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DESIGN REPORT
ON
THE DETAIL DESIGN SURVEY FOR THE EXPERIMENTAL FARM
FOR
THE AGRICULTURAL DEVELOPMENT RESEARCH CENTER
IN
KHON KAEN

January 1985

Japan International Cooperation Agency

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JANUARY 1985

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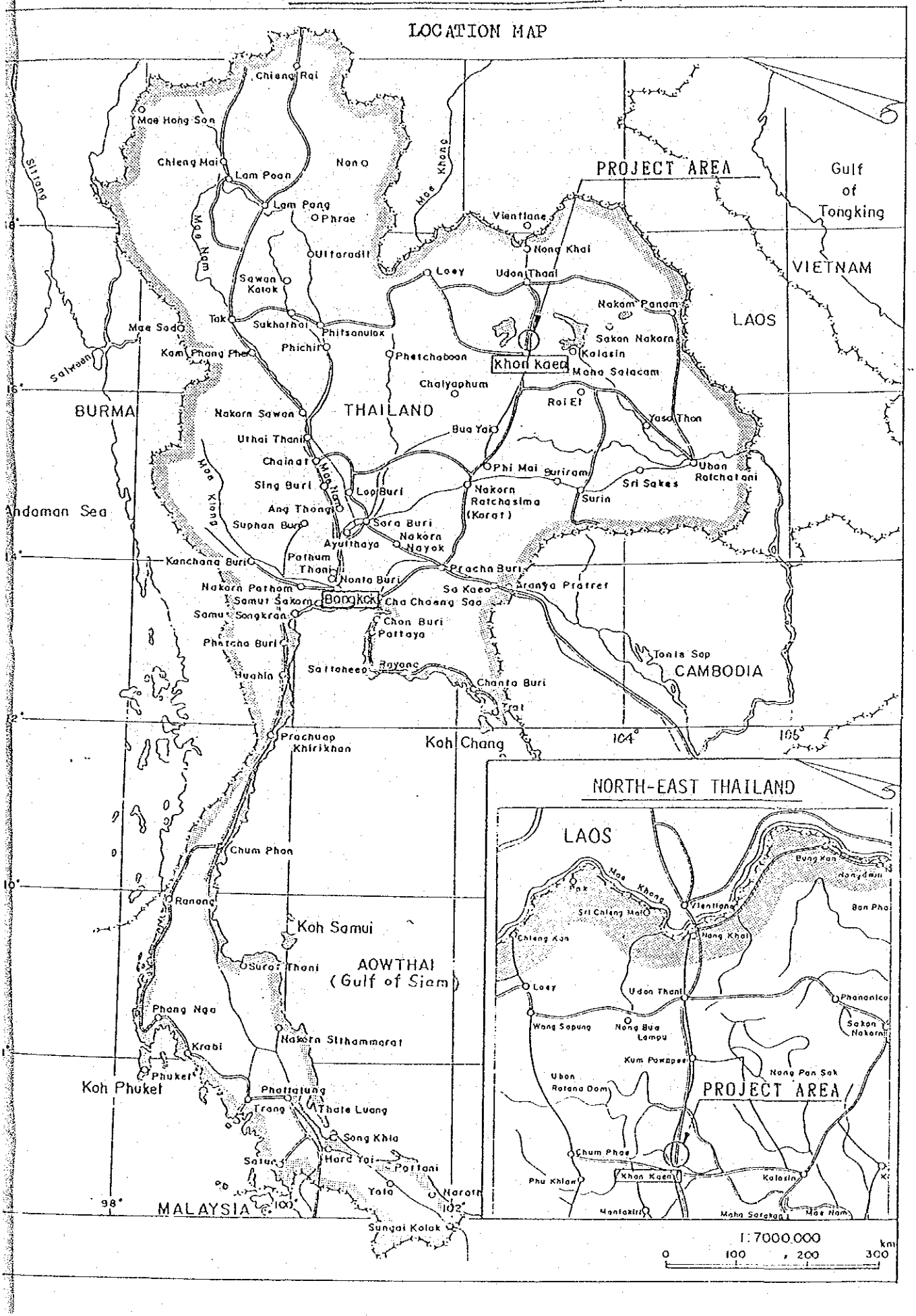
LOCATION MAP
PROJECT AREA
Gulf of Tongking
VIETNAM
LAOS
BURMA
THAILAND
CAMBODIA
Andaman Sea
Koh Chang
Koh Samui
Koh Phuket
AOWTHAI (Gulf of Siam)
MALAYSIA
Chiang Rai
Mae Hong Son
Chiang Mai
Lam Poon
Nan
Lam Pang
Phrae
Uttaradit
Sawan Kalok
Tak
Sukhothai
Phitsanulok
Mae Sod
Kam Phang Phet
Phichit
Phetchaboon
Khon Kaen
Maha Salacam
Chaiyaphum
Roi Et
Nakorn Sawan
Uthai Thani
Bua Yai
Yasothon
Chainat
Phi Mai
Buriram
Ubon Ratchatani
Sing Buri
Loop Buri
Nakorn Ratchasima (Korat)
Sri Sakes
Surin
Ang Thong
Suphan Buri
Sara Buri
Nakorn Nayok
Ayutthaya
Kanchana Buri
Pathum Thani
Nonta Buri
Prachin Buri
Nakorn Pathom
Samut Sakorn
Bangkok
Sa Kaeo
Aranya Pratret
Samut Songkran
Cha Choeng Sao
Chon Buri
Pattaya
Phetcha Buri
Hua Hin
Sattaheep
Rayong
Chanta Buri
Trat
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105
Chum Phon
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Surat Thani
Phang Nga
Krabi
Nakorn Sithammarat
Phuket
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Udon Thani
Phanomico
Wang Saphung
Nong Bua Lampu
Sakon Nakorn
Kum Pawapee
Nong Pan Sak
Ubon Ratana Dam
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Manfaxim
Maha Sarakam
Mae Nam
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PREFACE

The Government of Kingdom of Thailand has made a request to the Government of Japan a technical cooperation, for the purpose of strengthening agricultural development research activities, which will contribute as a fundamental strategy to the acceleration of development in Northeast Thailand.

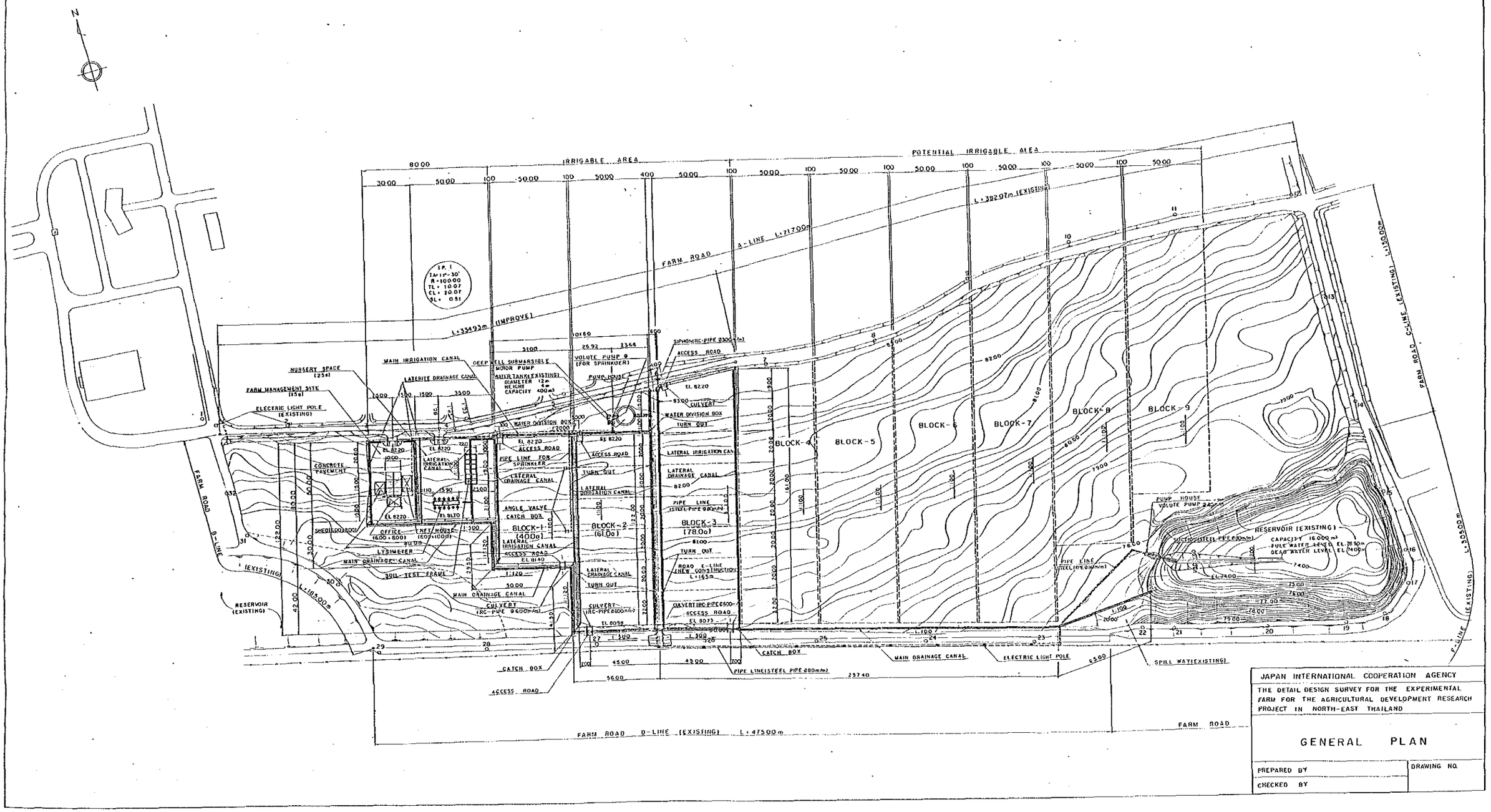
In response to the requrest, The Japanese Government has appreciated suitable to promote the Agricultural Development Research Project in Northeast Thailand as the tripartite project of Japan, U.S.A. and Thailand.
At present, The Agricultural Development Research Center under construction at Khon Kaen as a key station of the above project, under the Japanese grant aid. The team has been dispatched to the Kingdom of Thailand for the purpose of identifing the contents and formulating a detail plan about land consolidation of experimental farm which belongs to the Agricultural Development Research Center, through a series of discussions with Thai authorities and Japanese experts.
This reports presents the results of the field investigation and the subsequent study in Japan.

We hope that this report will serve as a guideline for the land consolidation and construction of experimental farm near future.

On behalf of the team members, I wish to take this opportunity to express my heartfelt gratitude to the all the authorities concerned for the valuable cooperation and assistance extended to the team throughout the survey period.

January, 1985

Takashi Tauchi
Director
Agricultural Development
Cooperation Department
Japan International Cooperation Agency



JAPAN INTERNATIONAL COOPERATION AGENCY

THE DETAIL DESIGN SURVEY FOR THE EXPERIMENTAL FARM FOR THE AGRICULTURAL DEVELOPMENT RESEARCH PROJECT IN NORTH-EAST THAILAND

GENERAL PLAN

PREPARED BY	DRAWING NO.
CHECKED BY	

MAIN WORKS OF THE PROJECT

1.	Land Shape Adjustment and Land Leveling	2.04	ha
2.	Land Leveling for Farm Management Site	0.15	ha
3.	Irrigation Canal (concrete lining)		
	Main canal	460	m
	Lateral Canal	1,470	m
4.	Drainage Canal (concrete lining)		
	Main canal	590	m
	Lateral Canal	1,740	m
5.	Farm Road		
	A - Line (Improve)	717	m
	B - Line (Existing)	(185	m)
	C - Line (Existing)	(150	m)
	D - Line (Existing)	(370	m)
	E - Line (New construction)	160	m
	F - Line (Improve)	305	m
6.	Lysimeter	12	pcs
7.	Soil Test Frame	12	pcs
8.	Reservoir		
	Sod Facing		L.S.
	Spillway		L.S.
9.	Deepwell (ø 150 mm w/h casing, H = 60 m)	1	Nos.
10.	Pumps		
	Submergeble Pump	1	set
	(Q = 90 l/min, H = 25 m, 1.5 KW)		
	Water Supply Pump	1	set
	(Q = 170 l/min, H = 22 m, 2.2 KW)		
	Sprinkler Pump	1	set
	(Q = 170 l/min, H = 26 m, 2.2 KW)		
11.	Pipeline for Water Supply	750	m
12.	Houses for Farm Management		
	Shed (6 m x 8 m)	1	Nos.
	Office (6 m x 8 m)	1	Nos.
	Net House (6 m x 10 m)	1	Nos.

DESIGN REPORT

ON

THE DETAIL SURVEY FOR THE EXPERIMENTAL FARM

FOR

THE AGRICULTURAL DEVELOPMENT RESEARCH CENTER

IN

KHON KAEN

CONTENTS

CHAPTER 1

SITE SURVEY OF THE PROJECT AREA

1 - 1 Location

The experimental farm is located in the area of Agricultural Development Research Center in the suburbs of Khon Kaen City linked with Bangkok for the distance of about 450 km, by the Freind-ship highway, national railway and domestic airway. The location of the farm is shown in Fig. 1.

1 - 2 Topography, Geology

The existing topographic map prepared by LDD is available for the general layout of design, but it does not meet with the accuracy required for the detail design. The topographical survey works were carried out to cover the project area. Items of the survey works are as follows.

(1) Plane survey for the project area
Travers survey for boundary, plane table survey with scale of 1/1000 and level survey of 10 m grids were executed for about 10 ha in total of the farm.

(2) Route survey for the project area
Route survey and level survey were carried out for the farm roads, irrigation canals and drainage canals.

(3) Mapping
Mapping works based on the results of above survey were carried out, and plane map of the farm with scale of 1/1,000 and 20 cm counterline were completed.

Geologically, Khon Kaen Province situates in the Plateau (Known as the Korat Plateau) composed of fine grained sandstone and shale strata which are overlain in the vally depressions with alluvium and river terrace deposit. The sandstone in the upper strata are highly pervious.

1 - 3 Soil

The investigation of a profile of the soil was carried out by two test pits and their locations are shown in Fig.2. Depth of the both test pits is about 2 m and supplemental drilling by augerhole was also carried out from the bottom of the test pit.

The result of the above investigation shows that the project area is covered with homogeneous fine silt originated from sandstone. And no other course grained materials was observed.

Color of the soil, about 50 cm depth from the ground surface, shows gray and changes into yellow-red deeper than therefrom. The profile of there soils seems to show no problems for cultivation.

Ground water level was observed about 2.6 m below the ground surface at the test pit No. 2 (TP-2), near to the reservoir and this seems to be same level of the water surface in the reservoir. Another test pit (TP-1) shows no ground water level.

1 - 4 Meteorology

1 - 4 - 1 Precipitation

Daily rainfall records were available for the years from 1970 to 1983 at the rainfall observation station in Khon Kaen University (KKU) located adjacent to the project area.

Based on the daily rainfall records, mean monthly rainfall was calculated and summarized in Table-2 Annual mean rainfall of 1,157 mm on the Table-2 is well corresponded to the figure of isohyetal map analysed by Khon Kaen University, as shown in Fig. 3.

1 - 4 - 3 Temperature, Humidity, Duration of Sunshine

Observation records of Temperature, Humidity and Duration of Sunshine were also avilable. Observation period up to 1983 are 12 years for Temperature, 8 years for Humidity and 9 years for duration of Sunshine respectively.

There are summarized in Table-3, Table-4, and Table-5.

1 - 4 - 4 Evapotranspiration

Summary table of estimated potential evapotranspiration in the Northeast Thailand including Khon Kaen Province was available, which was estimated through multiplying panevaporation (class A pan of 120 cm in diameter) by 0.6. The duration of the record is from 1965 to 1970, as shown in Table-6.

1 - 5 Irrigation conditions

There are no water supply system in the project area. Existing reservoir located at the southeast corner of the project area has a capacity of 16,000 cum approximately but actual stored water in dry season is about 3,400cum at most. Small amount of storage in dry season may be caused by evaporation and shortage of catchment area. This reservoir is only available water resources for irrigation of the farm. The enlargement of the reservoir and catchment area as well as an effective water supply system would be essentially required.

1 - 6 Drainage Conditions

Actual drainage facilities is not found in the project area, and flooded water seems to flow into the reservoir through the low elevation area along the southern boundary of the farm road.

As the reservoir has no spillway, excess water of flood seems to be naturally overflowed from the lowest crest elevation of the reservoir to the out side.

Considering above circumstances, new construction of reasonable drainage facilities such as main and lateral drainage canals and spillway of reservoir are required for the project area.

CHAPTER 2

PROJECT DESIGN

2 - 1 Outline of the Design

The total area of the farm will be expanded to 7.81 ha in full operation stage when the water supply system from the Nong Wai Right Main Canal will be hopefully completed by the concerned organization. Therefore, the design specification of main irrigation canal for the farm is forcused to the required water capacity on the above full operation stage.

The irrigation area will be limited to 2.04 ha estimated from the water supply capacity of the existing reservoir and expected underground water supply by deep well.

Nursery space having a soil test frame and lysimeter and farm management site having a shed, office, net house and so on are also designed.

Lateral drainage canal of each farm area is linked to main drainage canal and the drainage water flows through the canal into the reservoir.

In order to gain the effective use of water, the drainage water in the drainage canal can be re-used for irrigation.

Stored water in the existing water tank from the reservoir and the deepwell, supplied by pumping systems, is used for the farm irrigation by gravity and sprinkler.

2 - 2 Land Shape Adjustment

The experimental farm is composed of Farm Management Site (0.15 ha), Nursery Space (0.25 ha) and farm area (7.41 ha) as scaled in paragraph 2 - 4.

Farm area is divided into nine (9) large blocks by disposion of new lateral irrigation and drainage canals or farm roads. Each block has a size of 50 m in width and the length of long side of the block forming trapezoid is variable with conforming the topography of the farm.

Each large block is also divided into several plots having its size of twenty (20) meters in width and fifty (50) meters in length which are bounded by a irrigation ditch.

Nursery Space and three (3) blocks of the farm from West side (herein after referred to as "irrigable area") will be constructed intensively on the construction stage, and other blocks (herein after referred to as "potential irrigable area") will be freely formed in line with the research program in future.

2 - 3 Land leveling

The design gradient of each block of irrigable area is decided as 1/1000 on longitudinal direction, taking account of a suitable irrigation and drainage system and economical earth moving plan of the construction. A gradiant of cross sectional direction is designed as almost level.

The proposed ground elevation of each block is as shown in Fig 8.

2 - 4 Area of the Farm

After completion of the design for the land shape adjustment, the area of the farm is summarized as follows,

1.	Farm Management Site	0.15	ha
2.	Irrigable Area	2.04	ha
	Nursery Space (furrow irrigation)	0.25	ha
	Irrigable Farm	1.79	ha
	for sprinkler	(0.40	ha)
	for furrow irrigation	(1.39	ha)
3.	Potential Irrigable Area	5.62	ha
	Total	7.81	ha

2 - 5 Irrigation Plan

2 - 5 - 1 Unit Water Requirement

The project irrigation water supply requirements (V) can be obtained from;

$$Vi = \frac{10}{Ep} \sum_i \left[\frac{A \times In}{I - LR}\right]_i \qquad m^3/\text{period}$$

where: Ep = Project irrigation efficiency

A = Cropping area, ha

In = Net water requirement of given crop, mm/period

LR = Leaching requirement

The factor 10 appeares due to conversion of In in mm/period to V in m^3/period

Net irrigation requirement of the crops (In)

Net irrigation requirement (In) is calculated using the field water balance. The variables included in the calculation are crop evapotranspiration (ET crop), rainfall (Pe), ground water contricution (Ge) and stored soil water at the beginning of each period (Wb), or;

$$In = Et\ crop - (Pe + Ge + Wb)$$

losses - gains

ET crop is given by the refference between crop evapo-transpiration (ETo) and crop coefficient (Kc) or;

$$ET\ crop = ETo \times Kc$$

For the value of ETo, 6.5 mm/day is given as a maximum value from the result of calculations by using Perman Radiation, Blaney-Criddle and Pan-evaporation Method as shown in Table-10, and 1.05 is given for Kc taking into consideration of the crop charasteristics. The value of ET crop is then calculated as follows,

$$ET\ crop = 6.7 \times 1.05 = 7\ mm/day$$

The value of Ge and Wb is given as zero (0) because of negligible small amount. The value of Pe is also neglected as a safty factor on the above calculation of In. The value of In is obtained at 7 mm/day.

Leaching Requirement (LR)

Soil salinity is mainly affected by water quality, irrigation method and pratices, soil conditions and rainfall. Leaching requirement (LR) is the minimum amount of irrigation water supplied that must be through the root zone to control soil salinity at the given specific level.

The leaching requirement (LR) for surface irrigation method including sprinklers can be obtained from following equation.

$$LR = \frac{ECw}{5\ ECe - ECw}$$

where; ECw electrical conductivity of the irrigation water, mmho/cm

ECe electrical conductivity of soil saturation extract for a given crop appropriate to the tolerable degree of yield reduction

The value of ECw and ECe is estimated at 0.16 mmho/cm and 0.92 mmho/cm respectively according to the actual data obtained. (see paragraph 2 - 8 - 3) The value of ECe is smaller than that of ECw. This means that no water for leaching is required for the soil in the farm, and the value of 1-LR on the above equation can be negligible.

On the other hand, the value of ECw itself having 0.92 mmho/cm shows good quality for general crops in the farm. (See paragraph 2-8-4)

Irrigation Efficiency (Ep)

To account for losses of water incurred during conveyance and application to the farm, an efficiency factor should be included. The value of Ep is estimated as 0.6 for a furrow irrigation and 0.8 for a sprinkler irrigation.

Unit water requirements

Unit water requirement (m^3/ha/day) can be given from said equation for Vi with estimated values so far, as follows.

$$V = \frac{10}{0.6} \left[\frac{1.0 \times 7}{1}\right]$$

$$= 117 \ m^3/day/ha$$

$$= 1.4 \ l/sec/ha \text{ (for furrow irrigation)}$$

$$V = \frac{10}{0.8} \left[\frac{1.0 \times 7}{1}\right]$$

$$= 88 \ m^3/day/ha$$

$$= 1.0 \ l/sec/ha \text{ (for sprinkler irrigation)}$$

2 - 5 - 2 water Requirement for the Farm

The irrigable area is 1.64 ha for furrow irrigation and 0.4 ha for sprinkler irrigation as shown in paragraph 2 - 4 . The water requirement of the irrigable area is resulted as follows,

Water Requirement

Furrow Irrigation Area

1.64 ha x 1.4 lit/sec/ha = 2.3 lit/sec

(= 200 m^3/day)

Sprinkler Irrigation Area

0.40 ha x 1.0 lit/sec/ha = 0.4 lit/sec

(= 35 m^3/day)

Total 2.7 lit/sec

(= 235 m^3/day)

2-5-3 Sprinkler irrigation

Movable spray irrigation by medium pressure sprinkler is adapted for irrigable area of 0.40 ha. The detailed upland irrigation plan is as follows.

