THE KINGDOM OF THAILAND

DETAILED DESIGN REPORT ON CHONBURI UPLAND IRRIGATION PROMOTION PROJECT

FEBRUARY 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a survey on the Up-land Irrigation Promotion Project in Chonburi and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Thailand a survey team headed by Mr. Kouchi Kamijo from 15 December, 1982 to 28 January, 1983.

The team held discussions with the officials concerned of the Government of Thailand and conducted a field survey in Chonburi area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

1 March, 1983

Keisuke Arita
President
Japan International Cooperation Agency

Mr. Keisuke Arita
President
Japan International Cooperation Agency(JICA)
Tokyo, Japan

February, 1983

LETTER OF TRANSMITTAL

Dear Sir,

We are pleased to submit herewith the Final Report on the Detail Design for Chonburi Upland Irrigation Promotion Project in Thailand.

The Project is part of numerous projects under the suggestion and guidance of His Majesty the King of Thailand and is envisaged to establish a pilot farm with modern upland irrigation facilities on part of hilly areas owned by His Majesty.

We are firmly convinced that the introduction of upland irrigation system, by replacing the traditional rain-fed farming, would facilitate various research and experiments, advance the village modernization through educational facilities of the system, and eventually contribute to the development of vast upland as well as to the introduction of modern agriculture in the whole country.

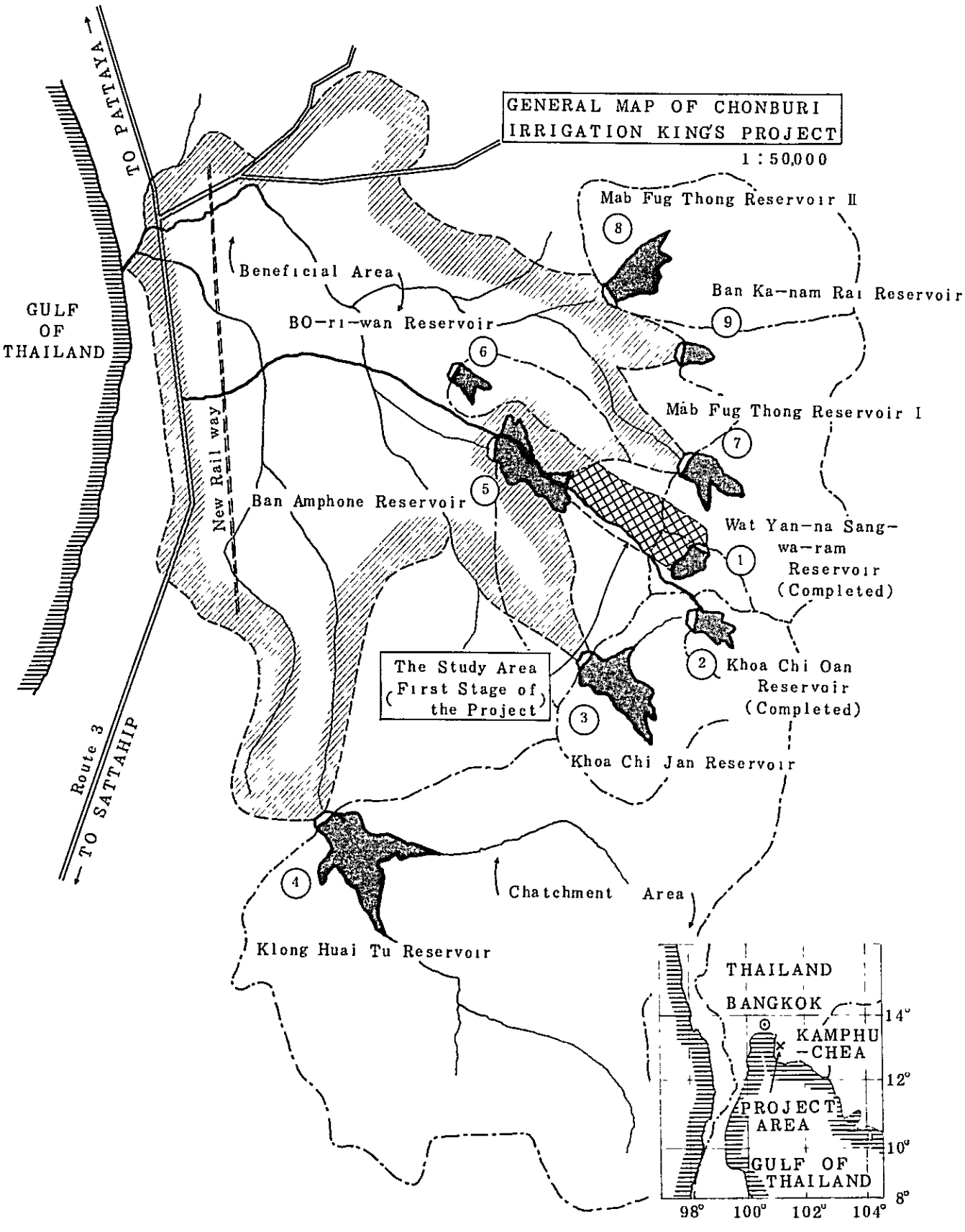
The four-member survey team dispatched to the field was headed by Mr. Koichi Kamijo and the Report has been prepared by Mr.Yasuhiro Amatsuji and the undersigned in cooperation with the RID officials concerned.

We take this opportunity to acknowledge our sincerest gratitude to Royal Irrigation Department, the executing agency of the Project in Thailand, the Japanese Ministry of Foreign Affairs, Japanese Embassy in Thailand, and Japan International Cooperation Agency(JICA) for their valuable guidance.

Respectfully yours,

C. Takahashi

Chikaichi Takahashi
Member, Survey Team for
Chonburi Upland Irrigation
Promotion Project


GENERAL MAP OF CHONBURI IRRIGATION KING'S PROJECT
1 : 50,000
TO PATTAYA
GULF OF THAILAND
New Rail way
Beneficial Area
BO-ri-wan Reservoir
Mab Fug Thong Reservoir II
Ban Ka-nam Rai Reservoir
Mab Fug Thong Reservoir I
Ban Amphone Reservoir
Wat Yan-na Sang-wa-ram Reservoir (Completed)
Khoa Chi Oan Reservoir (Completed)
The Study Area (First Stage of the Project)
Khoa Chi Jan Reservoir
Route 3
TO SATTAHIP
Chatchment Area
Klong Huai Tu Reservoir
THAILAND
BANGKOK
KAMPHU-CHEA
PROJECT AREA
GULF OF THAILAND
14°
12°
10°
8°
98°
100°
102°
104°

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1. INTRODUCTION

On May 12, 1982, His Majesty, the King of Thailand advised to R.I.D. to construct the irrigation facilities in the basin of Klong Ban Amphoe at Amphoe Ban La Mung and Amphoe Sattahip in Changwat Chonburi, about 160 km. south east from Bangkok, covering about 13,000 Rai (2,000 ha) of beneficial area including a domestic water supply in the area. Two reservoirs should be constructed in the year out of nine proposed reservoirs. One or more sequent reservoirs shall be constructed in every year and all construction works shall be completed within the year of 1985. (one reservoir was cancelled afterward) First two reservoirs have been completed already till the end of 1982, and the first stage area covers about 180 ha. of hilly land including the gentle slope (2 to 4%) of upland cropping field.

The project has particular character as so called "King's Project" which has been set up by His Majesty, the King's opinion. R.I.D. is the executing agency of the project under the guidance of the King, and actual construction works have been carried out on force account work by R.I.D., but major parts of construction equipment and their fuel expenses have been born by many contributors and many other sources of good-will.

Under the circumstances, the Government of Japan intended to extend an assistance to the Project especially for upland irrigation system. Because, many irrigation projects in Thailand have been undertaken with the assistance by the Government of Japan technically and/or financially, but no assistances related to upland irrigation project have been done yet. In Thailand, the paddy field irrigation must have a higher priority than upland one in view of the present social and economic conditions prevailing in the country, but the upland irrigation will also play an important role in the agricultural development in future.

As of January 1983, the Khoa Chi Oan Reservoir has been completed and the Wat Yan-na Sang-wa-ram Reservoir is substantially completed except minor finishing works of the dam.

The pipe laying work from reservoirs to the field is partially done by R.I.D. when the study team arrived at the site. Asbestos Cement Pipes of 300 mm. diameter with 15 class (inner pipe breaking presure is 15 kg/cm^2) are installed already in 30 m. length for the Khoa Chi Oan Reservoir outlet and in 130 m. length for the Wat Yan-na Sang-wa-ram Reservoir outlet.

This detailed design had been undertaken in consonance with R.I.D.'s design works because it was already on going project. The study team have made considerable discussions with R.I.D.'s staff at R.I.D. reginal office 9 on planning and design, the decisions were made in accordance with the discussions.

This study area is a part of the King's Project, which is including not only irrigation facilities but also building construction works for a pavilion, an agricultural training school, a clinic and temple as well. This study, however, covers only the irrigation water supply system at first stage of the Project area.

2. BACKGROUND AND PURPOSE OF THE PROJECT

In the east coast area of Thailand, there extend relatively gentle hilly lands in scarcity of flat lands. In general, the area is covered with considerably poor soil fertility.

Annual average rainfall in the Area is 1,256 mm., and average rainfall in dry season from December to April is about 300 mm. only, which causes the extremely low agricultural production in the area. Commonly, cassavas and poorly grown sugar canes, both of which are rather low profitable crops, have been planted, and scattered thin coconut plantations at places and rainfed paddy field at depressed lands can be observed in the Area. It can be said that the Area has been left intact in the field of the agricultural development.

The Area, however, has advantages in geography that is only about 160 km. apart from Bangkok, the biggest market in the country and it is easily accessible by the National Highway Route 3. Furthermore, the new national railway from Bangkok to Sattahip passing through the Area is under construction at present. Sattahip and Laem Chabang, which are being promoted as commercial ports, are located closely to the Area. While the region including the Area has recently become highlighted as the project area of the large-scaled industry development by the utilization of natural gas in the Gulf of Thailand.

In harmony with the development of these peripheral areas, the agricultural development of the Area should be expedited to cope with expected rapid population growth in supplying fresh foods and farm products.

Under the above mentioned circumstances, the irrigation King's Project have been launched by R.I.D. in the Area and first stage of the development scheme are going to get under way. In reply to the request of the Ministry of Agriculture and Cooperatives, Thailand, the Government of Japan is trying assist the to establishment of an Irrigation Model Farm providing with modernized upland irrigation facilities in the Area.

3. AGRICULTURAL ASPECT IN THE AREA

3.1 S O I L

The soil texture in the proposed field consists of sandy loam in about 30 cm. of surface soil and its clay content increase gradually with depth grading to sandy clay loam in the lower layer. The chemical reaction is slightly acid (PH. 6) in the surface and strongly acid (PH 4.5 - 5.5) in the lower layer, and overall soil are with relatively poor fertility. The top soil are considerably eroded by wind and rain due to no soil conservative measure taken up to the present. But this is a counter advantage on physical property of the soil for introducing of mechanized farming.

3.2 C R O P S

Existing crops in the Area are mostly cassava and few of sugar cane only, there is nothing else of a crop due to ill natural conditions for farming. When adequate irrigation facilities are provided in the Area, any kinds of upland crops can be introduced such as fruit trees of mango, managosuchin, dorian, guava, coconut (Mapulao nam hom), rambutan, jackfruit and oranges, and vegetables of tomato, egg plant, cucumber, green pepper, cabbage, cauliflower, Chinese cabbage, Japanese radish and leaf mustard. Other cash crop cultivations also are possible to be introduced in the Area such as sugar cane, ground nut, mung bean, bean, sweet corn, and cotton.

It can be affirmed that the irrigation farming with above mentioned diversified croppings will contribute to increase farmer's income, and stabilization and leveling up of the farmer's livelihood in the area.

4. PLANNING

4.1 GENERAL

The basic plan of the project is originated from the idea of His Majesty and the plan has been modified several times with having technical advises by His Majesty the King. This project involves various structures and facilities including not only irrigation facilities but also domestic water supply and several others which were derived from the advices by His Majesty. The present planning has been made in accordance with said ideas/advices and detailed study was carried out by the study team with having due cooperation by RID Region 9 staff.

The scope of works of the study covers thereby planning and design of water supply facilities for irrigation and domestic water.

4.2 METEOROLOGY AND HYDROLOGY

4.2.1 Climate

The climate in Thailand is classified roughly into two rainy season and dry season. Generally, rainy season covers the period from beginning of May until end of October in Northern, Northeastern and Central regions. Almost 80% of annual rainfall occurs during this period. In dry season, therefore, the effective rainfall for crop cannot be expected.

Monthly average temperature varies between the lowest, 20°C in January and the highest, 32°C in April. The average diurnal variation is approximately 8.3°C, varying between 11.1°C in January and 6.3°C in July.

According to the data in sattahip station, monthly average humidity varies between the lowest, 70% in December and the highest,

82% in October. Also monthly wind velocity varies 2.2 to 9.4 Knots (1.0 to 4.2 m/sec) and Wind directions are mainly south from January to May, Southwest from June to September and North from October to December.

4.2.2 Rainfall

This area stands about 30 km. north of Sattahip and Sattahip rain gauge station is the nearest one to this area. So it is suitable to use rainfall data of Sattahip rain gauge station for this study. This data is collected from 1952 to 1981 by Hydrology Division of RID. According to this data, the annual rainfalls varied between the lowest 757.5 mm. in 1955, and the highest 2,089.4 mm. in 1970. Average annual rainfall is 1,213.9 mm. (Appendix - 2)indicates the variation of annual rainfall during a 25 - year period from 1958 to 1981. (Appendix 3) shows the monthly rainfalls at the selected 10 - years period from 1968 to 1977.

4.2.3 Evaporation

In general, the evaporation measured by the Class-A pan is commonly applied for water resources and irrigation engineering. But Sattahip Station is equipped with piche for measuring evaporation records.

This records are available at Hydrology Division of RID from 1951 to 1972. Actual Evaporation = Piche x 1.289. This formula is for converting value from Piche to actual evaporation value.

Then (Table - 1) is converted by the formula to actual monthly evaporation in 5 year period from 1965 to 1969.

