and heavy construction to be required for the canal maintenance and repair, all the main inspection roads are so designed as to have an effective width of 5 m and to be laterite-paved. These roads are also used for transportation of agricultural products and equipment.

(2) Lateral inspection road

The lateral inspection road is mainly provided alongside the lateral canal. All these roads have a width of 4 m.

The typical cross section of inspection road is shown in Fig. VII-11.

5.3 Layout Planning of Canal System for High Priority Projects

A layout planning of canal systems for the high priority projects in made by using the topographic maps on a scale of 1/50,000. The layout is shown in Fig. VII-12.

Table VII-1 EXISTING LARGE AND MEDIUM SCALE IRRIGATION PROJECT

Project Name	Irrigation Area (rai)	Main Features of Facilities	Construction Year	Existing Condition
Existing Large Scale Irrigation Project				
I. Thap Salao River				
1. Thap Salao	88,000	Weir : L = 60 m , H = 3.0 m Intake : left bank 1.5 m x 1.5 m x 1 right bank 2.0 m x 1.75 m x 2 Irrigation System : main = 37.9 km lateral = 45.8 km	1970 - 1982	Good
Existing Medium Scale Irrigation Project				
I. Mae Wong River				
1. Khun Lard Boriban (R.G.)	55,000	Radial Gate : 6 m x 3 m x 1	1975 - 1977	Good
2. Wang Khun Pao	105,000	Radial Gate : 4 m x 3 m x 1	1975 - 1977	Useless
II. Khlong Pho River				
1. Khlong Nam Hom	10,000	Weir : L = 18 m, H = 2.5 m Intake : ϕ1.0 m x 3	1975 - 1976	
III. Sakae Krang River				
1. Wang Rom Klao	12,500	Earth Dam: L = 366 m, H = 11.0 m, T.W = 8.0 m Reservoir: 3,700 x 10^3 m^3 Spillway : Max Capacity 430 m^3/sec radial gate 6.0 m x 11.5 m x 3 Intake : 1.5 m x 1.5 m x 2 at both bank	1980 - 1982	Good
IV. Thap Salao				
1. Khlong Yang	7,500	Weir and intakes were deteriorated	1950 - 1954	to be rehavilitated

Table VII-2 INVENTORY LIST OF EXISTING SMALL SCALE IRRIGATION PROJECT (1/3) IN SAKAEKRANG RIVER BASIN

Project Name	Irrigation Area (rai)	Main Feature of Structure: Head Works Length (m)	Head Works Height (m)	Head Regulator Left Bank	Head Regulator Right Bank	Irrigation System	Construction Year	Construction Cost (10^6 ฿)
I. Mae Wang River								
1. Ban Wang Nam Kao (RG)	3,000	-	-	-	2 - ϕ1.0m	Yes	1984	0.641
2. Khlong Saingu (RE)	10,000	235	2.5	1 - ϕ0.3m	2 - ϕ1.0m	No	1982	1.100
3. Huai Hin Lab (RE)	3,000	392	4.5	-	-	Yes	1984	3.079
4. Wang Ma (W)	26,000	25	3	2 - ϕ1.0m	-	Yes	1977	2.489
5. Sawang A-ROM (W)	200	40	3	-	-	No	1982	3.854
6. Lan Bai Dieo (W)	4,000	25	2	-	2 - ϕ1.0m	Yes	1982	2.600
7. Nong Yao (W)	4,000	15	1.5	-	1 - ϕ1.0m	Yes	1983	1.221
8. Wang Hin Phoeng (W)	10,000	14	1.5	2 - ϕ1.0m	1 - 2.0m x 2.0m	Yes	1981	2.730
9. Huai Pra Khun	300	15	2.25	1 - ϕ1.0m	1 - ϕ1.0m	No	1984	1.165
Total	60,500 (9,680 ha)							
II. Khlong Pho River								
1. Bank Hua Khao Daeng (W)	4,000	50	2.75	-	1 - ϕ1.0m	Yes	1984	3.417
2. Khlong Pho (RG)	4,000	20	3	1 - ϕ1.0m	2 - ϕ1.0m	Yes	1984	3.166
3. Ban Khlong Khoi (W)	4,300	152.5	4	1 - ϕ1.0m	1 - ϕ1.0m	Yes	1984	1.733
4. Thung Mon (W)	5,000	12	1	-	1 - ϕ1.0m	Yes	1982	0.585
5. Wang Hin (W)	1,500	16	2	1 - ϕ1.0m	-	Yes	1982	1.198
6. Huai Yai Hen (W)	6,000	10	1.8	1 - ϕ1.0m	-	Yes	1983	0.969
7. Map Kae (W)	6,000	24	3	2 - ϕ1.0m	-	Yes	1981	3.540
8. Khao Kwang Thong (W)	7,500	25	2.5	1 - ϕ1.0m	2 - ϕ1.0m	Yes	1980	2.613
9. Khlong Pho (W)	4,000	35	1.7	-	-	No	1981	2.321
10. Ban Wang Ta Kien (W)	2,500	17.5	2.5	1 - ϕ1.0m	1 - ϕ1.0m	Yes	1983	1.229
11. Nong Yai Da (W)	8,000	20	2.5	-	-	No	1983	1.475
12. Nong Kwan Koob (W)	1,000	57	1.8	-	3 - ϕ1.0m	Yes	1983	1.765
Total	53,800 (8,600 ha)							

Table VII-2 INVENTORY LIST OF EXISTING SMALL SCALE IRRIGATION PROJECT (2/3) IN SAKAEKRANG RIVER VASIN

Project Name	Irrigation Area (rai)	Main Feature of Structure: Heas Works Length (m)	Heas Works Height (m)	Head Regulator Left Bank	Head Regulator Right Bank	Irrigation System	Construction Year	Construction Cost (10^6 ฿)
III. Thap Salao River								
1. Pak Muang (RG)	3,500	-	-	2 - ϕ1.0m	-	Yes	1981	0.454
2. Takro (RG)	10,000	-	-	2 - 1.75m x 1.50m	-	Yes	1981	0.728
3. Lak Met (RG)	21,500	-	-	-	3 - 1.0m x 1.75m	Yes	1981	0.957
4. Khong Chai (W)	4,000	65	3.5	2 - ϕ1.0m	-	Yes	1981	2.106
5. Ban Bo Mad (W)	2,000	12	1.7	1 - ϕ1.0m	1 - ϕ1.0m	Yes	1984	0.885
6. Nong Ban (W)	3,000	12.5	1.65	1 - ϕ1.0m	1 - ϕ1.0m	No	1984	1.005
7. Huai Wi (W)	3,000	15	1.5	-	-	No	1984	1.576
8. Ban Mok Thaeo (W)	1,000	15	1.75	-	-	No	1981	1.330
9. Don Kloi (W)	5,000	9	1.5	-	-	No	1980	0.633
10. Nong Phangkha (W)	5,000	11	1.25	-	-	No	1980	0.633
11. Tha Pho (W)	1,000	11	1.25	-	-	No	1981	1.298
12. Ban Sup Pra Kon (RG)	500	-	-	1 - ϕ1.0m	-	Yes	1984	0.216
13. Huai Pra Chan (W)	3,000	7	0.6	-	-	No	1983	0.193
14. Ban Kao Hin Chon (RG)	2,000	-	-	-	3 - 1.50m x 1.50m	Yes	1983	1.121
15. Huai Rob (RG)	2,000	-	-	2 - ϕ1.0m	4 - ϕ1.0m	Yes	1984	0.875
Total	66,600 (10,640 ha)							

Table VII-2 INVENTORY LIST OF EXISTING SMALL SCALE IRRIGATION PORJECT (3/3) IN SAKAEKRANG RIVER VASIN

Project Name	Irrigation Area (rai)	Main Feature of Structure: Head Works Length (m)	Head Works Height (m)	Head Regulator Left Bank	Head Regulator Right Bank	Irrigation System	Construction Year	Construction Cost (10^6 ฿)
IV. Khok Khwai River								
1. Pong Khoi (W)	6,000	3.0	3.0	1 - φ1.0m	-	Yes	1984	3.334
2. Ban Nong Kae (RG)	2,000	15.6	2.1	-	1 - φ1.0m	No	1981	1.038
3. Huai Khun Kaew (W)	4,000	10.6	1.5	2 - φ0.8m	2 - φ0.8m	Yes	1984	1.385
4. Wang Nam Khao (W)	10,000	15	2.5	-	2 - φ0.8m	Yes	1984	1.471
5. Norachon (W)	25,000	28	2.64	2 - 1.0m x 0.8m	-	Yes	1981	1.331
6. Dong Prai (RG)	1,500	-	-	1 - φ1.0m	-	Yes	1981	0.352
7. Bo Luk (W)	2,700	31.5	4	-	2 - φ1.0m	Yes	1979	1.740
8. Huai Luk (RE)	800	290	9	2 - φ1.0m	-	Yes	1983	3.782
9. Ban Khlong Wai (RE)	300	290	9	1 - φ1.0m	-	No	1984	3.782
10. Ban Hin Ngun (W)	4,500	35	0.5	1 - φ1.0m	-	Yes	1983	1.643
11. Huai Khot	2,000	15	2.5	-	2 - φ1.0m	Yes	1984	1.768
12. I Toob (W)	4,000	24.9	2.5	1 - φ1.0m	1 - φ1.0m	Yes	1984	3.710
13. Kao Chong Lom (W)	10,000	12	1.5	-	3 - φ1.0m	Yes	1981	2.400
14. Kao Ta Nod (W)	3,000	30	1.6	1 - φ0.8m	2 - φ0.8m	No	1981	1.526
Total	75,800 (12,130 ha)							

Table VII-3 POTENTIAL EVAPOTRANSPIRATION

Nakhom Sawan Station

	Unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
T mean	°C	25.6	28.3	30.7	31.9	30.6	29.6	29.0	28.5	28.0	27.9	26.7	25.2
RH mean	%	63	62	61	61	70	74	75	78	82	80	73	67
ea	mbar	32.8	38.5	44.2	47.3	43.9	41.5	40.1	39.0	37.8	37.6	35.1	32.1
ed	mbar	20.7	23.9	27.0	28.9	30.7	30.7	30.1	30.4	31.0	30.1	25.6	21.5
ea-ed	mabr	12.1	14.6	17.2	18.4	13.2	10.8	10.0	8.6	6.8	7.5	9.5	10.6
U	km/day	25	37	60	64	44	44	33	34	18	21	30	30
$f(u) = 0.27(1 + \frac{u}{100})$		0.34	0.37	0.43	0.44	0.39	0.39	0.36	0.36	0.32	0.33	0.35	0.35
1-W		0.26	0.23	0.22	0.20	0.21	0.22	0.23	0.23	0.23	0.23	0.24	0.26
W		0.74	0.77	0.78	0.80	0.79	0.78	0.77	0.77	0.77	0.77	0.76	0.74
Ra	mm/day	12.0	13.3	14.7	15.6	16.0	15.9	15.9	15.7	15.0	13.9	12.4	11.6
n/N		0.75	0.75	0.67	0.69	0.61	0.48	0.43	0.44	0.43	0.63	0.75	0.79
$(1-\alpha)(0.25+0.50\,n/N)$		0.47	0.47	0.44	0.45	0.42	0.37	0.35	0.35	0.35	0.42	0.47	0.48
Rns	mm/day	5.6	6.3	6.5	7.0	6.7	5.9	5.6	5.5	5.3	5.8	5.8	5.6
f(T)		15.8	16.4	16.9	17.2	16.9	16.7	16.5	16.4	16.3	16.3	16.0	15.7
f(ed)		0.14	0.12	0.12	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.12	0.13
f(n/N)		0.78	0.78	0.70	0.72	0.65	0.53	0.49	0.50	0.49	0.67	0.78	0.81
Rnl	mm/day	1.7	1.5	1.4	1.4	1.1	0.9	0.8	0.8	0.8	1.1	1.5	1.6
Rn = Rns - Rnl	mm/day	3.9	4.8	5.1	5.6	5.6	5.0	4.8	4.7	4.5	4.7	4.3	4.0
W.Rn	mm/day	2.9	3.7	4.0	4.5	4.4	3.9	3.7	3.6	3.5	3.6	3.3	3.0
(1-W) f(u) (ea-ed)	mm/day	1.1	1.2	1.6	1.6	1.1	0.9	0.8	0.7	0.5	0.6	0.8	1.0
Rs = Rns/0.75	mm	7.5	8.4	8.7	9.3	8.9	7.9	7.5	7.3	7.1	7.7	7.7	7.5
RH max	%	87.3	86.9	87.3	86.5	89.1	90.5	91.5	92.9	95.5	94.7	92.4	89.9
U	m/sec	0.3	0.4	0.7	0.7	0.5	0.5	0.4	0.4	0.2	0.2	0.3	0.4
C		1.02	1.02	1.01	1.03	1.03	1.00	1.00	1.01	1.02	1.03	1.03	1.02
ETP	mm/day	4.1	5.0	5.7	6.2	5.7	4.8	4.5	4.3	4.1	4.3	4.2	4.1
	mm/month	127	140	177	186	177	144	140	133	123	133	126	124

$\Sigma = 1,733$ mm

Note: Claculated by the Modefied Penman Method.