TRAM (Assumption)	18 mm	(Table 16, 17)
Daily requirements	7 mm/day	
Interval	2 days (18 mm ÷ 7 mm/day)	
Net irrigation water per operation	14 mm	
Irrigation efficiency	80 %	
Gross irrigation water per operation	18 mm (14 mm ÷ 0.8)	
Operation hour	4 hr/day	

(1) Determination of irrigation capacity by total sprinkler system

The irrigation capacity by the total sprinkler system is estimated by the following equation.

$$Q = 166.7 \times \frac{A \times D}{F \times H}$$

Where,

Q = System's capacity (lit/min)

A = Irrigation area (ha)	A = 0.40 ha
D = Gross irrigation water (mm)	D = 18 mm
F = Interval (day)	F = 2 days
H = Operation hours (hr)	H = 4 hr.

$$Q = 166.7 \times \frac{0.40 \times 18}{2 \times 4} = 150.0 \text{ lit/min}$$

(2) Determination of the type of sprinkler to be used

The capacity of the sprinkler required for this project is estimated by the following equation.

$$q = \frac{D \times S_1 \times S_2}{60\ T}$$

Where,

q = Capacity of sprinkler (lit/min)

D = Gross sprinkling water (mm) D = 18 mm

S_1= Interval of sprinkler (m) S_1= 12.0 m

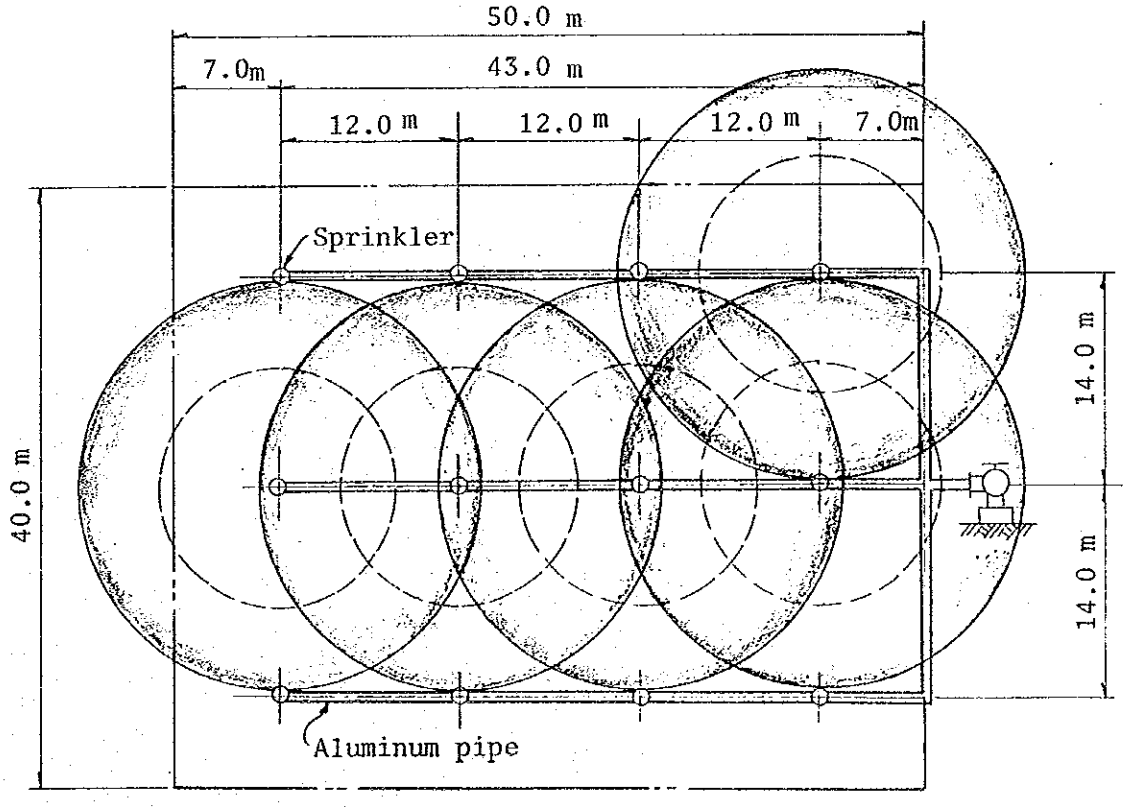
S_2= Interval of branch pipes (m) S_2= 14.0 m

T = Sprinkling time per operation (hr) T = 4 hr.

$q = 18 \times 12 \times 14 / 60 \times 4 = 12.6$ lit/min

The sprinkler type to be adopted is determined as follows, referring to the specifications.

- sprinkler diameter 3.2 × 2.4 mm
- water pressure 2.1 kg/sq.cm
- sprinkler water 14.6 lit/min
- sprinkling coverage in diameter 24.1 m



(3) Sprinkling intensity

The sprinkling intensity is obtained from the following expression.

$$I = \frac{60 \times q}{A}$$

Where,

I = Sprinkling intensity (mm/hr)

q = Average capacity of sprinklers (lit/min) q = 14.6 lit/min

A = Sprinkled area per sprinkler head

$= S_1 \times S_2$ $A = 12 \times 14 = 168\ m^2$

$I = 60 \times 14.6 / 168 = 5.2$ mm/hr

The values of S_1 and S_2 should satisfy the following equation to the sprinkling coverage diameter (D), in taking into the sprinkling efficiency.

$S_1 = 0.3D \sim 0.5D$

$S_2 = 0.5D \sim 0.7D$

For $S_1 = 12$, $S_2 = 14$

$S_1/D = 12/24.1 = 0.50$ ..... OK

$S_2/D = 14/24.1 = 0.58$ ..... OK

(4) Branch pipe lines for sprinkler

One set of the sprinkler is composed of four (4) sprinkling heads equipped with alminum branch pipe.

Friction head loss of branch pipe line can be computed by Scobbys Formula as follows.

$$Hf = F\left\{\frac{2.59Ks\left(\frac{4}{\pi}\right)^{1.9} LQ^{1.9}}{1{,}000D^{4.9}}\right\}$$

Where,

Hf = Friction head loss (m)

F, Ks = Scobby's coefficient F=0.48, K=0.40

L = Length of branch pipe

D = Pipe diameter (m)

Q = Quantity

Taking pipe diameter (D) as 0.05 m, the results of calculation can be tabulated as follows:

$$Hf = 0.480 \times \left\{ \frac{2.59 \times 0.40 \times \left(\frac{4}{\pi}\right)^{1.9} \times 57.0 \times (9.73 \times 10^{-4})^{1.9}}{1{,}000 \times (0.05)^{4.9}} \right\}$$

$$= 0.20 \text{ (m)}$$

2 - 5 - 4 Design of Irrigation Canal

The proposed irrigation canal systems of the farm are as shown in Fig. 9, which is formulated taking account of various factors such as gradiant and elevation of designed farm, the designed water level, and designed water velocity, etc.

The irrigation canal is designed to be of concrete lining in order to make seepage losses at minimum. The cross section of the main canal is designed so as to convey the required water in future at full operation stage.

The hydraulic calculation is done by using Manning's formula for the irrigation canal, as follows,

$$Q = A\frac{1}{N} \cdot R^{2/3} \cdot I^{1/2}, \quad Q = A \times V$$

Where
- Q : Design discharge
- A : Discharge area
- V : Current velocity
- n : Roughness coefficient
- R : Hydraulic radius
- I : Bed slope

The result of the calculated hydraulic elements of irrigation canal system is shown in Table 18.

2 - 6 Drainage Plan

2 - 6 - 1 Designed drainage discharge

Probable rainfall intensity

The data of the maximum daily rainfall records (1970 - 1983) are used for probability analysis. From the probability analysis shown in Fig. 11, rainfall intensity of 110 mm/day with 5 years return period is determined as the design rainfall intensity for the drainage in the farm area and farm management site.

Design discharge for the farm area

Design discharge for drainage of the farm area is given by following equation,

$$Q = 10 \times f \times Ra \times A / 3,600$$

where;

Q : Design discharge

F : Run-off coefficient for the farm = 0.6

Ra : Rainfall (4 hours), or

$$Ra = \frac{R24}{24} \left(\frac{24}{T}\right)^{2/3}$$

$$= \frac{110}{24} \left(\frac{24}{4}\right)^{2/3} = 15.1 \text{ mm}$$

T : Duration of discharge 4 hours

A : Unit area 1 ha

therefore,

$Q = 10 \times 0.6 \times 15.1 \times 1 / 3,600 = 0.025 \text{ m}^3/\text{s/ha}$

Design discharge for the farm management site

Design discharge for drainage of the farm management area is given by following equation,

$$Q = 10 \times F \times Ra \ A / 3,600$$

where;

Q : Design discharge

f : run-off coefficient for the area = 0.8

r : hourly rainfall, or

$$r = \frac{R24}{24} \times \left(\frac{24}{1}\right)^{2/3}$$

$$= \frac{110}{24} \times \left(\frac{24}{1}\right)^{2/3} = 38.1 \text{ mm}$$

A : unit area = 1 ha

therefore

$$Q = 0.2778 \times 0.8 \times 38.1 \times 0.01 = 0.085 \ m^3/sec/ha$$

2 - 6 - 2 Design of Drainage Canals

Layout of main and lateral canal is shown in Fig. 12, which also indicates catchment area covered by each lateral drainage canal.

The depth of drainage canals is designed to be sufficiently deep so that the drained water can smoothly flow down into the existing reservoir.

Excavated surface of both drainage canal of main and lateral is proposed to be lined with concrete to keep smooth water flow and protect from erosion. The typical cross section of these canals is illustrated in drawing, and the designed drainage discharge of each canals is shown in Table 19,20.

2 - 7 Farm Road Network

Farm road network is indicated in Fig. 14. As the exsisting center line of road A-Line is a little winding, the rehabilitation works of the road is proposed.

B-Line, C-Line and F-Line is used as the existing condition, and E-Line is proposed to be newly constructed.

Typical cross section of the farm road is illustrated in the drawing, and the surface of the road is proposed to be paved with laterite.

2 - 8 Water Resources

2 - 8 - 1 Back Ground

The full size of 7.8 ha which required the total amount of water 1,000 m^3/day approximately, will be irrigated in future by the intake system planned by LDD from the Nong Wai Right Main Canal. However the completion of this future irrigation water supply system will not be in time when the farm construction be completed in mid-1985. The following water resources are temporarily proposed to irrigate the area of 2.04 ha until the intake system is completed hopefully in the near future.

(1) surface water stored in the existing reservoir

(2) underground water

2 - 8 - 2 Existing Reservoir

The capacity of existing reservoir is about 16,000 m^3 which is not meet with the irrigation demand for full operation of porposed 2.04 ha of irrigable area.

Total reservoir capacity of 35,000 m^3 will be required for irrigation taking account of losses by evapolation and a amount of supplemental water from deep well. Therefore, around 20,000 m^3 of excavation for enlargement of the reservoir will be necessary.

2 - 8 - 3 Underground Water

Since underground water functions mainly for the auxiliary water resources for the farm during the dry season, installation of deep well with pumping facility is proposed to be constructed.

Geological data are not sufficient to decide the depth of the deep well. However, it is concluded that the deep well will be enough at 60 m in depth based on the data from the existing deep well as shown in Fig. 7 and Table 7. The available water capacity is estimated as mean 90 lit/min from the data above.

2 - 8 - 4 Water Quality

Electrical conductivity (EC) tests on the proposed irrigation water from the exsisting reservoir and exsisting deep well were excuted and the results are shown in Table 14.

The EC value of underground water from the existing deep well is higher than the water from the reservoir, but the value of 0.92 mmho/cm is estimated as a grade of "moderate to high" or "class I" quoted from the standard which is shown in Table 15. Therefore the water from deep well is evaluated to be suitable for the irrigation water.

2 - 9 Pumping System

Irrigation water from the reservoir and deepwell is conveyed to the existing water tank through pipe line by volute pump and submergeble pump, respectively.

The required water for office-use is also designed to be available from the submergeble pump.

Stored water in the water tank is conveyed for the sprinkler irrigation by the volute pump installed beside the water tank, which is also designed to be available for furrow irrigation.

Each specification above pumps is as follows,

1)	Deep well pump :	capacity	90 lit/min
		Head	25 m
		Motor	1.5 KW/3phase
2)	Water supply pump	capacity	170 lit/min
		Head	22 m
		Motor	1.1 KW/3phase
3)	Sprinkler pump	capacity	170 lit/min
		Head	26 m
		Motor	2.2 KW/3phase

2 - 10 Nursery Space

For various institutional tests of soil, the lysimeter and soil test frame will be constructed at the nursery space.

The 12 pieces of lysimeter and 12 blocks of test frame are designed to be made of concrete and the water supply and drainage system for the above facilities are also designed.

2 - 11 Farm Management Site

For the management of the experimental farm, proposed shed, office including space for plant sample treatment and net house are designed, and each size and specification are as follows, and detailed design is illustrated in the drawings.

Shed ;	Size	6 m x 8 m
	Roof	Roman tile
	Wall	Void
	Base	Concrete steel trowel finish
Office ;	Size	6 m x 8 m
	Roof	Roman Tile
	Wall	Concrete Block with Window
	Base	Concrete steel trowel finish
Net House;	Size	6 m x 10 m
	Roof	Glasolit
	Wall	Steel Net
	Base	Concrete Steel Trowel Finish

CHAPTER 3

CONSTRUCTION PLANNING

3-1 General

The main works of the land consolidation in the experimental field of the A.D.R.C. under the Model Infrastructure Improvement Project are as follows.

(1) Land leveling
(2) Irrigation canal
(3) Drainage canal
(4) Farm road
(5) Lysimeter and soil test frame
(6) Drilling of deep well
(7) Setting of pumps and pipe lines
(8) Concrete pavement for farm management site
(9) Houses of farm management
(10) Reservoir

3-2 Basic Planning

3-2-1 The number of workable days

Suspension of construction works is mainly caused by rainfall and national holidays and Sundays. Mean workable day is decided as 21 days per month, considering the suspension days caused by rainfall, Sundays and national holidays.

3-2-2 Conversion rate of earth volume

Earth volume is changeable according to the condition of earth, for example, earth of natural ground will increase in volume after excavation and decrease after compaction. This rate of change in volume of earth is defined as the conversion rate which play an important role in establishing the earth moving plan. Tadking account the characteristic of earth materials in the project, the conversion rate is dicided as 1 vs 1.

3-2-3 Earth moving plan

Required amount of earth necessary for embanking pertinent to construction of land leveling is supplied with excess earth materials excavated from the high-lying land in the experimental field under construction. Distribution plan of earth materials is proposed in Table 27.

3-2-4 Application of construction machinery and equipment

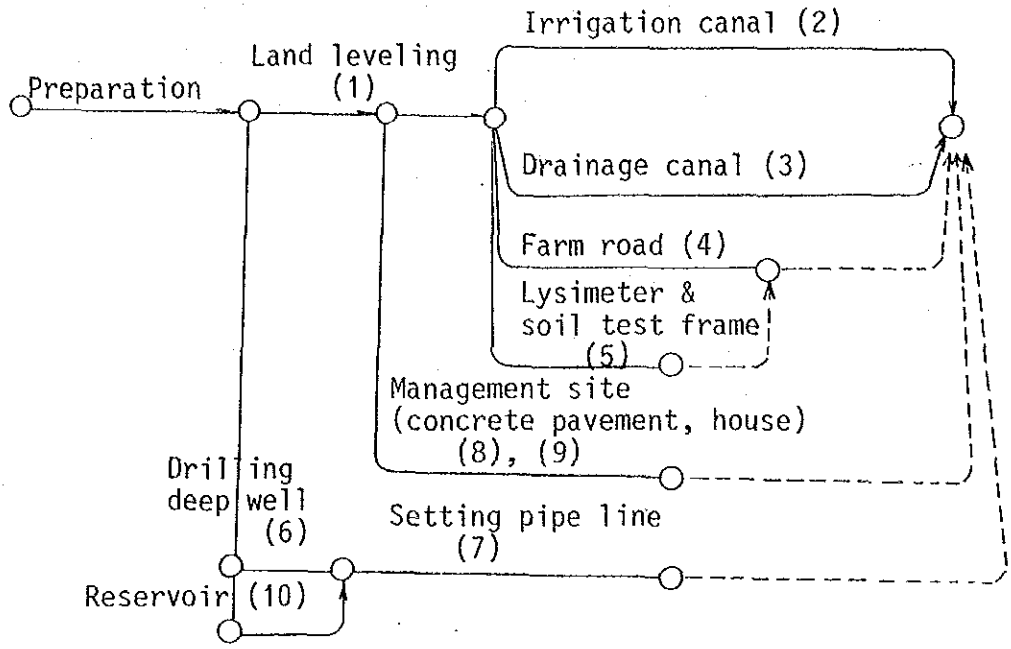
Man power will be applied for the work as much as possible, so as to comply with the comparative small scale of the work and to contribute to the increase of employment for local labour. It intend to use the construction equipments as follows.

Dump Truck (8 ton)	transportation
Bull Dozer (11 ton)	excavation or spreading
Back-Hoe shovel (0.35 m^3)	excavation
Tractor shovel (1.2 m^3)	loading
Vibration roller (3 ton)	compaction
Portable concrete mixer	mixing of concrete

3-2-5 Work routine

It is desirable to take the following work routine for implementation of the construction works, which is shown below be means of flow network.

Flow Network of the Construction



3-3 Working Planning

3-3-1 Land shape adjustment and land levelling

The construction work for the land shape adjustment and land levelling would be executed by construction equipment, because the earth volume of cut and banking is very much. The Fig. 24 shows planning for haulage of earth materials which will be done among five (5) large blocks and the planning has been done based on a map made by putting the border of each large block on the contour map of the experimental farm. We designed that surface treatment for pretecting the surface soil from lowering soil about experimental farm, but it is not necessary about farm management site and nursery space. Therefore, the surface soil is stocked temporariry before the work of land levelling. Excavation works of the farm are mainly made by Bull dozer, loading by Tractor shovel, and hauled by Dump truck. The construction of land shape adjustment would start after completion of the land levelling.

3-3-2 Irrigation and drainage canals

Irrigation and drainage canals are made of concrete lining. The excavation and filling work for these canals will be executed together with the work of farm road construction where the road and canals run parallel; earth works for canals will be done by man-power. Concrete for canal lining is to be mixed by portable concrete mixer of about $0.22m^3$ in capacity, placed by man-power, and compacted by vibrator. Stone materials for stone masonry will be purchased and the mortar is produced by portable mixer. Construction work will be all done by man-power.

3-3-3 Farm road

Excavation will be executed by equipment. Materials suitable for the embankment of farm road will be obtained from the site and be transported by using 8 ton dump truck, and will be placed in layer by equipment and compacted by Vibration roller or hand operated mechanical tamper. The surface of the road is paved with bought laterite. Pavement will be executed after completion of embankment for the farm road.

3-3-4 Deep well and deep well pump

The drilling of deep well would be done by using percussion or rotary drilling machine and keeping outside diameter 250 mm up to depth of sixty (60) meters below ground surface. After completion of the drilling, electic logging test would be made in order to confirm aquifer. The processed casing pipe with diameter of 150 mm would be installed into the hole after completion of the drilling. The crevice between the hole and the casing would be filled with appropriate filter materials. After filling of filter materials was completed, the pumping test would be conducted in order to find the mutual relation among pumping lift, and pumping discharge.

After completion of pumping test done the second time, installation of the deep well pump as well as building of pumping station would be started.

3-3-5 Appurtenant structure

The appurtenant structures related to the farm road and canals are turnouts, culverts, diversion facility, etc., which are relatively small-scaled concrete structures. These will be constructed according to the construction progress of the road and canals. Concrete will be mixed by portable concrete mixer at site and placed by man-power.

3-4 Bill of Quantities

The bill of quantities of the construction works are indicated in the Table 28 .

CHAPTER 4

CONSTRUCTION COST ESTIMATION

Construction cost of the experimental farm is calculated from the bill of quantities taken from the detail designs, drawings, and reasonable unit costs. The construction cost includes tax, profit and overhead, and also including contingency for price escalation and physical measures of bill of quantities.

Cost for civil works is calculated taking account of various factors such as construction method, earth moving plan for land leveling, workable days and so on.

Unit cost of each work item is calculated based on the labour cost and material cost which are current market prices surveryed on the beginning of Nov. 1984.

Construction cost is shown in Table 30.

APPENDIX

November 5, 1984

Mr. Chote Suvipakit
Director
Foreign Agricultural Relations Division
Ministry of Agriculture and Cooperatives

Subject : Summary Report of the Detail Design Survey for the Experimental Farm of the Agricultural Development Research Center in Khon Kaen

Dear Sir,

The Japanese Detail Design Survey Team (herein after referred to as "the Team") organized by Japan International Cooperation Agency (herein after referred to as "JICA") visited the Kingdom of Thailand, from October 24th to November 7th(to December 2nd for the consultant), for the purpose of formulating a detail plan on the Construction of Experimental Farm (herein after referred to as "the farm") at Agricultural Development Research Center in Northeast Thailand (herein after referred to as "ADRC").

During its stay in Thailand, the team exchanged views and had a series of discussions with Thai authorities concerned of the Agricultural Development Research Project in Northeast Thailand on the necessary measures to be taken by both governments for the sucessful implementation of construction of the farm in ADRC.

As the result of exchange of views and surveys, I have the honor of submitting you the Summary Report of the Team attached hereto, showing the outline of the farm design which will be consolidated by consultant members during their stay in Thailand.

Finally, I express my deep appreciation for your kind cooperation and I hope that necessary arrangement will be taken for the smooth implementation of construction works.

Bangkok, November 5, 1984.

Yours Sincerely,

Yukio Imasaka

Yukio IMASAKA
Team Leader

Japanese Detail Design Survey Team
for the Agricultural Development
Research Project in Northeast Thailand

cc: Dr. Anunt Komes
Dr. Yookti Sarikaphuti
Dr. Kavi Chutikul

ANNEX - 1

SUMMARY REPORT

OF

THE DETAIL DESIGN SURVEY

FOR

THE EXPERIMENTAL FARM OF THE AGRICULTURAL DEVELOPMENT RESEARCH CENTER IN KHON KAEN

OUTLINE OF THE CONSTRUCTION WORK OF EXPERIMENTAL FARM

1. Location and scale of the Construction Work of Experimental Farm

The Experimental Farm (herein after referred to as "the farm") will be established as the facilities of ADRC to support the research activities of the Agricultural Development Research Project in Northeast Thailand. The farm will be managed by the Land Development Department (herein after referred to as "LDD") Ministry of Agriculture and Cooperatives (herein after referred to as "MOAC") but opened for the following two research institutions participating in the Project as well.