(Table - 1)

EVAPORATION RECORD AT SATTAHIP

[Unit : mm)

Month / Year	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.
1969	88.9 114.6	78.5 101.2	89.0 114.7	83.0 107.0	68.1 87.8	63.6 82.0	40.5 52.2	58.1 74.9	91.6 118.1	75.9 97.8	81.6 105.2	83.0 107.0
1968	69.9 90.1	55.7 71.8	56.6 72.9	82.9 106.9	88.4 113.9	73.6 94.9	53.4 68.8	73.7 95.0	86.5 111.5	86.7 111.8	61.7 79.5	68.5 88.3
1967	96.9 124.9	87.9 113.3	94.5 121.8	93.3 120.3	102.4 132.0	79.5 102.5	47.7 61.5	58.5 75.4	90.2 116.3	95.2 122.7	72.0 92.8	110.6 142.6
1966	74.1 95.5	59.4 76.6	61.7 79.5	59.7 77.0	58.5 75.4	45.5 58.6	32.7 42.2	55.9 72.1	58.4 75.3	77.9 100.4	51.2 66.0	71.9 92.7
1965	77.7 100.2	60.4 77.9	75.7 97.6	91.0 117.3	59.0 76.1	45.7 58.9	38.9 50.1	55.2 71.2	72.2 93.1	93.0 119.9	70.2 90.5	72.8 93.8
TOTAL	407.5 525.3	341.9 440.8	377.5 486.5	409.9 528.5	376.4 485.1	307.9 396.9	213.2 274.8	301.4 388.6	398.9 514.3	428.7 552.6	336.7 434.0	406.8 524.4
MONTHLY AVE.	105.1	88.2	97.3	105.7	97.0	79.4	55.0	77.7	102.9	110.5	86.8	104.9
DAILY AVE.	3.5	2.8	3.2	3.4	3.1	2.6	1.8	2.6	3.3	3.6	3.1	3.4

NOTE : Upper figures in columns show evaporation value by PICHE.
Lower figures in columns show equivalent to actual evaporation value converted above.

To calculate the diurnal evaporation, it varies between the highest 3.6 mm. in January and the lowest 1.8 mm. in October. Annual average evaporation per day is 3.0 mm/day. Dry season average evaporation per day is 3.3 mm/day. At view point of safety side, it should be 4.0 mm/day in dry season, because measuring method with piche is not common way for the evaporation.

4.3 WATER RESOURCES

4.3.1 Selection of Model Year

Analysis of rainfall data as well as run-off discharge are carried out based on the selected model year which indicates return period of 10 year and 2 year of the drought rainfall during rainy season from 1952 to 1981. The following table shows monthly rainfall data at Sattahip Station. The probability graphs which are plotted by Hazen Plotting Method for drought rainfall are shown in (Appendix - 4).

Probability	Model Year	Annual Rainfall
W = 1/10	1961	873.3 mm
W = 1/2	1973	1,168.8 mm

Year	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1961	44.5	188.6	136.1	20.3	32.7	53.1	161.4	94.6	13.7	0.2	10.9	117.2
1973	10.5	192.6	152.5	143.2	63.0	325.7	112.5	71.5	1.0	35.7	7.9	52.7

4.3.2 Run-off Discharge

The reservoir is supplied by run-off discharge, which is effected by many factors such as topographic condition, vegetation of watershed area, rainfall intensity and etc. However, an unit run-off discharge is estimated by assuming run-off coefficient based on the above conditions. These following formulas are one of the method to estimate the monthly run-off coefficient.

Formula	Adaptation
C = 0.130 (R - 60)	From April to May
C = 0.132 (R - 30)	From June to September
C = 0.130 (R + 10)	From October to November

(R : Monthly rainfall data)

It assumes rainfall is no effect for run-off discharge in dry season during December to March. This estimation method is derived from SSIP report.

4.3.3 Study of water balance in the two reservoir

The following table gives water inflow and evaporation and percolation, and estimated available amount of water.

WATER BALANCE IN THE BASIN

(Table - 2)

	MONTH	Rainfall	R.C.	Runoff	Discharge for (RC)	Discharge for (Rd)	Water Surface Area of (Rc)	Water Surface Area of (Rd)	Total discharge	Total Storage Loss	Available Pondage	
		(mm)	(%)	(mm)	$\times 10^3 (m^3)$	$\times 10^3 (m^3)$	(ha)	(ha)	$\times 10^3 (m^3)$	$\times 10^3 (m^3)$	$\times 10^3 (m^3)$	
1973	Apr	10.5	-	-	-	-	-	-	-		-	
	May	192.6	17.2	33.1	26.48	19.03	1.50	1.00	45.51	0.13	45.38	
	Jun	152.5	12.0	18.3	14.64	10.52	2.50	1.50	25.16	0.20	70.34	
	Jul	143.2	14.9	21.3	17.04	12.25	3.00	2.00	29.29	0.25	99.38	
	Aug	63.0	9.6	6.0	4.80	3.45	3.20	2.20	8.25	0.27	107.36	
	Sep	325.7	43.6	142.0	113.60	81.65	6.00	4.80	192.25	0.54	299.07	
	Oct	112.5	15.9	17.9	14.32	10.29	6.20	4.90	24.61	0.56	323.08	
	Nov	71.5	10.6	7.6	6.08	4.37	6.40	5.00	10.45	0.57	332.96	
	Dec	1.0										
	Jan	35.7										
	Feb	7.9										
	Mar	52.7										
	Total	1,168.8										
1961	Apr	44.5	-	-	-	-	-	-	-	-	-	
	May	188.6	16.7	31.5	25.20	18.11	1.50	1.00	43.31	0.13	43.18	
	Jun	136.1	14.0	19.1	15.28	10.98	2.30	1.60	26.26	0.20	69.24	
	Jul	20.3	-	-	-	-	2.30	1.60	-	0.20	69.04	
	Aug	32.7	0.4	0.1	0.08	0.06	2.30	1.60	0.14	0.20	68.98	
	Sep	53.1	3.0	1.6	1.28	0.92	2.30	1.60	2.20	0.20	70.98	
	Oct	161.4	22.3	36.0	28.80	20.70	3.20	2.30	49.50	0.28	120.20	
	Nov	94.6	13.6	12.9	10.32	7.42	4.00	2.60	17.74	0.33	137.61	
	Dec	13.7										
	Jan	0.2										
	Feb	10.9										
	Mar	117.2										
	Total	873.3										

4.4 LAND USE PLAN

The original vaguely land use plan was prepared by RID, and the latest plan was established based on the discussion between the study team and RID with approval by His Majesty the King. There have been considerable modifications on the process to finalize the latest plan and some more minor changes might be required to suit the advices to be given in future by His Majesty.

Most of the land belong to the property of His Majesty except the land owned by the temple. The land partition are shown on the general map and each acreage of plots are as follows:-

Forest Zone	120.0 ha	
Orchard	28.5	
Pavilion	8.8	
School	3.2	
Demonstration Farm	12.0	
Clinic	1.6	
Sub-total	174.1 ha	(property of His Majesty)
Temple	6.3 ha	
Residencial Zone	4.0	
Sub-total	10.3 ha	(property of the temple)
Total	184.4 ha	

The detailed design has been made based on this land use plan. The water utilization plan, water distribution plan and water requirement have also been established based on the above mentioned acreage of plots.

4.5 WATER UTILIZATION PLAN

4.5.1 General

Two reservoirs are involved in this stage of the project. Names of reservoirs are Khoa Chi-Oan and Wat Yan-na Sang Wa-ram. The former reservoir has been completed before the end of 1982, and the latter one is under construction though it is also substantially completed at present. Major descriptions of two reservoirs are as follows:-

Item	Unit	Khoa Chi-Oan Reservoir	Wat Yan-na Sang Wa-ram Reservoir	Total
Catchment Area	km^2	0.8	0.575	1.375
Storage Capacity (whole)	m^3	310,000	230,000	540,000
Storage Capacity (available)	m^3	270,000	180,000	450,000
H W.L.	m	78.8	68.0	
L.W.L.	m	74.0	64.0	

The water utilization plan of these reservoirs is very complicated due to limited amount of water resources and difference of storage water levels between two reservoirs. Wat Yang-na Sang wa-ram Reservoir is seemed to have too small catchment area acutually, but RID has a plan to expand the catchment area through providing diversion or transbasin canal to introduce the run-off water from the vicinity area in future in order to get more inflow into the reservoir.

At the present situation, Khoa Chi-Oan Reservoir shall be filled at first, then if excessed inflow arise it shall be discharged into Wat Yan-na Sang Wa-ram Reservoir through the pipeline system.

The annual available amount of water is 450,000 cu.m. allocating 100,000 cu.m. for the domestic use and rest of them for the irrigation water. The water of Khoa Chi-Oan Reservoir is to be used through the service ponds for the domestic water supply in the first instance, for the upper part of upland irrigation system in the second instance and for the water supply to the orchard and other plants in the last instance. The utilization of Wat Yan-na Sang Wa-ram Reservoir water is to irrigate by direct connection with pipelines for the lower part of upland irrigation system and for the orchard and other plants with insufficient water pressure. These water distribution schemes are established after due consideration upon the priority of usage, and the water pressure and amount of usefull water of each reservoir.

4.5.2 Water demand

(1). Domestic Water

Amount of water for domestic use should be less than 100,000 m^3. There is monasteries, pavilion, school, private houses and clinic in this area. The following table shows estimated number of people and annual demand.

Daily water demand per capita is adapted at 200 l/day/capita as suggested by RID.

Facility	Number of People	Annual amount of water use (m^3)
Monstery	100	7,300
Pavilion	100	7,300
School	150	10,950
Private Zone	200	14,600
Clinic	50	3,650
MON DOP	---	7,300
TOTAL	600	51,100

Domestic water should be purified by water purification system. The purification system is considered to be established at two sites, one for the pavilion and another for the others.

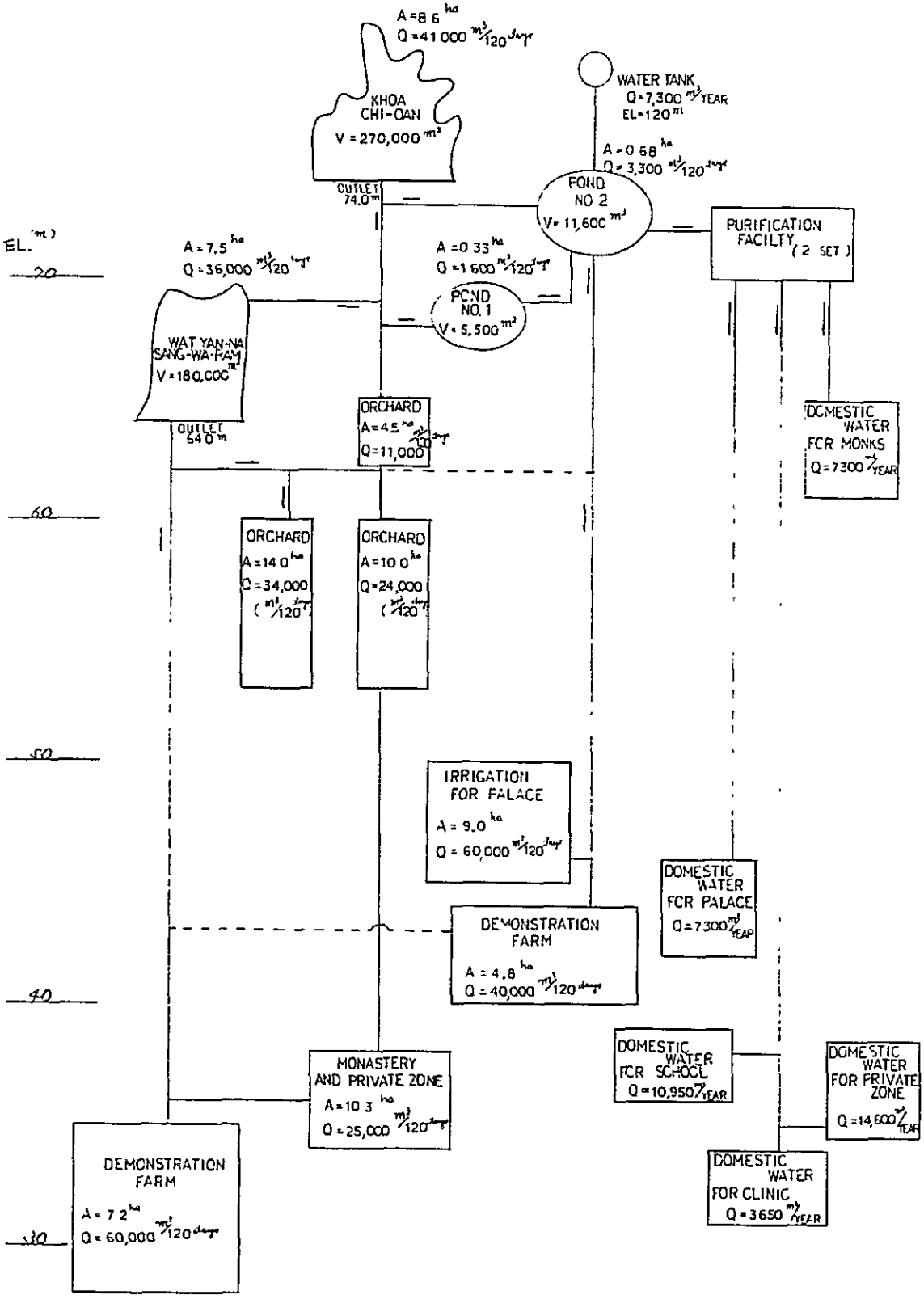
(2). Irrigation

The water demand for irrigation should be less than 350,000 m^3. The whole area except the forest zone should be provided with irrigation facilities. But water resources are not sufficient to cover the whole system. The whole area shall therefore be classified into four divisions which have a different priority. The following table shows each division's priority and areas.

Division	Priority	area (ha)	Remarks
Pavilion	First	8.8	5 mm/0.75 = 6.7 mm/day
Demonstration farm	Second	12.0	5 mm/0.75 = 6.7 mm/day
Private Zone and monastery Zone	Third	10.3	1.5 mm/0.75 = 2.0 mm/day
Orchard Zone	Forth	28.5	1.5 mm/0.75 = 2.0 mm/day

Pavilion and demonstration farm can use 5 mm/day without irrigation efficiency loss, because this value is maximum consumptive use in upland irrigation, assuming the total irrigation efficiency at 75%. Rained water can be used for the other part. It is estimated at about 2 mm/day including the irrigation efficiency. So, actual available amount of water is 1.5 mm/day. The following (Fig. - 1) shows annual water demand for irrigation in each division and storage losses in reservoirs during a dry season, and annual water demand for domestic use.