Table VII-4 IRRIGATION WATER REQUIREMENTS FOR PRESENT CONDITION, IRRIGATED FIELD (1/2)

1954 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	187.	160.	120.	273.	226.	20.	88.	55.	12.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.699	0.598	0.462	1.018	0.873	0.074	0.328	0.227	0.046	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.112	0.096	0.074	0.163	0.140	0.012	0.052	0.036	0.007	0.	0.

1955 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	124.	142.	102.	293.	124.	20.	88.	49.	20.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.462	0.530	0.394	1.093	0.477	0.074	0.328	0.201	0.074	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.074	0.085	0.063	0.175	0.076	0.012	0.052	0.032	0.012	0.	0.

1956 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	164.	161.	102.	216.	216.	20.	88.	51.	13.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.612	0.599	0.394	0.808	0.834	0.074	0.328	0.209	0.048	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.098	0.096	0.063	0.129	0.133	0.012	0.052	0.034	0.008	0.	0.

1957 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	213.	159.	102.	205.	232.	20.	80.	45.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.795	0.593	0.394	0.764	0.895	0.074	0.297	0.186	0.086	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.127	0.095	0.063	0.123	0.143	0.012	0.048	0.030	0.014	0.	0.

1958 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	152.	205.	102.	279.	232.	20.	88.	50.	20.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.566	0.765	0.394	1.041	0.895	0.074	0.328	0.208	0.076	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.091	0.122	0.063	0.167	0.143	0.012	0.052	0.033	0.012	0.	0.

1959 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	154.	244.	102.	254.	205.	20.	88.	51.	21.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.575	0.919	0.394	0.950	0.791	0.074	0.328	0.212	0.077	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.092	0.147	0.063	0.152	0.127	0.012	0.052	0.034	0.012	0.	0.

1960 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	124.	137.	108.	203.	148.	20.	88.	49.	20.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.462	0.512	0.418	0.756	0.570	0.074	0.328	0.204	0.075	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.074	0.082	0.067	0.121	0.091	0.012	0.052	0.033	0.012	0.	0.

1961 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	182.	218.	164.	203.	232.	20.	88.	55.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.681	0.813	0.634	0.758	0.895	0.074	0.328	0.227	0.086	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.109	0.130	0.101	0.121	0.143	0.012	0.052	0.036	0.014	0.	0.

1962 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	255.	179.	102.	211.	232.	20.	88.	55.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.950	0.666	0.394	0.790	0.895	0.074	0.328	0.227	0.086	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.152	0.107	0.063	0.126	0.143	0.012	0.052	0.036	0.014	0.	0.

1963 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	192.	177.	108.	232.	108.	20.	88.	51.	21.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.718	0.661	0.418	0.866	0.418	0.074	0.328	0.211	0.080	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.115	0.106	0.067	0.139	0.067	0.012	0.052	0.034	0.013	0.	0.

1964 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	124.	220.	102.	220.	218.	17.	88.	49.	15.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.462	0.821	0.394	0.821	0.842	0.065	0.328	0.203	0.057	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.074	0.131	0.063	0.131	0.135	0.010	0.052	0.033	0.009	0.	0.

1965 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	242.	162.	102.	254.	215.	19.	59.	48.	18.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.903	0.603	0.394	0.950	0.831	0.069	0.220	0.199	0.068	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.144	0.097	0.063	0.152	0.133	0.011	0.035	0.032	0.011	0.	0.

1966 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	205.	137.	157.	203.	178.	19.	88.	55.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.764	0.512	0.606	0.756	0.686	0.072	0.328	0.227	0.086	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.122	0.082	0.097	0.121	0.110	0.012	0.052	0.036	0.014	0.	0.

1967 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	169.	221.	102.	283.	192.	20.	88.	54.	17.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.629	0.824	0.394	1.057	0.743	0.074	0.328	0.225	0.063	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.101	0.132	0.063	0.169	0.119	0.012	0.052	0.036	0.010	0.	0.

1968 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	167.	221.	164.	265.	229.	20.	84.	55.	21.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.624	0.827	0.631	0.990	0.885	0.074	0.314	0.227	0.078	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.100	0.132	0.101	0.158	0.142	0.012	0.050	0.036	0.012	0.	0.

1969 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	155.	337.	102.	263.	219.	20.	87.	52.	13.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.578	1.258	0.394	0.983	0.846	0.074	0.324	0.214	0.050	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.092	0.201	0.063	0.157	0.135	0.012	0.052	0.034	0.008	0.	0.

1970 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	180.	182.	147.	232.	209.	18.	79.	48.	22.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.671	0.681	0.566	0.867	0.804	0.068	0.295	0.198	0.082	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.107	0.109	0.091	0.139	0.129	0.011	0.047	0.032	0.013	0.	0.

1971 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	161.	145.	118.	235.	232.	19.	88.	54.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.601	0.543	0.455	0.879	0.895	0.072	0.328	0.221	0.085	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.096	0.087	0.073	0.141	0.143	0.011	0.052	0.035	0.014	0.	0.

1972 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	165.	147.	102.	204.	90.	16.	88.	55.	20.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.615	0.550	0.394	0.761	0.346	0.061	0.328	0.226	0.075	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.098	0.088	0.063	0.122	0.055	0.010	0.052	0.036	0.012	0.	0.

1973 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	203.	205.	102.	323.	174.	20.	88.	50.	22.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.759	0.767	0.394	1.207	0.670	0.074	0.328	0.205	0.084	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.121	0.123	0.063	0.193	0.107	0.012	0.052	0.033	0.013	0.	0.

Table VII-4 IRRIGATION WATER REQUIREMENT FOR PRESENT CONDITION, IRRIGATED FIELD (2/2)

1974 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	172.	203.	102.	203.	162.	19.	49.	52.	16.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.641	0.758	0.394	0.756	0.623	0.070	0.183	0.216	0.058	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.103	0.121	0.063	0.121	0.100	0.011	0.029	0.035	0.009	0.	0.

1975 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	174.	185.	149.	245.	88.	18.	88.	54.	13.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.650	0.691	0.575	0.915	0.338	0.068	0.328	0.223	0.048	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.104	0.111	0.092	0.146	0.054	0.011	0.052	0.036	0.008	0.	0.

1976 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	193.	137.	116.	206.	170.	20.	88.	55.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.719	0.512	0.449	0.769	0.654	0.074	0.328	0.227	0.086	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.115	0.082	0.072	0.123	0.105	0.012	0.052	0.036	0.014	0.	0.

1977 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	1.	203.	140.	113.	302.	232.	18.	87.	45.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.004	0.758	0.523	0.434	1.128	0.895	0.067	0.326	0.184	0.085	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.001	0.121	0.084	0.069	0.181	0.143	0.011	0.052	0.030	0.014	0.	0.

1978 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	124.	205.	109.	277.	232.	20.	88.	47.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.462	0.766	0.421	1.033	0.895	0.074	0.328	0.195	0.086	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.074	0.123	0.067	0.165	0.143	0.012	0.052	0.031	0.014	0.	0.

1979 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	175.	174.	102.	389.	232.	20.	88.	53.	20.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.653	0.649	0.394	1.453	0.895	0.074	0.328	0.220	0.074	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.104	0.104	0.063	0.233	0.143	0.012	0.052	0.035	0.012	0.	0.

1980 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	162.	161.	116.	203.	105.	20.	88.	43.	21.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.605	0.601	0.447	0.756	0.405	0.074	0.328	0.178	0.079	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.097	0.096	0.071	0.121	0.065	0.012	0.052	0.029	0.013	0.	0.

1981 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	151.	200.	125.	235.	55.	20.	88.	53.	23.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.562	0.747	0.483	0.876	0.211	0.074	0.328	0.221	0.086	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.090	0.119	0.077	0.140	0.034	0.012	0.052	0.035	0.014	0.	0.

Table VII-5 IRRIGATION WATER REQUIREMENT FOR PRESENT CONDITION, SEMI-IRRIGATED FIELD (1/2)

1954 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	100.	101.	103.	275.	330.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.374	0.376	0.397	1.028	1.271	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.060	0.060	0.063	0.164	0.203	0.077	0.	0.	0.	0.	0.

1955 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	30.	75.	82.	295.	192.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.112	0.280	0.315	1.103	0.741	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.018	0.045	0.050	0.176	0.119	0.077	0.	0.	0.	0.	0.

1956 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	74.	101.	82.	219.	316.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.276	0.379	0.315	0.817	1.218	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.044	0.061	0.050	0.131	0.195	0.077	0.	0.	0.	0.	0.

1957 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	129.	99.	82.	208.	337.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.481	0.369	0.315	0.776	1.301	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.077	0.059	0.050	0.124	0.208	0.077	0.	0.	0.	0.	0.

1958 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	61.	164.	82.	281.	337.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.227	0.612	0.315	1.051	1.301	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.036	0.098	0.050	0.168	0.208	0.077	0.	0.	0.	0.	0.

1959 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	63.	222.	82.	257.	301.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.237	0.829	0.315	0.959	1.161	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.038	0.133	0.050	0.153	0.186	0.077	0.	0.	0.	0.	0.

1960 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	30.	68.	89.	205.	224.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.112	0.255	0.345	0.766	0.865	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.018	0.041	0.055	0.123	0.138	0.077	0.	0.	0.	0.	0.

1961 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	95.	182.	156.	206.	337.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.354	0.680	0.600	0.768	1.301	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.057	0.109	0.096	0.123	0.208	0.077	0.	0.	0.	0.	0.

1962 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	172.	127.	82.	214.	337.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.643	0.474	0.315	0.799	1.301	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.103	0.076	0.050	0.128	0.208	0.077	0.	0.	0.	0.	0.

1963 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	106.	125.	89.	235.	172.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.396	0.466	0.344	0.877	0.662	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.063	0.074	0.055	0.140	0.106	0.077	0.	0.	0.	0.	0.

1964 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	30.	185.	82.	222.	319.	117.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.112	0.692	0.315	0.830	1.230	0.436	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.018	0.111	0.050	0.133	0.197	0.070	0.	0.	0.	0.	0.

1965 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	161.	103.	82.	257.	315.	122.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.600	0.384	0.315	0.960	1.215	0.455	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.096	0.061	0.050	0.154	0.194	0.073	0.	0.	0.	0.	0.

1966 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	119.	68.	147.	205.	265.	126.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.446	0.255	0.568	0.766	1.021	0.470	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.071	0.041	0.091	0.123	0.163	0.075	0.	0.	0.	0.	0.

1967 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	80.	186.	82.	286.	284.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.297	0.696	0.315	1.066	1.096	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.048	0.111	0.050	0.171	0.175	0.077	0.	0.	0.	0.	0.

1968 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	78.	187.	155.	268.	334.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.291	0.700	0.597	0.999	1.287	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.047	0.112	0.095	0.160	0.206	0.077	0.	0.	0.	0.	0.

1969 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	64.	340.	82.	266.	320.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.240	1.268	0.315	0.993	1.235	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.038	0.203	0.050	0.159	0.198	0.077	0.	0.	0.	0.	0.

1970 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	92.	132.	135.	235.	306.	121.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.343	0.494	0.520	0.876	1.179	0.452	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.055	0.079	0.083	0.140	0.189	0.072	0.	0.	0.	0.	0.

1971 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	71.	80.	101.	238.	337.	125.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.266	0.299	0.388	0.888	1.301	0.468	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.043	0.048	0.062	0.142	0.208	0.075	0.	0.	0.	0.	0.

1972 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	75.	83.	82.	206.	146.	112.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.281	0.309	0.315	0.771	0.565	0.419	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.045	0.049	0.050	0.123	0.090	0.067	0.	0.	0.	0.	0.

1973 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	118.	165.	82.	326.	259.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.441	0.615	0.315	1.216	0.999	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.071	0.098	0.050	0.195	0.160	0.077	0.	0.	0.	0.	0.

Table VII-5 IRRIGATION WATER REQUIREMENT FOR PRESENT CONDITION, SEMI-IRRIGATED FIELD (2/2)

1974 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	83.	161.	82.	205.	243.	123.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.310	0.603	0.315	0.766	0.936	0.460	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.050	0.096	0.050	0.123	0.150	0.074	0.	0.	0.	0.	0.
1975 CROP SEASON	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
COMBINED WATER REQUIREMENT (MM)	0.	86.	136.	137.	248.	144.	121.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.320	0.508	0.530	0.925	0.555	0.453	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.051	0.081	0.085	0.148	0.089	0.072	0.	0.	0.	0.	0.
1976 CROP SEASON	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
COMBINED WATER REQUIREMENT (MM)	0.	106.	68.	99.	208.	253.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.397	0.255	0.381	0.778	0.978	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.063	0.041	0.061	0.125	0.156	0.077	0.	0.	0.	0.	0.
1977 CROP SEASON	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
COMBINED WATER REQUIREMENT (MM)	0.	118.	72.	94.	305.	337.	119.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.440	0.270	0.364	1.138	1.301	0.446	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.070	0.043	0.058	0.182	0.208	0.071	0.	0.	0.	0.	0.
1978 CROP SEASON	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
COMBINED WATER REQUIREMENT (MM)	0.	30.	164.	90.	279.	337.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.112	0.613	0.348	1.043	1.301	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.018	0.098	0.056	0.167	0.208	0.077	0.	0.	0.	0.	0.
1979 CROP SEASON	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
COMBINED WATER REQUIREMENT (MM)	0.	87.	120.	82.	392.	337.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.323	0.448	0.315	1.463	1.301	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.052	0.072	0.050	0.234	0.208	0.077	0.	0.	0.	0.	0.
1980 CROP SEASON	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
COMBINED WATER REQUIREMENT (MM)	0.	72.	102.	98.	205.	167.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.270	0.382	0.378	0.766	0.646	0.472	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.043	0.061	0.061	0.123	0.103	0.077	0.	0.	0.	0.	0.
1981 CROP SEASON	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**MAY**
COMBINED WATER REQUIREMENT (MM)	0.	60.	157.	109.	237.	100.	128.	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.223	0.586	0.421	0.885	0.384	0.478	0.	0.	0.	0.	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.036	0.094	0.067	0.142	0.061	0.077	0.	0.	0.	0.	0.