(1) Department of Agriculture (herein after referred to as "DA"), MOAC

(2) Faculty of Agriculture, Khon Kaen University (herein after referred to as "KKU").

The designed size will be about 8 ha at full operation stage including nursery space; the farm management facilities will be planned to set up near the farm. However, the proposed irrigated area will be limitted to about 1.5 ha at initial stage because of shortage of irrigation water in that stage as mentioned in 3.

Further consultations will be made if necessity arises for the final dicision of farm size at the construction stage.

2. Outline of the work (See Annex-1)

3. Water Resources for Irrigation

LAD has a plan to request a budget of 1986 fiscal year necessary to construct an intake system to take irrigation water directly from the Nong Wai Right Main Canal which has been under the management of the

Royal Irrigation Department (herein after referred to as "RID").

The full size of 8 ha, which require the total amount of water 1000 m^3/day approximately, will be irrigated when the intake system mentioned above is completed.

However, this planned irrigation water can not be used for the farm immediately after the farm is completed in mid-1985.

Therefore, the following combination of water resources, the total amount of which is 200 m^3/day approximately, are proposed to irrigate the area of about 1.5 ha temporarily until the intake system is complete hopefully in the near future;

(1) Under ground water by deep well
(2) Surface water stored in the reservoir located at the corner of the farm area.

The enlargement of the reservoir mentioned in (2) will be necessary; the excavation work will be carried out by the concerned organization, preferably LDD, by using the heavy equipments to be donated by the Government of Japan, under the grant aid program.

The figures mentioned above might be changed as the result of detailed calculations of water requirement for irrigation.

4. Others

(1) Preparation of the Site
Removing or clearing the plants on the site, if necessary. will be completed by LDD by the beginning of February.

(2) Preparation of Electricity
Three pumps for the deep well, the intake at the reservoir, and the sprinkler system will be planned. The electricity facility for these pumps will be prepared by LDD.

(3) A letter of the request addressed to JICA Bangkok Office.
If there is the necessity of Japanese Cooperation on the construction of the farm, a formal letter to request for the Japanese Cooperation to implement the Construction work should

be forwarded in the name of the Permanent Secretary of MOAC to JICA Bangkok Office.

(4) Submission of the Interim Report of the Detail Design Survey of the Farm

Messr. Y. Yukawa and H. Nozoe will sumbit the Interim Report of the Detail Design Survey of the Project to the concerned organizations before their departure on December 2nd, 1984.

(5) Donation of Equipments and Materials for Construction

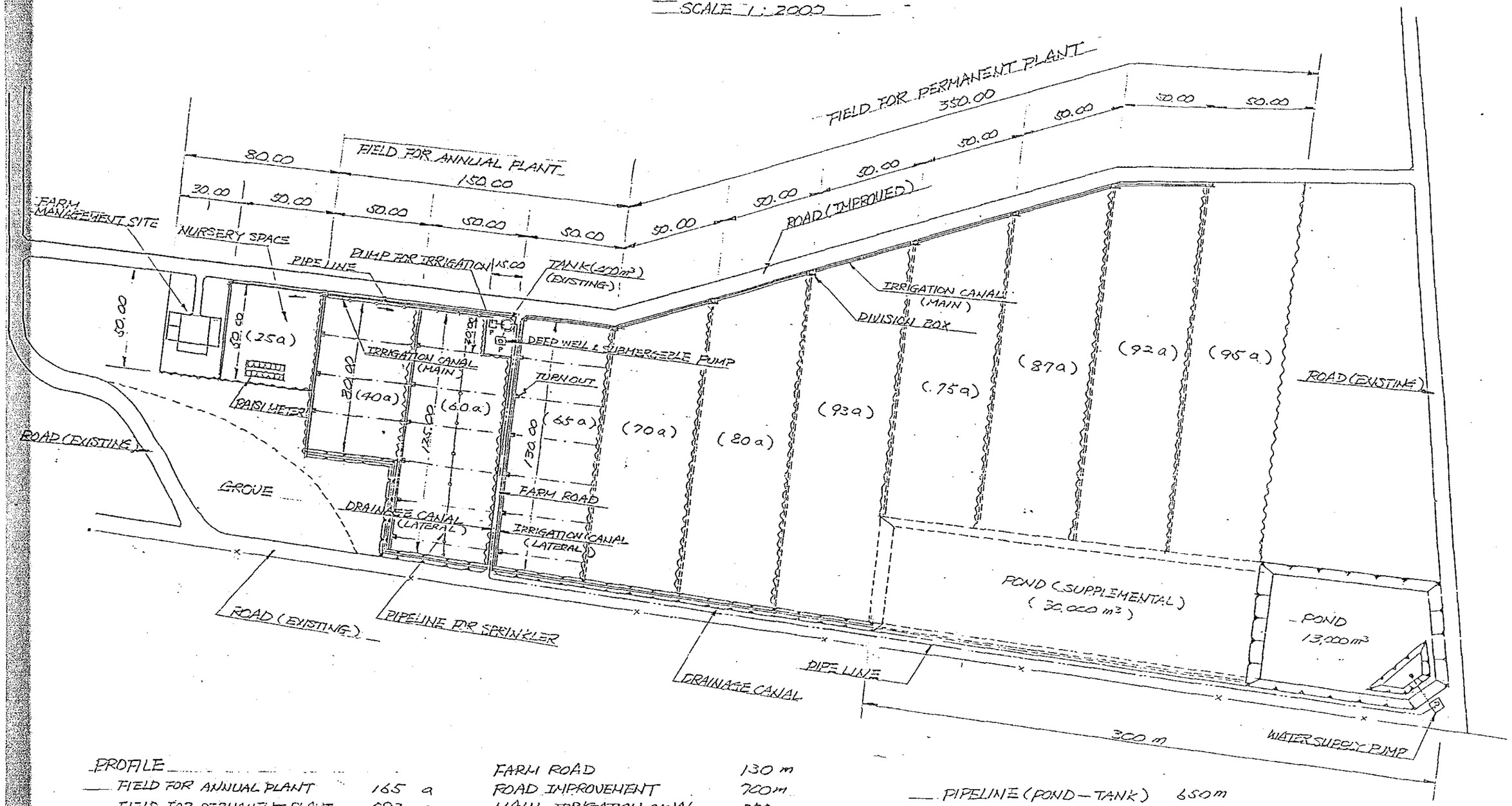
If necessity arises, equipments and materials for construction will be donated, and Form A4 will be forwarded to the Embassy of Japan as soon as possible.

(6) Dispatch of the Short Term Expert

If necessity arises, the construction superviser will be dispatched, and Form A1 will be forwarded to the Embassy of Japan as soon as possible.

LAYOUT FOR EXPERIMENTAL FARM

SCALE 1 : 2000



PROFILE			
FIELD FOR ANNUAL PLANT	165 a	FARM ROAD	130 m
FIELD FOR PERMANENT PLANT	592 a	ROAD IMPROVEMENT	700 m
FARM MANAGEMENT SITE	15 a	MAIN IRRIGATION CANAL	550 m
NURSERY SPACE	25 a	LATERAL IRRIGATION CANAL	385 m + (1,130 m)
		MAIN DRAINAGE CANAL	450 m
		LATELAL DRAINAGE CANAL	515 m + (1,200 m)

PIPELINE (POND – TANK)	650 m
PIPELINE (FOR IRRIGATION)	100 m
PIPELINE (FOR SPRINKLER)	125 m

Tables

Tables List

Continue

Table No.	T i t l e
21.	Hydraulic Calculation of Deep Well Pump
22.	Hydraulic Calculation of Reservoir Pump
23.	Hydraulic Calculation of Reservoir Pump (Suction)
24.	Hydraulic Calculation of Reservoir Pump (Discharge)
25.	Hydraulic Calculation of Sprinkler Pump (Suction)
26.	Hydraulic Calculation of Sprinkler Pump (Discharge)
27.	Distribution Plan of Earth Materials
28.	Bill of Quantities
29.	Project Cost
30	List of Equipment

TABLE [ ] RAINFALL YEAR [ ]

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	0.0	0.0	10.2	1.8	2.7	0.0	0.0	0.0	7.1
	2	0.0	0.0	0.0	18.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.4	0.0	15.8	0.0	26.8	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	4	0.0	0.0	1.4	0.0	9.1	1.1	0.0	5.5	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	29.7	0.0	1.0	34.2	0.0	0.0	0.0
TOTAL		0.4	0.0	17.2	18.0	35.9	47.3	1.8	9.2	34.2	0.0	0.0	7.4
AVERAGE		0.1	0.0	3.4	3.6	7.2	9.5	0.4	1.8	6.8	0.0	0.0	1.5
	6	0.0	0.0	0.0	2.2	14.4	0.0	0.0	11.9	29.6	0.0	0.0	0.0
	7	0.0	0.0	0.0	0.0	0.0	40.2	0.0	6.8	7.6	0.1	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0	1.1	0.0	2.7	0.0	0.0	0.1
	9	0.0	0.0	0.0	0.0	0.0	3.4	0.0	12.4	44.3	0.0	0.0	0.0
	10	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	49.4	0.0	0.0	0.0
TOTAL		0.0	0.8	0.0	2.2	14.4	43.6	1.1	31.1	133.6	0.1	0.0	0.1
AVERAGE		0.0	0.2	0.0	0.4	2.9	8.7	0.2	6.2	26.7	0.0	0.0	0.0
	11	0.0	0.0	0.0	31.2	0.0	123.8	0.0	0.0	29.5	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	2.2	24.3	0.0	5.3	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	7.4	5.8	5.4	0.3	0.0	0.0	0.0	0.2
	14	0.0	0.0	0.0	0.0	0.6	0.4	0.4	0.0	2.8	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.4	0.0	0.0	2.2	20.4	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	31.2	10.6	154.3	5.8	7.8	52.7	0.0	0.0	0.2
AVERAGE		0.0	0.0	0.0	6.2	2.1	30.9	1.2	1.6	10.5	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	1.9	0.0	0.1	29.6	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	31.1	48.8	3.1	11.0	3.5	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	1.5	0.0	15.0	2.2	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	93.7	0.0	0.0	13.7	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.1	60.4	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	33.1	204.4	3.2	55.6	19.4	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	6.6	40.9	0.6	11.1	3.9	0.0	0.0	0.0
	21	0.0	0.0	0.0	6.0	25.7	0.0	12.6	0.1	0.0	1.9	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	1.3	0.0	6.2	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	20.6	0.0	2.7	17.4	9.9	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0	14.1	1.8	0.0	1.9	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.8	2.9	0.8	16.7	0.2	37.7	0.0	0.0
TOTAL		0.0	0.0	0.0	26.6	26.5	6.9	44.9	34.7	0.2	41.5	0.0	0.0
AVERAGE		0.0	0.0	0.0	5.3	5.3	1.4	9.0	6.9	0.0	8.3	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	56.6	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	6.5	0.0	0.2	0.0	17.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	1.0	2.3	0.0	0.2	2.4	2.2	1.6	0.0
	29	0.0	--	0.0	30.7	0.0	0.0	4.6	7.9	0.0	0.0	0.0	0.0
	30	0.0	--	0.0	0.0	28.2	0.0	3.0	2.7	0.0	0.0	0.6	0.0
	31	0.0	--	7.1	--	7.7	--	0.7	1.3	--	0.0	--	0.0
TOTAL		0.0	0.0	7.1	30.7	43.4	2.3	8.5	16.3	76.0	2.2	2.2	0.0
AVERAGE		0.0	0.0	1.2	6.1	7.2	0.5	1.4	2.7	15.2	0.4	0.4	0.0
MONTHLY TO.		0.4	0.8	24.3	108.7	163.9	458.8	65.3	154.7	316.1	43.8	2.2	7.7
MONTHLY AV.		0.0	0.0	0.8	3.6	5.3	15.3	2.1	5.0	10.5	1.4	0.1	0.2

ANNUAL	1346.7	AVERAGE	3.7
MAX. DAYLY RAINFALL	123.8	6/11	
MAX. 2-DAY RAINFALL	154.1	6/19	
MAX. 3-DAY RAINFALL	155.6	6/18	

x---x---x TABLE 1-2 RAINFALL YEAR : 1971 UNIT : MM x---x---x

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	2.9	0.0	0.5	8.1	0.0	14.4	6.7	0.0	0.0
	2	0.0	0.0	0.0	0.0	4.4	0.0	3.3	1.8	18.1	2.2	0.0	0.0
	3	0.0	0.0	20.2	0.0	0.8	0.0	0.0	0.0	0.0	0.6	0.0	0.0
	4	0.0	0.0	0.0	0.0	87.7	0.0	3.1	12.8	3.9	0.0	0.0	0.0
	5	0.0	0.0	0.0	24.2	0.0	1.0	17.3	0.5	0.0	14.2	0.0	0.0
TOTAL		0.0	0.0	20.2	27.1	92.9	1.5	31.8	15.1	36.4	23.7	0.0	0.0
AVERAGE		0.0	0.0	4.0	5.4	18.6	0.3	6.4	3.0	7.3	4.7	0.0	0.0
	6	0.0	0.0	0.0	17.2	0.0	11.1	2.2	5.1	24.9	0.1	0.0	0.0
	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	1.3	0.7	3.6	0.0	16.2	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	7.8	5.3	0.0	0.0
	10	0.0	0.0	0.0	7.9	0.0	1.1	6.4	5.1	0.0	0.5	0.0	0.0
TOTAL		0.0	0.0	0.0	25.1	0.0	13.5	9.3	15.5	33.3	22.1	0.0	0.0
AVERAGE		0.0	0.0	0.0	5.0	0.0	2.7	1.9	3.1	6.7	4.4	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0	20.9	2.3	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	8.8	38.4	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	20.7	58.3	5.4	0.4	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	1.9	0.0	36.2	9.6	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	4.0	24.9	0.2	11.1	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	0.0	35.4	142.5	44.1	21.1	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	0.0	7.1	28.5	8.8	4.2	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	5.9	49.4	0.0	7.1	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	18.8	0.6	36.9	26.8	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	3.7	0.0	37.5	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	46.9	0.3	0.0	4.0	0.0	0.0	0.0	26.6
	20	0.0	0.0	0.0	0.0	28.4	0.0	0.0	18.2	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	75.3	28.7	50.0	96.6	33.9	0.0	0.0	26.6
AVERAGE		0.0	0.0	0.0	0.0	15.1	5.7	10.0	19.3	6.8	0.0	0.0	5.3
	21	0.0	0.0	0.0	0.0	1.5	7.7	0.0	9.3	0.0	0.0	0.0	0.0
	22	0.0	15.9	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	9.7	0.0	0.0	1.2	10.6	0.5	0.0	0.0	0.0	0.0	0.0
	24	0.0	2.1	0.0	0.0	5.0	0.0	4.4	0.2	3.8	0.0	7.7	0.0
	25	0.0	9.1	0.0	0.0	4.9	0.0	1.0	9.0	16.2	6.0	0.0	0.0
TOTAL		0.0	36.8	0.0	0.0	12.6	21.2	5.9	18.5	20.0	6.0	7.7	0.0
AVERAGE		0.0	7.4	0.0	0.0	2.5	4.2	1.2	3.7	4.0	1.2	1.5	0.0
	26	0.0	0.6	0.2	0.8	0.0	0.0	2.0	0.0	3.0	0.0	0.0	0.2
	27	0.0	0.0	0.0	0.0	0.0	10.3	2.0	1.4	0.0	0.4	0.0	0.0
	28	0.0	0.0	0.0	0.0	9.7	0.0	0.0	7.1	1.8	0.0	0.0	0.0
	29	0.0	--	0.0	0.0	0.0	0.0	0.0	1.2	31.9	0.0	0.0	0.0
	30	0.0	--	0.0	8.7	0.0	0.0	1.0	52.7	6.1	0.0	0.0	0.0
	31	0.0	--	0.0	--	1.2	--	0.0	4.5	--	0.0	--	0.0
TOTAL		0.0	0.6	0.2	9.5	10.9	10.3	5.0	66.9	42.8	0.4	0.0	0.2
AVERAGE		0.0	0.2	0.0	1.9	1.8	2.1	0.8	11.1	8.6	0.1	0.0	0.0
MONTHLY TO.		0.0	37.4	20.4	61.7	191.7	110.6	244.5	256.7	187.5	52.2	7.7	26.8
MONTHLY AV.		0.0	1.3	0.7	2.1	6.2	3.7	7.9	8.3	6.3	1.7	0.3	0.9

ANNUAL 1107.2 AVERAGE 3.3

x---x---x TABLE 1-3 RAINFALL YEAR : 1972 UNIT : MM x---x---x PAGE-- 2

NAME OF STATION : KHON KAEN

TABLE 3 RAINFALL YEAR : 1972 UNIT : MM PAGE 2

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.0	6.2	1.6	0.0	0.0
	2	0.0	0.0	0.0	29.0	0.0	35.3	7.0	0.0	0.2	114.7	0.0	0.0
	3	0.0	0.0	0.0	26.3	0.0	21.0	0.0	30.3	0.0	7.1	0.1	0.0
	4	0.0	0.0	0.0	24.6	0.0	0.0	3.1	7.8	13.6	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	8.9	5.1	19.8	2.9	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	79.9	0.0	65.2	19.0	57.9	22.9	123.4	0.1	0.0
AVERAGE		0.0	0.0	0.0	16.0	0.0	13.0	3.8	11.6	4.6	24.7	0.0	0.0
	6	0.0	0.8	0.0	0.0	0.0	0.3	0.1	11.2	8.9	0.0	0.0	0.0
	7	0.0	3.9	0.0	4.1	0.0	7.6	1.1	0.9	0.0	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	10.4	2.1	0.0	0.0	16.0	0.6	57.3	0.0
	9	0.0	0.0	0.0	0.0	0.0	10.7	0.0	4.6	0.0	0.0	0.8	0.0
	10	0.0	0.0	1.3	0.0	0.0	12.6	0.0	0.0	0.0	0.0	0.0	7.6
TOTAL		0.0	4.7	1.3	4.1	10.4	33.3	1.2	16.7	24.9	0.6	58.1	7.6
AVERAGE		0.0	0.9	0.3	0.8	2.1	6.7	0.2	3.3	5.0	0.1	11.6	1.5
	11	0.0	0.0	5.5	14.3	0.0	47.2	0.0	9.9	0.0	10.2	0.0	4.2
	12	0.0	0.0	0.0	9.2	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	1.2	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
TOTAL		0.0	0.0	5.5	26.9	0.0	47.6	1.1	10.5	0.0	10.4	0.0	4.2
AVERAGE		0.0	0.0	1.1	5.4	0.0	9.5	0.2	2.1	0.0	2.1	0.0	0.8
	16	0.0	0.0	0.0	0.0	1.6	11.4	0.0	0.0	5.1	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	1.2	16.6	0.1	5.1	8.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	3.9	9.9	5.2	0.2	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0
	20	0.0	0.0	3.0	0.0	0.0	0.0	2.7	2.3	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	3.0	0.0	2.8	31.9	12.7	12.6	13.3	0.0	2.2	0.0
AVERAGE		0.0	0.0	0.6	0.0	0.6	6.4	2.5	2.5	2.7	0.0	0.4	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	3.8	0.0	0.0	0.0
	22	0.0	0.0	0.0	27.7	0.0	13.8	0.0	3.1	2.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	9.9	0.0	0.9	31.3	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	9.8	0.0	0.1	8.6	1.9	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	6.3	0.0	5.4	0.0	15.2	0.8	0.0
TOTAL		0.0	0.0	0.0	27.7	0.0	39.8	2.1	9.5	45.7	17.1	0.8	0.0
AVERAGE		0.0	0.0	0.0	5.5	0.0	8.0	0.4	1.9	9.1	3.4	0.2	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	17.1	0.0	7.1	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.3	10.6	13.4	0.0	0.0	0.0
	29	0.0	0.0	0.0	0.0	0.4	64.5	23.8	25.4	2.8	0.0	0.0	0.0
	30	0.0	--	11.0	0.0	3.9	22.1	2.2	0.4	13.3	0.0	0.0	0.0
	31	0.0	--	0.0	--	0.0	--	0.0	0.0	--	0.0	--	0.0
TOTAL		0.0	0.0	11.0	0.0	4.3	104.5	26.3	43.5	29.5	0.0	0.0	0.0
AVERAGE		0.0	0.0	1.9	0.0	0.7	20.9	4.4	7.2	5.9	0.0	0.0	0.0
MONTHLY TO.		0.0	4.7	20.8	138.6	17.5	322.3	62.4	150.7	136.3	151.5	61.2	11.8
MONTHLY AV.		0.0	0.2	0.7	4.6	0.6	10.7	2.0	4.9	4.5	4.9	2.0	0.4

ANNUAL 1077.8 AVERAGE 2.9

MAX. DAYLY RAINFALL 114.7 10/ 2

MAX. 2-DAY RAINFALL 121.8 10/ 2

MAX. 3-DAY RAINFALL 129.6 9/30

#---#---# TABLE 1-4 RAINFALL YEAR : 1973 UNIT : MM #---#---# PAGE-- 4

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	0.0	8.5	12.1	0.2	24.5	0.5	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	8.0	33.4	0.0	4.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	50.5	7.5	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	17.6	0.0	10.0	0.0	0.5	0.0	0.0
	5	0.0	0.0	0.0	0.0	4.8	0.0	4.8	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	21.3	63.1	55.5	46.0	0.5	0.5	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	4.3	12.6	11.1	9.2	0.1	0.1	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.4	2.2	0.0	0.0	0.0	0.0	0.0	0.0
	7	0.0	0.0	0.0	0.0	0.0	0.0	27.7	0.0	20.2	2.3	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.8	0.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	1.5	10.0	0.0	0.0	0.0	0.0
	10	0.0	0.0	0.0	0.0	0.0	11.2	39.2	29.4	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	0.4	13.4	68.4	39.4	50.0	2.3	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	0.1	2.7	13.7	7.9	10.0	0.5	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.4	1.9	27.8	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
	15	0.0	0.0	0.0	4.4	0.2	0.0	0.0	0.0	0.5	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	4.4	0.6	1.9	32.8	0.0	0.7	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.9	0.1	0.4	6.6	0.0	0.1	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	18.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	18.5	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	1.8	2.4	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	18.8	2.4	0.8	8.5	51.5	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	3.8	0.5	0.2	1.7	10.3	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.2	0.0	0.0	2.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	14.4	0.0	0.8	0.0	10.5	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	8.4	2.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	4.5	0.0	2.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	4.4	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	18.8	0.0	13.9	2.0	22.0	2.0	0.0	0.0	0.0	0.0
AVERAGE		0.0	0.0	3.8	0.0	2.8	0.4	4.4	0.4	0.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	12.0	0.0	66.5	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	13.6	0.8	10.4	20.7	4.5	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	48.8	7.7	30.1	0.0	0.0	0.0
	29	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0
	30	0.0	--	0.0	0.0	0.0	0.7	0.8	0.0	2.5	0.0	0.0	0.0
	31	0.0	--	0.0	--	8.0	--	12.0	2.0	--	0.0	--	0.0
TOTAL		0.0	0.0	0.0	0.0	21.6	1.5	84.0	30.4	116.1	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	3.6	0.3	14.0	5.1	23.2	0.0	0.0	0.0
MONTHLY TO.		0.0	0.0	18.8	4.4	76.6	84.3	263.5	126.3	218.8	2.8	0.0	0.0
MONTHLY AV.		0.0	0.0	0.6	0.1	2.5	2.8	8.5	4.1	7.3	0.1	0.0	0.0