(Fig. - 1)


A=8.6 ha
Q=41,000 m³/120 day
KHOA CHI-OAN
V=270,000 m³
OUTLET 74.0 m
WATER TANK
Q=7,300 m³/YEAR
EL=120 m
A=0.68 ha
Q=3,300 m³/120 day
POND NO 2
V=11,600 m³
PURIFICATION FACILTY (2 SET)
EL. (m)
20
A=7.5 ha
Q=36,000 m³/120 day
A=0.33 ha
Q=1,600 m³/120 day
POND NO. 1
V=5,500 m³
WAT YAN-NA SANG-WA-RAM
V=180,000 m³
OUTLET 64.0 m
ORCHARD
A=4.5 ha
Q=11,000
DOMESTIC WATER FOR MONKS
Q=7300 m³/YEAR
60
ORCHARD
A=14.0 ha
Q=34,000 (m³/120 day)
ORCHARD
A=10.0 ha
Q=24,000 (m³/120 day)
50
IRRIGATION FOR FALACE
A=9.0 ha
Q=60,000 m³/120 day
DOMESTIC WATER FOR PALACE
Q=7300 m³/YEAR
DEMONSTRATION FARM
A=4.8 ha
Q=40,000 m³/120 day
40
DOMESTIC WATER FOR SCHOOL
Q=10,950 m³/YEAR
DOMESTIC WATER FOR PRIVATE ZONE
Q=14,600 m³/YEAR
MONASTERY AND PRIVATE ZONE
A=10.3 ha
Q=25,000 m³/120 day
DOMESTIC WATER FOR CLINIC
Q=3650 m³/YEAR
DEMONSTRATION FARM
A=7.2 ha
Q=60,000 m³/120 day
30

5. DESIGN

5.1 FIELD SURVEY

The field survey have been mostly finished already by RID. RID has prepared 1 : 5,000 map covering whole the study area by aerial photo survey and 1 : 1,000 map by ground servey. Some parts of the pipeline survey, including the location of the pipeline center and longitudinal profile have been completed by RID. The actual field survey works were made by RID survey staff.

5.2 PIPELINES

5.2.1 Location of Pipeline

The pipeline system in this area is originated from two reservoirs and it is terminated at the lower demonstration farm, covering about 70 ha. of irrigable land.
The drawing No. 301 shows location of the pipeline system.

5.2.2 Diameter of Pipes

The following table shows the appropriate velocity of flow in pipeline.

Diameter (mm)	Velocity of flow (m/sec)
75 - 150	0.7 - 1.0
200 - 400	0.9 - 1.6
450 - 800	1.2 - 1.8
900 - 1500	1.3 - 2.0
1600 - 300	1.4 - 2.5

The velocity of flow is calculated by the following formula.

$\bar{V} = Q/A$ ..... $\bar{V}$ = Velocity of flow
Q = Amount of water
A = Section area of pipe

The section area of pipe for each diameter is as shown in the following Table.

Diameter of pipe ----- (mm) ----	Section area (m^2)
ø 300	0.0707
ø 250	0.0491
ø 200	0.0314
ø 150	0.0177
ø 125	0.0123
ø 100	0.0079
ø 75	0.0044
ø 50	0.0020

The diameter of pipe was so decided by changing the section area as to realize the appropriate velocity of flow.

5.2.3 Material of pipe

In deciding the material of pipe, attention was paid on as much aspects as possible. In conclusion PVC pipe has been selected. PVC has many advantages which are less troùble in maintenance, sufficient strength for pressure, easiness in construction, varieties in dimensions from 10 mm to 300 mm and economical price.

5.2.4 Calculation of friction loss

The following is called Hazen-Williams formula.

$$\overline{V} = 0.84935\ CR^{0.63}\ I^{0.54} \quad \text{---------(1)}$$

$\overline{V}$ = Velocity of flow (m/s)
C = Coefficient of velocity
R = Hydraulic radius (m)
I = Hydraulic gradient

In the case of circular pipe, (1) truns to the following

$$\overline{V} = 0.35464 \quad CD^{0.63}(hf/L)^{0.54} \text{ ----------(2)}$$

D = Diameter of pipe (m)
I = hf/L
hf = Friction loss (m)
L = Length (m)

The the following formula is shown.

$$Hf = \frac{6.819 \times L \times V^{1.852}}{C^{1.852} \times D^{1.167}}$$

C = 130
V = Q/A (m/s)
Q = amount of water
A = Section area of pipe

Dimensions concluded for each pipeline is as shown in Appendix - 5

5.2.5. Pipe Joints

There are two method of the PVC pipe connection, naming a Rubber Ring Type Socket joint and a T.S Socket joint. A Rubber Ring Type (R.R.) joint shall be used particular treated pipes which have a special formed socket at one side of pipe end, and a rubber ring shall be used at the joint between the Socket and the inserted pipe in order to secure the water tight joint. This type of joint is very easy in the field work and no particular technic is necessary for the pipe laying work. But the material cost is slightly higher than another type of joint.

T.S Socket joint is a most simple and cheapest PVC pipe connecting method. The insertion part of a pipe end shall be coated with adhesive agent so as to adhere with the Socket of the other pipe end. The Socket treatment on one side of pipe end can be made at the field. But this method is requested skilled technic at the field especially for large size pipe connections under the tropical atmosphere and the water tightness of the joint is little lower than another.

In this connection the Rubber Ring Type Socket joint is applied in this project and all standard pipes are 5 meter in effective length.

Furthermore special joints, such as tees, crosses, reducers, bendings, elbows, dresser couplings are provided in the pipeline in order to make sound pipelines.

5.3 WATER SUPPLY SYSTEM

5.3.1 Pipeline Networks

(1) Pavilion

The pavilion zone is classified into two, flower garden and the reservoir. The water demand for flower garden is estimated at 5 mm/day. The storage loss from the reservoir is estimated at 4 mm/day. But the area of reservoir is much smaller than the area of flower garden, and 5 mm/day is estimated as the water demand in the this zone.

$$Qd = \frac{q \times A}{E_1}$$

$$= \frac{5\ mm/day \times 10^{-3} \times 7.5\ ha \times 10^{4}}{0.85}$$

$$= 441\ m^3/day$$

Qd = Diurnal available amount of water (m^3/day)
q = Water demand (mm/day)
A = Irrigation area (m^3)
E_1 = Water-application efficiency

Maximum amount of water is

$$Q\ max = \frac{q \times A}{E \times T}$$

$$= \frac{5 \times 10^{-3} \times 7.5 \times 10^{4}}{0.75 \times 9 \times 60 \times 60}$$

$$= 0.0154\ m^3/s$$

E = Irrigation efficiency
T = Irrigation time

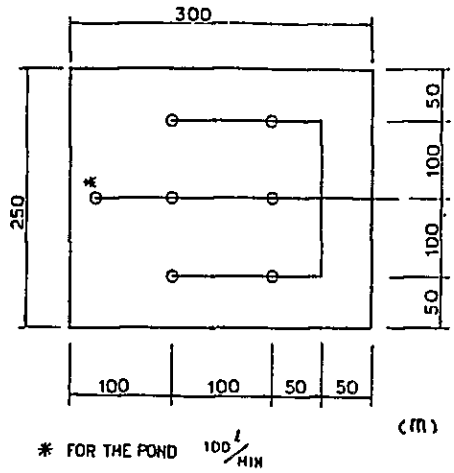
This formula gives the available amount of water per day. The following Fig.- 2 is system of water supply called Hydrant

It estimates capacities of valve at 120 ℓ/M and 100 ℓ/M

$$Q^1 = 120\ \ell \times 10^{-3} \times 6 \times 60 \times 9 + 100 \times 10^{-3} \times 1 \times 60 \times 9$$

$$= 442.8\ m^3/day \qquad Q^1 \doteq Qd$$

and $$Q^2 = \frac{442.8}{9 \times 60 \times 60} = 0.0137\ m^3/s \qquad Q^2 < Q\ max$$



(Fig. - 2)

The valve which has 100 ℓ/M capacity is for reservoir, and the others are for flower garden. The materials for this system is shown by Table - 3-1.

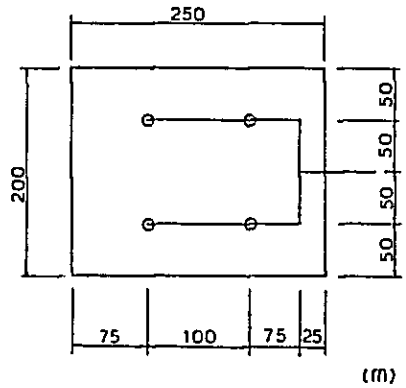
(2) Residencial zone

The residencial zone consists of private zone and monastery zone. Available amount of water for these zone is 25,000 m^3/dry season. So, daily available amount of water during dry season is 25,000 x 0.9/120 = 187.5 m^3/day. The following Fig. - 3 is standard water supply system to these zone. It is semilar system to the one for pavilion but system capacity is different. Capacity of the valve is 70 ℓ/M in this system. Actual available amount of water for standard supply system is

$$Qd = 187.5 \times \frac{5 \text{ ha}}{10.3 \text{ ha}} = 91 \text{ m}^3/\text{day}$$

$$Q^1 = 70 \times 10^{-3} \times 60 \times 9 \times 4 \times 0.6 = 90.7 \text{ m}^3/\text{day}$$

$Q^1 \doteqdot Qd$



(Fig. - 3)

It estimates the rate of operation of valve at 60%

The residencial zone is supplied by two pipeline systems. One system is for monastery zone and the other is for private zone. But it is considered each zone can be adapted to the standard water supply system.

$$Q\ max = \frac{1.5 \times 10^{-3} \times 5.0 \times 10^{4}}{0.75 \times 9 \times 60 \times 60} = 0.0031\ m^3/sec.$$

$$Q^2 = \frac{90.7}{9 \times 60 \times 60} = 0.0028\ m^3/day = Q^2 < Q\ max$$

The material for this system is shown by Table - 3-1.

(3) Orchard

The standard water supply system of orchard is given in Fig. - 4 The total area of ochard is 28.5 ha. It is large enough to consider rotation blocks for irrigation. The ochard zone can be divided into six rotation blocks, Fig. - 4.

It is estimated the diurnal available amount of water for the rotation block by the following.

$$Qd = (34{,}000 + 24{,}000 + 11{,}000) \times 0.9/120 = 517.5\ m^3/day$$

The capacity of valve is assumed at 160 ℓ/M.

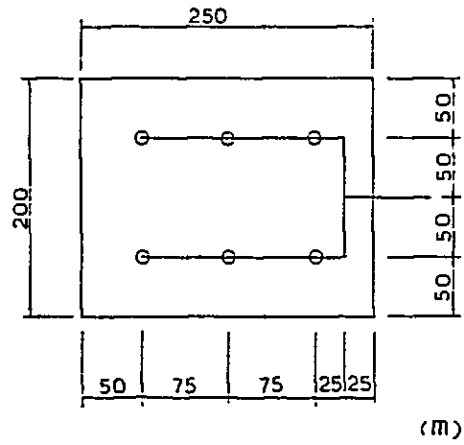
$$Q^1 = 160^{\ell} \times 10^{-3} \times 6 \times 60 \times 9 = 518.4\ m^3/day = Q^1 \doteqdot Qd$$

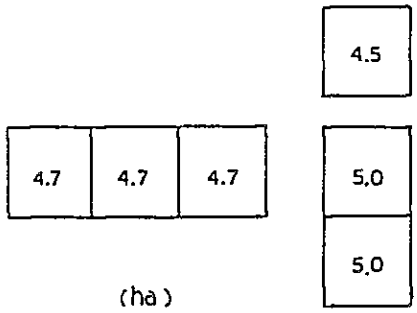
$$Q\ max = \frac{1.5 \times 10^{-3} \times 5.0 \times 10^{4} \times 6}{0.75 \times 9 \times 60 \times 60} = 0.0185\ m^3/s$$

$$Q^2 = \frac{518.4}{9 \times 60 \times 60} = 0.0160\ m^3/s = Q^2 < Q\ max$$

The materials for this system is shown in Table - 3-1.

(Fig. - 4)





(4) Demonstration farm

Term of irrigation ..... Dry season (Dec. 1 - Mar. 30) 120 days

Consumptive use ..... 5 mm/day

Irrigation period ..... 6 days

Irrigation effeciency (E) ... 75% (E = Et x Ea) = 0.90 x 0.85 ≒ 0.75

Transport efficienty (Et) 90%

Application efficiency (Ea) 85%

Irrigation hour ..... 8 hr. (9:00 - 17:00)

Method of irrigation ..... Medium pressure sprinkler system (using gravity water head)

Intervals of pipe..... 18 m.

Intervals of sprinkler..... 18 m.

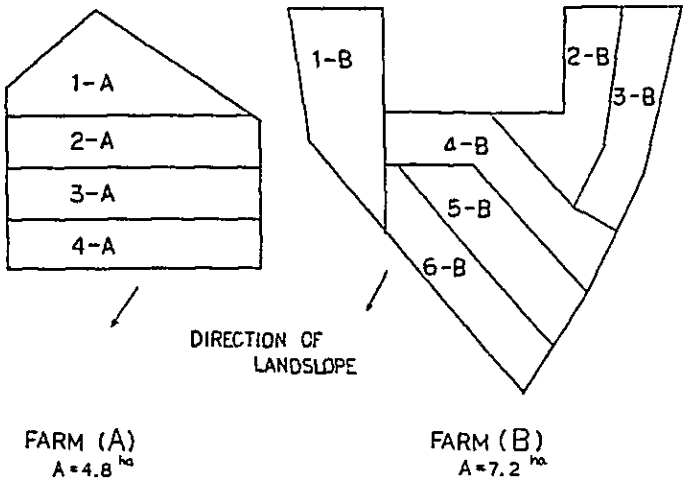
Rotation block ..... 2.4 ha (60 m x 120 m x 2)

1) Irrigation period and Rotation Block

General, irrigation period is estimated by T.R.A.M. which is total readily available moisture. But there is not sufficient data, so it adaptes the irrigation period commonly applied which is 4 - 6 day.

The demonstration farm is divided into 2, such as farm (A) and farm (B). Each farm has different water supply system. Farm (A) is supplied water from Khoa Chi-Oan reservoir and farm (B) from Wat Yan-na Sang Wa-ram reservoir. The following Fig. - 5 shows shape of these farms and the rotation block. These block's area is 1.2 ha for each.

(Fig. - 5)



It is more economical to irrigate each farm at the same time, because it can be estimated the smaller value of maximum amount of water in the case. For example, if irrigation covers (1)-A and (2)-A at the same time, the pipeline supplying water to farm (A) should be of larger diameter than to irrigate farm (A) and farm (B). The following table shows irrigation plans in this case.

First day	Second day	Third day	fourth day	Fifth day	Sixth day
(1)-A	(2)-A		(3)-A	(4)-A	
		(5)-B			(6)-B
(1)-B	(2)-B		(3)-B	(4)-B	

In conclusion, unit irrigation block is 1.2 ha, rotation block is 2.4 ha and irrigation period is 6 days.

2) Consumptive use

According to many experimention for maximum consumptive use for crops, commonly, the highest value is 5 mm/day. As this area has no particular crops to bring in 5 mm/day consumptive use shall be adopted.

3) Irrigation time

Commonly, irrigation time is estimated at about 12-14 hr/day. But, demonstration farm is a special case. When considering the people who takes care of this farm.8 hr/day (9:00-17:00) which is based on the office time shall be applied.

4) Method of upland irrigation

The method of upland irrigation is classified roughly into three, surface irrigation, spray irrigation and sub-surface irrigation. The following is introduction of common upland irrigation method.

i) Surface irrigation
- Border method
- Contour ditch method
- Basin method
- Furrow irrigation
- Ooze irrigation

ii) Spray irrigation
- Sprinkler method
- Perforated pipe method
- Mist irrigation

iii) Sub-surface irrigation
- Open canal method
- Pipeline method

(i)-a Border method

This method consist of a long and narrow field enclosing with a low bordes where has gentle slope for water flowing down.