Table VII-6 IRRIGATION WATER REQUIREMENT FOR WITH-PROJECT CONDITION (CROPPING INTENSITY 120 %) (1/2)

	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
1954 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	183.	104.	113.	200.	128.	16.	7.	47.	33.	14.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.684	0.389	0.437	0.747	0.492	0.060	0.026	0.193	0.123	0.054	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.109	0.062	0.070	0.120	0.079	0.010	0.004	0.031	0.020	0.009	0.
1955 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	102.	86.	98.	216.	70.	16.	7.	40.	62.	9.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.380	0.321	0.378	0.805	0.268	0.060	0.026	0.167	0.231	0.035	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.061	0.051	0.061	0.129	0.043	0.010	0.004	0.027	0.037	0.005	0.
1956 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	153.	105.	98.	157.	122.	16.	7.	42.	36.	12.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.572	0.391	0.378	0.586	0.470	0.060	0.026	0.175	0.136	0.047	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.092	0.062	0.061	0.094	0.075	0.010	0.004	0.028	0.022	0.007	0.
1957 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	216.	103.	98.	149.	131.	16.	6.	37.	71.	15.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.808	0.384	0.378	0.555	0.505	0.060	0.021	0.152	0.264	0.058	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.129	0.061	0.061	0.089	0.081	0.010	0.003	0.024	0.042	0.009	0.
1958 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	138.	149.	98.	205.	131.	16.	7.	42.	63.	13.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.514	0.556	0.378	0.765	0.505	0.060	0.026	0.175	0.236	0.049	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.082	0.089	0.061	0.122	0.081	0.010	0.004	0.028	0.038	0.008	0.
1959 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	141.	190.	98.	186.	116.	16.	7.	43.	64.	12.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.525	0.708	0.378	0.695	0.446	0.060	0.026	0.178	0.238	0.045	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.084	0.113	0.061	0.111	0.071	0.010	0.004	0.028	0.038	0.007	0.
1960 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	102.	81.	104.	147.	83.	16.	7.	41.	63.	13.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.380	0.303	0.400	0.547	0.321	0.060	0.026	0.169	0.234	0.050	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.061	0.049	0.064	0.088	0.051	0.010	0.004	0.027	0.037	0.008	0.
1961 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	177.	161.	152.	147.	131.	16.	7.	47.	71.	11.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.661	0.603	0.585	0.548	0.505	0.060	0.026	0.193	0.264	0.043	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.106	0.096	0.094	0.088	0.081	0.010	0.004	0.031	0.042	0.007	0.
1962 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	267.	122.	98.	153.	131.	16.	7.	47.	71.	17.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.997	0.457	0.378	0.572	0.505	0.060	0.026	0.193	0.264	0.064	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.160	0.073	0.061	0.092	0.081	0.010	0.004	0.031	0.042	0.010	0.
1963 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	190.	121.	103.	169.	61.	16.	7.	43.	66.	12.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.709	0.452	0.399	0.632	0.235	0.060	0.026	0.177	0.246	0.047	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.113	0.072	0.064	0.101	0.038	0.010	0.004	0.028	0.039	0.008	0.
1964 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	102.	164.	98.	160.	123.	15.	7.	41.	49.	16.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.380	0.611	0.378	0.596	0.475	0.055	0.026	0.169	0.184	0.060	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.061	0.098	0.061	0.095	0.076	0.009	0.004	0.027	0.030	0.010	0.
1965 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	253.	106.	98.	186.	121.	15.	2.	40.	58.	13.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.946	0.394	0.378	0.695	0.469	0.057	0.007	0.165	0.216	0.051	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.151	0.063	0.061	0.111	0.075	0.009	0.001	0.026	0.035	0.008	0.
1966 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	200.	81.	146.	147.	100.	16.	7.	47.	71.	8.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.745	0.303	0.562	0.547	0.387	0.059	0.026	0.193	0.264	0.032	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.119	0.049	0.090	0.088	0.062	0.009	0.004	0.031	0.042	0.005	0.
1967 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	159.	164.	98.	208.	108.	16.	7.	46.	54.	12.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.594	0.614	0.378	0.777	0.418	0.060	0.026	0.191	0.202	0.048	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.095	0.098	0.061	0.124	0.067	0.010	0.004	0.031	0.032	0.008	0.
1968 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	157.	165.	151.	194.	129.	16.	6.	47.	65.	10.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.587	0.617	0.583	0.726	0.499	0.060	0.024	0.193	0.241	0.038	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.094	0.099	0.093	0.116	0.080	0.010	0.004	0.031	0.039	0.006	0.
1969 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	142.	276.	98.	193.	124.	16.	7.	43.	40.	9.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.529	1.037	0.378	0.721	0.477	0.060	0.026	0.179	0.151	0.037	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.085	0.166	0.061	0.115	0.076	0.010	0.004	0.029	0.024	0.006	0.
1970 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	173.	126.	137.	169.	118.	15.	5.	40.	68.	10.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.647	0.472	0.527	0.632	0.454	0.057	0.020	0.164	0.253	0.039	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.104	0.075	0.084	0.101	0.073	0.009	0.003	0.026	0.041	0.006	0.
1971 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	150.	90.	112.	172.	131.	16.	7.	45.	70.	5.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.559	0.336	0.431	0.641	0.505	0.059	0.026	0.187	0.262	0.020	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.089	0.053	0.069	0.102	0.081	0.009	0.004	0.030	0.042	0.003	0.
1972 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	154.	91.	98.	147.	50.	14.	7.	46.	63.	16.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.576	0.341	0.378	0.551	0.194	0.052	0.026	0.191	0.234	0.061	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.092	0.055	0.061	0.088	0.031	0.008	0.004	0.031	0.037	0.010	0.
1973 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	204.	149.	98.	239.	98.	16.	7.	41.	69.	14.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.762	0.557	0.378	0.891	0.377	0.060	0.026	0.171	0.257	0.054	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.122	0.089	0.061	0.143	0.060	0.010	0.004	0.027	0.041	0.009	0.

Table VII-6 IRRIGATION WATER REQUIREMENT FOR WITH-PROJECT CONDITION (CROPPING INTENSITY 120 %) (2/2)

1974 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	163.	147.	98.	147.	91.	15.	0.	44.	56.	14.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.610	0.548	0.378	0.547	0.351	0.056	0.	0.182	0.188	0.056	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.098	0.088	0.061	0.088	0.056	0.009	0.	0.029	0.030	0.009	0.
1975 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	166.	129.	139.	179.	49.	15.	7.	46.	37.	15.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.621	0.481	0.534	0.668	0.189	0.057	0.026	0.188	0.138	0.056	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.099	0.077	0.085	0.107	0.030	0.009	0.004	0.030	0.022	0.009	0.
1976 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	190.	81.	110.	149.	95.	16.	7.	47.	70.	10.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.710	0.303	0.426	0.557	0.368	0.060	0.026	0.193	0.263	0.040	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.114	0.049	0.068	0.089	0.059	0.010	0.004	0.031	0.042	0.006	0.
1977 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	1.	204.	84.	107.	223.	131.	15.	7.	36.	70.	8.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.003	0.760	0.314	0.413	0.831	0.505	0.056	0.026	0.151	0.261	0.029	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.000	0.122	0.050	0.066	0.133	0.081	0.009	0.004	0.024	0.042	0.005	0.
1978 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	102.	149.	104.	203.	131.	16.	7.	39.	71.	10.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.380	0.556	0.402	0.759	0.505	0.060	0.026	0.160	0.264	0.037	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.061	0.089	0.064	0.121	0.081	0.010	0.004	0.026	0.042	0.006	0.
1979 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	167.	118.	98.	289.	131.	16.	7.	45.	62.	12.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.625	0.439	0.378	1.080	0.505	0.060	0.026	0.185	0.231	0.048	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.100	0.070	0.061	0.173	0.081	0.010	0.004	0.030	0.037	0.006	0.
1980 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	151.	105.	110.	147.	59.	16.	7.	35.	65.	8.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.563	0.393	0.424	0.547	0.228	0.060	0.026	0.145	0.243	0.031	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.090	0.063	0.068	0.088	0.036	0.010	0.004	0.023	0.039	0.005	0.
1981 CROP SEASON	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
COMBINED WATER REQUIREMENT (MM)	0.	136.	144.	118.	171.	30.	16.	7.	45.	70.	14.	0.
UNIT WATER REQUIREMENT (L/SEC/HA)	0.	0.508	0.537	0.455	0.638	0.117	0.060	0.026	0.187	0.263	0.055	0.
UNIT WATER REQUIREMENT (L/SEC/RAI)	0.	0.081	0.086	0.073	0.102	0.019	0.010	0.004	0.030	0.042	0.009	0.

Table VII-7 MAIN FEATURES OF IRRIGATION MODEL AREA

1. Head Works

1.1 Intake Weir

Type of weir	Ogee type
Weir height	4.5 m
Weir length	28.6 m

1.2 Scouring Sluice

Gate type	Slide gate
Size of gate (B x H x No.)	2.0 m x 2.0 m x 2 nos

1.3 Intake Structure

Intake discharge	7.36 m^3/sec
Gate type	Slide gate
Size of gate (B x H x No.)	2.0 m x 1.8 m x 3 nos

2. Irrigation System

Irrigation service area	7,360 ha
Main canal (concrete linning)	12.7 km
Lateral (concrete linning)	52.7 km
Sub-lateral	44.8 km
Related structures	
Turnout with Check	48 nos
Syphon	7 nos
Culvert	24 nos
Side Spillway	2 nos

3. Drainage System

Lateral drain	4 km

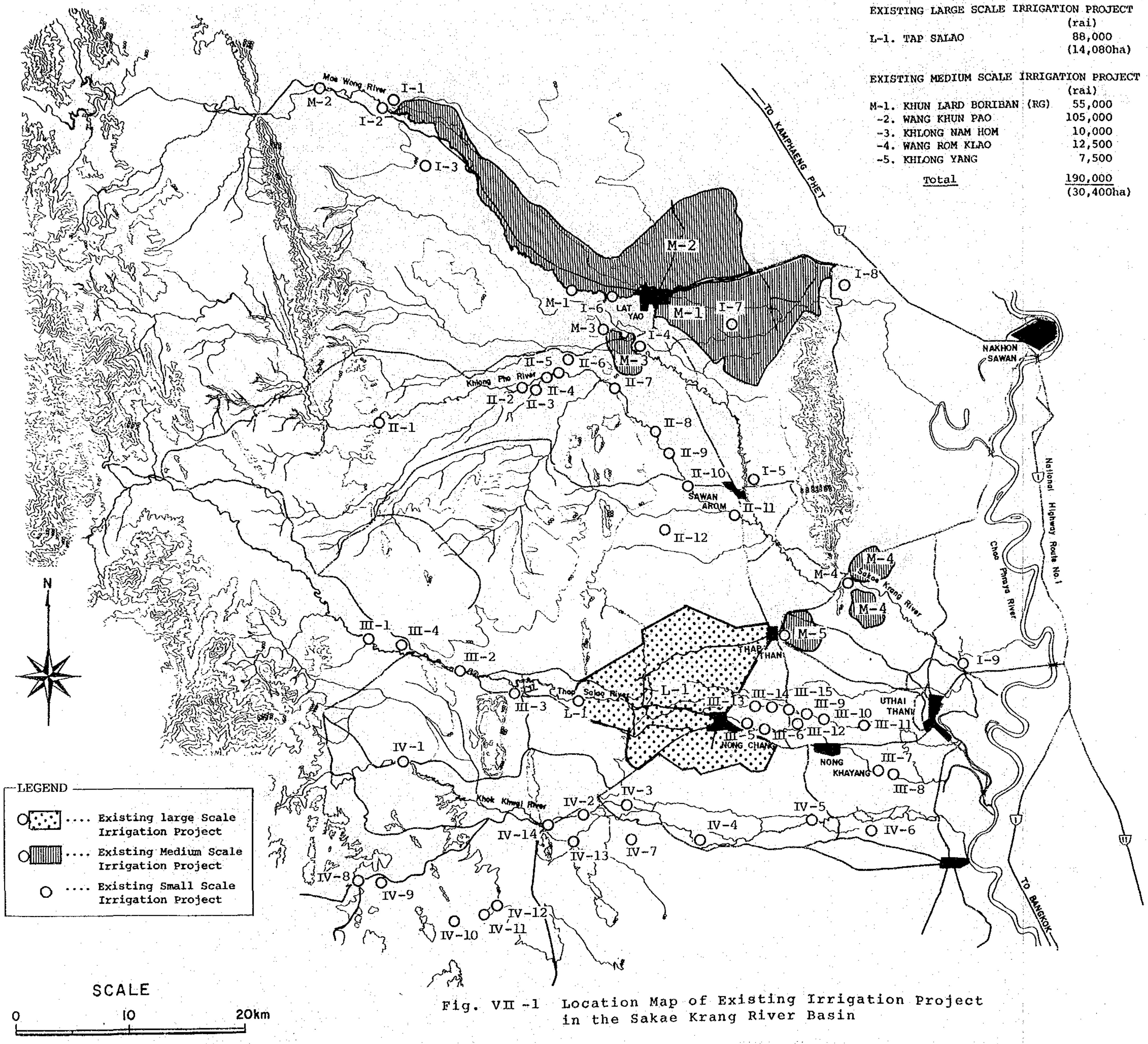


Fig. VII-1 Location Map of Existing Irrigation Project in the Sakae Krang River Basin