ANNUAL 732.5 AVERAGE 2.2

NAME OF STATION : KHON KAEN

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	1.4	0.0	0.0	19.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	36.9	0.0	11.8	0.0	10.4	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.2	0.0	0.5	0.2	2.3	0.0	15.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6	2.7	6.0	0.0
	5	0.0	0.0	6.4	0.0	0.0	33.9	0.0	0.0	10.3	11.9	0.0	0.0
TOTAL		0.0	1.4	6.4	0.0	56.8	33.9	12.3	0.2	51.6	14.6	21.0	0.0
AVERAGE		0.0	0.3	1.3	0.0	11.4	6.8	2.5	0.0	10.3	2.9	4.2	0.0
	6	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	73.7	0.0	0.0	0.0
	7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	6.9	0.9	4.5	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	24.4	0.0	0.0
	9	0.0	0.0	0.0	0.0	1.0	0.0	14.0	0.0	14.8	49.4	81.0	0.0
	10	0.0	0.0	4.6	23.3	0.0	0.0	3.2	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	4.6	24.1	1.2	0.0	17.3	6.9	89.4	48.3	81.0	0.0
AVERAGE		0.0	0.0	0.9	4.8	0.2	0.0	3.5	1.4	17.9	9.7	16.2	0.0
	11	0.0	0.0	0.0	1.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.9	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	2.1	0.0	7.1	0.0	6.7	0.0	0.0
	14	0.0	0.0	0.0	5.6	8.2	0.0	0.9	21.3	19.9	0.0	0.0	0.0
	15	0.0	0.0	0.0	29.2	7.6	0.0	0.0	81.0	0.2	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	36.0	16.2	2.1	0.9	132.3	20.1	6.7	0.0	0.0
AVERAGE		0.0	0.0	0.0	7.2	3.2	0.4	0.2	26.5	4.0	1.3	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	21.4	0.5	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0	17.6	0.0	0.8	0.4	0.0	0.0
	18	0.0	0.0	0.0	0.0	4.0	0.0	0.3	47.7	4.8	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	4.0	0.0	34.8	49.4	27.0	0.9	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	0.8	0.0	7.0	9.9	5.4	0.2	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	10.6	0.0	6.0	0.0	0.0	0.0
	22	0.0	0.0	11.7	0.0	0.0	0.0	7.2	0.0	2.0	0.0	0.0	0.0
	23	0.0	0.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.4	0.0	0.0	0.0	0.0	0.0	0.0	8.2	0.2	0.0	0.0	0.0
	25	0.5	0.0	0.0	0.7	0.0	46.6	9.4	9.1	3.6	0.0	0.0	0.0
TOTAL		0.9	0.0	17.7	0.7	0.0	46.6	27.2	17.3	11.8	0.0	0.0	0.0
AVERAGE		0.2	0.0	3.5	0.1	0.0	9.3	5.4	3.5	2.4	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.2	0.0	1.1	12.1	1.0	2.0	17.4	0.0	0.0
	27	0.0	0.0	0.0	2.8	26.9	0.0	28.8	34.8	8.6	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	14.8	0.0	0.0	0.0	0.0	0.0
	29	0.1	--	0.6	0.0	0.0	0.0	0.5	21.2	5.1	0.0	0.0	0.0
	30	0.0	--	6.7	0.0	1.6	0.0	2.8	37.4	2.7	0.0	0.0	0.0
	31	0.0	--	0.0	--	2.8	--	0.0	0.0	--	0.0	--	0.0
TOTAL		0.1	0.0	7.3	3.0	31.3	1.1	59.0	94.4	18.4	17.4	0.0	0.0
AVERAGE		0.0	0.0	1.2	0.6	5.2	0.2	9.8	15.7	3.7	2.9	0.0	0.0
MONTHLY TO.		1.0	1.4	36.0	63.8	109.5	83.7	151.5	300.5	218.3	87.9	102.0	0.0
MONTHLY AV.		0.0	0.0	1.2	2.1	3.5	2.8	4.9	9.7	7.3	2.8	3.4	0.0

ANNUAL 1155.6 AVERAGE 3.2
MAX. DAYLY RAINFALL 81.0 11/ 9
MAX. 2-DAY RAINFALL 102.3 8/14
MAX. 3-DAY RAINFALL 112.6 9/ 4

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	4.2	0.0	0.0	0.0	0.0	8.0	0.0	6.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	7.6	6.2	6.7	5.3	13.2	6.7	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	3.2	5.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	6.2	0.0	6.7	9.0	0.0	0.0	0.0
	5	0.4	0.0	0.0	0.0	7.8	0.0	0.0	2.6	0.0	0.0	0.0	0.0
TOTAL		0.4	0.0	4.2	0.0	15.4	12.4	6.7	30.3	25.4	17.7	0.0	0.0
AVERAGE		0.1	0.0	0.8	0.0	3.1	2.5	1.3	6.1	5.1	3.5	0.0	0.0
	6	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	28.0	1.7	0.0	0.0
	7	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	5.0	0.0	0.0
	9	0.0	1.3	0.0	0.0	0.0	0.0	0.8	0.0	30.5	0.0	0.0	0.0
	10	0.2	0.0	0.0	0.0	21.0	0.0	41.7	6.4	8.3	15.0	0.0	0.0
TOTAL		0.2	1.3	0.0	0.2	24.3	0.0	42.5	6.4	91.8	22.9	0.0	0.0
AVERAGE		0.0	0.3	0.0	0.0	4.9	0.0	8.5	1.3	18.4	4.6	0.0	0.0
	11	0.4	2.4	0.0	0.0	33.4	11.3	13.3	0.0	1.2	12.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	6.2	5.4	0.0	1.0	20.0	18.2	0.0	0.0
	13	0.0	0.0	0.0	0.0	1.5	0.0	20.5	0.0	22.1	0.3	0.0	0.0
	14	0.0	0.0	0.0	0.0	21.2	0.0	3.3	0.0	3.0	1.0	0.0	0.0
	15	0.0	0.0	0.8	0.0	82.6	47.7	15.5	4.3	20.0	0.0	0.0	0.0
TOTAL		0.4	2.4	0.8	0.0	144.9	64.4	52.6	5.3	66.3	31.5	0.0	0.0
AVERAGE		0.1	0.5	0.2	0.0	29.0	12.9	10.5	1.1	13.3	6.3	0.0	0.0
	16	0.0	0.0	0.0	0.0	3.9	20.0	0.2	0.0	0.2	0.0	0.0	0.0
	17	19.0	0.0	0.0	2.7	19.8	0.0	1.5	0.0	0.0	0.0	0.0	0.0
	18	7.0	0.0	0.0	0.0	11.9	0.0	0.0	0.0	0.8	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	17.3	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	4.0	0.2	30.0	0.0	46.7	0.0	0.0	0.0
TOTAL		26.0	0.0	0.0	2.7	39.6	37.5	31.7	0.0	47.7	0.0	0.0	0.0
AVERAGE		5.2	0.0	0.0	0.5	7.9	7.5	6.3	0.0	9.5	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	2.5	0.0	28.4	10.0	3.5	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	5.7	4.8	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	8.5	0.0	0.0	12.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	1.3	0.0	18.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	13.5	0.0	15.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	16.7	19.6	28.4	55.0	3.5	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	3.3	3.9	5.7	11.0	0.7	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	10.0	4.9	10.0	40.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	4.0	1.3	11.6	0.0	0.0	0.0	0.0
	28	0.0	20.1	0.0	1.1	20.2	0.0	0.0	3.3	18.3	0.0	0.0	0.0
	29	0.0	--	29.1	4.0	2.4	21.7	0.0	2.2	16.0	0.0	0.0	0.0
	30	0.0	--	0.0	0.0	72.3	28.3	20.8	0.4	16.0	0.0	0.0	0.0
	31	0.0	--	0.0	--	4.9	--	25.0	0.0	--	0.0	--	0.0
TOTAL		0.0	20.1	29.1	5.1	109.8	58.9	57.1	57.5	50.3	0.0	0.0	0.0
AVERAGE		0.0	6.7	4.9	1.0	18.3	11.8	9.5	9.6	10.1	0.0	0.0	0.0
MONTHLY TO.		27.0	23.8	34.1	8.0	350.7	192.8	219.0	154.5	285.0	72.1	0.0	0.0
MONTHLY AV.		0.9	0.8	1.1	0.3	11.3	6.4	7.1	5.0	9.5	2.3	0.0	0.0

ANNUAL 1367.0 AVERAGE 3.7

NAME OF STATION : KHON KAEN

	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
1	0.0	0.0	0.0	3.3	28.3	0.0	0.3	1.7	0.0	0.0	14.0	0.0
2	0.0	0.0	0.0	3.3	0.0	0.0	1.6	0.0	0.0	32.1	0.0	0.0
3	0.0	0.0	0.5	0.0	8.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	22.5	18.3	0.0	1.6	0.0	27.5	0.2	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	8.3	0.0	8.5	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	23.0	24.9	36.6	10.3	1.9	37.7	0.2	32.1	14.0	0.0
AVERAGE	0.0	0.0	4.6	5.0	7.3	2.1	0.4	7.5	0.0	6.4	2.8	0.0
6	0.0	0.0	0.0	0.0	21.7	0.0	0.0	0.0	6.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.4	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	6.6	0.0	0.0	0.3	12.3	0.0	0.0	0.0
9	0.0	3.2	0.0	0.0	6.6	0.0	0.0	0.0	0.0	1.5	0.0	0.0
10	0.0	0.0	0.0	0.0	5.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	3.2	0.0	0.0	39.9	0.0	2.0	0.3	38.7	1.5	0.0	0.0
AVERAGE	0.0	0.6	0.0	0.0	8.0	0.0	0.4	0.1	7.7	0.3	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	13.3	0.0	0.0	6.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0	0.7	5.0	0.0	1.5	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	6.7	0.0	8.3	0.0	2.0	0.0	0.0	0.0
14	0.0	0.0	33.0	0.0	5.0	0.0	0.0	2.1	0.0	5.6	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	33.0	0.0	11.7	14.0	13.3	2.1	9.5	5.6	0.0	0.0
AVERAGE	0.0	0.0	6.6	0.0	2.3	2.8	2.7	0.4	1.9	1.1	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	3.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0	0.0	13.3	9.4	0.0	2.5	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	6.7	20.3	0.0	37.4	12.1	0.0	0.0
TOTAL	0.0	0.0	0.0	0.0	0.0	6.7	51.2	9.8	40.4	14.6	0.0	0.0
AVERAGE	0.0	0.0	0.0	0.0	0.0	1.3	10.2	2.0	8.1	2.9	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	13.6	1.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	25.5	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.2	11.1	0.0	0.0	0.0
24	0.0	0.0	0.0	6.6	0.0	0.0	0.0	3.5	27.5	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	6.0	8.5	0.0	28.2	0.0	0.0	0.0
TOTAL	0.0	0.0	0.0	6.6	0.0	6.0	12.8	11.7	105.9	1.0	0.0	0.0
AVERAGE	0.0	0.0	0.0	1.3	0.0	1.2	2.6	2.3	21.2	0.2	0.0	0.0
26	0.0	0.3	0.0	0.0	0.0	1.7	3.7	6.4	26.4	35.9	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	27.5	0.0	0.0
28	0.0	0.0	0.0	10.0	0.0	0.8	0.0	37.4	0.0	29.2	0.0	0.0
29	0.0	0.0	5.0	0.0	0.0	0.0	63.8	1.7	0.0	20.0	0.0	0.0
30	0.0	--	0.0	0.0	0.0	0.0	4.3	2.0	0.0	0.0	0.0	0.0
31	0.0	--	0.0	--	0.0	--	24.3	5.1	--	0.0	--	0.0
TOTAL	0.0	0.3	5.0	10.0	0.0	1.7	96.1	52.8	26.7	112.6	0.0	0.0
AVERAGE	0.0	0.1	0.8	2.0	0.0	0.3	16.0	8.8	5.3	18.8	0.0	0.0
MONTHLY TO.	0.0	3.5	61.0	41.5	88.2	38.7	177.3	114.4	221.4	167.4	14.0	0.0
MONTHLY AV.	0.0	0.1	2.0	1.4	2.8	1.3	5.7	3.7	7.4	5.4	0.5	0.0

ANNUAL	927.4	AVERAGE	2.5
MAX. DAYLY RAINFALL	63.8	7/29	
MAX. 2-DAY RAINFALL	68.1	7/29	
MAX. 3-DAY RAINFALL	92.6	10/26	

TABLE I-8 RAINFALL YEAR : 1977 UNIT : MM

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	1.0	8.3	0.0	1.7	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	11.7	0.0	0.0	0.0
	3	0.0	0.0	0.0	21.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	16.0	0.0	2.5	0.0	26.7	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	19.3	0.0	1.7	0.0	80.8	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	22.7	43.6	0.0	5.9	0.5	119.2	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	4.5	8.7	0.0	1.2	0.1	23.8	0.0	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	6.5	0.0	0.0	0.0
	7	0.0	0.0	0.0	1.0	21.6	0.0	4.2	3.4	1.5	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0
	10	0.0	0.0	0.0	1.0	0.0	0.0	0.0	14.2	2.5	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	2.0	31.6	0.0	5.6	17.6	19.2	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.4	6.3	0.0	1.1	3.5	3.8	0.0	0.0	0.0
	11	0.0	0.0	0.0	6.7	0.0	4.4	0.0	5.9	2.2	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.6	0.0	0.0	13.7	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.6	6.7	0.0	0.0	0.0	11.7	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.2	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	0.8	21.7	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	7.9	6.7	5.2	35.4	5.9	23.1	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	1.6	1.3	1.0	7.1	1.2	4.6	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	51.7	1.7	0.0	16.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0	7.0	5.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	14.2	0.0	20.0	0.8	25.3	46.7	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	23.3	5.0	86.7	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	14.2	0.0	71.7	32.8	40.3	149.4	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	2.8	0.0	14.3	6.6	8.1	29.9	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.5	0.0	45.3	15.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	70.0	0.0	18.9	1.7	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	1.7	31.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	10.3	0.0	5.0	0.0	0.0	0.0	0.3
	25	0.0	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	20.0
TOTAL		0.0	0.0	0.0	1.7	101.0	19.1	18.9	52.0	15.0	0.0	0.0	20.3
AVERAGE		0.0	0.0	0.0	0.3	20.2	3.8	3.8	10.4	3.0	0.0	0.0	4.1
	26	0.0	0.0	0.0	1.7	8.3	0.0	1.7	0.0	0.0	1.0	0.1	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	11.7	4.5	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	1.0	0.0	0.0	0.0
	29	0.0	--	0.0	0.0	0.0	43.3	0.0	21.7	0.0	0.0	0.0	0.0
	30	0.0	--	38.3	0.0	0.0	1.6	0.0	5.0	0.0	0.0	0.0	0.0
	31	0.0	--	0.0	--	0.0	--	0.0	5.0	--	0.0	--	0.0
TOTAL		0.0	0.0	38.3	1.7	8.3	44.9	1.7	34.1	12.7	5.5	0.1	0.0
AVERAGE		0.0	0.0	6.4	0.3	1.4	9.0	0.3	5.7	2.5	0.9	0.0	0.0
MONTHLY TO.		0.0	0.0	38.3	50.2	191.2	140.9	100.3	150.4	338.6	5.5	0.1	20.3
MONTHLY AV.		0.0	0.0	1.2	1.7	6.2	4.7	3.2	4.9	11.3	0.2	0.0	0.7

ANNUAL 1035.8 AVERAGE 2.8

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	0.0	19.5	0.0	69.7	7.5	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	17.2	0.0	58.8	9.7	13.4	0.0	0.0	0.0
	3	0.0	0.0	0.0	1.0	0.0	0.0	29.5	0.0	0.7	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	15.5	0.0	12.0	0.0	0.0	3.3	0.2	0.0
	5	0.0	0.0	0.0	0.0	18.8	4.2	0.5	0.6	8.3	15.0	2.0	0.0
TOTAL		0.0	0.0	0.0	1.0	71.0	4.2	170.5	17.8	22.4	18.3	2.2	0.0
AVERAGE		0.0	0.0	0.0	0.2	14.2	0.8	34.1	3.6	4.5	3.7	0.4	0.0
	6	0.0	0.0	0.0	0.0	21.7	12.0	3.1	0.0	18.0	0.0	0.0	0.0
	7	0.0	0.0	0.0	0.0	8.7	0.0	1.9	0.1	0.0	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	5.3	38.0	0.2	5.0	0.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	3.1	1.6	5.5	0.0	0.0	0.0
	10	0.0	0.0	0.0	0.0	0.3	0.0	3.3	0.0	43.4	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	30.7	17.3	49.4	1.9	71.9	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	6.1	3.5	9.9	0.4	14.4	0.0	0.0	0.0
	11	0.1	0.0	0.0	0.0	0.0	1.7	0.1	13.5	4.7	0.0	0.0	0.0
	12	0.0	0.0	0.0	8.3	8.3	2.8	1.3	113.3	8.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	25.0	0.0	0.0	0.0
	14	0.0	0.0	1.6	2.2	33.0	0.0	13.0	9.1	0.1	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	11.0	8.0	0.1	1.1	6.5	0.0	0.0	0.0
TOTAL		0.1	0.0	1.6	10.5	52.3	12.5	14.5	139.6	44.3	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.3	2.1	10.5	2.5	2.9	27.9	8.9	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.2	1.7	0.0	3.6	11.1	0.0	0.0	0.0
	17	0.0	0.0	0.0	2.0	6.7	17.2	0.0	1.6	41.6	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	30.3	1.6	12.6	52.3	0.0	0.0	0.0
	19	0.0	0.0	6.3	0.0	0.0	23.8	0.0	0.0	1.3	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	1.3	3.3	0.0	15.0	0.0	0.0	0.0
TOTAL		0.0	0.0	6.3	2.0	6.9	74.3	4.9	17.8	121.3	0.0	0.0	0.0
AVERAGE		0.0	0.0	1.3	0.4	1.4	14.9	1.0	3.6	24.3	0.0	0.0	0.0
	21	0.0	0.1	0.0	0.0	0.0	31.4	12.6	3.1	25.0	0.0	0.0	0.0
	22	0.0	0.0	10.0	45.3	0.0	30.5	0.0	0.0	1.6	0.0	0.0	0.0
	23	0.0	0.0	0.0	48.7	0.0	1.7	0.0	0.0	38.5	13.4	0.0	0.0
	24	0.0	0.0	0.0	0.0	7.0	2.2	9.5	0.6	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.2	1.1	0.0	3.6	0.0	13.5	0.0	0.0
TOTAL		0.0	0.1	10.0	92.0	7.2	66.9	22.1	7.3	65.1	26.9	0.0	0.0
AVERAGE		0.0	0.0	2.0	18.4	1.4	13.4	4.4	1.5	13.0	5.4	0.0	0.0
	26	0.0	6.6	0.0	1.6	2.0	1.1	3.9	0.0	15.9	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.1	0.2	0.0	0.0	36.6	4.8	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.1	0.0	1.1	0.0	37.5	0.0	0.0	0.0
	29	0.0	--	0.0	0.0	0.0	0.0	2.0	0.0	0.1	0.0	0.0	0.0
	30	0.2	--	0.0	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	31	0.0	--	0.0	--	3.5	--	4.1	0.1	--	0.0	--	0.0
TOTAL		0.2	6.6	0.0	1.6	5.8	1.3	11.1	0.3	90.1	4.8	0.0	0.0
AVERAGE		0.0	2.2	0.0	0.3	1.0	0.3	1.8	0.1	18.0	0.8	0.0	0.0
MONTHLY TO.		0.3	6.7	17.9	107.1	173.9	176.5	272.5	184.7	415.1	50.0	2.2	0.0
MONTHLY AV.		0.0	0.2	0.6	3.6	5.6	5.9	8.8	6.0	13.8	1.6	0.1	0.0

ANNUAL 1406.9 AVERAGE 3.9

MAX. DAYLY RAINFALL 113.3 8/12

MAX. 2-DAY RAINFALL 128.5 7/ 1

MAX. 3-DAY RAINFALL 158.0 7/ 1

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	0.0	0.0	1.5	0.1	2.9	11.8	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.6	0.1	6.7	0.0	19.8	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	6.1	4.0	0.0	0.1	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	1.0	0.0	13.4	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	0.6	27.4	10.8	16.3	31.7	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	0.1	5.5	2.2	3.3	6.3	0.0	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	17.1	0.0	23.3	1.6	0.0	0.0	0.0
	7	0.1	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0	3.1	45.8	0.0	0.0	0.0	0.0
	9	0.0	0.0	0.0	49.7	0.0	3.8	4.5	65.0	0.0	0.0	0.0	0.0
	10	0.0	2.9	0.0	10.0	0.0	0.0	3.1	15.0	0.0	0.0	0.0	0.0
TOTAL		0.1	2.9	0.0	59.7	0.0	28.0	10.7	149.1	1.6	0.0	0.0	0.0
AVERAGE		0.0	0.6	0.0	11.9	0.0	5.6	2.1	29.8	0.3	0.0	0.0	0.0
	11	0.0	0.0	0.0	0.0	5.9	72.3	0.0	0.0	11.8	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	39.5	0.2	0.0	6.1	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	16.6	0.0	0.0	4.1	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.1	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.1	0.0	5.8	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	6.0	130.0	6.0	0.1	22.0	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	1.2	26.0	1.2	0.0	4.4	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	11.6	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	21.6	9.0	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.8	25.0	0.0	0.0	0.0	5.1	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	15.9	0.0	0.0	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.1	14.1	12.5	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.9	60.7	37.4	11.6	0.0	5.1	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.2	12.1	7.5	2.3	0.0	1.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	25.5	5.9	0.0	0.0	11.7	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	13.3	1.0	0.1	0.0	34.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	27.0	59.0	0.0	0.0	3.1	17.8	0.0	0.0	0.0
	24	0.0	0.0	0.0	2.0	0.0	1.0	0.0	1.0	48.5	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	12.7	0.0	0.0	15.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	29.0	97.8	20.6	0.1	4.1	127.0	0.0	0.0	0.0
AVERAGE		0.0	0.0	0.0	5.8	19.6	4.1	0.0	0.8	25.4	0.0	0.0	0.0
	26	0.0	0.0	0.0	1.7	0.0	0.0	26.3	0.0	0.1	0.0	0.0	0.0
	27	0.0	9.1	0.0	0.1	0.0	0.0	1.6	0.0	6.6	0.0	0.0	0.0
	28	0.0	0.0	0.0	3.6	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
	29	0.0	--	0.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0	--	0.0	0.2	4.1	4.1	1.1	0.0	0.0	0.0	0.0	0.0
	31	0.0	--	0.0	--	45.0	--	0.1	0.0	--	0.0	--	0.0
TOTAL		0.0	9.1	0.0	8.2	49.1	5.1	29.1	0.0	6.7	0.0	0.0	0.0
AVERAGE		0.0	3.0	0.0	1.6	8.8	1.0	4.9	0.0	1.3	0.0	0.0	0.0
MONTHLY TO.		0.1	12.0	0.0	97.8	214.2	248.5	68.3	169.6	194.1	0.0	0.0	0.0
MONTHLY AV.		0.0	0.4	0.0	3.3	6.9	8.3	2.2	5.5	6.5	0.0	0.0	0.0