(i)-b Furrow irrigation

Making furrowes on the field, water flows down along these furrowes.

(ii)-a Sprinkler method

Using pressured water, sprinklers supply water to the field like rainfall.

(ii)-b Perforated pipe method

Using perforated pipe or hose sprays water to the field.

5) Choice of upland irrigation method

The following factor shall be considered in choosing the method of upland irrigation.

i) Field condition

(a) Topograhy
(b) Soil texture
(c) Shape of the field

ii) Climate condition

(a) Velocity of wind
(b) Direction of wind

iii) Water efficiency

iv) Farming

(a) Cropping plan
(b) Labor's operation technique

v) Economy

(a) Marketing
(b) Economic evaluation

vi) Multipurpose use and Automation

vii) The others

In this study, (vii), the other factor is very important. Because demonstration farm has many purposes such as, introduction of upland irrigation, extension to the farmer and etc. Further, this area has enough water head to irrigate by sprinkler system without pumping facility.

The following table shows adaptability of upland irrigation Method.

(Table - 4)

ADAPTABILITY OF UPLAND IRRGATION METHOD

	THIS AREA	SPRAY IRRGATION		SURFACE IRRGATION		
		SPRINKLER	PERFORATED PIPE	FURROW	BORDER	COZE
(1) FIELD CONDITION ⓐ TOPOGRAHY	FLAT (1~2°)	O	O	△	△	O
ⓑ SOIL TEXTURE	SANDY LOAM	O	O	O	O	O
ⓒ SHAPE OF THE FIELD	200×120M	O	△	△	△	△
(2) CLIMATE CONDITION	AVERAGE WIND VELOCITY ×2.5M	O	O	O	O	O
- WATER EFFICIENCY		O	O	△	△	O
(3) FARMING ⓐ CROPING PLAN	NO DESIGNED CROP	O	O	△	△	X
ⓑ LAVOR INSTALLTIM AND TECHNIQUE		O	O	△	△	O
(4) ECONOMY		-	-	-	-	-
(5) MULTIPURPOSE USE & AUTOMATION		O	O	X	X	X
(6) THE OTHERS	DEMONSTRATION EFFECT	O	O	O	O	O
	EXTENSION		O	O	O	△

O AVAILABLE
△ POSSIBLE
X IMPOSSIBLE
- NO CONSIDERATION

According to this table, sprinkler system is recommended to be brought in the project. In addition, it is necessary to arrange valves for water supply to make it possible to introduce the other method of upland irrigation for the area.

6) Sprinkler System

(Table - 5)

Spray intensity	Less than 20 mm/hr.
Type of Sprinkler	Meddium pressure sprinkler ($2.5 - 2.0$ kg/cm^2)
Size of nozzle	4.8 m/m x 2.4 m/m
Spray facility	Fixed type
Distance of pipeline	18 m
Distance of sprinkler	18 m
Number of sprinkler on the one line	11
Number of one rotation line	3
Area of one rotation line	1.2 ha (200 m x 60 m)
Amount of water in one line	15.6 ℓ/s
Rotation block	2.4 ha (1.2 ha x 2)

i) Spray intensity

The following table shows the maximum permissible spray intensity classified by the soil texture and the land slope.

(mm/hr)

Soil Texture	Flat	Incline
Sand	30	20
Loam	15	10
Clay	10	7

The soil texture of this area is sandy loam and the land slope is about 2°, being a flat field. So, the maximum permissible spray intensity is estimated at 20 mm/hr.

ii) Pipeline and sprinkler distance

The following formula gives adaptable distance of pipeline and sprinkler.

α = 0.5 - 0.7 D α = Sprinkler interval (m)

β = 0.55 - 0.65 D β = Pipeline interval (m)

D = Spray diameter

Table - 6 is a efficiency of sample of sprinkler

NOZZLE / PRESURE	4.0×2.4%		4.4×2.4%		4.4×3.2%		4.8×2.4%		4.8×3.2%		5.2×3.2%	
	DIAMETER	AMOUNT OF WATER	DIAMETER	AMOUNT OF WATER	DIAMETER	AMOUNT OF WATER	DIAMETER	AMOUNT OF WATER	DIAMETER	AMOUNT OF WATER	DIAMETER	AMOUNT OF WATER
1.5	24.0	16.2	24.4	20.8								
2.0	25.2	19.0	26.4	23.8	26.4	28.4	27.5	27.7	27.5	29.0	27.8	36.4
2.5	26.1	21.4	27.5	26.4	27.5	29.2	28.5	28.4	28.5	33.0	29.4	40.7
3.0	27.0	24.1	28.3	28.6	28.3	32.2	29.5	31.5	29.5	37.0	30.5	44.6
3.5							30.2	33.4	30.2	40.5	31.2	47.7
4.0							30.8	35.3	30.8	42.6	31.8	51.0

Note : Pressure; kg/cm^2; Diameter; m; Amount of water; ℓ/min

The minimum spray intensity is

$$I_1 = \frac{5 \text{ mm} \times 6}{0.85 \times 7}$$

$= 5.04$ mm/hr

* Irrigation period = 6 days
* Application efficiency = 85%
* Actual irrigation time = 7 hr.

The following formula gives spray intensity.

$$I = \frac{60 \times q}{\alpha \times \beta}$$

I = spray intensity

q = capacity of water amount (ℓ/min)

It shall be $I > I_1$

The table - 7 shows spray intensity, changing distance of pipeline and sprinkler. This area is favoured by gravity water head for sprinkler system, in this case water pressure for sprinkler is changeable. So, the water presure between 2.5 - 2.0 kg/cm^2 shall be considered.

(Table - 7)

β m	α m	I mm/hr					
		4.4 X 2.4 M/H		4.4 X 3.2 M/H		4.8 X 3.2 M/H	
		P = 2.0 Kg/cm² Q = 23.8 L/MIN D = 26.4 M	P = 2.5 Q = 26.4 D = 27.5	P = 2.0 Q = 26.4 D = 26.4	P = 2.5 Q = 29.2 D = 27.5	P = 2.0 Q = 27.7 D = 27.5	P = 2.5 Q = 28.4 D = 28.5
16	15	5.95	6.60	7.10	7.30	6.93	7.10
	16	5.58	6.19	6.66	6.84	6.49	6.65
	17	5.25	5.82	6.26	6.44	6.11	6.26
	18	4.96	5.50	5.92	6.08	5.77	5.92
18	15	5.29	5.87	6.31	6.49	6.16	6.31
	16	4.96	5.50	5.92	6.08	5.77	5.92
	17	4.67	5.18	5.57	5.73	5.43	5.57
	18	4.41	4.89	5.26	5.41	5.13	5.26

To find the most adaptable case which satisfies the upper condition ($I > I_1$) and has the most closely value of spray intensity to the minimum, case is selected and checked the condition for the interval of pipeline and sprinkler to satisfy

α = (0.5 - 0.7) D = 14 - 19 m, —— 18 m

β = (0.55 - 0.65) D = 15 - 18 m, —— 18 m

Fig. - 8 shows the standard type of the sprinkler irrigation farm in this area. A rotation line occupies 1.2 ha, so number of rotation line which works at the same time is 3 lines.

The amount of water at this time is

$$Q = \frac{28.4 \times 10^{-3} \times 11 \times 3}{60} = 0.0156 \ m^3/s$$

The daily maximum amount of water is

$$Qd = \frac{(600,000 + 40,000) \times 0.9}{120} = 750 \ m^3/day$$

The maximum amount of water in a irrigation period is

$$Q_{IP} = 750 \times 6 = 4,500 \ m^3/6 \ day$$

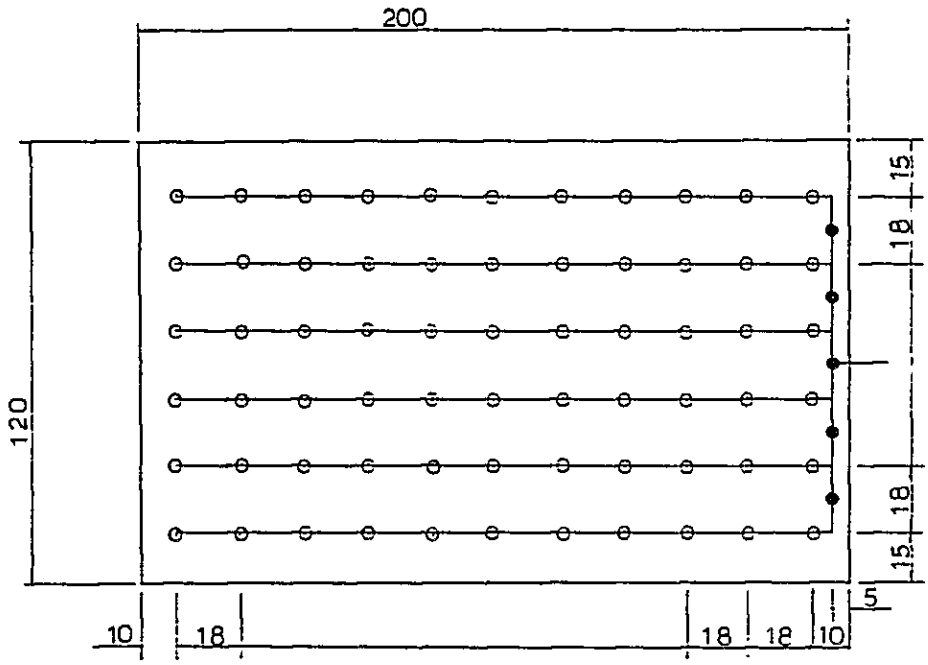
$$Q'_{IP} = 0.0156 \times 60 \times 60 \times 8 \times 12.0/112 = 4492.8 \ m^3/6 \ day$$

$$Q'_{IP} < Q_{IP}$$

$$Q \ max = \frac{5 \times 10^{-3} \times 1.2 \times 10^{4} \times 6}{0.75 \times 8 \times 60 \times 60} = 0.0167 \ m^3/s$$

$$Q < Q \ max$$

(Fig. - 6)



(m)

○ SPRINKLER

● ANGLE VALVE

5.4 PUMPING FACILITIES

5.4.1 Electo Motor Pump

Pumping facilities shall be provided for two systems, a main water supply system from the lower service pond to the upper service pond and a water supply system to the hill top. Former pumping station shall be at the lower pond and latter one is at the upper pond of the nearest place to the discharge tank in order to minimize the pipeline length and pipe friction head loss.

The main water supply pumps shall consist of two same type of pumps which have an advantage for the operation and maintenance, and decreasing of risks in emergency. Two sets of the prevailing type of pumps, end suction type volute pumps of 100 mm of diameter with 5.5 KW electro motors are applied. The discharge capacity is 1.0 m^3/min x 2 set = 2.0 m^3/min.

Since amount of water supply to the hill top a 1" size pump is sufficient in discharge capacity but lifting height of supplying water is required 62 meters in actual and 75 meters in total head considering delivery pipes water head loss. Then special multi-stage turbine pump shall be provided. However a smallest ready made a standard pump is 40 mm bore having 0.10 to 0.2 m^3/min discharge capacity. It is about 4 times of required discharge capacity but it is more suitable than the special ordered a small size pump practically.

The electric power shall be used for those pump operation. The present power line seems to be single phase current, so that new power line with three phase and 380 volt shall be provided to the pumping stations.

5.4.2 Substitutional Energy Pump

The utilization of substitutional energy such as a wind mill pump and a sola-powered pump are studied whether they can be applied in the project or not. In conclusion, they are not recommendable for the project. Because these pumps have very small discharge capacity and their lifting height are also not sufficient. The wind mill will not work in dry season from December to March due to insufficient wind velocity. In any case these facilities can be considered only at no electrical power zone only.

5.4.3 Pump Specification

The specification of pumps are as follows:-

Main Pumps

Lifting height	(actual) 7.00 m (El. 68.00 to El. 75.00) (Total) 10.00 m (using 80 m x Ø 100 m x 2 Row P.V.C. pipes)
Discharge	1.0 m^3/min x 2 set 16 hrs/day operation 60 x 2 x 16 = 1,920 m^3/day
Pumps	End suction Type Volute Pump Ø 100 mm x 2 sets
Motors	3.7 kw x 2 sets 50 c/s x 4 p x 1,500 r.p.m.
Appurtenance	2 sets of Foot valves with strainer and steel suction pipe, check valves, Stop valves, and other necessary fittings and electrical facilities.

Water supply pump to the hill top

Lifting height (Actual) 62.00 m (El. 73.00 to El. 15,500)
(Total) 75.00 m (using 250 m. of Ø 40 mm P.V.C. pipes)

Discharge 20 m^3/day
8 hrs/day operation 2.5 m^3/hr
2.5 m^3 ÷ 60 = 0.042 m^3/min

The smallest prevaling standard pump of Ø 40 mm. diameter having 0.10 m^3/min discharge capacity is applicable.

Pump Multi stage turbine pump Ø 40 mm

Motor 5.5 kw - 50 c/s x 4 P x 1,500 r.p.m.

Appurtenance Foot valve with strainer and steel suction pipe, check valve, stop valve, and other necessary fittings and electrical facilities.

5.5 SERVICE PONDS

5.5.1 Purpose of the Service Pond and Location

The service pond in the irrigation network has roles in general;

1. to regulate the discharge water from the main reservoir and to save the distribution water losses
2. to save the operation labor, and
3. to minimize the construction cost for water conveyance pipeline through reducing pipe size.

The location of ponds shall be at the most convenient place for the operation and ponds shall have sufficient water level for utilization of the water.

Therefore, at the highest portion of the irrigation area, about 1.1 km down stream from Khoa Chi-Oan Reservoir, two farm ponds are planned utilizing depressed areas caused by the borrow excavation for main reservoirs construction. These service pond have extra roles in addition to the above to keep the constant water pressure for both irrigation and domestic water supply and control the water supply when the water table in main reservoir lowers down to El. 76.00 m or lower. If the water table in reservoir becomes lower than El 76.00 m., the water head becomes infufficient to convey the maximum design discharge through the main pipeline by gravity flow without pump operation. However it is possible to adjust the amount of inflow into the pond by extension of the pouring time till midnight or overnight, inspite of the discharge time from the pond is mostly day time only. So that insufficient amount of water supply to the pond due to low water pressure can be supplemented in the night time. This way is able to save the pump operation hours and cost also.

5.5.2 Storage Capacity of Ponds and Water Level

In general, bigger storage capacity of ponds are more convenient in the operation though it will cause higher cost in construction. The storage capacity should have at least 36 hours of regular water supply for the irrigation, in general. But in this case storage capacities were decided according to the excavated volume of borrow embankment for main reservoirs, and their earth works have been finished already. That is considerably large amount as estimated at 11,600 m^3 for No. 2 pond (upper one) and 5,500 m^3 for No. 1 pond (lower one). It is equivalent 4.8 days and 2.3 days water demand respectively. Elevation of high water

level are 75.00 m and 70.00 m respectively and pumping facilities are to be provided to lift up the water from the lower pond to the upper pond.