EXISTING LARGE SCALE IRRIGATION PROJECT

		(rai)
L-1.	TAP SALAO	88,000
		(14,080ha)

EXISTING MEDIUM SCALE IRRIGATION PROJECT

		(rai)
M-1.	KHUN LARD BORIBAN (RG)	55,000
-2.	WANG KHUN PAO	105,000
-3.	KHLONG NAM HOM	10,000
-4.	WANG ROM KLAO	12,500
-5.	KHLONG YANG	7,500
	Total	190,000
		(30,400ha)

EXISTING SMALL SCALE IRRIGATION PROJECT

		(rai)
I.	MAE WANG RIVER	
-1.	BAN WANG NAM KAO (RG)	3,000
-2.	KHLONG SAINGU. (RE)	10,000
-3.	HUAI HIN LAB (RE)	3,000
-4.	WANG MA (W)	26,000
-5.	SAWANG A-ROM (W)	200
-6.	LAN BAI DIEO (W)	4,000
-7.	NONG YAO (W)	4,000
-8.	WANG HIN PHOENG (W)	10,000
-9.	HUAI PRA KHUN	300
	Total	60,500
		(9,680ha)
II.	KHLONG PHO RIVER	
-1.	BAN HUA KHAO DAENG (W)	4,000
-2.	KHLONG PHO (RG)	4,000
-3.	BAN KHLONG KHOI (W)	4,300
-4.	THUNG MON (W)	5,000
-5.	WANG HIN (W)	1,500
-6.	HUAI YAI HEN (W)	6,000
-7.	MAP KAE (W)	6,000
-8.	KHAO KWANG THONG (W)	7,500
-9.	KHLONG PHO (W)	4,000
-10.	BAN WANG TA KIEN (W)	2,500
-11.	NONG YAI DA (W)	8,000
-12.	NONG KWAN KOOB (W)	1,000
	Total	53,800
		(8,600ha)
III.	THAP SALAO RIVER	
-1.	PAK MUANG (RG)	3,500
-2.	TAKRO (RG)	10,000
-3.	LAK MET (RG)	21,500
-4.	KHONG CHAI (W)	4,000
-5.	BAN BO MAD (W)	2,000
-6.	NONG BAN (W)	3,000
-7.	HUAI WI (W)	3,000
-8.	BAN MOK THAEO (W)	1,000
-9.	DON KLOI (W)	5,000
-10.	NONG PHANGKHA (W)	5,000
-11.	THA PHO (W)	1,000
-12.	BAN SUP PRA KON (RG)	500
-13.	HUAI PRA CHAN (W)	3,000
-14.	BAN KAO HIN CHON (RG)	2,000
-15.	HUAI ROB (RG)	2,000
	Total	66,500
		(10,640ha)
IV.	KHOK KHWAI RIVER	
-1.	PONG KHOI (W)	6,000
-2.	BAN NONG KAE (RG)	2,000
-3.	HUAI KHUN KAEW (W)	4,000
-4.	WANG NAM KHAO (W)	10,000
-5.	NORACHON (W)	25,000
-6.	DONG PRAI (RG)	1,500
-7.	BO LUK (W)	2,700
-8.	HUAI LUK (RE)	800
-9.	BAN KHLONG WAI (RE)	300
-10.	BAN HIN NGUN (W)	4,500
-11.	HUAI KHOT	2,000
-12.	I TOOB (W)	4,000
-13.	KAO CHONG LOM (W)	10,000
-14.	KAO TA NOD (W)	3,000
	Total	75,800
		(12,130ha)