ANNUAL 1004.4 AVERAGE 2.8

TABLE I-11 RAINFALL YEAR : 1980 UNIT :

NAME OF STATION : KHON KAEN

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	12.8	0.0	11.7	0.0	0.0	0.0	1.5	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	56.5	0.0	0.0	0.9	1.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	24.5	0.0	0.1	7.1	19.2	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	9.0	5.8	16.7	3.0	0.9	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	3.3	3.1	23.3	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	12.8	33.5	74.0	20.1	13.2	44.3	2.5	0.0	0.0
AVERAGE		0.0	0.0	0.0	2.6	6.7	14.8	4.0	2.6	8.9	0.5	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.8	52.5	24.0	0.0	0.0
	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0
	8	0.0	0.0	0.0	1.7	13.5	0.0	0.0	0.0	13.3	3.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	12.0	0.0	45.8	10.0	0.0	0.0	0.0
	10	0.0	0.0	0.0	0.0	0.0	10.0	0.0	3.1	12.6	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	1.7	13.5	22.0	0.9	49.7	88.4	28.5	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.3	2.7	4.4	0.2	9.9	17.7	5.7	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	6.5	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.1	0.0	5.3	5.7	0.0	0.0	28.8	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	4.0	3.3	3.0	7.1	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.2	0.0	0.0	0.0
	15	0.0	0.0	18.3	0.0	0.0	1.3	0.0	3.8	1.6	0.0	0.0	0.0
TOTAL		0.0	0.0	18.4	0.0	5.3	17.5	3.3	10.6	37.7	0.0	0.0	0.0
AVERAGE		0.0	0.0	3.7	0.0	1.1	3.5	0.7	2.1	7.5	0.0	0.0	0.0
	16	0.0	0.0	0.0	5.1	0.0	1.0	0.0	0.0	26.7	0.0	0.0	0.0
	17	0.0	0.0	0.1	0.0	0.0	81.7	0.0	0.0	4.5	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	3.1	8.3	1.1	0.0	51.2	3.1	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	2.9	0.0	18.8	15.3	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	28.3	7.7	5.1	0.1	0.1	0.0	0.0	0.0
TOTAL		0.0	0.0	0.1	5.1	31.4	101.6	6.2	18.9	97.8	3.1	0.0	0.0
AVERAGE		0.0	0.0	0.0	1.0	6.3	20.3	1.2	3.8	19.6	0.6	0.0	0.0
	21	0.0	0.0	0.0	4.0	39.5	6.3	52.3	0.0	1.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	17.2	0.0	0.0	0.0	1.0	25.0	0.0	0.0
	23	0.0	7.7	0.0	0.0	31.0	70.3	0.0	1.0	10.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	4.5	3.5	0.0	1.0	6.7	0.0	0.0
	25	0.0	0.0	0.0	9.2	2.1	7.1	4.8	9.5	12.5	3.7	0.0	0.0
TOTAL		0.0	7.7	0.0	13.2	89.8	88.2	60.6	10.5	25.5	35.4	0.0	0.0
AVERAGE		0.0	1.5	0.0	2.6	18.0	17.6	12.1	2.1	5.1	7.1	0.0	0.0
	26	0.0	0.0	0.0	0.0	24.7	4.5	0.0	0.0	3.3	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	3.8	0.0	10.0	1.1	0.7	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	6.6	0.0	0.2	3.1	0.0	0.0
	29	0.0	0.0	0.0	0.0	0.0	0.0	2.0	27.2	4.0	1.0	0.0	0.0
	30	0.0	--	0.0	0.0	0.0	0.0	0.0	1.0	0.1	0.0	0.0	0.0
	31	0.0	--	0.0	--	0.0	--	0.0	9.7	--	0.0	--	0.0
TOTAL		0.0	0.0	0.0	0.0	28.5	4.5	18.6	39.0	8.3	4.1	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	4.7	0.9	3.1	6.5	1.7	0.7	0.0	0.0
MONTHLY TO.		0.0	7.7	18.5	32.8	202.0	307.8	109.7	141.9	302.0	73.6	0.0	0.0
MONTHLY AV.		0.0	0.3	0.6	1.1	6.5	10.3	3.5	4.6	10.1	2.4	0.0	0.0

ANNUAL	1196.0	AVERAGE	3.3
MAX. DAYLY RAINFALL	81.7	6/17	
MAX. 2-DAY RAINFALL	90.0	6/17	
MAX. 3-DAY RAINFALL	92.9	6/17	

#---#---# TABLE 1-12 RAINFALL YEAR : 1981 UNIT : MM #---#---# PAGE-- 12

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	9.1	2.1	0.0	0.0
	2	0.0	0.0	0.0	0.1	0.0	0.2	14.2	10.5	1.7	15.0	18.5	0.0
	3	0.0	0.0	0.0	0.0	33.5	24.3	2.0	0.0	0.0	2.1	0.1	0.0
	4	0.0	0.0	0.0	3.3	0.0	0.0	6.1	2.0	0.0	10.8	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0	17.7	0.1	0.0	0.2	0.0	0.0
TOTAL		0.0	0.0	0.0	3.4	33.5	26.1	40.0	12.6	10.8	30.2	18.6	0.0
AVERAGE		0.0	0.0	0.0	0.7	6.7	5.2	8.0	2.5	2.2	6.0	3.7	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.2	3.3	3.5	3.8	0.0	0.0	0.0
	7	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	2.0	0.6	0.0	0.0	0.0	3.1	0.0	0.0
	9	0.0	0.0	0.0	4.7	0.0	0.1	2.0	31.0	0.0	0.0	0.0	0.0
	10	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	48.2	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	4.7	2.0	1.0	5.4	34.8	52.0	3.1	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.9	0.4	0.2	1.1	7.0	10.4	0.6	0.0	0.0
	11	0.0	0.0	0.0	1.1	0.0	5.0	1.0	0.2	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.1	0.0	7.1	2.8	0.0	0.0	2.5	0.0	0.0
	13	0.0	0.0	0.0	0.0	1.7	5.0	0.0	4.0	0.5	0.0	2.1	0.0
	14	0.0	0.0	0.0	0.0	60.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	0.0	10.1	2.8	0.1	0.0	88.0	0.0	0.0
TOTAL		0.0	0.0	0.0	1.2	61.9	28.3	6.6	4.3	0.5	90.5	2.1	0.0
AVERAGE		0.0	0.0	0.0	0.2	12.4	5.7	1.3	0.9	0.1	18.1	0.4	0.0
	16	0.0	0.0	0.0	0.0	69.0	18.8	0.0	0.0	0.5	14.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	5.3	0.3	0.0	0.5	0.2	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	13.3	38.4	5.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	4.1	11.7	28.3	1.5	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	4.8	19.5	11.7	44.3	0.0	1.1	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	4.8	92.6	60.8	111.3	6.5	2.1	14.2	0.0	0.0
AVERAGE		0.0	0.0	0.0	1.0	18.5	12.2	22.3	1.3	0.4	2.8	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.5	11.9	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	12.7	10.1	0.0	0.0	2.8	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.5	0.9	0.0	12.4	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	2.0	10.0	2.3	0.0	9.1	0.0	0.0	0.0	0.0
	25	0.0	14.2	0.0	0.0	0.0	0.1	0.0	3.0	0.0	0.0	0.0	0.0
TOTAL		0.0	14.2	0.0	2.0	23.7	25.3	0.0	24.5	2.8	0.0	0.0	0.0
AVERAGE		0.0	2.8	0.0	0.4	4.7	5.1	0.0	4.9	0.6	0.0	0.0	0.0
	26	0.0	0.0	0.0	11.0	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	0.0	0.0	2.7	13.7	1.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	0.0	0.0	0.0
	29	0.0	--	1.9	11.0	19.5	0.0	0.0	15.2	0.0	0.0	0.0	0.0
	30	0.0	--	0.0	0.0	71.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	0.0	--	11.8	--	3.1	--	5.0	12.7	--	0.0	--	0.0
TOTAL		0.0	0.0	13.7	22.0	22.9	2.7	9.8	41.6	1.0	0.0	0.0	0.0
AVERAGE		0.0	0.0	2.3	4.4	15.5	0.5	1.6	6.9	0.2	0.0	0.0	0.0
MONTHLY TO.		0.0	14.2	13.7	38.1	306.6	144.2	173.1	124.3	69.2	138.0	20.7	0.0
MONTHLY AV.		0.0	0.5	0.4	1.3	9.9	4.8	5.6	4.0	2.3	4.5	0.7	0.0

ANNUAL 1962-1 AVERAGE 2.9

NAME OF STATION : KHON KAEN

NAME OF STATION — KUDN KAENG

	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.8
2	0.0	0.0	43.2	0.0	0.0	0.0	0.0	0.0	54.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	27.8	0.0	0.0	9.1	9.9	27.1	0.0	0.0
4	0.0	0.0	0.0	0.6	0.0	0.0	3.1	0.0	0.6	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	0.0	0.0	43.2	0.6	27.8	6.7	3.1	9.1	64.5	27.1	0.0	10.8
AVERAGE	0.0	0.0	8.6	0.1	5.6	1.3	0.6	1.8	12.9	5.4	0.0	2.2
6	0.0	5.8	0.0	0.0	0.0	8.3	5.8	0.0	64.1	0.0	0.0	0.0
7	0.0	7.7	0.0	0.0	26.0	6.2	0.0	2.3	130.7	0.0	0.0	0.0
8	0.0	4.1	0.0	71.5	0.0	14.4	46.8	2.5	20.8	1.0	0.0	0.0
9	0.0	0.0	0.0	0.0	1.5	18.0	0.3	0.0	5.0	6.0	0.0	0.0
10	0.0	36.2	0.0	0.0	0.0	0.0	0.7	0.0	1.4	16.6	0.0	0.0
TOTAL	0.0	53.8	0.0	71.5	27.5	46.9	53.6	4.8	222.0	23.6	0.0	0.0
AVERAGE	0.0	10.8	0.0	14.3	5.5	9.4	10.7	1.0	44.4	4.7	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	0.0	0.1	14.1	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	3.6	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.8	0.0
15	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	7.8	0.0	0.1	0.0
TOTAL	0.0	0.0	0.0	5.7	10.0	0.0	0.1	14.1	9.2	0.0	0.9	0.0
AVERAGE	0.0	0.0	0.0	1.1	2.0	0.0	0.0	2.8	1.8	0.0	0.2	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	11.0	0.0	6.6	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0
18	0.0	0.2	0.0	11.0	0.0	1.4	34.9	0.4	16.1	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	27.8	0.0	0.0	23.4	0.0	23.1	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0	0.0	36.7	6.2	0.0	0.8	0.0	0.0
TOTAL	0.0	0.2	0.0	11.0	27.8	1.4	71.6	30.9	41.4	23.9	6.6	0.0
AVERAGE	0.0	0.0	0.0	2.2	5.6	0.3	14.3	6.2	8.3	4.8	1.3	0.0
21	0.0	0.0	0.0	11.3	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.1	36.2	0.0	0.0	0.0
23	0.0	0.0	0.0	1.7	0.0	0.7	0.0	8.5	0.8	0.6	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.1	0.8	0.7	34.1	0.0	0.0	0.0
25	0.0	0.0	24.8	0.0	0.0	0.9	0.0	0.0	10.2	33.4	0.0	0.0
TOTAL	0.0	0.0	24.8	13.0	0.0	2.4	0.8	9.4	81.3	34.0	0.0	0.0
AVERAGE	0.0	0.0	5.0	2.6	0.0	0.5	0.2	1.9	16.3	6.8	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	16.0	0.2	0.0	0.0
27	0.0	0.0	39.2	0.0	0.4	0.0	18.0	0.1	9.8	0.5	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0	8.0	1.5	0.5	0.0	0.0	0.0	0.0
29	0.0	--	0.0	0.0	0.0	0.0	0.0	0.0	10.5	0.0	0.0	0.0
30	0.0	--	0.0	0.0	0.0	0.0	5.2	0.0	67.6	0.0	0.0	0.0
31	0.0	--	0.0	--	0.0	--	0.7	3.2	--	0.0	--	0.0
TOTAL	0.0	0.0	39.2	0.0	0.4	0.0	25.4	4.3	103.9	0.7	0.0	0.0
AVERAGE	0.0	0.0	6.5	0.0	0.1	0.0	4.2	0.7	20.8	0.1	0.0	0.0
MONTHLY TO.	0.0	54.0	107.2	101.8	93.5	57.4	154.6	72.6	522.3	109.3	7.5	10.8
MONTHLY AV.	0.0	1.9	3.5	3.4	3.0	1.9	5.0	2.3	17.4	3.5	0.3	0.3

ANNUAL 1291.0 AVERAGE 3.5

MAX. DAYLY RAINFALL 130.7 9/ 7

MAX. 2-DAY RAINFALL 194.8 9/ 6

MAX. 3-DAY RAINFALL 215.6 9/ 6

TABLE 1-14 RAINFALL YEAR : 1983 UNIT : MM PAGE-- 14

NAME OF STATION : KHON KAEN

		JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	OCT.	DEC.
	1	0.0	0.0	0.0	0.0	3.8	3.9	0.3	5.8	1.9	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	7.3	0.0	0.9	3.6	0.5	31.1	0.0	0.0
	3	4.3	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0.0	1.7	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	13.0	0.0	92.8	8.5	7.5	0.0	0.0
TOTAL		4.3	0.0	0.0	0.0	11.1	16.9	1.2	106.4	14.2	40.3	0.0	0.0
AVERAGE		0.9	0.0	0.0	0.0	2.2	3.4	0.2	21.3	2.8	8.1	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.8	26.3	0.0	0.0	0.0
	7	0.0	0.0	0.0	5.3	2.0	15.7	0.1	77.6	6.1	1.1	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	54.3	8.9	1.8	0.0	0.9	4.2	0.0
	9	0.0	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.3	1.0	1.3	0.0
	10	0.0	0.0	0.0	0.0	0.0	4.2	0.1	0.0	0.0	8.8	8.2	0.0
TOTAL		0.0	0.0	0.0	5.3	2.0	78.0	9.1	84.2	32.7	11.8	13.7	0.0
AVERAGE		0.0	0.0	0.0	1.1	0.4	15.6	1.8	16.8	6.5	2.4	2.7	0.0
	11	0.0	0.0	0.0	0.0	0.0	36.5	0.0	40.0	32.2	22.4	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.6	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.2	2.3	0.0	0.0	0.0
	15	0.0	0.0	0.0	0.0	18.9	0.0	21.6	0.0	0.0	24.7	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	19.2	36.5	21.6	40.4	35.2	49.7	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	3.8	7.3	4.3	8.1	7.0	9.9	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.6	0.0	24.9	0.0	0.0	3.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	13.6	0.0	5.7	14.1	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	2.1	3.8	10.3	0.0	1.3	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.2	0.0	0.0	0.0	0.0
	20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.5	0.0	0.0	0.0	0.0
TOTAL		0.0	0.0	0.0	0.0	14.2	2.1	34.4	96.1	0.0	4.3	0.0	0.0
AVERAGE		0.0	0.0	0.0	0.0	2.8	0.4	6.9	19.2	0.0	0.9	0.0	0.0
	21	5.6	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.0	0.0	0.0	0.0
	22	0.0	8.2	0.0	0.0	0.0	1.8	8.1	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	29.7	3.3	13.2	65.1	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	13.6	0.0	2.1	0.0	3.4	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	28.6	2.5	2.2	0.0	0.0	0.0
TOTAL		5.6	8.2	0.0	29.7	16.9	15.0	103.9	6.4	5.6	0.0	0.0	0.0
AVERAGE		1.1	1.6	0.0	5.9	3.4	3.0	20.8	1.3	1.1	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	18.0	144.7	0.0	0.0	0.0	0.0	0.0	0.0
	27	0.0	0.0	0.0	0.0	55.6	34.9	0.0	1.0	12.2	2.3	0.0	0.0
	28	0.0	0.0	0.0	5.3	6.2	23.5	0.0	5.6	0.3	0.0	0.0	0.0
	29	0.0	--	0.0	0.0	9.2	5.0	0.0	0.0	12.9	0.0	0.0	0.4
	30	0.0	--	0.0	11.2	0.2	0.0	0.0	7.9	0.0	2.1	0.0	0.0
	31	0.0	--	0.0	--	0.0	--	0.5	33.2	--	1.3	--	0.8
TOTAL		0.0	0.0	0.0	16.5	89.8	208.1	0.5	47.7	25.4	5.7	0.0	1.2
AVERAGE		0.0	0.0	0.0	3.3	15.0	41.6	0.1	7.9	5.1	1.0	0.0	0.2
MONTHLY TO.		9.9	8.2	0.0	51.5	153.2	356.6	170.7	381.2	113.1	111.8	13.7	1.2
MONTHLY AV.		0.3	0.3	0.0	1.7	4.9	11.9	5.5	12.3	3.8	3.6	0.5	0.0

ANNUAL 1373.1 AVERAGE 3.8

MAX. DAYLY RAINFALL 144.7 6/26

Table 2 Monthly Mean Rainfall

(mm/day)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
0	0.4	0.8	24.3	108.7	163.9	458.8	65.3	154.7	316.1	43.8	2.2	7.7	1,346.7
1	0.0	37.4	20.4	61.7	191.7	110.6	244.5	256.7	187.5	52.2	7.7	26.8	1,197.2
2	0.0	4.7	20.8	138.6	17.5	322.3	62.4	150.7	136.3	151.5	61.2	11.8	1,077.8
3	0.0	0.0	18.8	4.4	76.6	84.3	263.5	126.3	218.8	28.0	T	0.0	795.5
4	1.0	1.4	36.0	63.8	109.5	83.7	151.5	300.5	218.3	87.9	102.0	T	1,155.6
5	27.0	23.8	34.1	8.0	350.7	192.8	219.0	154.5	285.0	72.1	0.0	0.0	1,367.0
6	0.0	3.5	61.0	41.5	88.2	38.8	177.4	114.4	221.4	167.4	14.0	0.0	921.6
7	T	0.0	38.3	50.2	191.2	140.9	100.3	150.4	338.6	5.5	0.1	20.3	1,035.8
8	0.3	6.7	17.9	107.1	173.9	176.5	272.5	184.7	415.1	50.0	2.2	0.0	1,401.9
9	0.1	12.0	0.0	97.8	214.2	248.5	68.3	169.6	194.1	0.0	0.0	0.0	1,004.6
0	0.0	7.7	18.5	32.8	202.0	307.8	109.7	141.9	302.0	73.6	T	T	1,196.0
1	0.0	14.2	13.7	38.1	306.6	144.2	173.1	124.3	69.2	138.0	20.7	T	1,042.1
2	0.0	54.0	107.2	101.8	93.5	57.4	154.6	72.6	522.3	109.3	7.5	10.8	1,291.1
3	9.9	8.2	T	51.5	153.2	356.6	170.7	381.2	113.1	111.8	13.7	1.2	1,371.1
n	2.8	12.5	29.4	64.4	166.6	194.5	159.5	176.9	252.7	76.1	16.5	5.6	1,157.5

Table 3 Monthly Mean Temperature

(°c/day)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Ramark
1972	21.5	26.0	26.9	28.4	31.5	29.1	28.6	28.0	27.9	27.5	26.3	24.2	
1973	24.1	27.9	29.9	32.3	30.7	29.9	28.7	28.0	27.4	26.5	24.1	21.2	
1974	22.8	24.1	27.1	29.4	29.5	29.8	28.7	27.9	27.0	24.9	24.9	24.1	
1975	23.9	26.7	29.9	31.5	29.2	28.4	27.9	27.5	27.6	26.6	24.4	20.4	
1976	21.2	27.2	27.2	29.4	27.9	29.4	28.2	26.9	27.6	27.3	24.3	23.6	
1977	23.5	22.9	27.6	29.5	28.9	30.3	28.4	28.1	26.9	27.7	24.7	24.3	
1978	24.8	25.8	30.4	30.8	28.8	29.0	27.5	27.4	26.8	26.7	25.2	23.8	
1979	25.9	27.3	30.7	30.2	29.5	28.2	29.1	28.1	27.9	26.2	24.0	23.5	
1980	24.3	25.8	28.6	30.8	29.8	28.0	28.7	28.3	27.2	27.2	25,7	24.1	
1981	23.0	26.8	29.7	30.2	29.1	28.4	27.6	28.2	28.2	27.1	25.8	21.7	
1982	23.4	26.3	29.5	28.2	30.2	29.3	28.8	27.7	27.0	27.3	26.6	21.3	
1983	22.2	27.5	29.0	32.5	30.2	29.2	29.2	27.9	28.3	26.9	23.6	22.2	
Mean	23.4	26.2	28.9	30.3	29.6	29.1	28.4	27.8	27.5	27.0	25.0	22.9	

Table 4 Monthly Mean Humidity

(%/day)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1977	73	69	66	70	75	71	79	80	82	77	72	71
1978	70	61	64	66	76	85	85	85	85	78	76	73
1979	72	68	61	66	73	84	81	85	85	77	74	73
1980	71	73	69	72	79	88	84	84	81	84	78	45
1981	71	69	69	74	80	83	86	84	83	84	80	74
1982	72	74	73	77	77	80	80	83	85	82	78	73
1983	73	71	68	68	76	80	81	86	82	84	84	16
Mean	72	69	69	70	77	80	82	84	84	81	16	73

Table 5 Monthly Mean Duration of Sunshine

(hr/day)

	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
1975	-	-	-	-	-	-	-	-	5.5	6.8	8.4	8.4	
1976	9.7	7.9	7.8	8.0	7.3	7.0	4.5	3.8	5.4	7.7	9.3	8.9	
1977	8.6	8.6	7.4	8.6	7.7	8.1	4.5	4.3	5.2	8.0	8.3	8.9	
1978	8.2	6.5	8.6	8.0	6.9	5.6	3.4	3.6	3.7	8.3	8.7	9.5	
1979	9.1	8.7	9.0	7.5	6.8	4.4	8.0	5.0	6.0	9.4	9.2	9.5	
1980	9.3	8.7	8.2	8.1	7.1	4.7	5.6	6.2	4.4	6.5	7.9	9.1	
1981	9.1	8.7	8.7	7.5	6.5	4.9	3.9	5.2	6.6	6.0	6.5	8.1	
1982	9.2	8.5	8.0	7.5	7.3	5.5	5.2	3.2	4.0	7.4	8.5	8.9	
1983	8.5	8.8	8.2	8.4	7.3	6.9	7.0	4.4	6.3	5.6	7.5	7.8	
Mean	9.0	8.3	8.2	8.0	7.1	5.9	5.3	4.5	5.2	7.3	8.3	8.8	

Table 6 Estimated Potential Evapotranspiration in the Northeast

Unit : mm

Station	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Sakhon Nakhon	117	119	154	132	102	90	92	81	81	101	112	110	1291
Roi Et	77	77	102	108	95	86	75	76	70	76	77	70	989
Ubon Ratchathani	105	112	145	130	110	99	112	99	91	117	117	115	1352
Surin	103	108	130	138	105	102	100	85	80	95	100	100	1246
Loei	73	76	96	99	86	79	80	72	60	70	67	69	927
Nakhon Ratchasima	91	92	116	116	104	108	104	100	81	84	81	85	1162
Khon Kaen	101	106	132	135	120	102	110	100	89	102	103	104	1304

Note: Potential evapotranspiration was estimated through multiplying panevaporation (class A pan of 120 cm in diameter) by 0.6.
The period of record was 1965 - 1970.