No. 1 pond is able to connect with the reservoir by gravity flow at any time, but it is not possible to take as much as design maximum discharge into No. 2 pond when main reservoir's water table comes down to the lower water table than El. 76.00 m approximately. However amount of the gravity discharge till El. 76.00 m are estimated at about 210,000 m^3 out of 270,000 m^3 of available storage capacity. Moreover, some parts of 60,000 m^3, remained water are also available to discharge into the No. 2 pond without the pump operation by means of above mentioned pond operation manner. Then actual pump operation hours are deemed to be in very short time at a critical dry season only. In such case the water consumption for irrigation shall be restricted because of the shortage of storage water so that pumping capacity at the lower pond shall not have the full of design irrigation water requirement.

5.5.3 Sealing Methods of Ponds

The foundation and embankment materials of ponds are composed of sandy soil with few clay. Since original soil texture is considerablly permeable, sealing methods shall be applied to cut or minimize the seepage water loss from the ponds. Following numerous sealing methods have been developed up to date.

1. Compacted Earth Lining (Soil Blanket)

   If suitable material is possible to be availed with appropriate cost, compacted earth lining is applied as a most ordinary method. But, protection works are necessary in this case on side slope facing against wave impact, erosion and drying by using the stone pitching or the rip rap.

If the pond is shallow, the existing material on site may be adaptable by means of remixing and compaction at optinum moisture content.

If impervious material can be obtained, earth lining method with 30 to 50 cm thickness is recommendable.

2. Bentnite Lining

Bentnite is a hydrophilic clay which swells upon water absorption. It absorbs water up to six times of its own dry weight and consequently expands up to fifteen times of its dry volume. The expanded mass is a gel-like, structurally unstable substance, but when mixed with a sandy soil, a structurally stable and impervious layer can be produced due to the swelling of the bentnite when it becomes wet.

A burried membrance 5 to 10 cm thick, of soil mixed with 10 to 25% bentnite will provide a good seal against seepage. The percentage of bentnite and the thickness of the layer required depends on the quality, purity, moisture content, grain size, construction method used in placing the bentnite, and the soil with which it is to be mixed.

The bentnite also can be used as a blanket material to be mixed with existing material on site in order to improve permeability of the soil.

3. Buried Asphalfic Membrane

The asphaltic membrane consists of an asphalfic layer, 5 to 10 mm thick poured hot onto a well-prepared subgrade. When completed, this membrane has a tough, pliable, rug-like consistency. The advantages of this method that asphalt can be

poured over unconsolidated soil with hardly any danger of rupture if the soil settles. It can be poured on any material, whether compacted or not, stony or stone-free, porous or even gravelly.

The asphaltic membrane shall be protected by a gravel cover with 10 to 15 cm thick or a soil cover with 20 to 30 cm thick to prevent damage from sun rays and creep during the hot hours.

4. Asphalt concrete Lining

This method require aggregate, mixing and compaction equipment. It is applicable only for big scale project in technical and economical viewpoint.

5. Prefabricated Asphalt Lining

This lining is made with asphalt sandwich craft paper or bitumin sandwich fiberglass tabric and other varieties similar to roofing materials. This type of lining is rather costly and the sealing effect is not satisfactory.

6. Plastic Film Lining

Various plastic film lining materials, such as polyethelene, P.V.C., pure vinyl have been employed at present, but they are 0.3 to 0.5 mm thick only and this method is considered as a temporary sealing expedient usually.

7. Butyl Rubber Lining

This method is also same category as the plastic film lining, but butyl rubber has very high durability as long as 15 years and thickness of the materials are 1 to 2 mm usually.

Disadvantages of this method are in high material cost (400 Bahts or more) and unsuitable appearance in the site. In case if this method is to be applied in this project, it is necessary to make a facing with stone masonry on the upper part of the slope. (see attached illustration)

8. Concrete Lining

The concrete lining method is a conventional method and it is most popular. The lining thickness is 7.5 to 10 cm without reinforcing steel when facing slope is flatter than 1 to 1.5. This method have a highest duarability and a big advantage on the operation and maintenace.

But subbase or foundation of the concrete lining shall be compacted sufficiently especially embankment part, otherwise cracks may be created on the concrete facing in future.

Construction joint shall be provided for each 5 m. intervals and water stop made of rubber or P.V.C. shall be arranged on every joints in order to prevent the leakage water through the joint.

9. Shot-crete Lining

The blasted cement mortar by using a blasting gun with very low water cement ratio mortar can be used as a lining material with considerable low cost. Sometimes soil cement (sandy soil and cement with very low raito of water) can applied as a blasting material with very low cost. But these blasting method can be adopted on the hard base only. Embanked soil surface is not suitable for the blasting work.

As the result of the study, the concrete lining method is selected for the project with following reasons:-

1) RID has experience enough, and no problem in construction technic and material provision.

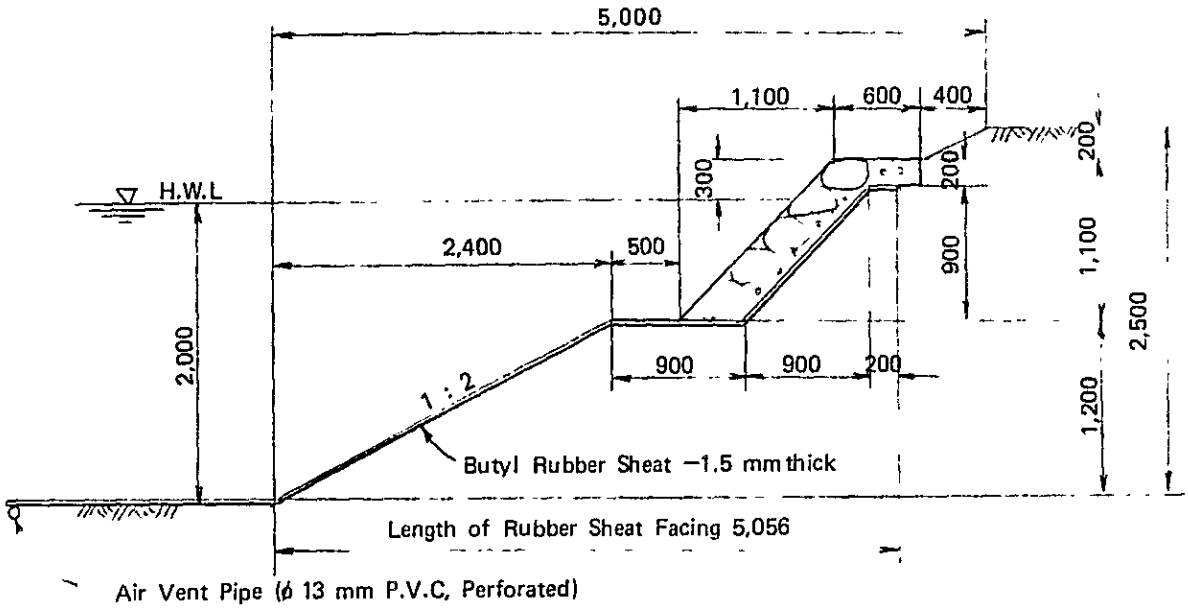
2) It is permanent facilities.

3) The construction cost is moderate.

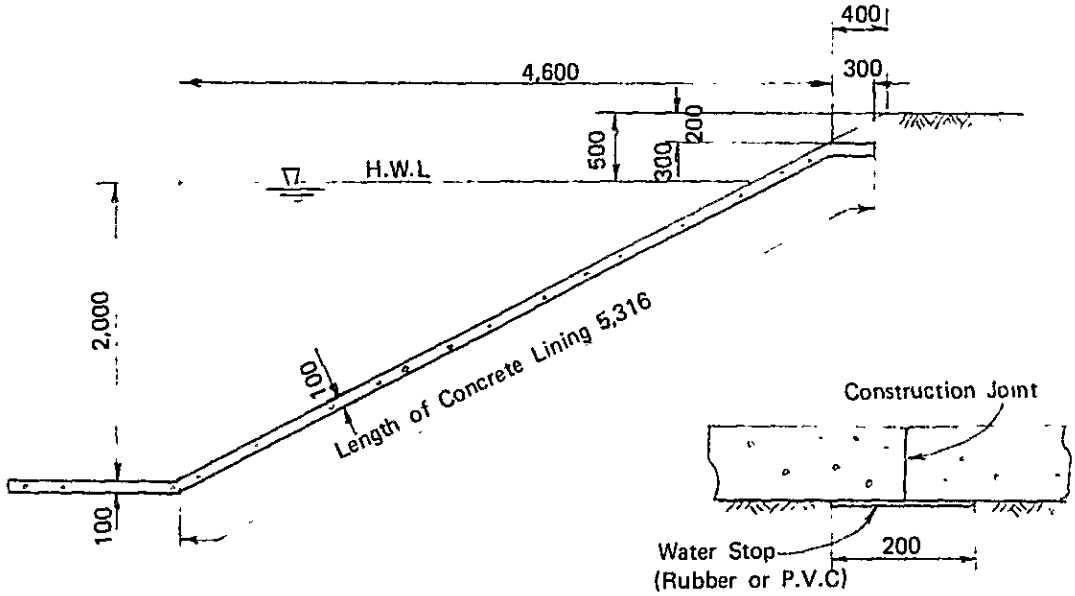
4) The permeability of subgrade is not so high. Even if some crack happen on concrete lining leakage water may not be so much.

TYPICAL POND SEALING METHOD

1. RUBBER SHEAT



2. CONCRETE LINING



6. IMPLEMENTATION OF THE PROJECT

6.1 IMPLEMENTATION

This project is on going by RID's force account work. The scale of the construction work is rather small so that it is not suitable to make a contract work by a reputable contractor. If the work is to be contracted with a contractor much higher construction cost be required than the force account work. Moreover, it will cause various trouble at the site because many intensive construction works will be concentrated at the narrow area including many kinds of building construction works, road construction works and RID's force account works.

While, this project is in need to be completed in a very short time. It will take a considerable time for the tendering process when the contract system is applied.

Consequently the implementation manner of this construction work shall be by the force account work by RID consecutively, and that meet a RID's intension. RID is accepting contribution from many sources for the implementation of this King's project in employment of construction equipment and supplying the construction materials.

The material supply seemes to be the best manner in the assistance to the project as a foreign aid.

6.2. MATERIALS AND EQUIPMENT TO BE SUPPLIED

All materials and equipment to be supplied for the irrigation system are described in the Bill of Quantities in detail, including PVC Pipes (VP) and fittings, valves, sprinklers, hydrants and accessories, and pumping equipment. Quantities of pipes and fittings involve some percent of reserves.

6.3. PIPE LAYING WORKS

The pipe laying works shall be executed in accordance with the specification and/or instruction which will be submitted by the material supplier.

Although the Rubber Ring Type joint have advantages of easiness of the site work and joint flexibility, particular attention shall be paid at the field. The compacted back fill shall be essentially important in order to prevent the future's movement of the pipe joints due to the settlement of the pipeline and/or inner water pressure. Especially at bending joints it is necessary to fix the pipes by means of the wooden piling with binding wire against the thrust force arisen from the inner water pressure.

As so many kinds and sizes of fittings are contained in the materials, all the fittings shall be used at correct positions according to the instruction.

The installation positions of sluice valves and air valves shall be determined after making the detailed survey on the pipeline.

A P P E N D I X E S

1. ITINERARY AND WORK SCHEDULE OF STUDY TEAM

2. ANNUAL RAINFALL AT SATTAHIP

3. MONTHLY RAINFALL AT SATTAHIP

4. PROBABILITY RAINFALL GRAPH BY
   HAZEN PLOTTIN METHOD

5. HYDRAULIC CALCULATION OF PIPELINES

6. STORAGE CAPACITY OF KHOA CHI OAN RESERVOIR

7. STORAGE CAPACITY OF WAT YAN-NA
   SANG WA-RAM RESERVOIR

8. RECOMMENDABLE TURNOUT TO SERVICE PONDS

9. ABSTRACT TABLE OF RESERVOIRS
   IN KING'S PROJECT

10. OPERATION MANUAL

11. DRAWINGS
    - 301 : GENERAL PLAN
    - 001 : SERVICE PONDS
    - 002 : SPILLWAY, PUMPING STATION AT SERVICE PONDS
    - 003 : PLAN OF MAIN PIPELINE
    - 004 : DEMONSTRATION FARM A
    - 005 : DEMONSTRATION FARM B

ITINERARY AND WORK SCHEDULE OF STUDY TEAM

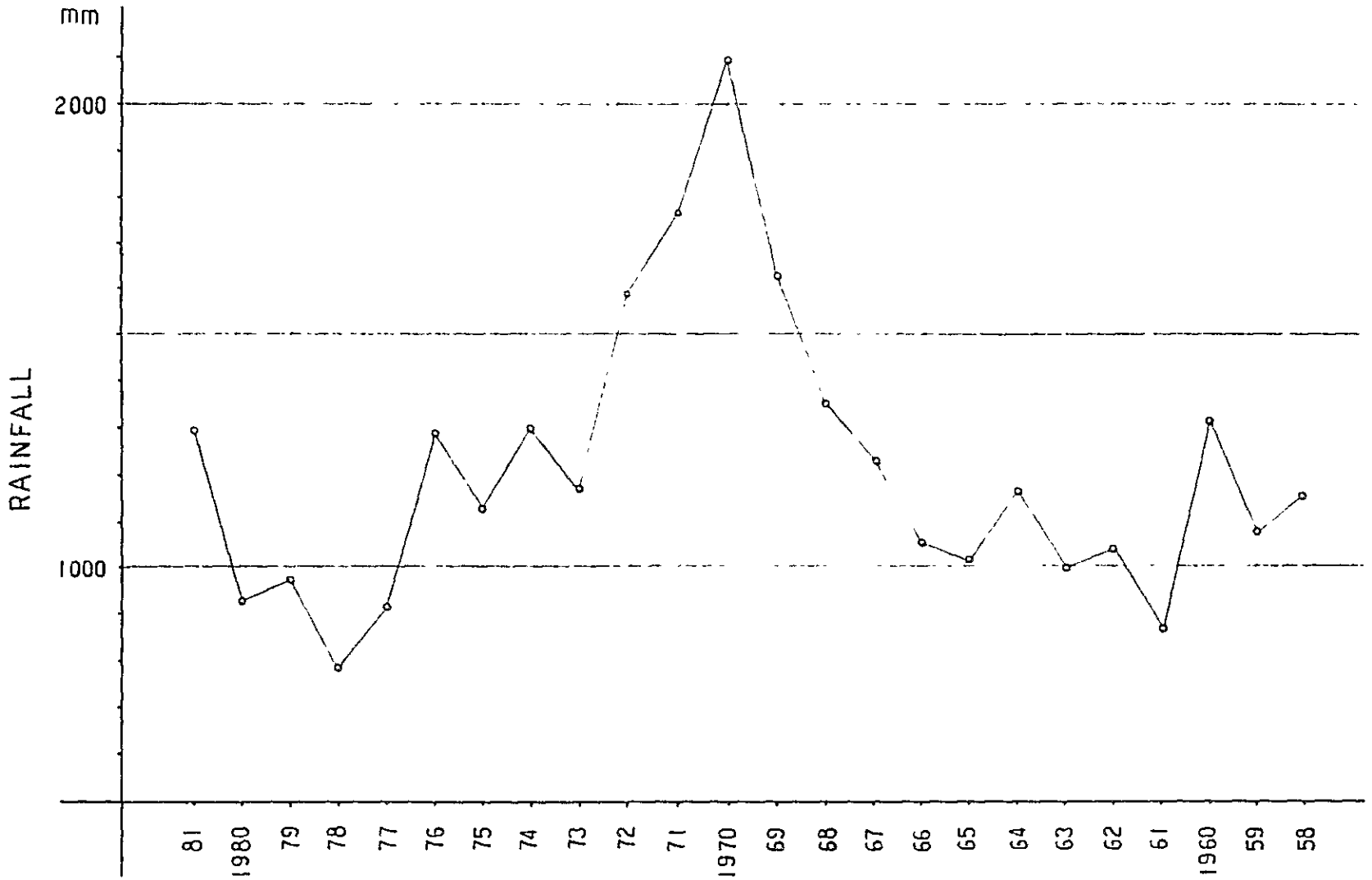
Irrigation Engineer : Mr. Chikaichi TAKAHASHI
Design Engineer : Mr. Yasuhiro AMATSUJI