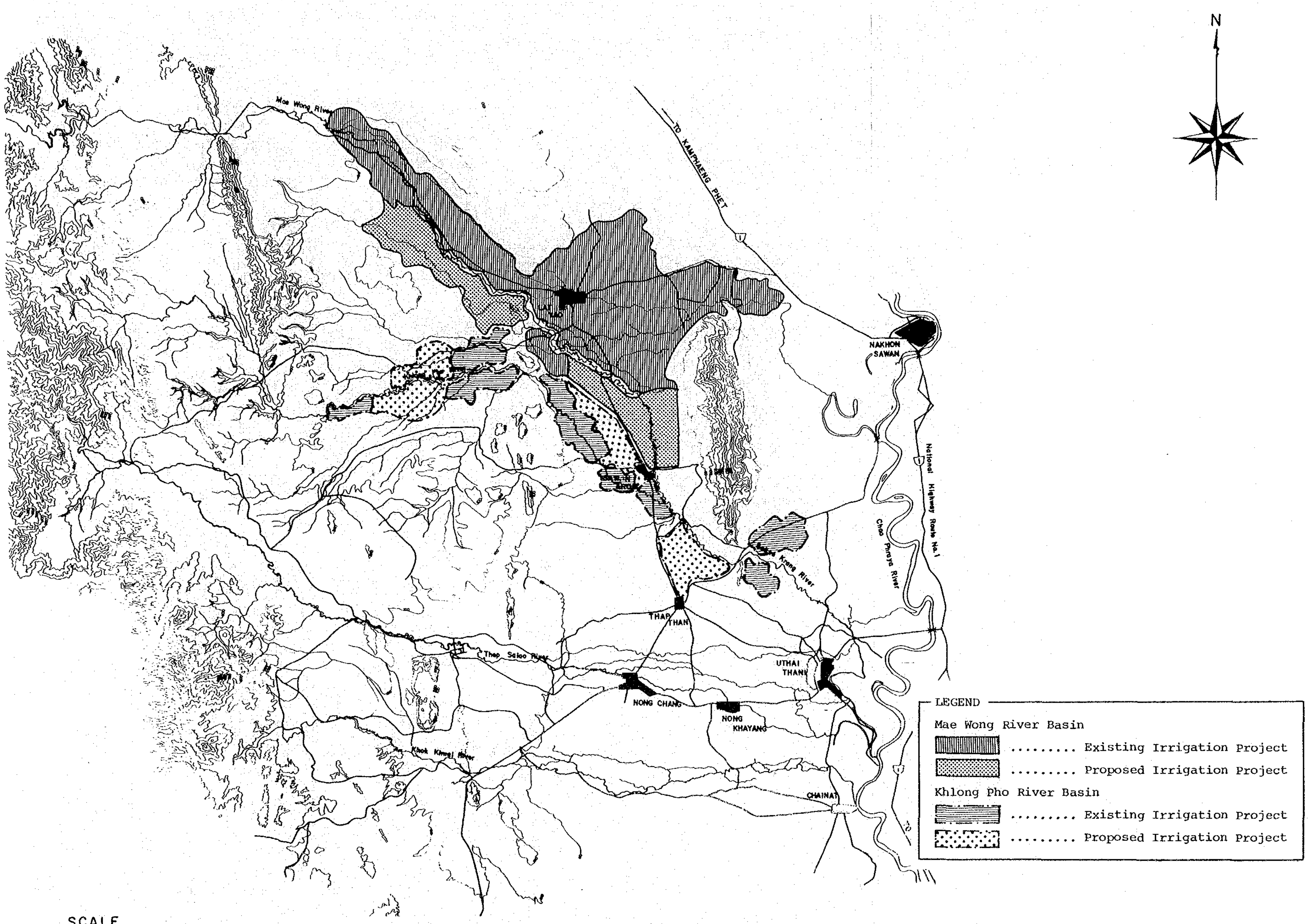


Fig. VII -2 Location Map of Irrigation Development Area

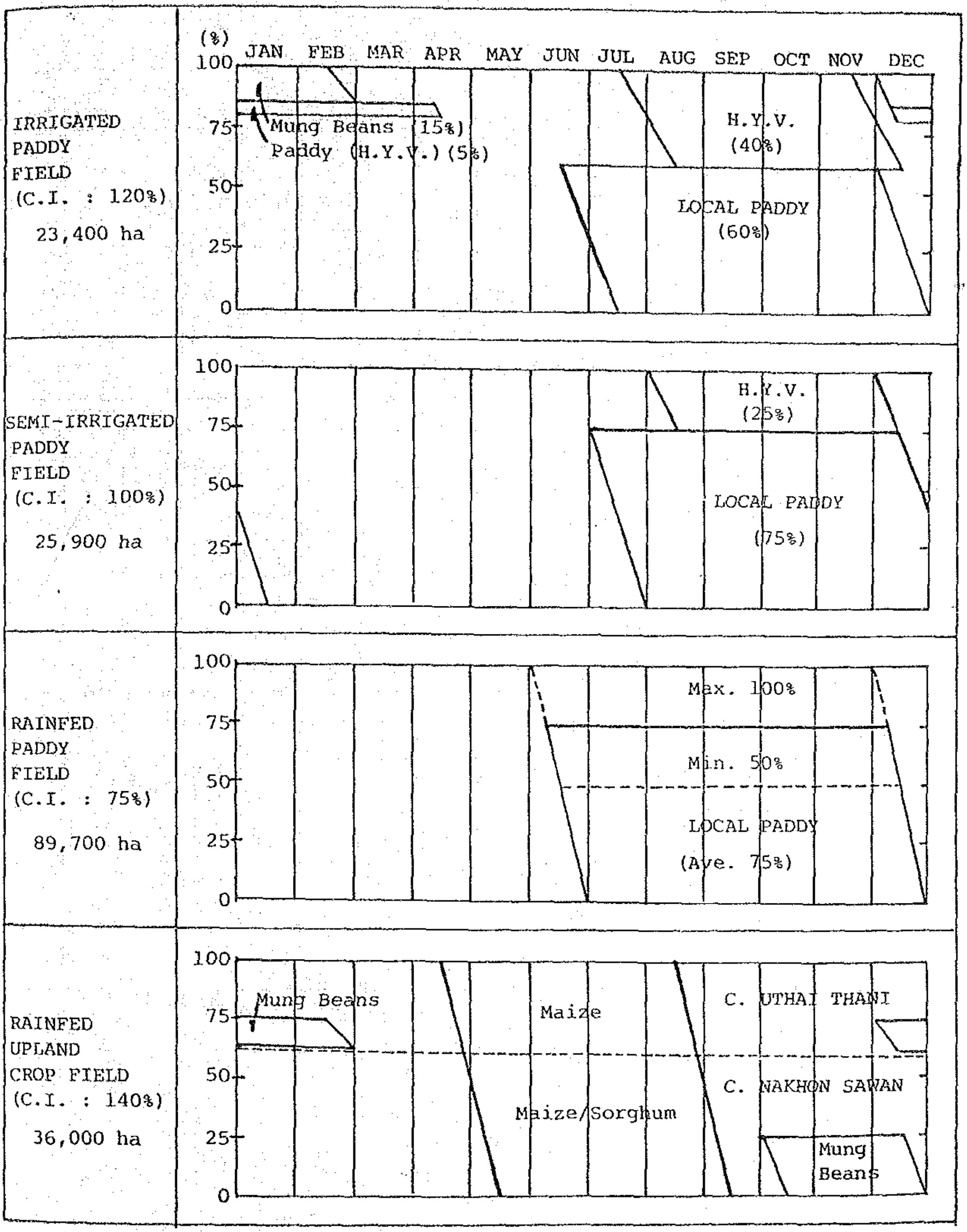


FIG. VII-3 Present Cropping Pattern

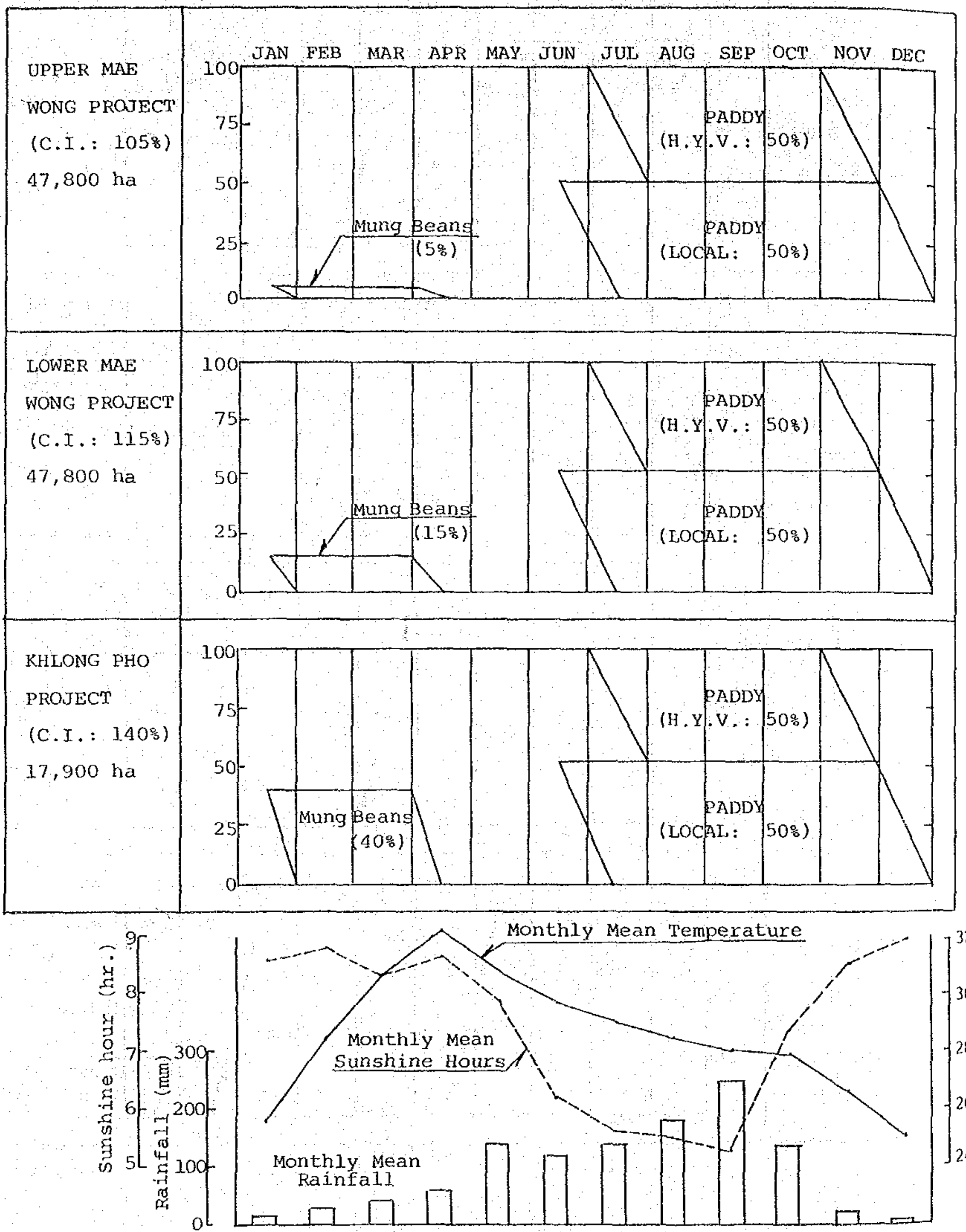


Fig. VII-4 Proposed Cropping Pattern

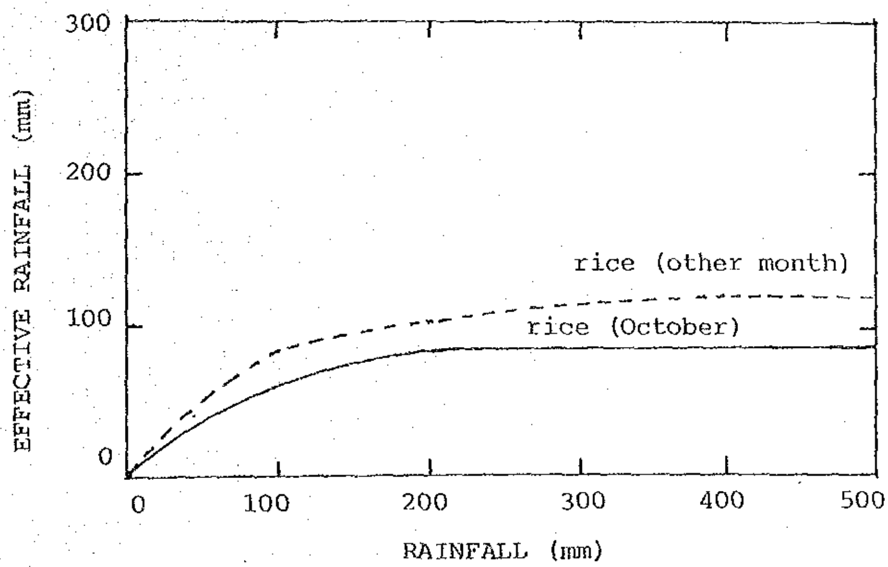


Fig. VII-5 Effective Rainfall by Chao Phraya - Meklong Basin Study

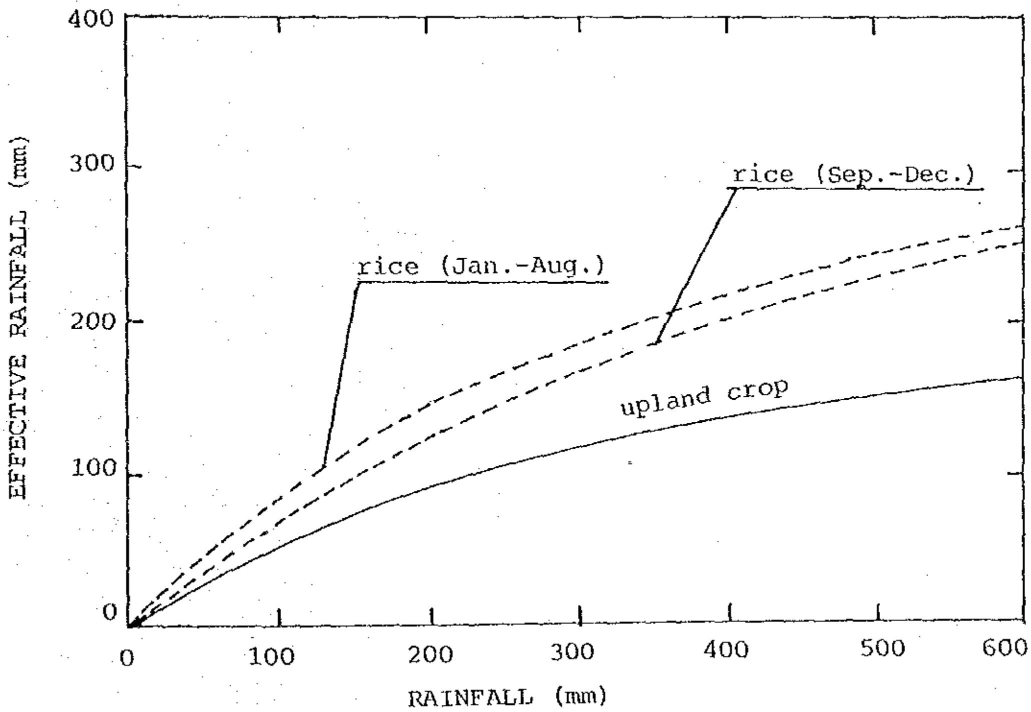


Fig. VII-6 Effective Rainfall Chart by RID

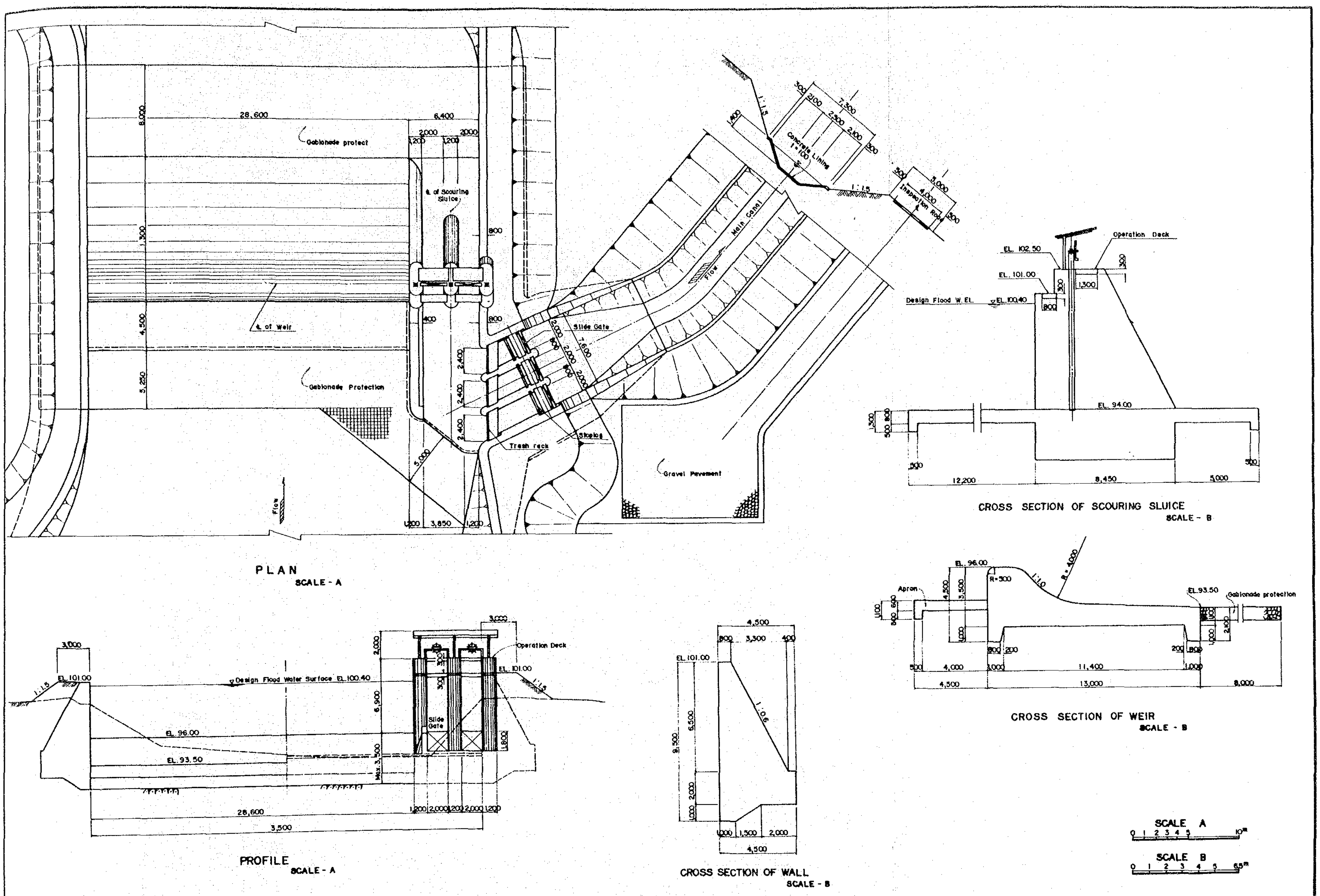


Fig. VII-7 Proposed Intake Weir for Model Area

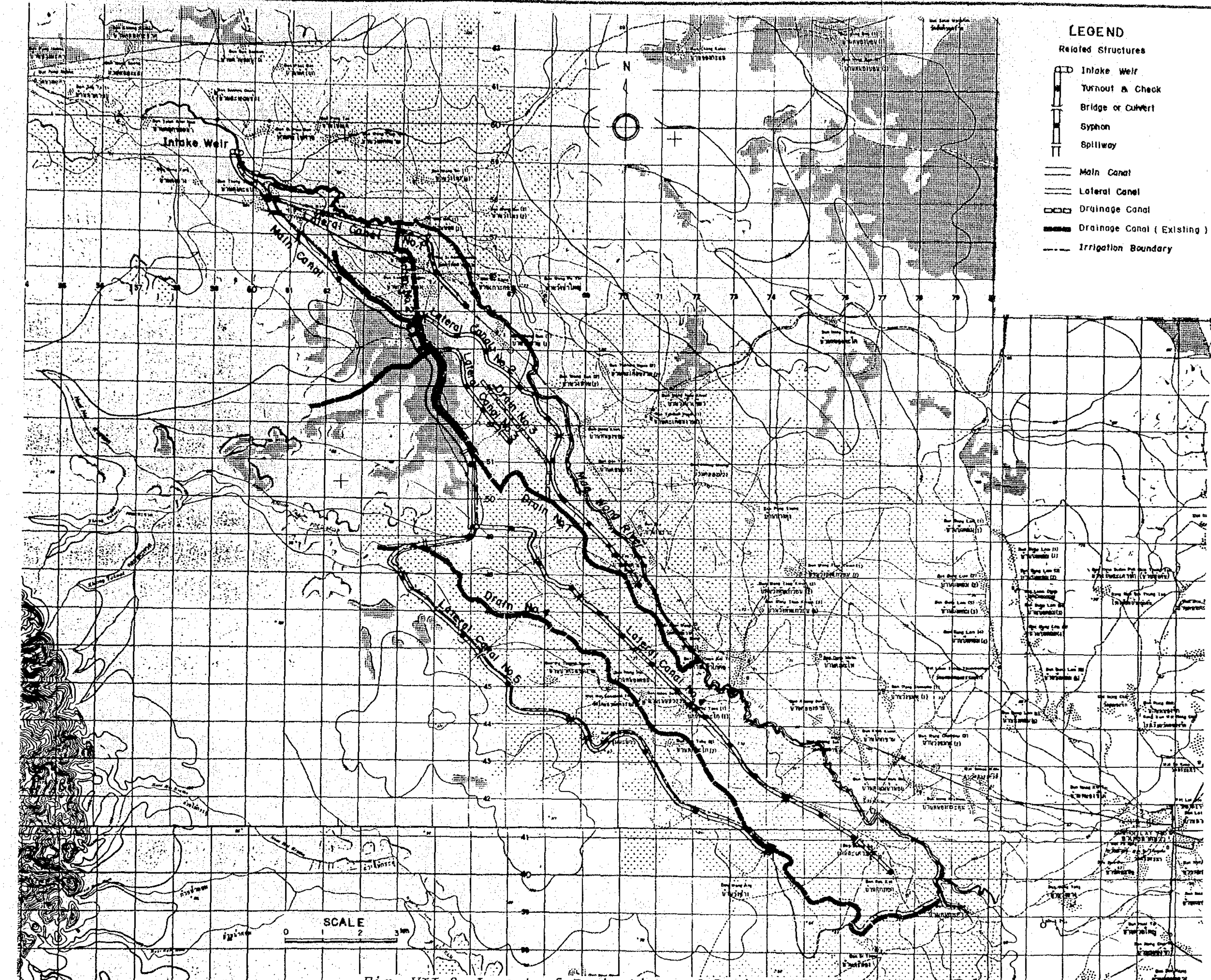


Fig. VII-8 Layout of Irrigation and Drainage Canal System for Model Area

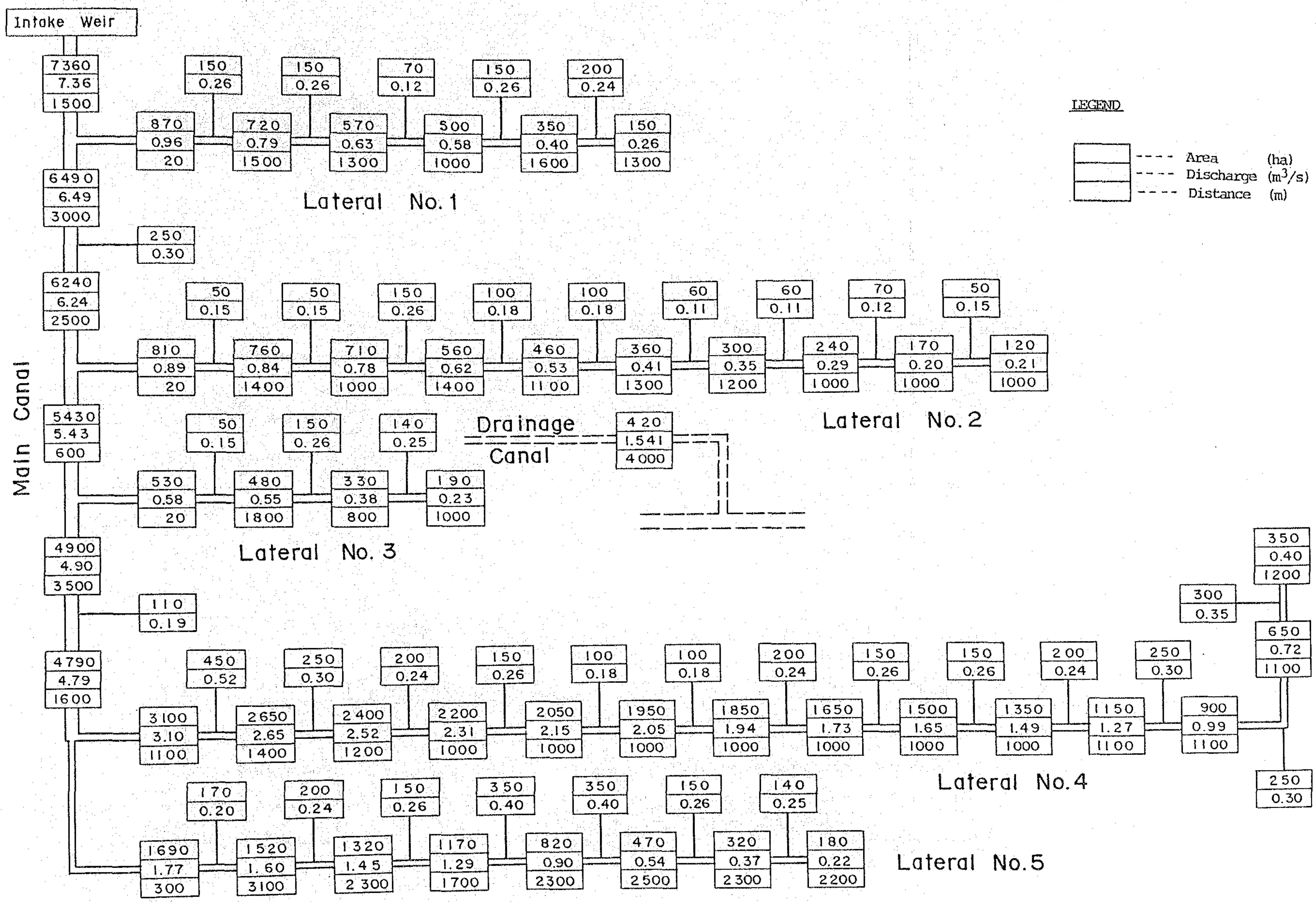
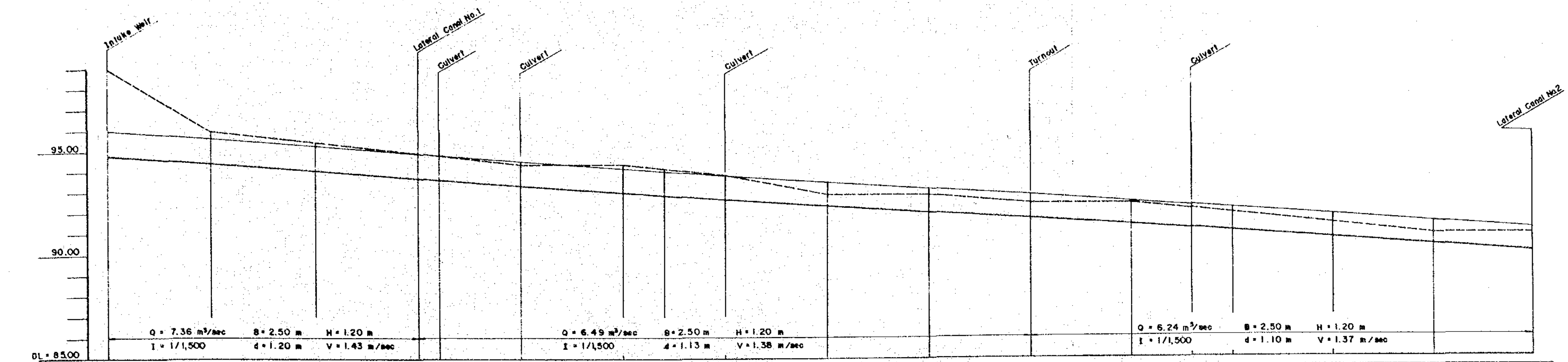
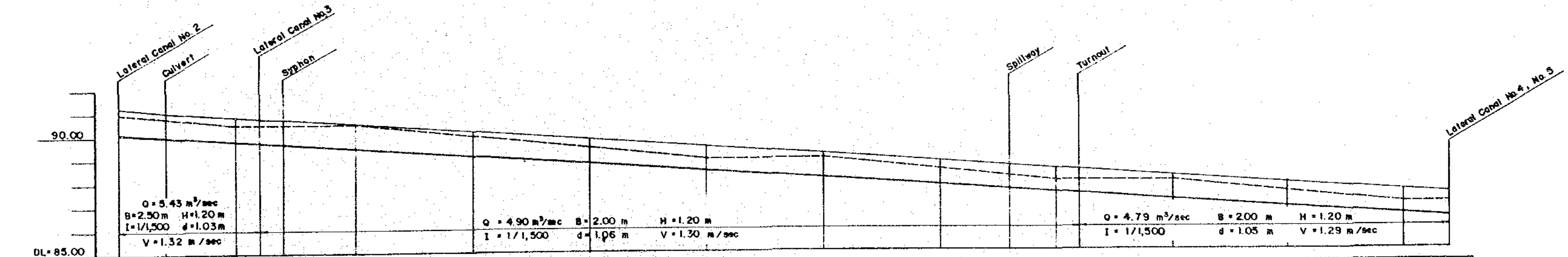


Fig. VII-9 Irrigation Diagram for Model Area



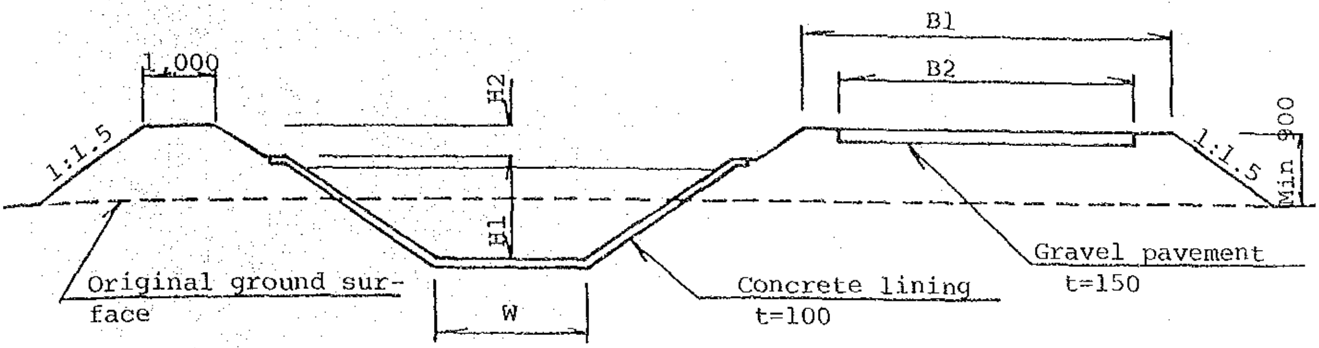
WATER SURFACE ELEVATION	96.00	95.67	95.34	95.00	94.86	94.60	94.27	93.93	93.60	93.27	92.93	92.57	92.37	92.24	91.90	91.57	91.24