Table 7 DEEP WELL BORING LOG DATA (Around LDC)

From Maintenance Section, Geological Department, Khon Kaen

1. Well No. F 297 KK 193 Provincial Police School, Amphur Muang, Khon Kaen

Depth of well	80 Ft. (24.39 M)
Casing pipe	Ø 8"
Water quantities	52.45 gal.min (11.93 M^3/hr)
Normal water level	16.00 Ft. (4.88 M)
Reducing water level	32.78 Ft. (9.99 M)
Condition of water	"Fresh no salty"

2. Well No. F 602 KK 498 Geological dormitory (behind LDC Building), Amphur Muang, Khon Kaen

Depth of well	100 Ft. (30.49 M)
Casing pipe	Ø 6"
Water quantities	25 ga /min (5.69 M^3/hr)
Normal water level	53 Ft. (16.16 M)
Reducing water level	66 Ft. (20.12 M)
Condition of water	"Fresh water"

3. Well No. F 603 KK 499 Geological dormitory (behind LDC Building), Amphur Muang, Khon Kaen

Depth of well	160 Ft. (48.78 M)
Casing pipe	Ø 6"
Water quantities	24 gal/min (5.46 M^3/hr)
Normal water level	52 Ft. (15.85 M)
Reducing water level	62 Ft. (18.90 M)
Condition of water	"Fresh water"

4. Well No. F 124 KK 26 Maintenance Section 1, Geological Department, Amphur Muang, Khon Kaen

Depth of well	110 Ft. (33.54 M)
Casing pipe	Ø 6"
Water quantities	17 gal/min (3.87 M^3/hr)
Normal water level	23.67 Ft. (7.22 M)
Reducing water level	68.03 Ft. (20.74 M)
Condition of water	"Fresh water"

5. Well No. F 157 KK 59 Maintenence Section 1, Geological Department, Amphur Muang, Khon Kaen

Depth of well	85 Ft. (25.91M)
Casing pipe	Ø 6"
Water quantities	31.7 gal/min (7.21 M^3/hr)
Normal water level	17.80 Ft. (5.43 M)
Reducing water level	43 Ft. (13.11 M)
Condition of water	"Fresh water"

6. Well No. 70 KK 5 Plant Crop Center, Amphur Muang, Khon Kaen

Depth of well	150 Ft. (45.73 M)
Casing pipe	Ø 6"
Water quantities	53 gal/min (12.05 M^3/hr)
Normal water level	112.31 Ft. (34.24 M)
Reducing water level	11.65 Ft. (3.55 M)
Condition of water	"Fresh water"

7. Well No. 101 KK 7 Wat Ban Noon Mung, Amphur Muang, Khon Kaen

Depth of well	200 Ft. (60.98 M)
Casing pipe	Ø 8"
Water quantities	19.8 gal/min (4.5 M^3/hr)
Normal water level	14.98 Ft. (4.57 M)
Reducing water level	104.86 Ft. (31.96 M)
Condition of water	"Fresh water"

Table 8 การหาแหล่งน้ำบาดาล

ศูนย์พัฒนาที่ดินขอนแก่น ไม่มีแหล่งน้ำสำหรับอุปโภคและบริโภคเป็นเวลาร่วมนานแล้ว ที่ผ่านมาต้องใช้รถบรรทุกน้ำไปขอตามหน่วยราชการต่าง ๆ เช่น จากสถานีรถไฟขอนแก่น ศูนย์ราชการ-ธรณี เป็นต้น ดังนั้นในปี 2515 ทางศูนย์ฯ ขอนแก่น ได้ไปติดต่อขอความอนุเคราะห์จากศูนย์เจาะบ่อบาดาล ของสำนักงานเร่งรัดพัฒนาชนบท เขตขอนแก่น โดยศูนย์ฯ เจาะบ่อบาดาลได้ให้ความช่วยเหลืออย่างดียิ่ง ได้จัดส่งนายช่างสนามมาทำการสำรวจหาแหล่งน้ำ และลงมือตั้งเครื่องเจาะจนแล้วเสร็จในระหว่างเดือน สิงหาคม 2515 ได้น้ำมีคุณภาพดีพอสมควรในปริมาณ 20 แกลลอน/นาที มีระดับความลึก 120 ฟุต ได้ทำการติดตั้งเครื่องสูบน้ำแบบมอเตอร์ (Submersible - Pump) ขนาด 1.5 แรงม้า 2 สาย 50 ไซ-เคิล 220-380 โวลท์ 3,000 รอบ/นาที ในระดับความสูง 120 ฟุต สูบน้ำได้ 15 - 20 แกลลอน/นาที เครื่องสูบนี้ได้จากงบประมาณในราคา 18,000.00 บาท สำหรับการเจาะบ่อ ฝังท่อเหล็กและใส่ตะแกรงกรอง ค่าท่อทางศูนย์เจาะบ่อบาดาล เขตขอนแก่น ให้ความช่วยเหลือทั้งหมด

ผลของการวิเคราะห์คุณภาพของน้ำ โดยศูนย์เจาะบ่อบาดาล เขตขอนแก่น
(Deep-Well Water Analysis) การประปาชนบท ขอนแก่น

Capacity 15-20 gal/min.

Physical Characteristics	Unit	Recommended Limits for Drinking
Turbidity	8.3	25.0
Color	25	50
pH	6.7	6.5 or 9.2

Chemical Characteristics	P.P.m	Recommended Limits for Drinking
Ca	344	200
Mg	32	150
Total-Hardness	376	300
Alkalinity A (Methyl orange)	476	335
Alkalinity B (Phenolphthalein)	0	150
Chloride	80	600
Total iron (Fe)	0.80	1.00

หมายเหตุ คัดลอกจากรายงานประจำปี 2515 ศูนย์พัฒนาที่ดินขอนแก่น หน้า 21

Table 9 Length of Furrows and Stream Size for Different Soil Type, Land Slope and Depth of Water Application *

Slope (%)	Length of Furrow (m)												Average Flow (l/sec)
	Heavy texture				medium texture				light texture				
0.05	300	400	400	400	120	270	400	400	60	90	150	190	12
0.1	340	440	470	500	180	340	440	470	90	120	190	220	6
0.2	370	470	530	620	220	370	470	530	120	190	250	300	3
0.3	400	500	620	800	280	400	500	600	150	220	280	400	2
0.5	400	500	560	750	280	370	470	530	120	190	250	300	1.25
1.0	280	400	500	600	250	300	370	470	90	150	220	250	0.6
1.5	250	340	430	500	220	280	340	400	80	120	190	220	0.4
2.0	220	270	340	400	180	250	300	340	60	90	150	190	0.3
Application Depth (mm)	75	150	225	300	50	100	150	200	50	75	100	125	

* Under conditions of perfect land grading.

Table 10 Reference Crop Evapotranspiration (ETo)

(mm/day)

Method	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Penman	4.4	5.3	6.2	6.7	5.9	5.2	4.8	4.4	4.2	4.7	4.7	4.3
Radiation	4.2	4.5	5.5	5.8	5.0	4.5	4.3	4.0	3.9	4.4	4.3	4.0
Blaney -Criddle	5.0	4.7	5.4	5.7	4.9	4.4	4.3	4.0	3.5	4.3	3.8	3.8
Pan -Evaporation	3.4	3.5	4.4	4.5	4.0	3.4	3.7	3.3	3.0	3.4	3.4	3.5

Table 11 CALCULATION OF EVAPOTRANSPIRATION

(1) *Modified Blaney Criddle Method* ETo = C { p (0.46T+8) } mm/day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
T mean (°c)	23.4	26.2	28.9	30.3	29.6	29.1	28.4	27.8	27.5	27.0	25.0	22.9	
p	0.26	0.26	0.27	0.28	0.29	0.29	0.29	0.28	0.28	0.27	0.26	0.25	
p (0.46T+8)	4.9	5.2	5.7	6.1	6.3	6.2	6.1	5.8	5.8	5.5	5.1	4.6	
* RH min	M	M	M	M	H	H	H	H	H	H	H	M	
** n/N	H	M	M	M	M	L	L	L	L	M	M	M	
*** U daytime	1	1	1	1	1	2	2	2	1	1	2	1	
ETo	5.0	4.7	5.4	5.7	4.9	4.4	4.3	4.0	3.5	4.3	3.8	3.8	

T (Tmean) : Mean daily temperature in °c over the month considered

P : Mean daily percentage of total annual day time hours

C : Adjustment factor which depends on minimum relative humidity, sunshine hours and daytime wind estimates

* RH min <20% ... Low

20 - 50 % ... Medium

>50 % ... High

** n/N ≒ 0.45 L (0.55)

≒ 0.7 M (0.55 - 0.8)

≒ 0.9 H (0.8)

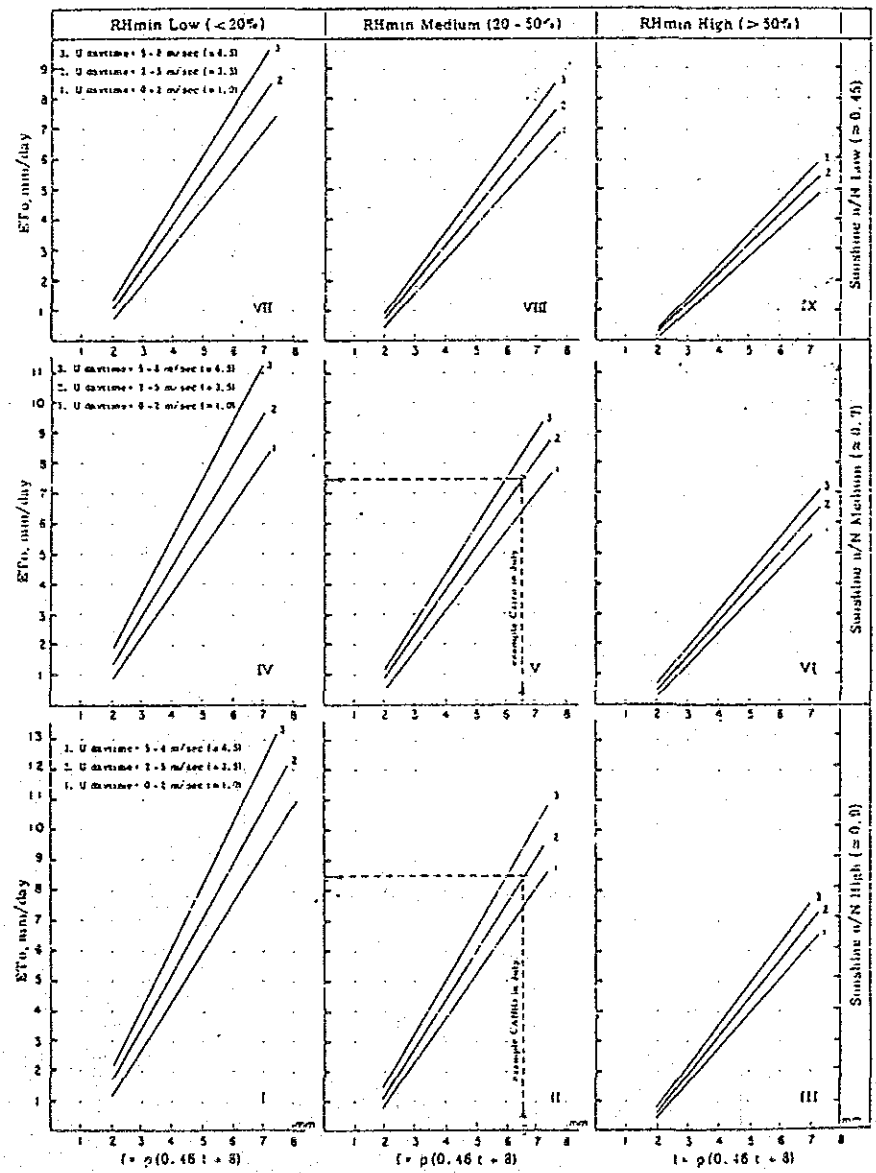
*** U daytime 5 - 8 (≒6.5) 3

2 - 5 (≒3.5) 2

0 - 2 (≒1.0) 1

Latitude North / South[1/]	Jan / July	Feb / Aug	Mar / Sept	Apr / Oct	May / Nov	June / Dec	July / Jan	Aug / Feb	Sept / Mar	Oct / Apr	Nov / May	Dec / June
60°	.15	.20	.26	.32	.38	.41	.40	.34	.28	.22	.17	.13
58	.16	.21	.26	.32	.37	.40	.39	.34	.28	.23	.18	.15
56	.17	.21	.26	.32	.36	.39	.38	.33	.28	.23	.18	.16
54	.18	.22	.26	.31	.36	.38	.37	.33	.28	.23	.19	.17
52	.19	.22	.27	.31	.35	.37	.36	.33	.28	.24	.20	.17
50	.19	.23	.27	.31	.34	.36	.35	.32	.28	.24	.20	.18
48	.20	.23	.27	.31	.34	.36	.35	.32	.28	.24	.21	.19
46	.20	.23	.27	.30	.34	.35	.34	.32	.28	.24	.21	.20
44	.21	.24	.27	.30	.33	.35	.34	.31	.28	.25	.22	.20
42	.21	.24	.27	.30	.33	.34	.33	.31	.28	.25	.22	.21
40	.22	.24	.27	.30	.32	.34	.33	.31	.28	.25	.22	.21
35	.23	.25	.27	.29	.31	.32	.32	.30	.28	.25	.23	.22
30	.24	.25	.27	.29	.31	.32	.31	.30	.28	.26	.24	.23
25	.24	.26	.27	.29	.30	.31	.31	.29	.28	.26	.25	.24
20	.25	.26	.27	.28	.29	.30	.30	.29	.28	.26	.25	.25
15	.26	.26	.27	.28	.29	.29	.29	.28	.28	.27	.26	.25
10	.26	.27	.27	.28	.28	.29	.29	.28	.28	.27	.26	.26
5	.27	.27	.27	.28	.28	.28	.28	.28	.28	.27	.27	.27
0	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27	.27

Mean Daily Percentage (p) of Annual Daytime Hours for Different Latitudes



Prediction of ETo from Blaney-Criddle f factor for different conditions of minimum relative humidity, sunshine duration and day time wind.

Table 12 CALCULATION OF EVAPOTRANSPIRATION

(2) Modified Radiation Method ETo = C(W.Rs) mm/day

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
N (hour)	11.3	11.6	12.0	12.5	12.8	13.0	12.9	12.6	12.2	11.8	11.4	11.2	
n (hour)	9.0	8.3	8.2	8.0	7.1	5.9	5.3	4.5	5.2	7.3	8.3	8.8	
n/N	0.80	0.72	0.68	0.64	0.55	0.45	0.41	0.36	0.43	0.62	0.73	0.79	
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	
Rs mm/day	7.80	8.11	8.67	8.89	8.40	7.55	7.23	6.75	6.98	7.78	7.63	7.48	
T mean (°c)	23.4	26.2	28.9	30.3	29.6	29.1	28.4	27.8	27.5	27.0	25.0	22.9	
W	0.72	0.75	0.77	0.78	0.78	0.78	0.77	0.77	0.77	0.76	0.74	0.72	
W.Rs	5.62	6.08	6.68	6.93	6.55	5.89	5.67	5.20	5.37	5.91	5.65	5.39	
RH (%)	72	69	67	70	77	80	82	84	84	81	76	73	
Wind Velocity (m/sec.)	1.6	1.5	1.8	1.9	1.9	2.0	2.1	2.0	1.4	1.7	2.0	1.9	
Fig. No.	IV-1	III-1	III-1	III-1	IV-1	IV-1,2	IV-1,2	IV-1,2	IV-1	IV-1	IV-1,2	IV-1	
ETo	4.2	4.5	5.5	5.8	5.0	4.5	4.3	4.0	3.9	4.4	4.3	4.0	

N : Maximum possible sunshine hours

n : Actual measured bright sunshine hours

Ra : Extra terrestrial radiation expressed in equivalent evaporation

Rs : Rs = (0.25 + 0.5 x n/N) x Ra

T mean: The mean air temperature

W : Values of weighting factor for the effect of radiation on ETo at different temperatures and altitudes

C : Adjustment factor which depends on mean himudity and daytime wind conditions

Northern Hemisphere														Southern Hemisphere											
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Lat	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
3.8	6.1	9.4	12.7	15.8	17.1	16.4	14.1	10.9	7.4	4.5	3.2	50°	17.5	14.7	10.9	7.0	4.2	3.1	3.5	5.5	8.9	12.9	16.5	18.2
4.3	6.6	9.8	13.0	15.9	17.2	16.5	14.3	11.2	7.8	5.0	3.7	48	17.6	14.9	11.2	7.5	4.7	3.5	4.0	6.0	9.3	13.2	16.6	18.2
4.9	7.1	10.2	13.3	16.0	17.2	16.6	14.5	11.5	8.3	5.5	4.3	46	17.7	15.1	11.5	7.9	5.2	4.0	4.4	6.5	9.7	13.4	16.7	18.3
5.3	7.6	10.6	13.7	16.1	17.2	16.6	14.7	11.9	8.7	6.0	4.7	44	17.8	15.3	11.9	8.4	5.7	4.4	4.9	6.9	10.2	13.7	16.7	18.3
5.9	8.1	11.0	14.0	16.2	17.3	16.7	15.0	12.2	9.1	6.5	5.2	42	17.8	15.5	12.2	8.8	6.1	4.9	5.4	7.4	10.6	14.0	16.8	18.3
6.4	8.6	11.4	14.3	16.4	17.3	16.7	15.2	12.5	9.6	7.0	5.7	40	17.9	15.7	12.5	9.2	6.6	5.3	5.9	7.9	11.0	14.2	16.9	18.3
6.9	9.0	11.8	14.5	16.4	17.2	16.7	15.3	12.8	10.0	7.5	6.1	38	17.9	15.8	12.8	9.6	7.1	5.8	6.3	8.3	11.4	14.4	17.0	18.3
7.4	9.4	12.1	14.7	16.4	17.2	16.7	15.4	13.1	10.6	8.0	6.6	36	17.9	16.0	13.2	10.1	7.5	6.3	6.8	8.8	11.7	14.6	17.0	18.2
7.9	9.8	12.4	14.8	16.5	17.1	16.8	15.5	13.4	10.8	8.5	7.2	34	17.8	16.1	13.5	10.5	8.0	6.8	7.2	9.2	12.0	14.9	17.1	18.2
8.3	10.2	12.8	15.0	16.5	17.0	16.8	15.6	13.6	11.2	9.0	7.8	32	17.8	16.2	13.8	10.9	8.5	7.3	7.7	9.6	12.4	15.1	17.2	18.1
8.8	10.7	13.1	15.2	16.5	17.0	16.8	15.7	13.9	11.6	9.5	8.3	30	17.8	16.4	14.0	11.3	8.9	7.8	8.1	10.1	12.7	15.3	17.3	18.1
9.3	11.1	13.4	15.3	16.5	16.8	16.7	15.7	14.1	12.0	9.9	8.8	28	17.7	16.4	14.3	11.6	9.3	8.2	8.6	10.4	13.0	15.4	17.2	17.9
9.8	11.5	13.7	15.3	16.4	16.7	16.6	15.7	14.3	12.3	10.3	9.3	26	17.6	16.4	14.4	12.0	9.7	8.7	9.1	10.9	13.2	15.5	17.2	17.8
10.2	11.9	13.9	15.4	16.4	16.6	16.5	15.8	14.5	12.6	10.7	9.7	24	17.5	16.5	14.6	12.3	10.2	9.1	9.5	11.2	13.4	15.6	17.1	17.7
10.7	12.3	14.2	15.5	16.3	16.4	16.4	15.8	14.6	13.0	11.1	10.2	22	17.4	16.5	14.8	12.6	10.6	9.6	10.0	11.6	13.7	15.7	17.0	17.5
11.2	12.7	14.4	15.6	16.3	16.4	16.3	15.9	14.8	13.3	11.6	10.7	20	17.3	16.5	15.0	13.0	11.0	10.0	10.4	12.0	13.9	15.8	17.0	17.4
11.6	13.0	14.6	15.6	16.1	16.1	16.1	15.8	14.9	13.6	12.0	11.1	18	17.1	16.5	15.1	13.2	11.4	10.4	10.8	12.3	14.1	15.8	16.8	17.1
12.0	13.3	14.7	15.6	16.0	15.9	15.9	15.7	15.0	13.9	12.4	11.6	16	16.9	16.4	15.2	13.5	11.7	10.8	11.2	12.6	14.3	15.8	16.7	16.8
12.4	13.6	14.9	15.7	15.8	15.7	15.7	15.7	15.1	14.1	12.8	12.0	14	16.7	16.4	15.3	13.7	12.1	11.2	11.6	12.9	14.5	15.8	16.5	16.6
12.8	13.9	15.1	15.7	15.7	15.5	15.5	15.6	15.2	14.4	13.3	12.5	12	16.6	16.3	15.4	14.0	12.5	11.6	12.0	13.2	14.7	15.8	16.4	16.5
13.2	14.2	15.3	15.7	15.5	15.3	15.3	15.5	15.3	14.7	13.6	12.9	10	16.4	16.3	15.5	14.2	12.8	12.0	12.4	13.5	14.8	15.9	16.2	16.2
13.6	14.5	15.3	15.6	15.3	15.0	15.1	15.4	15.3	14.8	13.9	13.3	8	16.1	16.1	15.5	14.4	13.1	12.4	12.7	13.7	14.9	15.8	16.0	16.0
13.9	14.8	15.4	15.4	15.1	14.7	14.9	15.2	15.3	15.0	14.2	13.7	6	15.8	16.0	15.6	14.7	13.4	12.8	13.1	14.0	15.0	15.7	15.8	15.7
14.3	15.0	15.5	15.5	14.9	14.4	14.6	15.1	15.3	15.1	14.5	14.1	4	15.5	15.8	15.6	14.9	13.8	13.2	13.4	14.3	15.1	15.6	15.5	15.4
14.7	15.3	15.6	15.3	14.6	14.2	14.3	14.9	15.3	15.3	14.8	14.4	2	15.3	15.7	15.7	15.1	14.1	13.5	13.7	14.5	15.2	15.5	15.3	15.1
15.0	15.5	15.7	15.3	14.4	13.9	14.1	14.8	15.3	15.4	15.1	14.8	0	15.0	15.5	15.7	15.3	14.4	13.9	14.1	14.8	15.3	15.4	15.1	14.8