DATE	WORKS	
	Mr. C. TAKAHASII	MR. Y. AMATSUJI
1982		
Dec. 15 (Wed)	Arrival at Bangkok from Tokyo	
16 (Thu)	Visit to Embassy of Japan, JICA Office and RID for orientation	
17 (Fri)	Orientation and data collection at RID	
18 (Sat)	---------- OFF ----------	
19 (Sun)	Trip to Pattaya	
20 (Mon)	Meeting at Regional Office 9 and field survey	
21 (Tue)	Meeting with Mr. Suha at Region 9 and Emabasy of Japan at Bangkok	
22 (Wed)	Team discussion at RID and meeting at Embassy of Japan	
23 (Thu)	Study on Water resources and meeting with Mr. Suha at RID	
24 (Fri)	S/W Sign, water resources study and meeting at Embassy of Japan	
25 (Sat)	Reporting to SCI head office	---------- OFF ----------
26 (Sun)	OFF (Messrs. KAMIJO and SHIRAISHI left for Tokyo)	
27 (Mon)	Data Collection	Study on Water Balance

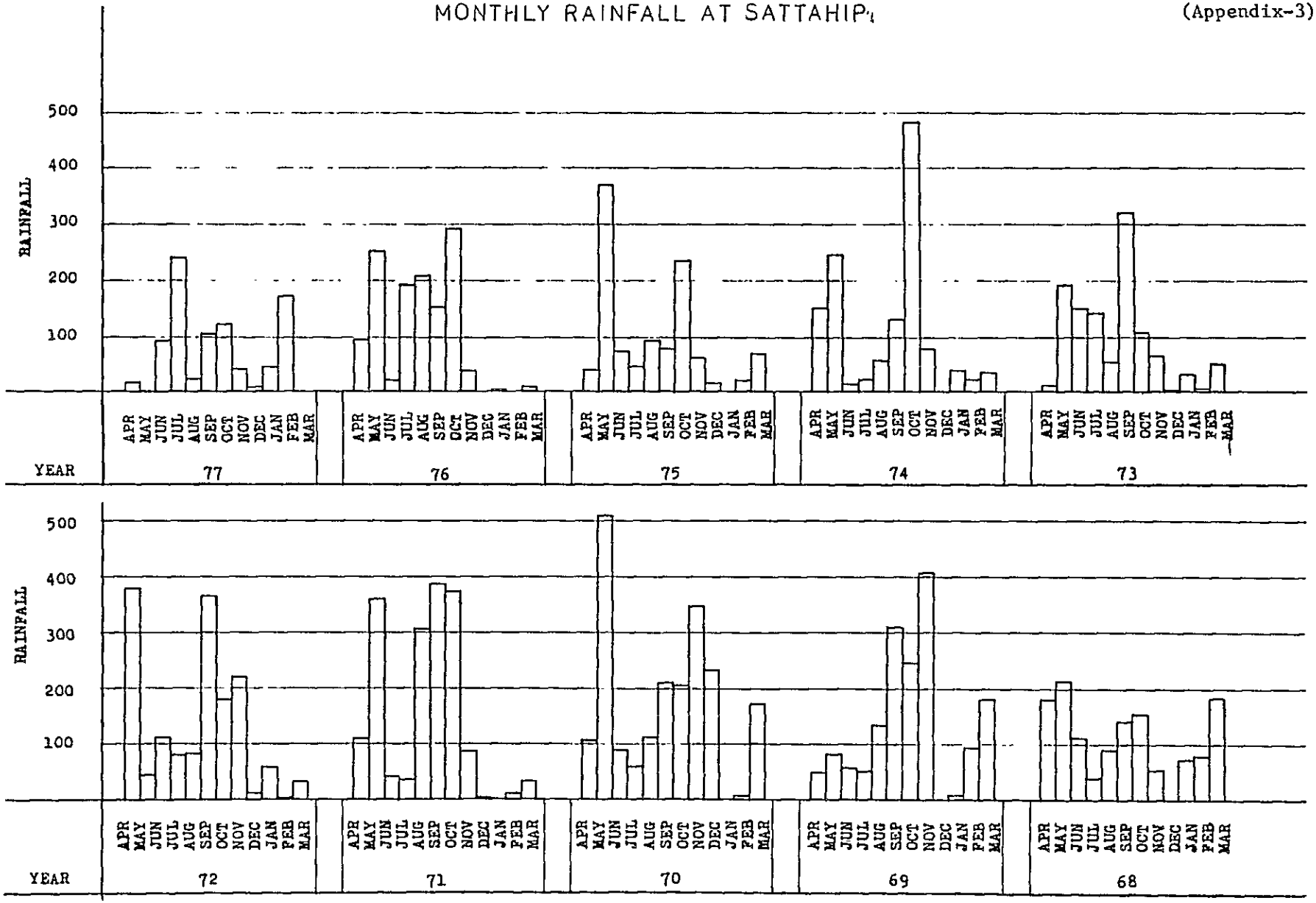
DATE	WORKS	
	MR. C. TAKAHASHI	MR. Y. AMATSUJI
Dec. 28 (Tue)	Discussion with Mr. Suha at Region 9 and design study	
29 (Wed)	Design Study	
30 (Thu)	Site investigation	Design Study
31 (Fri)	----------	
1983		---------- OFF ----------
Jan. 1 (Sat)		
2 (Sun)	----------	
3 (Mon)	Field investigation	
4 (Tue)	Study on pumping facilities	Study on pipelines
5 (Wed)	Study on service ponds	-------- do ------
6 (Thu)	Data arrangement for meeting	Study on sprinkler facilities
7 (Fri)	- do - and meeting at Embassy of Japan	
8 (Sat)	---------- OFF ----------	
9 (Sun)	---------- OFF ----------	
10 (Mon)	Design of pumping station	Design of upland irrigation
11 (Tue)	--------- do ---------	---------- do ----------
12 (Wed)	Detailed design and meeting with Mr. Suha	
13 (Thu)	Detailed design and preparation of drawing and interim report	
14 (Fri)	Field investigation	

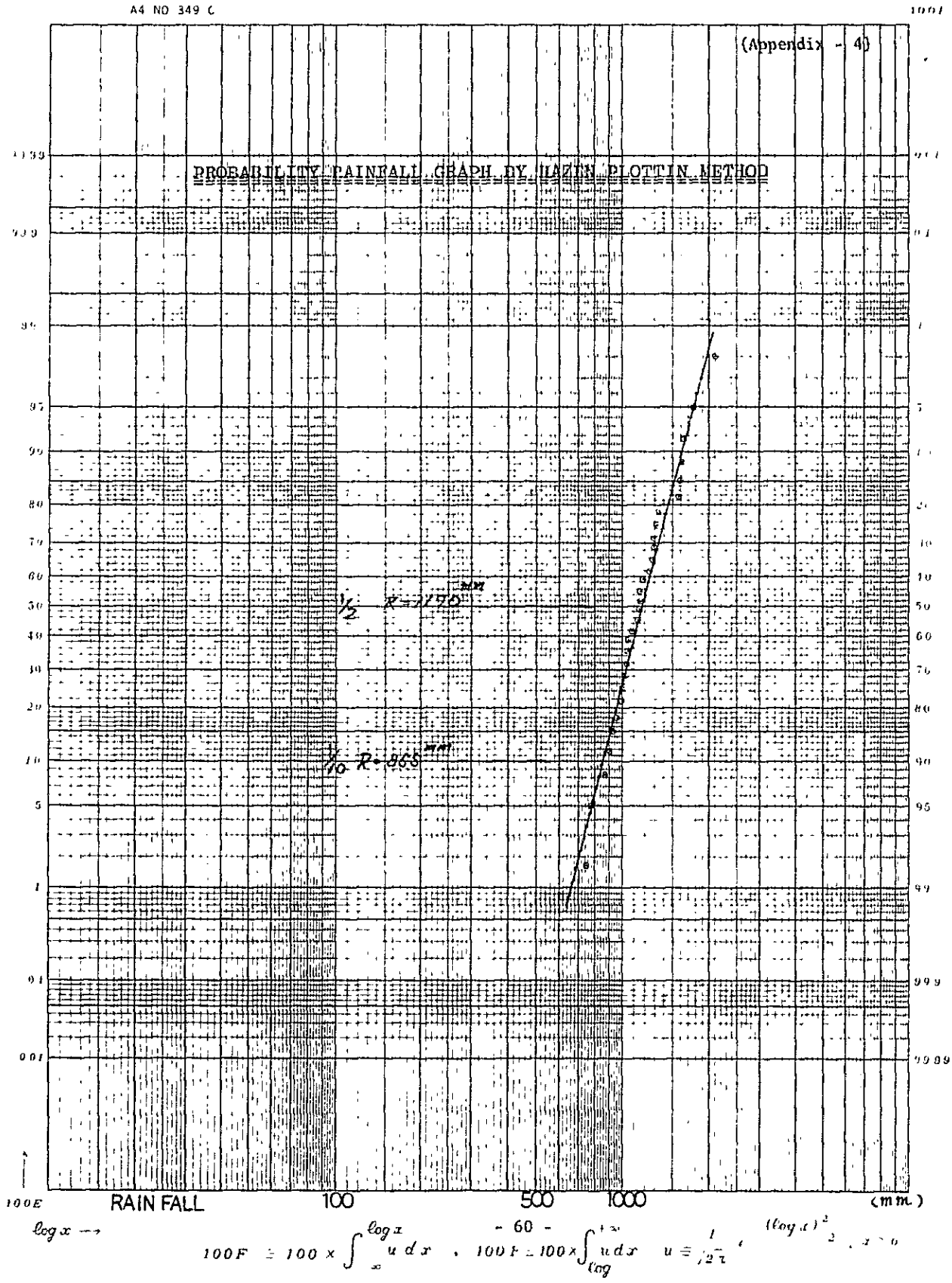
DATE	WORKS	
	MR. C. TAKAHASHI	MR. Y. AMATSUJI
1983		
Jan. 15 (Sat)		
16 (Sun)	Preparation of interim report	
17 (Mon)		
18 (Tue)	Meeting at Embassy of Japan	Preparation of interim report
19 (Wed)	Meeting at Embassy of Japan and meeting with Mr. Suha at Region 9	
20 (Thu)		
21 (Fri)	Preparation of interim report	
22 (Sat)		
23 (Sun)		
24 (Mon)	Meeting and discussion on interim report at Embassy of Japan	
25 (Tue)	Finalizing of interim report	
26 (Wed)	--------- do ----------	
27 (Thu)	Submiting of interim report to RID	
28 (Fri)	Leave for Tokyo	
29 (Sat)		
30 (Sun)	Home office work to prepare the detail design and final report	
31 (Mon)		
Feb. 1 (Tue)		
↓		
Feb. 27 (Sun)		
28 (Mon)	Submiting the final report to JICA	

ANNUAL RAINFALL AT SATTAHIP (Appendix-2)



(Appendix-3)


MONTHLY RAINFALL AT SATTAHIP
RAINFALL
500
400
300
200
100
APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR
YEAR
77
76
75
74
73
RAINFALL
500
400
300
200
100
APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR
YEAR
72
71
70
69
68

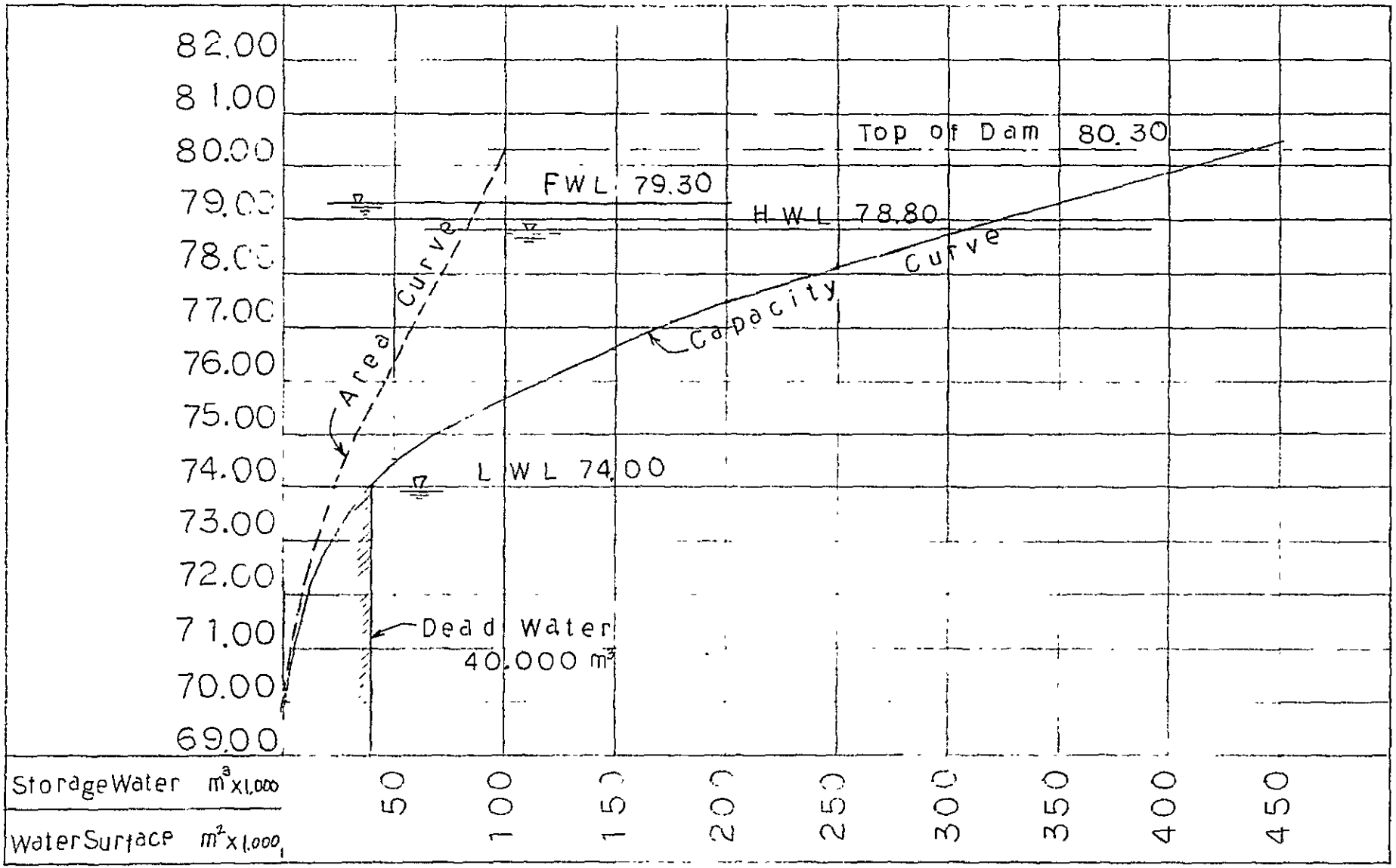

A4 NO 349 C
(Appendix - 4)
PROBABILITY RAINFALL GRAPH BY HAZEN PLOTTIN METHOD
1/2 R=1170mm
1/10 R=865mm
RAIN FALL
100
500
1000
(mm)
log x →
100F = 100 × ∫ u dx , 100F = 100 × ∫ u dx