CANAL BASE ELEVATION	94.80	94.47	94.14	93.80	93.73	93.47	93.14	92.80	92.47	92.14	91.80	91.47	91.27	91.14	90.80	90.47	90.14
GROUND SURFACE ELEVATION	99.0	96.0	95.5	95.0	94.9	94.5	94.5	94.0	93.0	93.0	92.5	92.5	92.2	92.0	91.5	91.0	91.0
REDUCED DISTANCE	0	500	1,000	1,500	1,600	2,000	2,500	3,000	3,500	4,000	4,500	5,000	5,300	5,500	6,000	6,500	7,000
DISTANCE	0	500	500	500	100	400	500	500	500	500	500	500	300	200	500	500	500



WATER SURFACE ELEVATION	91.24	91.04	90.83	90.76	90.72	90.52	90.19	89.86	89.53	89.20	88.86	88.66	88.53	88.46	88.18	87.85	87.52	87.39
CANAL BASE ELEVATION	90.14	90.01	89.80	89.73	89.66	89.46	89.13	88.80	88.47	88.14	87.80	87.60	87.47	87.40	87.13	86.80	86.47	86.34
GROUND SURFACE ELEVATION	91.0	90.8	90.5	90.5	90.5	90.5	90.0	89.5	89.0	89.0	88.5	88.2	88.0	88.0	88.0	87.5	87.0	87.0
REDUCED DISTANCE	7,000	7,200	7,500	7,600	7,700	8,000	8,500	9,000	9,500	10,000	10,500	10,800	11,000	11,100	11,500	12,000	12,500	12,700
DISTANCE	500	200	300	100	100	300	500	500	500	500	500	300	200	100	400	500	500	200