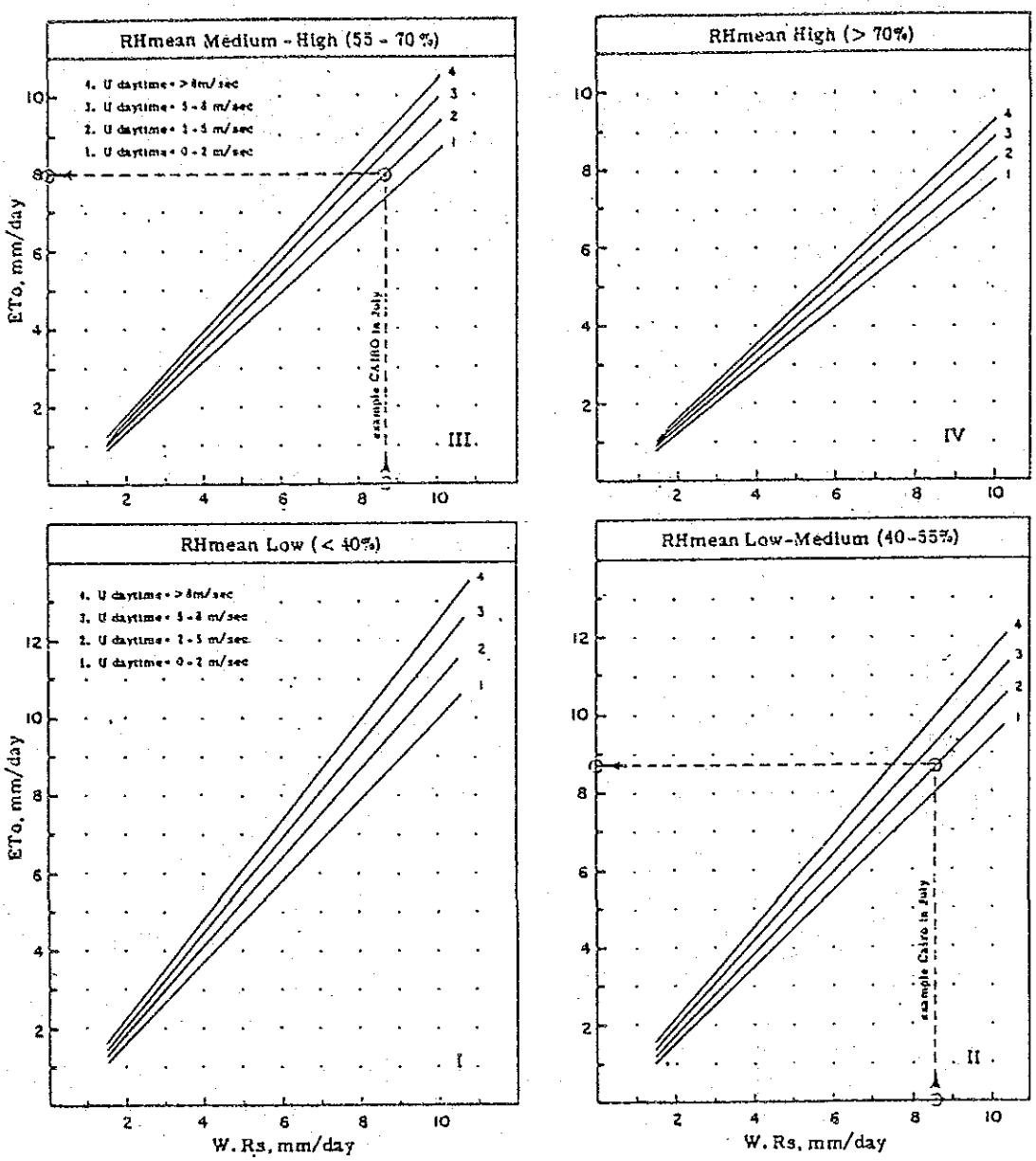
Extra Terrestrial Radiation (Ra) expressed in equivalent evaporation in mm/day

Northern Lats / Southern Lats	Jan / July	Feb / Aug	Mar / Sept	Apr / Oct	May / Nov	June / Dec	July / Jan	Aug / Feb	Sept / Mar	Oct / Apr	Nov / May	Dec / June
50	8.5	10.1	11.8	13.8	15.4	16.3	15.9	14.5	12.7	10.8	9.1	8.1
48	8.8	10.2	11.8	13.6	15.2	16.0	15.6	14.3	12.6	10.9	9.3	8.3
46	9.1	10.4	11.9	13.5	14.9	15.7	15.4	14.2	12.6	10.9	9.5	8.7
44	9.3	10.5	11.9	13.4	14.7	15.4	15.2	14.0	12.6	11.0	9.7	8.9
42	9.4	10.6	11.9	13.4	14.6	15.2	14.9	13.9	12.6	11.1	9.8	9.1
40	9.6	10.7	11.9	13.3	14.4	15.0	14.7	13.7	12.5	11.2	10.0	9.3
35	10.1	11.0	11.9	13.1	14.0	14.5	14.3	13.5	12.4	11.3	10.3	9.8
30	10.4	11.1	12.0	12.9	13.6	14.0	13.9	13.2	12.4	11.5	10.6	10.2
25	10.7	11.3	12.0	12.7	13.3	13.7	13.5	13.0	12.3	11.6	10.9	10.6
20	11.0	11.5	12.0	12.6	13.1	13.3	13.2	12.8	12.3	11.7	11.2	10.9
15	11.3	11.6	12.0	12.5	12.8	13.0	12.9	12.6	12.2	11.8	11.4	11.2
10	11.6	11.8	12.0	12.3	12.6	12.7	12.6	12.4	12.1	11.8	11.6	11.5
5	11.8	11.9	12.0	12.2	12.3	12.4	12.3	12.3	12.1	12.0	11.9	11.8
0	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1

Mean Daily Duration of Maximum Possible Sunshine Hours (N) for Different Months and Latitudes

Temperature °C	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
W at altitude m																				
0	0.43	.46	.49	.52	.55	.58	.61	.64	.66	.68	.71	.73	.75	.77	.78	.80	.82	.83	.84	.85
500	.45	.48	.51	.54	.57	.60	.62	.65	.67	.70	.72	.74	.76	.78	.79	.81	.82	.84	.85	.86
1 000	.46	.49	.52	.55	.58	.61	.64	.66	.69	.71	.73	.75	.77	.79	.80	.82	.83	.85	.86	.87
2 000	.49	.52	.55	.58	.61	.64	.66	.69	.71	.73	.75	.77	.79	.81	.82	.84	.85	.86	.87	.88
3 000	.52	.55	.58	.61	.64	.66	.69	.71	.73	.75	.77	.79	.81	.82	.84	.85	.86	.88	.88	.89
4 000	.55	.58	.61	.64	.66	.69	.71	.73	.76	.78	.79	.81	.83	.84	.85	.86	.88	.89	.90	.90

Values of Weighting Factor (W) for the Effect of Radiation on ETo at Different Temperatures and Altitudes



Prediction of ETo from W. RS for different conditions of mean relative humidity and day time wind.

Table 13 CALCULATION OF EVAPOTRANSPIRATION

(3) Modified Penman Method (ETo = C { W·Rn + (1-W) · f(u) · (ea-ed)})

		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
I. METEOROLOGICAL DATA														
Air Temperature (°c)		23.4	26.2	28.9	30.3	29.6	29.1	28.4	27.8	27.5	27.0	25.0	22.9	
Relative Humidity (%)		72	69	67	70	77	80	82	84	84	81	76	73	
Wind Velocity (m/s)		1.6	1.5	1.8	1.9	1.9	2.0	2.1	2.0	1.4	1.7	2.0	1.9	
Sun Shine Duration (n/N)		0.8	0.72	0.68	0.64	0.55	0.45	0.41	0.36	0.43	0.62	0.73	0.79	
II. CALCULATION														
ea		28.8	34.0	39.9	43.2	41.5	40.3	38.7	37.4	36.8	35.7	31.7	27.9	
ed=eaxRHmean/100		20.7	23.5	26.7	30.2	32.0	32.2	31.7	31.4	30.9	28.9	24.1	20.4	
(ea-ed)		8.1	10.5	13.2	13.0	9.5	8.1	7.0	6.0	5.9	6.8	7.6	7.5	
u		138	130	156	164	164	173	181	173	121	147	173	164	
f(u)=0.27(1+u/100)		0.64	0.62	0.69	0.71	0.71	0.74	0.76	0.74	0.60	0.67	0.74	0.71	
(1-W)		0.28	0.25	0.23	0.22	0.22	0.22	0.23	0.23	0.23	0.24	0.26	0.28	
W		0.72	0.75	0.77	0.78	0.78	0.78	0.77	0.77	0.77	0.76	0.74	0.72	
Ra		12.0	13.3	14.7	15.6	16.0	15.9	15.9	15.7	15.0	13.9	12.4	11.6	
Rs=(0.25+0.50n/N)Ra		7.8	8.1	8.7	8.9	8.4	7.6	7.2	6.8	7.0	7.8	7.6	7.5	
Rns= (1-α)Rs		5.9	6.1	6.5	6.7	6.3	5.7	5.4	5.1	5.3	5.9	5.7	5.6	
Rnl=f(T)·f(ed)·F(n/N)	f(T)	15.3	15.9	16.5	16.8	16.6	16.5	16.4	16.3	16.2	16.1	15.7	15.1	
	f(ed)	0.14	0.12	0.12	0.10	0.09	0.09	0.09	0.10	0.10	0.11	0.12	0.14	
	f(n/N)	0.82	0.75	0.71	0.68	0.60	0.51	0.47	0.43	0.49	0.66	0.76	0.81	
Rnl		1.8	1.4	1.4	1.1	0.9	0.8	0.7	0.7	0.8	1.2	1.4	1.7	
Rn=Rns-Rnl		4.1	4.7	5.1	5.6	5.4	4.9	4.7	4.4	4.5	4.7	4.3	3.9	
C		1.01	1.02	1.03	1.04	1.03	1.01	1.00	0.99	0.99	1.01	1.01	1.01	
ETo=C{W·Rn+(1-w)·f(u)·(ea-ed)}		4.4	5.3	6.2	6.7	5.9	5.2	4.8	4.4	4.2	4.7	4.7	4.3	

W	: temperature-related weighting factor
Rn	: net radiation in equivalent evaporation in mm/day
F(u)	: wind-related function
(ea-ed)	: difference between in saturation vapour pressure at mean air temperature and the mean actual vapour pressure of the air, both in mbar
C	: adjustment factor to compensate for the effect of day and night weather conditions

Temperature °C	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ea mbar	6.1	6.6	7.1	7.6	8.1	8.7	9.3	10.0	10.7	11.5	12.3	13.1	14.0	15.0	16.1	17.0	18.2	19.4	20.6	22.0

Temperature °C	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
ea mbar	23.4	24.9	26.4	28.1	29.8	31.7	33.6	35.7	37.8	40.1	42.4	44.9	47.6	50.3	53.2	56.2	59.4	62.8	66.3	69.9

1/ Also actual vapour pressure (ed) can be obtained from this table using available Tdewpoint data.
(Example: Tdewpoint is 18°C; ed is 20.6 mbar)

Saturation Vapour Pressure (ea) in mbar as Function of Mean Air Temperature (T) in °C 1/

Temperature °C	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
W at altitude m																				
0	0.43	.46	.49	.52	.55	.58	.61	.64	.66	.69	.71	.73	.75	.77	.78	.80	.82	.83	.84	.85
500	.44	.48	.51	.54	.57	.60	.62	.65	.67	.70	.72	.74	.76	.78	.79	.81	.82	.84	.85	.86
1 000	.46	.49	.52	.55	.58	.61	.64	.66	.69	.71	.73	.75	.77	.79	.80	.82	.83	.85	.86	.87
2 000	.49	.52	.55	.58	.61	.64	.66	.69	.71	.73	.75	.77	.79	.81	.82	.84	.85	.86	.87	.88
3 000	.52	.55	.58	.61	.64	.66	.69	.71	.73	.75	.77	.79	.81	.82	.84	.85	.86	.87	.88	.89
4 000	.54	.58	.61	.64	.66	.69	.71	.73	.75	.77	.79	.81	.82	.84	.85	.86	.87	.89	.90	.90

Values of Weighting Factor (W) for the Effect of Radiation on ETo at Different Temperatures and Altitudes

$T^{\circ}C$	0	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36
$f(T) = \sigma Tk^4$	11.0	11.4	11.7	12.0	12.4	12.7	13.1	13.5	13.8	14.2	14.6	15.0	15.4	15.9	16.3	16.7	17.2	17.7	18.1

Effect of Temperature f(T) on Longwave Radiation (Rnl)

ed mbar	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
$f(ed) = 0.34 - 0.044\sqrt{ed}$	0.23	.22	.20	.19	.18	.16	.15	.14	.13	.12	.12	.11	.10	.09	.08	.08	.07	.06

Effect of Vapour Pressure f(ed) on Longwave Radiation (Rnl)

n/N	0	.05	.1	.15	.2	.25	.3	.35	.4	.45	.5	.55	.6	.65	.7	.75	.8	.85	.9	.95	1.0
$f(n/N) = 0.1 + 0.9\ n/N$	0.10	.15	.19	.24	.28	.33	.37	.42	.46	.51	.55	.60	.64	.69	.73	.78	.82	.87	.91	.96	1.0

Effect of the Ratio Actual and Maximum Daily Sunshine Hours f(n/N) on Longwave Radiation (Rnl)

	RHmax = 30%				RHmax = 60%				RHmax = 90%			
Rs mm/day	3	6	9	12	3	6	9	12	3	6	9	12
Uday m/sec	Uday/Unight = 4.0											
0	.86	.90	1.00	1.00	.96	.98	1.05	1.05	1.02	1.06	1.10	1.10
3	.79	.84	.92	.97	.92	1.00	1.11	1.19	.99	1.10	1.27	1.32
6	.68	.77	.87	.93	.85	.96	1.11	1.19	.94	1.10	1.26	1.33
9	.55	.65	.78	.90	.76	.88	1.02	1.14	.88	1.01	1.16	1.27
	Uday/Unight = 3.0											
0	.86	.90	1.00	1.00	.96	.98	1.05	1.05	1.02	1.06	1.10	1.10
3	.76	.81	.88	.94	.87	.96	1.06	1.12	.94	1.04	1.18	1.28
6	.61	.68	.81	.88	.77	.88	1.02	1.10	.86	1.01	1.15	1.22
9	.46	.56	.72	.82	.67	.79	.88	1.05	.78	.92	1.06	1.18
	Uday/Unight = 2.0											
0	.86	.90	1.00	1.00	.96	.98	1.05	1.05	1.02	1.06	1.10	1.10
3	.69	.76	.85	.92	.83	.91	.99	1.05	.89	.98	1.10	1.14
6	.53	.61	.74	.84	.70	.80	.94	1.02	.79	.92	1.05	1.12
9	.37	.48	.65	.76	.59	.70	.84	.95	.71	.81	.96	1.06
	Uday/Unight = 1.0											
0	.86	.90	1.00	1.00	.96	.98	1.05	1.05	1.02	1.06	1.10	1.10
3	.64	.71	.82	.89	.78	.86	.94	.99	.85	.92	1.01	1.05
6	.43	.53	.68	.79	.62	.70	.84	.93	.72	.82	.95	1.00
9	.27	.41	.59	.70	.50	.60	.75	.87	.62	.72	.87	.96

Adjustment Factor (c) in Presented Penman Equation

Table- 14 Nov. 1984

Electrical Conductivity Test

	Sample	ECw	ECe	Remarks
Water	Reservoir (west)	0.150		Unit m mho/cm
	Reservoir	0.025		
	Deep well	0.92		
	Pipeline	0.175		
Soil	No. 1 30cm		0.103	No. of Test Pit
	60cm		0.119	cm shows depth
	No.2 30cm		0.156	
	60cm		0.139	

Equation of conversion to ECe :

$$ECe = 0.2468 + 3.3083\ Ec \quad (1:5)$$

Tested by the Team under expert of LDD
with use Presto-Teck, DS-12, made in USA

Table - 15 Standard of Irrigation Water

SOIL SALINITY

mS	%SALT	QUALITY OF SOIL
0-2	0-0.I3	NO EFFECT TO EVERY KIND OF PLANT.
2-4	0.I3 -0.26	SENSITIVE PLANT MAY BE EFFECTED
4-8	0.26 -0.5I	MANY KINDS OF PLANT MAY BE EFFECTED.
8-I6	0.5I -I.02	MOST OF PLANTS MAY BE EFFECTED.
I6-32	I.02 -2.05	ONLY TOLERATED PLANT ; CAN STAND FOR.

STANDARD OF IRRIGATED WATER

CLASS	μS	Na
I	0-I000	60
2	I000 -3000	60-75
3	3000	75

FROM: IRRIGATION PRINCIPLES AND PRATICES. by ISRAELSEN

NB. CLASS I GOOD-VERY GOOD, SUITABLE FOR EVERY KIND OF PLANT IN EVERY CONDITION.

CLASS 2 SENSITIVE PLANT MAY BE TOXIC.

CLASS 3 TOXIC TO EVERY KIND OF PLANT. NOT SUITABLE IN EVERY CONDITION.

S = Siemen = mho/cm

-contine -

STANDARD OF IRRIGATED WATER

CLASS	SALINITY	EC (microS)	UTILIZATION
C-I	LOW	0-250	CAN USE FOR EVERY KIND OF PLANT IN EVERY SERIE OF SOIL. WANTED SOME WATER FOR LEACHING. EXCEPT IN CLAYEY SOIL MUST BE CAREFUL ABOUT SALT RESIDUUM.
C-2	MODERATE	250-750	CAN USE FOR TOLERATED PLANT BY HAVING SOIL LEACHING.
C-3	HIGH	750-2250	CANNOT USE IN POOR-DRAINED SOIL BUT CAN GROW TOLERATED PLANT BY HAVING GOOD SOIL MANAGEMENT.
C-4	VERY	2250-5000	CANNOT USE EXCEPT FOR WELL-DRAI AND GOOD DRAINAGE SOIL THAT MU HAVE ENOUGH WATER FOR LEACHING AND USE VERY TOLERATED PLANT.

FROM: IRRIGATED AGRICULTURAL by SONSOMBOON SUREE.