HYDRAULIC CALCULATION OF PIPELINES

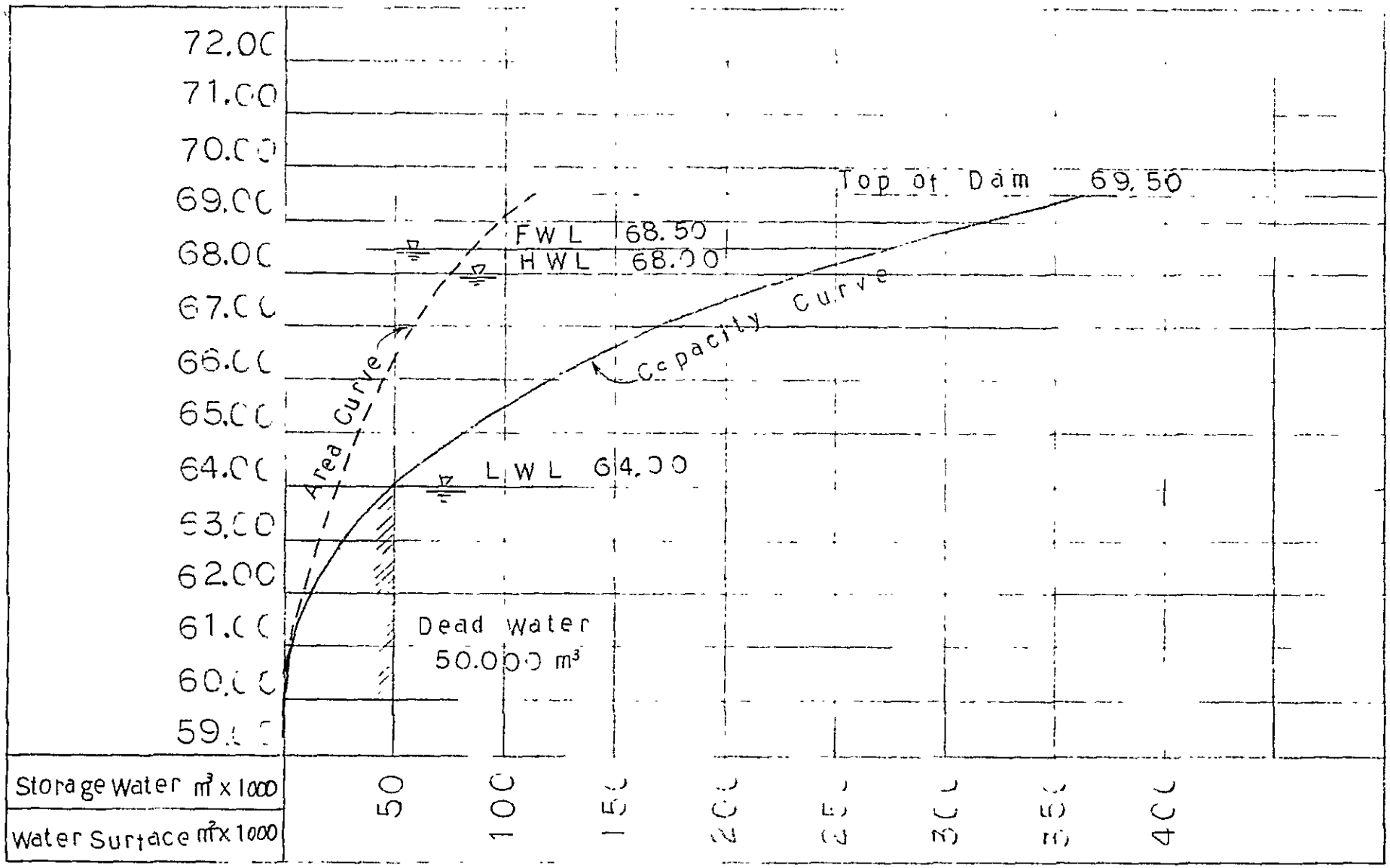
	E L. M	E L. M	LENGTH M	SLOPE $\times 10^{-3}$	AMOUNT OF WATER M^3	DIAMTER OF PIPE MM	SECTION AREA M^2	$D^{1.167}$	VELOCITY OF FLOW M/S	$V^{1.852}$	HYDRAULIC GRADIENT $\times 10^{-3}$	FRICTION LOSS M	
Rc-P2													
1) Rc-a	74.0	71.0	1,100	2.727	0.0691	300	0.0707	0.2454	0.977	0.958	3.239	3.56	
2) a-P2	71.0	73.0	80	-25.000	0.0506	300	0.0707	0.2454	0.716	0.538	1.819	0.15	
			1,180	0.847							3.144	3.71	
Rd-D													
1) Rd-b	64.0	62.0	675	2.963	0.0599	300	0.0707	0.2454	0.847	0.736	2.486	1.68	
2) b-f-i	62.0	38.0	1,170	20.513	0.0198	200	0.0314	0.1529	0.631	0.426	2.309	2.70	
3) i-D	38.0	35.0	610	4.918	0.0167	150	0.0177	0.1093	0.944	0.898	6.812	4.16	
			2,455	11.813							3.478	8.54	
P2-S													
1) P2-g	73.0	45.0	1,150	24.348	0.0321	250	0.0491	0.1903	0.654	0.455	1.903	2.19	
2) g-S	45.0	40.0	230	21.739	0.0167	150	0.0177	0.1093	0.944	0.898	6.812	1.57	
			1,380	23.913							2.725	3.76	

	E.L. M	E.L. M	LENGTH M	SLOPE $\times 10^{-3}$	AMOUNT OF WATER M^3	DIAMTER OF PIPE MM	SECTION AREA M^2	$D^{1.167}$	VELOCITY OF FLOW M/S	$V^{1.852}$	HYDRAULIC GRADIENT $\times 10^{-3}$	FRICTION LOSS M	
P_2-P													
1) P_2-g	73.0	45.0	1,150	24.348	0.0321	250	0.0491	0.1983	0.654	0.455	1.903	2.19	
2) g-p	45.0	50.0	50	-100.000	0.0154	150	0.0177	0.1093	0.870	0.773	5.863	0.29	
			1,200	19.167							2.067	2.48	
Rd- Ra													
1) Ra-b	64.0	62.0	675	2.963	0.0599	300	0.0707	0.2454	0.847	0.736	2.486	1.68	
2) b-c	62.0	61.0	300	3.333	0.0401	250	0.0491	0.1983	0.817	0.687	2.874	0.86	
3) c-d-e-k	61.0	45.0	950	16.842	0.0216	200	0.0314	0.1529	0.688	0.500	2.713	2.58	
4) k-Ra	45.0	33.0	350	34.286	0.0031	75	0.0044	0.0487	0.705	0.523	8.902	3.12	
			2,275	13.626							3.622	8.24	
Rd-S													
1) Rd-b	64.0	62.0	675	2.963	0.0599	300	0.0707	0.2454	0.847	0.736	2.486	1.68	
2) b-f	62.0	41.0	900	23.333	0.0198	200	0.0314	0.1529	0.631	0.456	2.309	2.08	
3) f-S	41.0	40.0	200	5.000	0.0167	150	0.0177	0.1093	0.944	0.898	6.812	1.36	
			1,775	13.521							2.885	5.12	

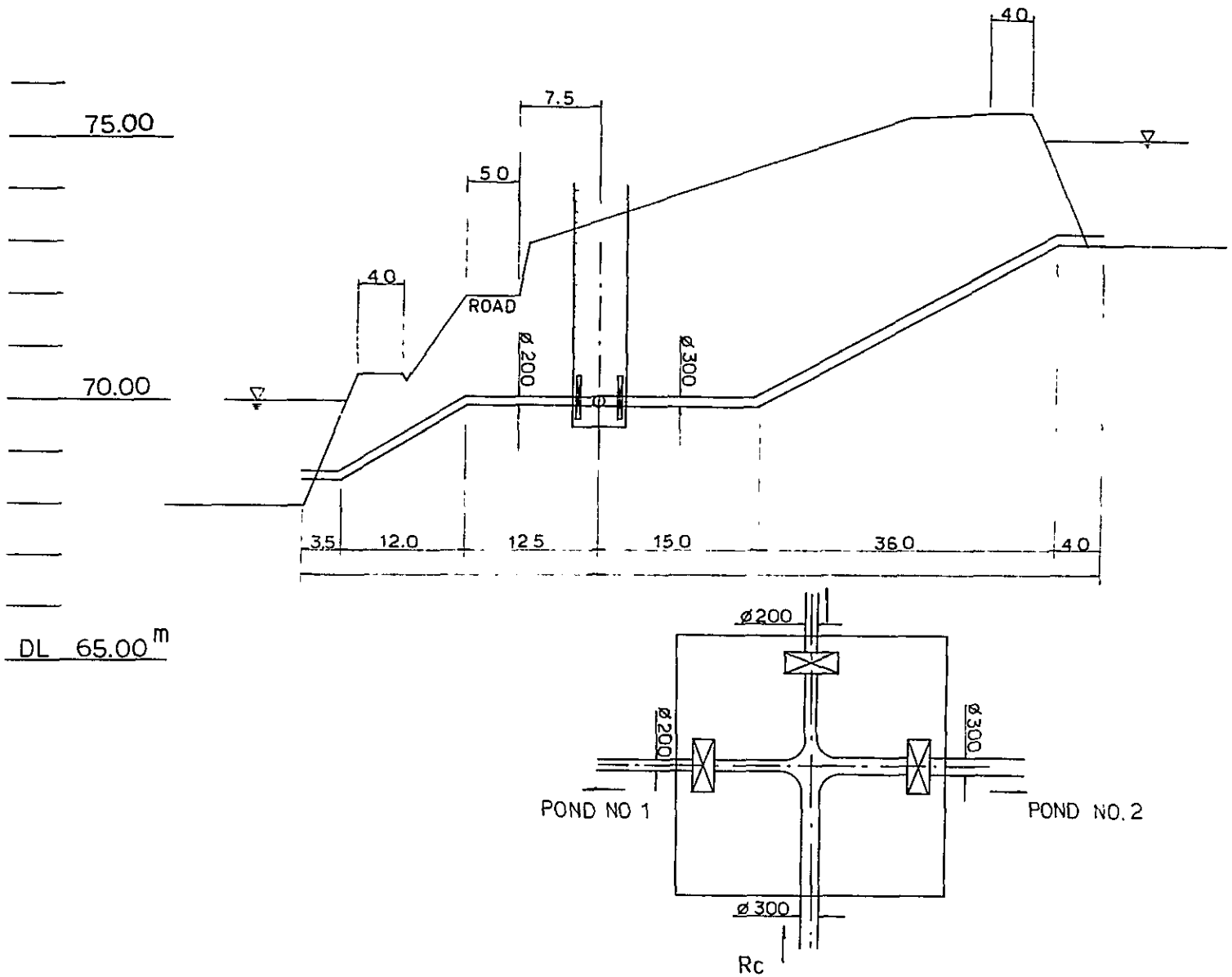
STORAGE CAPACITY OF KHOA CHI OAN RESERVOIR



STORAGE CAPACITY OF WAT YAN-NA SANG WA-RAM RESERVOIR



RECOMMENDABLE TURNOUT TO SERVICE PONDS



(Appendix - 9)

ABSTRACT TABLE OF RESERVOIRS IN KING'S PROJECT

Reservoir Name	Unit	① Wat Yan-Na Sand Wa-ram	② Khoa Chi Oan	③ Khoa Chi Jan	④ Klon Huai Tu	⑤ Ban Amphoe	⑥ Bo-ri-wan	⑦ Mab Fug Thong I	⑧ Mab Fug Thong II	⑨ Ban Ka-nam Rai
Catchment Area	km^2	0.575	0.80	3.33	20.65	7.36	0.40	4.05	3.60	0.93
Annual Inflow	$m^3 \times 10^3$	220	300	1,500	9,100	1,770	180	1,800	1,600	410
Dam Height	m	11.5	13.3	16.0	11.0	7.5	3.5	11.5	11.5	9.5
Dam Length	m	320	420	500	450	400	200	600	700	250
Blevation of										
Top of Dam	m	69.5	80.3	61.5	41.5	31.5	21.5	51.5	41.5	71.5
F. W. L.	m	68.5	79.3	60.5	40.5	30.5	20.5	50.5	40.5	70.5
H. W. L.	m	68.0	78.8	60.0	40.0	30.0	20.0	50.5	40.0	70.0
L. W. L.	m	64.0	74.0							
Storage Water	$m^3 \times 10^3$	230	310	2,600	3,250	1,050	50	1,600	2,100	330
Dead Water	$m^3 \times 10^3$	50	40	30	200	40	—	40	30	10
Available water	$m^3 \times 10^3$	180	270	2,570	3,050	1,010	50	1,560	2,070	320
Water Surface at H.W. L.	km^2	0.084	0.086	0.40	0.70	0.35	0.05	0.32	0.43	0.08
Construction Cost	$B \times 10^6$	9.33	18.00	20.65	52.01	14.60	1.65	18.60	19.53	7.40
Target of Completion	(F. Y.)	1982 (Substantially) Completed	1982 (Completed)	1983	1984	1983	Cancelled	1985	1985	1985

Note : This study was made by RID based on 1 : 50,000 map.