Fig. VII-10 Profile of Main Canal for Model Area

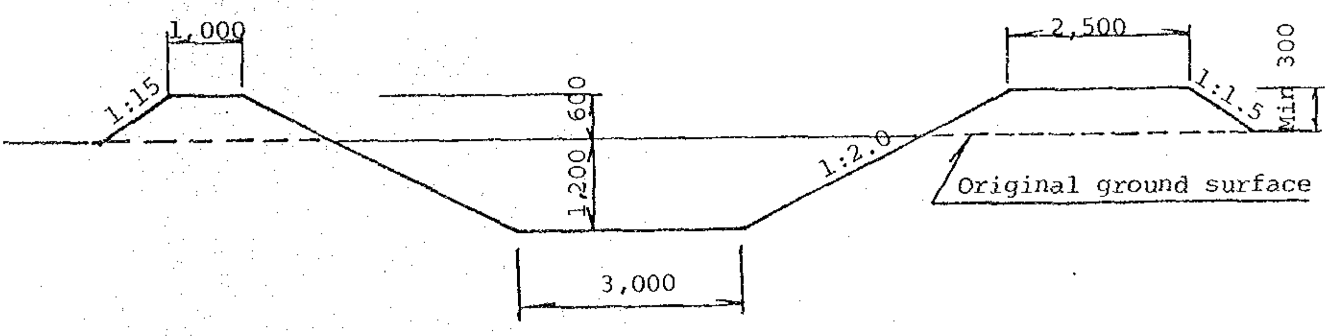
IRRIGATION CANAL



DIMENSIONS

Discharge (m^3/s)	Gradient	W (m)	H_1 (m)	H_2 (m)	B_1 (m)	B_2 (m)
5.00-7.00	1/1,500	2.50	1.20	0.40	5.00	4.00
3.00-5.00	1/2,000-1/1,000	2.00	1.20	0.40	5.00	4.00
1.00-3.00	1/2,000-1/1,000	1.50	1.00	0.40	4.00	-
0.50-1.00	1/2,000-1/1,000	1.00	0.70	0.40	4.00	-
-0.50	1/2,000-1/1,000	0.80	0.50	0.40	4.00	-

DRAINAGE CANAL



Discharge = 5.00 m^3/s

Fig. VII-11 Typical Cross Section of Irrigation and Drainage Canals for Model Area

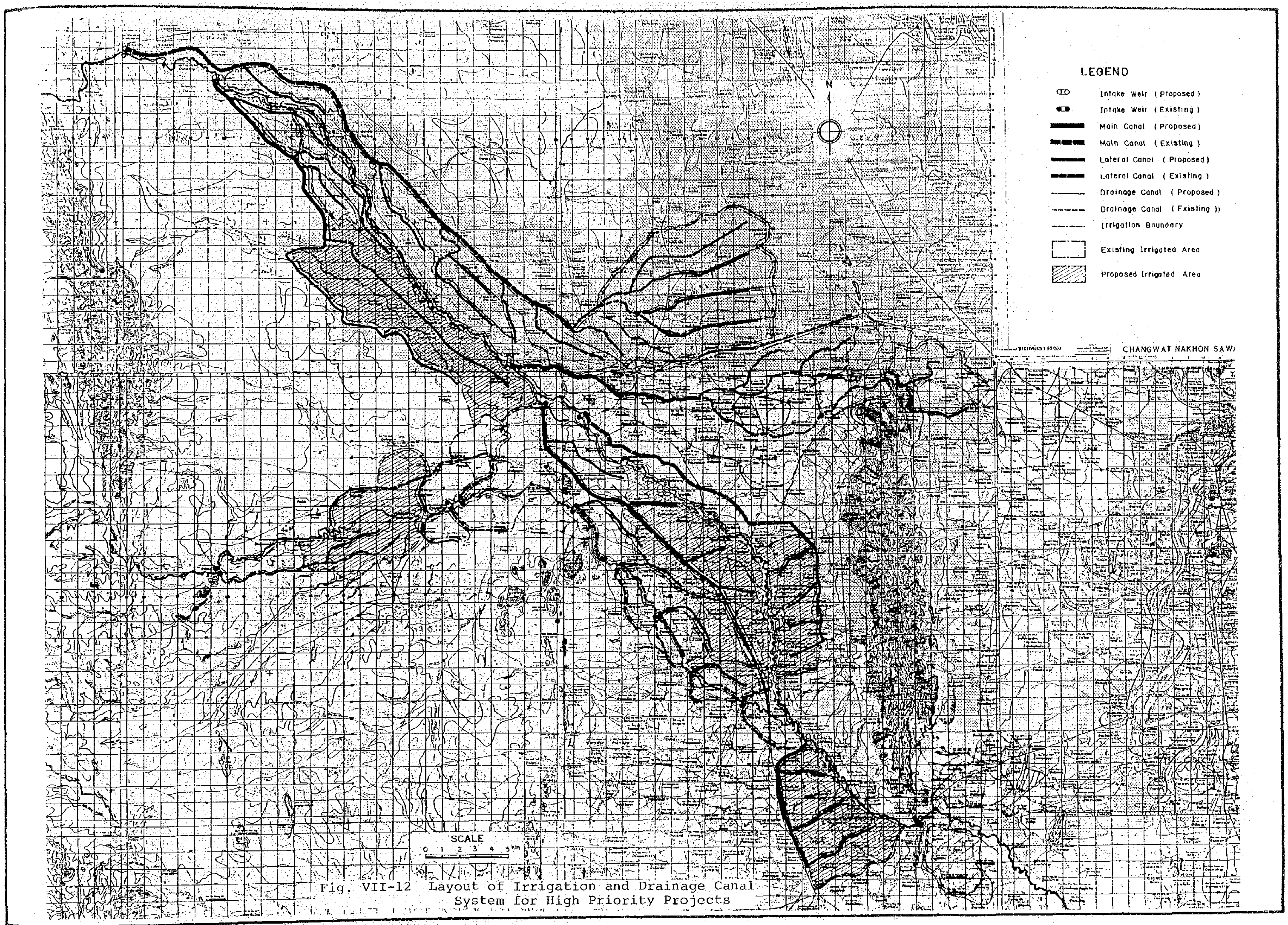


Fig. VII-12 Layout of Irrigation and Drainage Canal System for High Priority Projects

ANNEX VIII
HYDROPOWER DEVELOPMENT POTENTIAL

ANNEX VIII

HYDROPOWER DEVELOPMENT POTENTIAL

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ANNEX VIII

HYDRO POWER DEVELOPMENT

1. ELECTRIC POWER DEMAND

1.1 Present Situation of Power Demand

In connection with power demand increase in Thailand, except for some years in which power demand lowered due to the oil crises during the 1970's, the average annual growth of power demand during the same period was recorded at such a high rate as more than 13%.

This growth rate was forced to be lowered due to the energy-saving policies of the Thai Government and hike in electricity tariffs but still showed over 6% on the average per annum.

It has proved that power demand increase in local cities and rural areas is more brisk than the Metropolitan area. In other words, an average annual increase rate of power demand in the Metropolitan area is 9% while local cities and rural areas enjoy an average annual growth rate of 16% during the period from 1975 through 1982.

As of September 1981, the electrification ratio of the Metropolitan area was recorded at 76% and that of local cities and rural areas 34%. The average electrification ratio of the entire territory of Thailand is estimated at around 40%. Accordingly, a large amount of power demand in local cities and rural areas could be anticipated with the progress of the electrification thereof.

The Thai Government is desirous of realizing industrization by utilization of natural gas to be exploited on the Siam Gulf in accordance with the fifth Economic and Social Five Year Development Plan (which commenced in October 1981). It is estimated that the annual growth rate of power demand up to the year of 1992 in Thailand will be at least 6% on the average in succession.

1.2 Power Demand Forecast

1.2.1 Demand forecast in whole Thailand

Power demand (load) forecast in Thailand has been worked out by the "Load Forecast Working Group for Power Tariff Study Sub-Committee" composed of representative of EGAT, MEA, PEA, NEA and NESDB.

The load forecast by them was performed by means of micro and macro methods. Under the micro method, they have estimated power demand in the respective supply areas of MEA and PEA based on the time-series of energy sales in various types of power supply.

As for the supply areas of PEA, analyses were made definitely on correlation curves between per-capita GDP and energy consumption and perusal was also made into schemes for establishment of new industries and relevant projects, increase or decrease of the population, the progress of housing projects, etc.

For checking the appropriateness of the results of the study made by the above micro method, the macro method study was made on five (5) categories of power demands; residential (household) consumers, commercial consumers, industrial consumers, street lights and others. Then analyses were conducted on correlations between per-capita GDP and energy consumption thereby estimating the total values of power demand throughout the country up to the year of 1992.

As a result of comparisons of the results of load forecast between the micro and macro methods, it has proved that those results obtained by the two methods are almost approximate. Since the results of power demand (load) forecast are revised by the said Working Group every year based on actual records in the previous years, it can be said that such forecast fully reflects possible increase in power demand to a considerably accurate extent. (Refer to Fig. VIII-1)

1.2.2 Demand forecast in and around the study area

The supply area of PEA in which the site for the Sakae Krang River Basin Irrigation Project is located, belongs to Northern Region 3 of Thailand.

The above-mentioned Region has six (6) substations supplying electric power to seven (7) provinces. The expected supply areas of electric power to be obtained from this Project will be the present areas to which electric power is supplied at present through Nakhon Sawan Substation and Manoron Substation. Breakdown of the supply areas from the two substations after completion of the Project is expected to be as follows:

1) Nakhon Sawan Substation

Nakhon Sawan Province

1 A. Muang
2 A. Krok Phra
3 A. Lat Yao
4 A. Tha Tako
5 A. Chumsaeng
6 A. Banphot Phisai
7 A. Nong Bua
8 A. Phaisali
9 A. Khao Leo
10 T. Kaho Thong
11 Phayuha Khiri

Kamphaeng Phet Province

1 A. Khanu Woralaksaburi

2) Manorom Substation

1 A. Muang
2 A. Manorom
3 A. Sankhaburi
4 A. Sanphaya
5 A. Wat Sing
6 A. Hanka

Uthai Thani Province

1 A. Muang
2 A. Nong chang
3 A. Nong Khayang
4 A. Thap Than
5 A. Sawang Arom
6 A. Ban Rai
7 A. Lan Sak

Nakhon Sawan Province

1 A. Phayuha Khiri
2 T. Nong Pho
3 A. Takhli
4 T. Hua Wai

The values of power demand (load) forecast prepared by PEA have been compiled for each Province. The said forecast covering the period from 1984 up to 1992 is made by reference to each category of actual energy consumption recorded during the past ten (10) years from 1974 through 1983.

The results of the power demand forecast made for each of Nakhon Sawan, Chai Nat and Uthani Provinces are as shown in Figures VIII-2 and VIII-3. As may be seen from Tables VIII-1 to VIII-3, energy consumption in Nakhon Sawan Province is larger than that in the two other Provinces, and the quantity of energy consumption per household in Nakhon Sawan Province is larger than that in the two other Provinces, and the quantity of energy consumption per household in Hakhon Sawan Province is approximately 150 kWh, 100 kWh and 80 kWh.

The actual records of energy consumption for one year from October 1983 through September 1984 (See Tables VIII-4 and VIII-6) indicate that there are some disparities in energy consumption between the rainy season and dry season.

According to brewkdown of Province-wise energy consumption as given n Table VIII-7 to VIII-9, energy consumption for residential use in Nakhon Sawan Province accounts for some 50%, 58.1% and 73.4%, respectively, of the total energy consumption in the three Provinces occupies the largest portion of the total energy consumption.

As for energy consumption for commercial and industrial use, Nakhon Sawan Province is a hub of economic activities in this Region and has larger energy consumption in the said categories, compared with the two other Provinces.

The trend of increase in the number of consumers are as given in Table VIII-10 to VIII-12, proving that energy consumption for commercial and industrial use in the two Provinces other than Nakhon Sawan Province was not so larger in quantity from 1974 through 1983 while Nakhon Sawan Province has been making a rapid increase in the amount of energy consumption since 1977.

2. ELECTRIC POWER DEVELOPMENT PLAN

2.1 Necessities for Development

Economic growth of Thailand during the 1970's showed a rise of 7.4%. Of developing countries in Asia, this country takes pride in vigorous economic advancement immediately after Hong Kong, Korea, Taiwan and Singapore. Economic growth in the industrial sector of Thailand, among others, has almost doubled that in the 1960's.

Power demand as of 1982 is recorded at 17,500 GWh. As stated in Section 1.2 "Electric Power Demand Forecast", the increase in peak demand is to be gradually lowered down from an annual growth rate of 14% in 1983 to that of 6.5% in 1965. Thereafter an annual growth rate of 6% is estimated to continue.

2,900 MW and 17,500 GWh are actual figures as power demand as of 1982 and such demand is estimated to become two-fold or more in 1991. From 1982 onward power demand increase per year will reach a level of 400 to 500 MW and 2,400 to 3,200 GWh.

At present oil-fired power plants meet 65% of the total power demand in Thailand. As viewed from the whole of energies, the country relies upon oil by 78% for satisfying the requirements. Therefore, the Government of Thailand intends to develop alternative energies such as natural gas, lignite, hydro power and so forth on a large scale thereby ensuring her economic stability in the future. Accordingly, it is desired that development of hydro power plants be made by effective utilization of irrigation water to be obtained upon completion of the Sakae Krang River Basin Irrigation Project.

2.2 Hydro Power Development Plant

2.2.1 Basic plan

The Sakae Krang River Basin Irrigation Project is a water resources development scheme which mainly aims at realization of irrigation development. It is, therefore, essential that the hydro power development plan be scrutinized on the basis of reservoir operation which will depend on the said irrigation development plan. In other words, the above-mentioned hydro power development plan may be counted as the so-called "generation scheme incidental to irrigation water". Necessary studies have been made as follows in connection with the upper and lower stream sites of the Mae Wong River and the Khlong Pro river to which high priorities are given among the components of the Sakae Krang River Basin Irrigation Project.