Table 16 CALCULATION OF TRAM

Soil series	Depth (cm)	Field* capacity (%)	Permanent* wilting percentage (%)	Soil ** moisture extraction pattern (%)	Apparent-specific** gravity of soil	Readily available moisture (mm)	Total readily available moisture (mm)	Remarks
Yasothon	0-10	10.13	3.33	40	0.95	6.5	16.3 (controlled depth)	
	10-25	8.33	2.84	30		5.2	17.3	
	25-40	8.64	2.68	20		5.7	28.5	
	40-65	12.56	5.84	10		6.4	64.0	
Korat	0-15	15.40	5.98	50	0.95	8.9	17.8 (controlled depth)	
	15-30	14.65	4.70	30		9.5	31.7	
	30-45	13.62	4.82	20		8.4	42.0	
Namphong	0-10	7.82	2.18	50	0.95	5.4	10.8 (controlled depth)	
	10-25	6.67	2.30	30		4.2	14.0	
	25-40	8.88	2.50	20		6.1	30.5	
Roi-et	0-10	16.83	5.62	40	0.95	10.6	26.5 (controlled depth)	
	10-20	21.31	9.62	30		11.1	37.0	
	20-30	26.61	14.50	20		11.5	57.5	
	30-40	26.08	14.72	10		10.8	108.0	
Average							17.9 ≒ 18 mm (controlled depth)	

Original source : " KKU IDRC SEMI ARID 1976 ANNUAL REPORT FACULTY OF AGRICULTURE KHON KAEN UNIVERSITY"

* : Percent on dry weight basis
** : The value is assumption

Table 17 Hydraulic Conductivity

Soil Series	Depth (cm)	Hydraulic conductivity (cm/hr.)	Class
Yasothon	0 - 10	9.05	Moderately rapid
	10 - 25	9.92	- do -
	25 - 40	4.10	Moderate
	40 - 65	3.40	- do -
Korat	0 - 15	2.11	Moderate
	15 - 30	4.59	- do -
	30 - 45	2.66	- do -
Namphong	0 - 10	12.68	Rapid
	10 - 25	8.50	Moderately rapid
	25 - 40	7.18	- do -
Roi-et	0 - 10	0.65	Moderately slow
	10 - 20	0.78	- do -
	20 - 30	0.71	- do -
	30 - 40	0.50	- do -

Table 18 Hydraulic Elements on Irrigation Canal System

Canals		Pavement	Designed Water Requirements (m^3/s)	Slope	Bottom Width (m)	Water Depth (m)	Free Board (m)	Canal length (m)
MAIN CANAL	MIC - 1 to 2	concrete Lining	0.002	$\frac{1}{2,000}$	0.20	0.09	0.11	100
	MIC - 3 to 6	- do -	0.029	$\frac{1}{2,000}$	0.30	0.18	0.11	190
	MIC - 7 to 9	- do -	0.013	$\frac{1}{200}$	0.20	0.08	0.12	170
LATERAL CANAL	LIC - 1 to 10	- do -	0.003(MAX)	$\frac{1}{150}$	0.20	0.05	0.12	1,462

Table 19 Hydraulic Elements on Drainage Canal System

Canals		Pavement	Designed Water Requitements (m^3/sec)	Slope	Bottom Width (m)	Water Depth (m)	Free Board (m)	Canal Length (m)
MAIN CANAL	MDC - 1	Concrete Lining	0.059	$\frac{1}{500}$	0.30	0.18	0.12	308
	MDC - 2	- do -	0.174	$\frac{1}{100}$	0.30	0.21	0.29	271
LATERAL CANAL	LDC - 1 to 11	- do -	0.027	$\frac{1}{100}$	0.20	0.10	0.15	1,740

Farm Name	Area (ha)	Design Drainage Discharge (m^3/sec)	Accumulated Discharge (m^3/sec)	Main Drainage Canal Calculated Point	Area (ha)	Remarks
Farm Management	0.15	0.013	0.013			
Nursery Space	0.25	0.021	0.034			
Block - 1	0.40	0.010	0.044			
Block - 2	0.61	0.015	0.059	Main Drainage canal A	1.41	
Block - 3	0.78	0.020	0.079			
Block - 4	0.82	0.021	0.100			
Block - 5	0.88	0.022	0.122			
Block - 6	0.98	0.025	0.147			
Block - 7	1.09	0.027	0.174	Main Drainage canal B	4.87	
Block - 8	1.03	0.026	0.200			
Block - 9	0.82	0.021	0.221		7.81	

Table 20 ; Hydraulic Elements on Drainage Canal System (2)

Table 21 HYDRAULIC CALCULATION (Deep Well Pump)

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Friction Loss	1.257×10^{-3}	1.579×10^{-6}	$\frac{124.5 \times 0.012^2 \times 20.5}{0.04^{4/3}} = 26.866$	26.866	1.701×10^{7}	$\phi 40$
2	Friction Loss	1.963×10^{-3}	3.855×10^{-6}	$\frac{124.5 \times 0.012^2 \times 7.90}{0.05^{4/3}} = 7.689$	7.689	1.995×10^{6}	$\phi 50$
3	Bend Loss	1.257×10^{-3}	1.579×10^{-6}	90° fsc = 0.99	0.990	6.270×10^{5}	$\phi 40$
4	Bend Loss	1.963×10^{-3}	3.855×10^{-6}	90°x3 part 0.99x3 = 2.97	2.970	7.704×10^{5}	
5	Rapid Expanding Loss	1.257×10^{-3}	1.579×10^{-6}	D1/D2= 0.04/0.05 = 0.8 Fse = 0.13	0.130	8.233×10^{4}	
6	Sluice Valve Loss	"	"	$\frac{124.5 \times 0.012^2 \times 0.4}{0.04^{4/3}} = 0.524$	0.524	3.319×10^{5}	L=0.4
7	Check Valve Loss	"	"	$\frac{124.5 \times 0.012^2 \times 3.7}{0.04^{4/3}} = 4.849$	4.849	3.071×10^{6}	L=3.7
8	Glove Valve Loss	1.963×10^{-3}	3.855×10^{-6}	$\frac{124.5 \times 0.012^2 \times 21.3}{0.05^{4/3}} = 20.731$	20.731	5.378×10	L=21.3
9	Outlet Loss	"	"		1.000	2.594×10^{5}	
						2.953×10^{7}	

$$K = \frac{1}{\sqrt{Zfi/Ai^2}} = \frac{1}{\sqrt{2.953 \times 10^{7}}} = 1.840 \times 10^{-4} \qquad Q = K\sqrt{2gH} = 8.146 \times 10^{-4}\sqrt{H} \quad (m^3/sec)$$

$$H = \left(\frac{1.5 \times 10^{-3}}{8.146 \times 10^{-4}}\right)^2 = 3.39$$

Table 22-1 HYDRAULIC CALCULATION (ϕ50)

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Friction Loss	1.963×10^{-3}	3.855×10^{-6}	$\frac{124.5 \times 0.012^2 \times 540}{0.05^{4/3}} = 525.572$	525.572	1.363×10^{8}	
2	Entrance Loss	"	"		1.0	2.594×10^{5}	
3	Bend Loss	"	"	90° x 11 part 0.99 x 11 = 10.89	10.890	2.825×10^{6}	
4	Bend Loss	"	"	45° x 5 part 0.183 x 5 = 0.915	0.915	2.374×10^{5}	
5	Outlet Loss	"	"		1.000	2.594×10^{5}	
6							
7						1.399×10^{8}	
8							
9							

$$K = \frac{1}{\sqrt{\Sigma fi/Ai^2}} = \frac{1}{\sqrt{1.399 \times 10^{8}}} = 8.455 \times 10^{-5}$$

$$Q = K\sqrt{2gH} = 3.743 \times 10^{-4}\sqrt{H} \quad (m^3/sec)$$

$$Q = 2.778 \times 10^{-3} \qquad H = \left(\frac{2.778 \times 10^{-3}}{3.743 \times 10^{-4}}\right)^2 = 55.5 \text{ m}$$

Table 22-2 HYDRAULIC CALCULATION (ϕ65)

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Friction Loss	3.318×10^{-3}	1.101×10^{-5}	$\frac{124.5 \times 0.012^2 \times 540}{0.065^{4/3}} = 370.431$	370.431	3.364×10^{7}	
2	Entrance Loss	"	"		1.000	9.083×10^{4}	
3	Bend Loss	"	"		10.890	9.891×10^{5}	
4	Bend Loss	"	"		0.915	8.311×10^{4}	
5	Outlet Loss	"	"		1.000	9.083×10^{4}	
6							
7						3.489×10^{7}	
8							
9							

$$K = \frac{1}{\sqrt{\Sigma fi/Ai^2}} = \frac{1}{\sqrt{3.489 \times 10^{7}}} = 1.693 \times 10^{-4} \qquad Q = K\sqrt{2gH} = 7.495 \times 10^{-4}\sqrt{H} \quad (m^3/sec)$$

$$H = \left(\frac{2.778 \times 10^{-3}}{7.495 \times 10^{-4}}\right)^2 = 13.7 \text{ m}$$

Table 22-3 HYDRAULIC CALCULATION (ϕ80)

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Friction Loss	5.027×10^{-3}	2.527×10^{-5}	$\frac{124.5 \times 0.012^2 \times 540}{0.08^{4/3}} = 280.849$	280.849	1.111×10^{7}	
2	Entrance Loss	"	"		1.000	3.957×10^{4}	
3	Bend Loss		"		10.890	4.309×10^{5}	
4	Bend Loss	"	"		0.915	3.621×10^{4}	
5	Outlet Loss	"	"		1.000	3.957×10^{4}	
6							
7						1.166×10^{7}	
8							
9							

$$K = \frac{1}{\sqrt{2fi/Ai^2}} = \frac{1}{\sqrt{1.166 \times 10^{7}}} = 2.929 \times 10^{-4}$$

$$Q = K\sqrt{2gH} = 1.297 \times 10^{-3}\sqrt{H} \quad (m^3/sec)$$

$$H = \left(\frac{2.778 \times 10^{-3}}{1.297 \times 10^{-3}}\right)^2 = 4.6 \text{ m}$$

Table 22-4 HYDRAULIC CALCULATION (ϕ100)

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Friction Loss	7.854×10^{-3}	6.169×10^{-5}	$\frac{124.5 \times 0.012^2 \times 540}{0.1^{4/3}} = 208.573$	208.573	3.381×10^6	
2	Entrance Loss	"	"		1.000	1.621×10^4	
3	Bend Loss	"	"		10.890	1.765×10^5	
4	Bend Loss	"	"		0.915	1.483×10^4	
5	Outlet Loss	"	"		1.000	1.621×10^4	
6							
7						3.605×10^6	
8							
9							

$$K = \frac{1}{\sqrt{\Sigma fi/Ai^2}} = \frac{1}{\sqrt{3.605 \times 10^6}} = 5.267 \times 10^{-4} \qquad Q = K\sqrt{2gH} = 2.332 \times 10^{-3}\sqrt{H} \quad (m^3/sec)$$

$$H = \left(\frac{2.778 \times 10^{-3}}{2.332 \times 10^{-3}}\right)^2 \approx 1.4 \text{ m}$$

Table 23 HYDRAULIC CALCULATION Suction Pipe

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Entrance Loss	5.027×10^{-3}	2.527×10^{-5}		1.000	3.957×10^{4}	$\phi 80$
2	Friction Loss	"	"	$\frac{124.5 \times 0.012^2 \times 22}{0.08^{4/3}} = 11.442$	11.442	4.528×10^{5}	$\phi 80$
3	Friction Loss	1.257×10^{-3}	1.579×10^{-6}	$\frac{124.5 \times 0.012^2 \times 0.2}{0.04^{4/3}} = 0.262$	0.262	1.659×10^{5}	$\phi 40$
4	Bend Loss	5.027×10^{-3}	2.527×10^{-5}	90° x 3 0.99 x 3 = 2.970	2.970	1.175×10^{5}	
5	Rapid Contraction Loss	1.257×10^{-3}	1.579×10^{-6}	D2/D1=0.04/0.08=1/2 Fsc = 0.43	0.430	2.723×10^{5}	
6							
7						1.048×10^{6}	
8							
9							

$$K = \frac{1}{\sqrt{Zfi/Ai^2}} = \frac{1}{\sqrt{1.048 \times 10^{6}}} = 9.768 \times 10^{-4} \qquad Q = K\sqrt{2gH} = 4.324 \times 10^{-3}\sqrt{H} \quad (m^3/sec)$$

$$H = \left(\frac{2.778 \times 10^{-3}}{4.324 \times 10^{-3}}\right)^2 = 0.413 \text{ m}$$

Table 24 HYDRAULIC CALCULATION Discharge Pipe

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Friction Loss	1.257×10^{-3}	1.579×10^{-6}	$\frac{124.5 \times 0.012^2 \times 0.70}{0.04^{4/3}} = 0.917$	0.917	5.807×10^5	$\phi 40$
2	Friction Loss	5.027×10^{-3}	2.527×10^{-5}	$\frac{124.5 \times 0.012^2 \times 517}{0.08^{4/3}} = 268.887$	268.887	1.064×10^7	$\phi 80$
3	Bend Loss	"	"	90° x 8 part 0.99 x 8 = 7.920	7.920	3.134×10^5	
4	Bend Loss	"	"	45° x 5 part 0.183 x 5 = 0.915	0.915	3.621×10^4	
5	Rapid expanding Loss	1.257×10^{-3}	1.579×10^{-6}	D1/D2 = 0.5 Fse = 0.56	0.560	3.547×10^5	
6	Valve Loss	1.257×10^{-3}	1.579×10^{-6}	$\frac{124.5 \times 0.012^2 \times 0.40}{0.04^{4/3}} = 0.524$	0.524	3.318×10^5	Friction Loss L=0.4 m $\phi 40$
7	Valve Loss	5.027×10^{-3}	2.527×10^{-5}	$\frac{124.5 \times 0.012^2 \times 24.1}{0.08^{4/3}} = 12.534$	12.534	4.960×10^5	Friction Loss L=24.1 m, $\phi 80$
8	Outlet Loss	"	"		1.000	3.957×10^4	
9						1.279×10^7	

$$K = \frac{1}{\sqrt{\Sigma fi/Ai^2}} = \frac{1}{\sqrt{1.279 \times 10^7}} = 2.796 \times 10^{-4} \quad Q = K\sqrt{2gH} = 1.238 \times 10^{-3}\sqrt{H} \quad (m^3/sec)$$

$$H = \left(\frac{2.778 \times 10^{-3}}{1.238 \times 10^{-3}}\right)^2 = 5.04 \text{ m}$$

Table 25 HYDRAULIC CALCULATION Sprinkler Pump (Suction Pump Head)

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Entrance Loss	1.257×10^{-3}	1.579×10^{-6}		1.000	6.333×10^{5}	$\phi 40$
2	Friction Loss	"	"	$\frac{124.5 \times 0.012^2 \times 10.0}{0.04^{4/3}} = 13.105$	13.105	8.300×10^{6}	$\phi 40$
3	Bend Loss	"	"	90° x 3 part 0.99 x 3 = 2.97	2.97	1.881×10^{6}	$\phi 40$
4							
5							
6						1.081×10^{7}	
7							
8							
9							

$$K = \frac{1}{\sqrt{\Sigma fi/Ai^2}} = \frac{1}{\sqrt{1.081 \times 10^{7}}} = 3.041 \times 10^{-4} \qquad Q = K\sqrt{2gH} = 1.346 \times 10^{-3}\sqrt{H} \quad (m^3/sec)$$

$$H = \left(\frac{2.900 \times 10^{-3}}{1.346 \times 10^{-3}}\right)^2 = 4.64 \text{ m}$$

Table 26-1 HYDRAULIC CALCULATION Sprinkler Pump (Discharge Pump Head)

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Friction Loss	7.069×10^{-4}	4.996×10^{-7}	$\frac{124.5 \times 0.012^2 \times 1.9}{0.03^{4/3}} = 3.654$	3.654	7.314×10^{6}	ϕ30
2	Friction Loss	5.027×10^{-3}	2.527×10^{-5}	$\frac{124.5 \times 0.012^2 \times 100}{0.08^{4/3}} = 52.009$	52.009	2.058×10^{6}	ϕ80
3	Bend Loss	"	"	90° x 4 part 0.99 x 4 = 3.960	3.960	1.567×10^{5}	ϕ80
4	Bend Loss	"	"	45° x 2 part 0.183 x 2 = 0.366	0.366	1.448×10^{4}	ϕ80
5	Diversion Loss	"	"		1.000	3.957×10^{4}	
6	Diversion Loss	"	"		1.000	3.957×10^{4}	
7	Rapid Expanding Loss	7.069×10^{-4}	4.996×10^{-7}	D1/D2=0.03/0.08=0.375 Fse = 0.73	0.730	1.461×10^{6}	
8	Sluice Valve Loss	5.027×10^{-3}	2.527×10^{-5}	$\frac{124.5 \times 0.012^2 \times 0.3}{0.08^{4/3}} = 0.156$	0.156	6.173×10^{3}	L=0.3m
9	Check Valve Loss	"	"	$\frac{124.5 \times 0.012^2 \times 3.1}{0.08^{4/3}} = 1.612$	1.612	6.379×10^{4}	L=3.1m

$K = \frac{1}{\sqrt{\Sigma fi/Ai^2}} = \frac{1}{\sqrt{\quad}}$ $\quad Q = K\sqrt{2gH} \quad \sqrt{H}$

Table 26-2 HYDRAULIC CALCULATION Sprinkler Pump (Discharge Pump Head)

	LOSS	Ai (m^2)	Ai^2	COEFFICIENT	fi	$\frac{fi}{Ai^2}$	REMARKS
1	Angle Valve Loss	5.027×10^{-3}	2.527×10^{-5}	$\frac{124.5 \times 0.012^2 \times 5.5}{0.08^{4/3}} = 2.860$	2.860	1.132×10^{5}	L=5.5m
2							
3							
4						1.127×10^{7}	
5							
6							
7							
8							
9							

$$K = \frac{1}{\sqrt{\Sigma fi/Ai^2}} = \frac{1}{\sqrt{1.127 \times 10^{7}}} = 2.979 \times 10^{-4}$$

$$Q = K\sqrt{2gH} = 1.319 \times 10^{-3}\sqrt{H} \quad (m^3/sec)$$

$$H = \left(\frac{2.900 \times 10^{-3}}{1.319 \times 10^{-3}}\right)^2 = 4.83\ m$$

Table 27 DISTIBUTION PLAN OF EARTH MATERIALS

EXCAVATION \ EMBANKMENT			LAND LEVELING									IRRIGATION CANAL			DRAINAGE CANAL			FARM ROAD		RESERVOIR	SPOIL AREA	REMARKS
			FARM MANAGMENT SITE	NURSERY SPACE I	II	BLOCK 1 TOP SOIL	SOIL	BLOCK 2 TOP SOIL	SOIL	BLOCK 3 TOP SOIL	SOIL	IRRIGATION MAIN	LATERAL	ACCESS ROAD	DRAINAGE MAIN	LATERAL		FARM ROAD A	E			
			340	20	205	1,200	560	1,880	2,430	2,370	1,230	42	168	10	22	0	172	0	308	0		
	FARM MANAGMENT SITE	340	340																		—	
	NURSERY SPACE I	810		20					790												—	
	II	373			205								109				30				29	
	BLOCK 1 TOP SOIL	1,200				1,200															—	
LAND	SOIL	560					560														—	
LEVELING	BLOCK 2 TOP SOIL	1,880						1,880													—	
	SOIL	440							440												—	
	BLOCK 3 TOP SOIL	2,370								2,370											—	
	SOIL	2,430							1,200		1,230										—	
IRRIGATION	IRRIGATION MAIN	70										42									28	
CANAL	LATERAL	59											59								—	
	ACCESS ROAD	10												10							—	
DRAINAGE	DRAINAGE MAIN	238													22			308			408	
CANAL	LATERAL	168																			168	
	ACCESS ROAD	142															142				—	
FARM	FARM ROAD A	286																			286	
ROAD	E	0																				
RESERVOIR		209																			209	
TOTAL		12,085																				
BORROW PIT																					1,128	

Table 28

Bill of Quantities

1. Land shape adjustment and land leveling				
(1) Block-1	Excavation		cum	1 760
	Spreading		cum	1 760
(2) Block-2	Excavation		cum	2 320
	Spreading		cum	4 310
(3) Block-3	Excavation		cum	4 800
	Spreading		cum	3 600
(4) Nursery space				
	Loading, Hauling		cum	1 990
	Excavation		cum	810
	Spreading		cum	10
(5) Farm management site				
	Excavation		cum	350
	Spreading		cum	340
(6) Others				
	Smoothing face		sqm	960
2. Irrigation canal				
2-1 Main irrigation canal				
	Excavation		cum	29
	Embankment		cum	10
	Smoothing face		sqm	135

	Lining concrete	cum	9.9
	Wooden form	sqm	0.9
	RC- Pipe φ300 l=1.00m	pcs	5
2-2	Lateral irrigation canal		
	Excavation	cum	60
	Embankment	cum	168
	Smoothing face	sqm	582
	Lining concrete	cum	32.9
	Plain concrete	cum	2.2
	Wooden form	sqm	30.0
2-3	Access road and Water division box		
	Excavation	cum	51
	Embankment	cum	42
	Reinforced concrete	cum	4.5
	Plain concrete	cum	4.2
	Wooden form	sqm	99.3
	Iron bar	ton	0.5
3.	Drainage canal		
3-1	Main drainage canal		
	Excavation	cum	710
	Smoothing face	sqm	1592
	Lining concrete	cum	78.6
	Wooden form	sqm	11.6
3-2	Lateral drainage canal		
	Excavation	cum	168
	Smoothing face	sqm	864
	Lining concrete	cum	53.2
	Wooden form	sqm	7.5
3-3	Access road and Catch box		
	Excavation	cum	170
	Embankment	cum	194

	Reinforced concrete		cum	15.0
	Plain concrete		cum	3.9
	Wooden form		sqm	252
	Iron bar		ton	1.0
	RC- Pipe	ϕ600 l=1.00m	pcs	10
4. Farm Road				
	Excavation		cum	286
	Embankment		cum	308
	Laterite		cum	360
	Embankment (Laterite)		cum	360
	Smoothing face		sqm	75
5. Lysimeter and Soil test frame				
	Excavation		cum	373
	Embankment		cum	205
	Reinforced concrete		cum	14.3
	Plain concrete		cum	59.5
	Iron bar		tori	0.94
	Wooden form		sqm	306.9
	Rc-pipe	ϕ1,200 l=1.00m	pcs	36
	Roof		sqm	16
	Gravel		cum	1.5
6. Deep well				
	Excavation		set	1
7 Pump system				
	Deepwell pump		set	1
	Sprinkler pump		set	1
	Reser		set	1
	Setting Pipe		cum	362
	Plain concrete		cum	0.3
	Wooden form		sqm	0.8
	Rc- Pipe	ϕ300 l=1.00	pcs	1

8. Concrete pavement (Farm management site)				
	Plain concrete		cum	15.0
	Wooden form		sqm	8.5
9. Farm management site Houses				
	Office		set	1
	Shed		set	1
	Net house		set	1
10. Reservoir				
	Excavation		cum	209
	Smoothing face		sqm	368
	Drainage		days	50

Table 29 Project Cost

I t e m	Quantity	Equipment Cost (฿)	Construction Cost (฿)	Remarks
I. Construction Cost				
A. Direct cost				
1. Land leveling	2.2 ha		422,000	
2. Irrigation canal	560 m		141,000	
3. Drainage canal	1,140 m		357,000	
4. Farm road	335 m			
	165 m		119,000	
5. Lysimeter & Soil test frame				
Lysimeter	12			
Soil test frame	12		378,000	
6. Drilling deep well	60 m	130,000	141,000	
7. Construction of pump system & set-up water supply pipe	1 set	384,000	97,000	
8. Concrete pavement for management site	1 set		32,000	
9. House of management site	1 set	243,000	205,000	
10. Reservoir	1 set		22,000	
Sub-Total		757,000	1,914,000	(1)
B. Indirect cost			383,000	(2)=(1) x 20%
C. Physical contingency			230,000	{(1)+(2)} x 10%
Sub-Total			613,000	
Total			2,527,000	(3)
II.Others			173,000	(3) x 7% (±)
Grand Total		757,000 ฿	2,700,000 ฿	

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Table 30 LIST OF EQUIPMENT

No.	I T E M	QUANTITY	REMARKS
1.	Casing for Deep Well	1 set (60m)	ϕ150 m/m
2.	Pumps		
	Submersible Pump	1 set	90 l/min
	Volute Pump	1 set	170 l/min
	Volute Pump	1 set	170 l/min
3.	Pipes and Others	1 Ls	750 m
4.	Sprinkler	1 Ls	
5.	House		
	Roman Tile	550 m^2	500x1,200mm
	Glasolite	280 m^2	500x1,200mm
	Concrete Block	250 m^2	
	Steel Net	120 m^2	
	Window	11 pcs	
	Door	4 pcs	
6.	Miscellaneous		
	Flow Meter	4 pcs	
	Valve	51 pcs	
	Float Switch	2 pcs	
	Deformed Pipe Specials	1 Ls	