(a) Study on maximum discharge

The maximum discharge has been determined based on the quantity of the release water as given in Table VIII-13, which was obtained from the optimal water balance.

Four (4) cases were selected from among the monthly average discharge and duration curves of water to be released from the respective dam (covering 28 years from 1954 through 1981) at the Upper Mae Wong site, Lower Mae Wong site and Khlong Pho site.

(b) Rated head

The rated head has been obtained assuming that the standard water level (rated head) is to be the average water level of reservoir operation rule of each dam (which has been proposed to have the optimal scale) covering 28 years from 1954 through 1981.

(c) Estimate of construction cost

The construction cost has been estimated by reference to costs incurred in construction of other hydro power development projects with similar scale in Thailand.

(d) Benefits

The respective power plants at the proposed sites of the Project will provide firm power of null. According to a figure adopted by EGAT at the planning stage of projects, kWh benefit has been assumed to be ฿1 per kWh.

(e) Annual expenditures

The annual expenditures have been assumed to be 2% of the construction cost of the power facilities, according to a figure adopted by EGAT at the planning stage of projects.

2.2.2 Outline of hydro power development plan

The outcome of the studies as described in the Basic Plan is as shown in Table VIII-14. Table VIII-15 gives the results of the case study.

Table VIII-1 RECORD OF NAKHON SAWAN ELECTRIC ENERGY CONSUMPTION
SEPTEMBER, 1984

Names of Districts	No. of Consumers	Energy Consumption (kWh)	Revenue (฿)	Average Price (฿/kWh)	Per Capita Consumption (kWh)
Nakhon Sawan	22,096	6,626,809	11,736,795.27	1.77	299.91
Ban Nong Ben	3,281	178,246	247,888.63	1.39	54.33
Krok Phra	1,640	89,468	122,289.83	1.37	54.55
Ban Tak Eenleun	1,403	86,735	120,225.15	1.39	54.69
Lad Yao	6,014	841,529	1,524,222.47	1.81	139.93
Tha Tako	3,590	279,962	442,480.81	1.58	77.98
Ban Huo Tanon	2,328	93,187	118,159.53	1.27	40.03
Chun Saeng	5,251	477,160	730,470.63	1.53	90.87
Nong Buo	4,155	249,243	375,174.18	1.34	59.99
Thap Krit	1,219	66,960	92,199.48	1.38	54.93
Ban Pot Phisai	3,841	233,047	323,697.14	1.39	60.67
Paisali	2,584	139,633	200,503.10	1.44	54.04
Kao Leo	2,159	123,605	170,053.53	1.38	57.25
Ban Maha Pho	511	24,803	31,309.33	1.26	48.54
Phayuhakiri	4,253	463,041	793,410.88	1.71	108.87
Ban Khao Thong	1,102	51,101	69,193.64	1.35	46.37
Ban Tha Nam Oy	1,205	124,737	206,309.05	1.65	103.52
Nong Pho	869	43,644	58,955.99	1.35	50.22
Ta Kli	7,754	1,726,604	2,940,027.92	1.70	222.67
Ban Chong Khae	2,467	128,690	182,369.86	1.42	52.16
Ban Chan Sen	678	44,347	63,147.02	1.42	65.41
Ban Huo Sai	920	50,071	66,508.81	1.33	54.43
Tak Fa	2,105	183,758	282,209.74	1.54	87.30
Takro	1,190	27,724	32,419.64	1.17	23.30
Total	82,615	12,354,104	20,930,021.29	1.69	149.54

Table VIII-2 RECORD OF CHAI NAT ELECTRIC ENERGY CONSUMPTION

SEPTEMBER, 1984

Names of Districts	No. of Consumers	Energy Consumption (kWh)	Revenue (฿)	Average Price (฿/kWh)	Per Capita Consumption (kWh)
Chainat	10,375	1,310,174	2,117,628.50	1.62	126.28
Mano Rom	3,606	740,068	972,072.17	1.31	205.23
Sankaburi	3,620	205,589	287,234.25	1.40	56.79
Ban Huai Krot	1,167	54,747	75,417.03	1.38	46.91
Sapaya	1,370	66,298	86,491.84	1.30	48.39
Ban Pho Narg Darm	2,737	138,726	183,742.02	1.32	50.69
Hun Kha	3,554	285,450	459,249.44	1.61	80.32
Ban Neon Kham	1,104	40,002	50,980.24	1.27	36.23
Ban Huai Ngu	1,559	83,913	115,411.84	1.38	53.82
Total	29,092	2,924,967	4,348,227.33	1.49	100.54

Table VIII-3 RECORD OF UTAI THANI ELECTRIC ENERGY CONSUMPTION
SEPTEMBER, 1984

Names of Districts	No. of Consumers	Energy Consumption (kWh)	Revenue (฿)	Average Price (฿/kWh)	Per Capita Consumption (kWh)
Utai Thani	6,191	913,555	1,550,461.27	1.70	147.56
Nong Chang	2,727	160,207	233,033.62	1.45	58.75
Ban Khao Nang Grat	957	58,055	85,480.22	1.47	60.66
Nong Kha Yang	1,411	55,200	71,609.17	1.30	39.12
Thap Than	2,566	106,815	141,549.30	1.33	41.63
Ban Rai	829	49,269	70,963.65	1.44	59.43
Ban Pha Rung	546	47,762	72,416.18	1.52	87.48
Lan Sak	920	68,888	101,750.67	1.48	74.88
Wat Sing	2,696	150,676	216,170.07	1.43	55.89
Sawang Arom	1,000	40,830	55,348.39	1.36	40.83
Talvt Khu	1,298	50,437	66,337.23	1.32	38.86
Total	21,141	1,701,696	2,665,119.79	1.57	80.49

Table VIII-4 RECORD OF NAKHON SAWAN ELECTRIC ENERGY CONSUMPTION FROM OCT. 1983 TO SEP . 1984

Month	No. of Consumers	Energy Consumption (kWh)	Revenue (฿)	Average Price (฿/kWh)	Per Capita Consumption (kWh)
Oct. 1983	77,609	10,680,758	17,966,216.79	1.68	137.62
Nov. 1983	78,074	10,262,265	17,213,363.24	1.68	131.44
Dec. 1983	78,335	9,827,132	16,300,610.70	1.66	125.45
Jan. 1984	78,808	9,776,661	16,378,449.31	1.68	124.06
Feb. 1984	79,489	10,661,153	17,866,760.16	1.68	134.12
Mar. 1984	79,827	11,573,129	19,524,609.14	1.69	144.98
Apr. 1984	80,465	12,601,110	21,311,126.72	1.69	156.60
May 1984	81,062	12,954,217	21,728,078	1.68	159.81
June 1984	81,657	12,855,424	17,618,518.92	1.37	157.43
July 1984	82,135	12,136,649	20,480,757.36	1.69	147.76
Aug. 1984	93,508	12,001,097	20,169,675.40	1.68	128.34
Sep. 1984	82,615	12,354,104	20,930,021.29	1.69	149.54
Total	973,584	137,683,699	227,488,187.53	1.65	141.42

Table VIII-5 RECORD OF CHAINAT ELECTRIC ENERGY CONSUMPTION

FROM OCT. 1983 to SEP. 1984

Month	No. of Consumers	Energy Consumption (kWh)	Revenue (฿)	Average Price (฿/kWh)	Per Capita Consumption (kWh)
Oct. 1983	26,670	2,296,243	3,645,872.09	1.59	86.10
Nov. 1983	26,773	2,343,722	3,615,239.06	1.54	87.54
Dec. 1983	26,948	2,110,086	3,228,254.84	1.53	78.30
Jan. 1984	27,167	1,956,883	2,948,268.61	1.51	72.03
Feb. 1984	27,306	2,074,947	3,171,914.70	1.53	75.99
Mar. 1984	27,556	2,565,158	3,942,552.96	1.54	93.10
Apr. 1984	27,734	2,670,811	4,127,502.24	1.55	96.30
May 1984	27,904	2,643,891	4,058,412.28	1.54	94.75
June 1984	28,227	2,695,391	4,172,862.67	1.55	95.49
July 1984	28,077	2,575,555	3,965,454.16	1.54	91.73
Aug. 1984	28,709	2,606,428	3,934,090.52	1.51	90.79
Sep. 1984	29,092	2,924,967	4,358,229.33	1.49	100.54
Total	332,163	29,464,082	45,168,653.46	1.53	88.70

Table VIII-6 RECORD OF UTAI THANI ELECTRIC ENERGY CONSUMPTION FROM OCT. 1983 to SEP. 1984

Month	No. of Consumers	Energy Consumption (kWh)	Revenue (฿)	Average Price (฿/kWh)	Per Capita Consumption (kWh)
Oct. 1983	19,113	1,403,035	2,156,968.07	1.54	73.41
Nov. 1983	19,268	1,367,447	2,078,531.94	1.52	70.97
Dec. 1983	19,364	1,241,029	2,007,420.05	1.62	64.09
Jan. 1984	19,435	1,231,881	1,827,091.07	1.48	63.38
Feb. 1984	19,545	1,374,123	2,058,117.85	1.50	70.31
Mar. 1984	19,759	1,443,235	2,178,407.45	1.51	73.04
Apr. 1984	20,024	1,611,278	2,484,933.58	1.54	80.47
May 1984	20,260	1,652,861	2,574,394.67	1.56	81.58
June 1984	20,374	1,594,841	2,508,927.23	1.57	78.28
July 1984	20,653	1,616,580	2,548,843.71	1.58	78.27
Aug. 1984	20,812	1,591,299	2,463,520.45	1.55	76.46
Sep. 1984	21,141	1,701,696	2,665,119.79	1.57	80.49
Total	239,748	17,829,305	27,552,276.46	1.55	74.37

Table VIII-7 ENERGY SALES: NAKHON SAWAN

FISCAL YEAR 1974 ∼ 1983

(kwh)

Year	Street Light-ing	Residen-tial	Small Business	Large Business	Small Industry	Large Industry	Government Hospital, Health Service and Insti-tute of Education	Agri-culture Pumping	Tem-porary	Total	Free of Charge
1974	181,354	8,762,558	21,223,716	15,314,253	15,743,461	1,331,120		6,318	30,604	62,593,384	272,865
1975	172,429	9,599,490	19,324,057	13,943,528	14,334,319	1,211,976		1,151,260	27,127	59,764,186	288,911
1976	174,268	11,428,299	19,932,831	14,382,797	14,785,900	1,250,157		924,200	30,892	62,909,344	308,768
1977	209,792	26,625,220	14,509,028	10,469,180	10,762,597	909,985		941,400	84,033	64,511,235	2,998,415
1978	329,651	33,252,288	16,324,545	11,779,191	12,109,323	1,023,851		186,900	160,342	75,166,091	1,886,737
1979	243,146	36,932,409	19,246,386	13,887,484	14,276,704	1,207,105		2,302,073	131,546	88,226,853	1,863,914
1980	213,810	43,542,392	22,887,536	12,219,251	12,546,360	2,793,020		112,715	271,262	94,586,346	552,717
1981	206,887	42,375,699	20,707,855	14,942,026	15,360,802	1,298,766		5,850	352,156	95,250,041	551,660
1982	235,894	54,674,017	19,240,619	16,155,764	16,279,983	2,266,042		17,600	401,274	109,271,193	636,225
1983	260,059	62,421,882	20,252,115	16,575,983	17,780,480	2,854,830	2,674,853	500	496,208	123,316,910	736,289

Table VIII-8 ENERGY SALES: CHAI NAT

FISCAL YEAR 1974 ∿ 1983

(kwh)

Year	Street Lighting	Residential	Small Business	Large Business	Small Industry	Large Industry	Government Hospital, Health Service and Institute of Education	Agriculture Pumping	Temporary	Total	Free of Charge
1974	75,808	3,685,503	607,108	190,019	442,428	338,278		648,987	13,228	6,001,359	115,034
1975	97,900	4,772,424	1,158,792	362,690	844,467	645,674		713,685	23,792	8,619,424	121,686
1976	89,031	5,182,796	1,550,280	485,222	1,129,763	863,810		761,222	31,203	10,093,327	153,731
1977	98,276	7,094,987	1,724,857	539,864	1,256,986	961,083		606,618	18,304	12,300,975	181,752
1978	118,505	8,849,229	1,046,381	327,507	762,548	583,040		1,940,288	21,499	13,648,997	190,352
1979	128,346	9,602,254	2,717,801	850,645	1,980,592	1,514,348		2,302,073	34,996	19,131,055	172,358
1980	122,944	11,100,017	4,050,199	1,114,635	2,554,752	475,042		1,759,305	118,287	21,295,181	162,910
1981	127,388	12,492,590	3,784,313	1,184,453	2,757,811	2,108,604		1,009,416	50,379	23,514,954	160,746
1982	150,636	14,835,665	3,715,182	2,503,224	2,544,922	1,263,516		1,766,316	67,559	26,847,020	180,925
1983	153,117	16,920,924	3,016,064	1,585,416	2,984,327	1,418,568	736,733	2,209,343	93,737	29,118,229	192,510