OPERATION MANUAL

1. Reservoir

The water utilization plane is based upon water level of each reservoir on December First when is beginning of irrigation. It is prepared three cases which are shown on the following table.

	Case I (m)	Case II (m)	Case III (m)
K.C.O. Reservoir	EL = 78.8 - 78.0	EL = 78.0 - 77.0	EL = 77.0 (less than)
W.Y.S.W. Reservoir	EL = 68.0 - 67.0	EL = 67.0 - 66.0	EL - 66.0 (")

The valve operation of each case is shown on the following figures.

In rainy season, when K.C.O Reservoir is full of water, it should open the valve (V-2) and release water to W.Y.S.W. Reservoir.

2. Service Pond

It is considered two cases of water supplying to ponds which is based upon water level of K.C.O. Reservoir.

(1) Supplying water from K.C.O. Reservoir to Pond II with gravity head.

(2) Supplying water from K.C.O. Reservoir to Pond I with gravity head then pumping up water from Pond I to Pond II.

Valve operations shall be undertaken as following manners depending on above each case.

(CASE — 1)

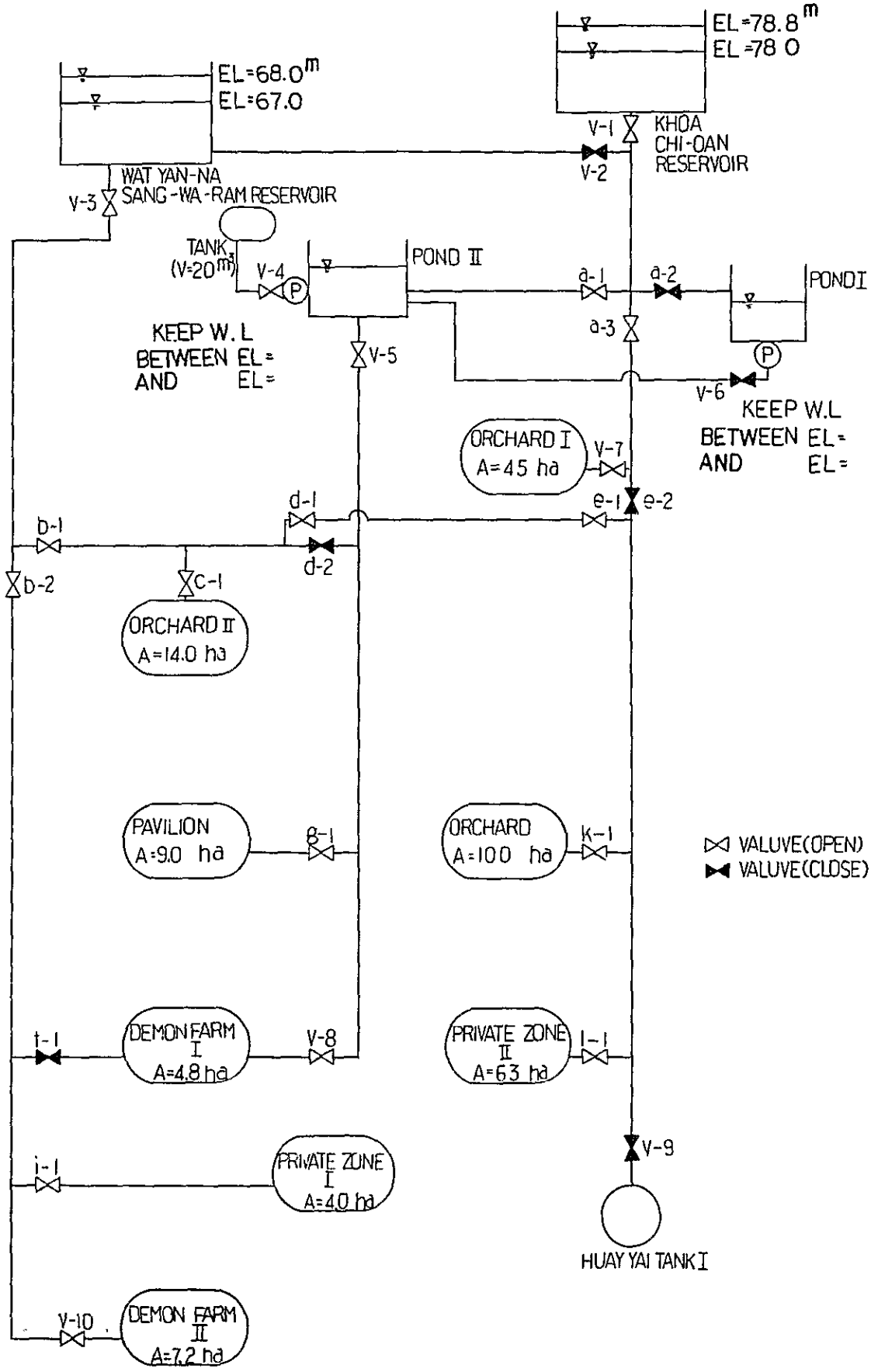
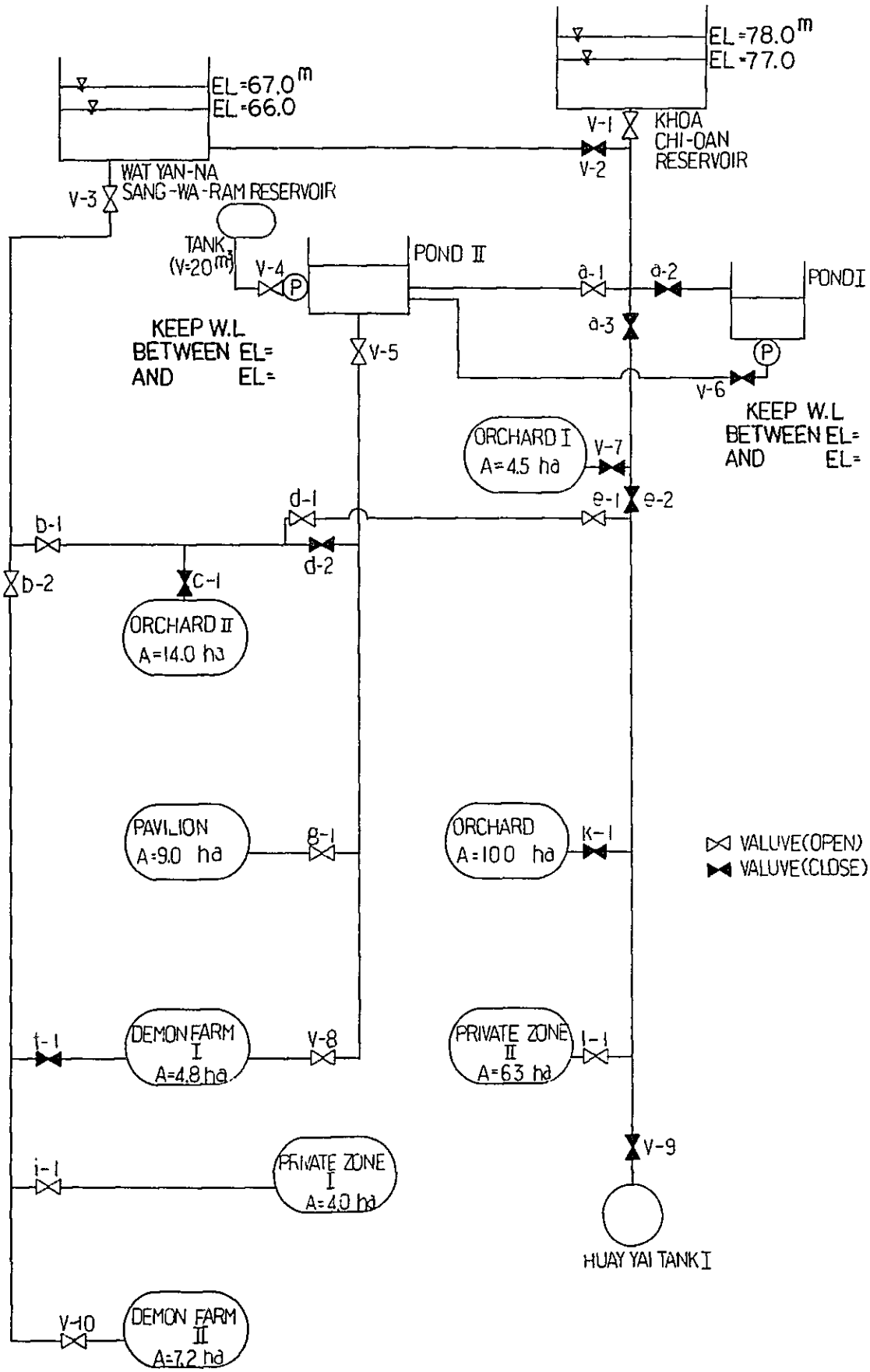
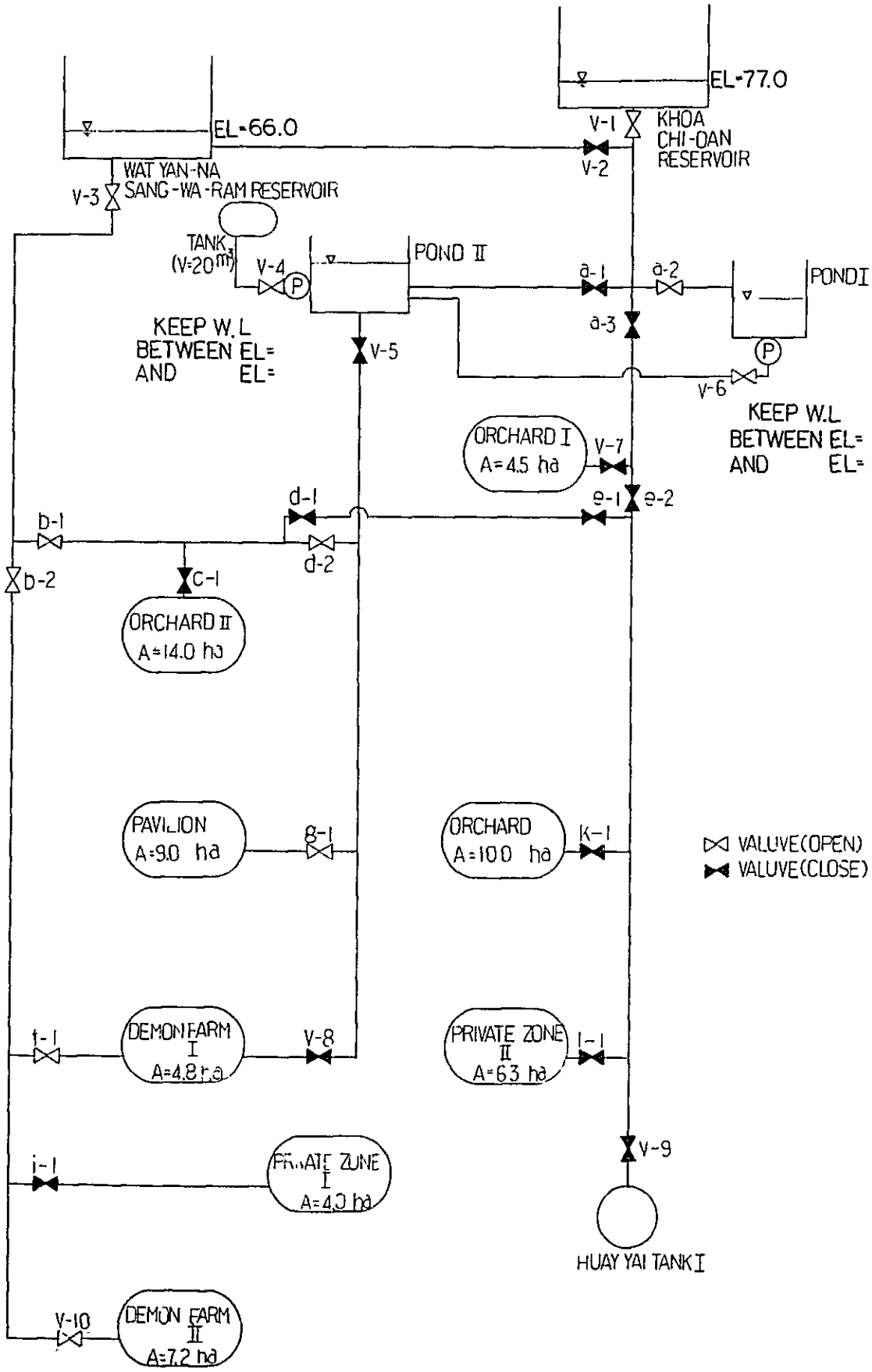

EL=78.8 m
EL=78.0
EL=68.0 m
EL=67.0
V-1
KHOA CHI-OAN RESERVOIR
V-2
WAT YAN-NA SANG-WA-RAM RESERVOIR
V-3
TANK (V=20 m³)
V-4
POND II
a-1
a-2
POND I
a-3
KEEP W.L BETWEEN EL= AND EL=
V-5
V-6
KEEP W.L BETWEEN EL= AND EL=
ORCHARD I A=45 ha
V-7
d-1
e-1
e-2
b-1
d-2
b-2
c-1
ORCHARD II A=14.0 ha
PAVILION A=9.0 ha
g-1
ORCHARD A=100 ha
k-1
VALUVE(OPEN)
VALUVE(CLOSE)
h-1
DEMON FARM I A=4.8 ha
V-8
PRIVATE ZONE II A=6.3 ha
l-1
V-9
i-1
PRIVATE ZONE I A=4.0 ha
HUAY YAI TANK I
V-10
DEMON FARM II A=7.2 ha

Fig.-1

(CASE —2)


EL=78.0 m
EL=77.0
EL=67.0 m
EL=66.0
V-1
KHOA CHI-OAN RESERVOIR
V-2
WAT YAN-NA SANG-WA-RAM RESERVOIR
V-3
TANK (V=20 m³)
V-4
POND II
a-1
a-2
POND I
a-3
KEEP W.L BETWEEN EL= AND EL=
V-5
V-6
KEEP W.L BETWEEN EL= AND EL=
ORCHARD I A=4.5 ha
V-7
d-1
e-1
e-2
b-1
d-2
b-2
C-1
ORCHARD II A=14.0 ha
PAVILION A=9.0 ha
g-1
ORCHARD A=100 ha
K-1
VALUVE(OPEN)
VALUVE(CLOSE)
f-1
DEMON FARM I A=4.8 ha
V-8
PRIVATE ZONE II A=63 ha
l-1
V-9
i-1
PRIVATE ZONE I A=4.0 ha
HUAY YAI TANK I
V-10
DEMON FARM II A=7.2 ha

(CASE — 3)


EL-77.0
EL-66.0
V-1
KHOA CHI-DAN RESERVOIR
V-2
WAT YAN-NA SANG-WA-RAM RESERVOIR
V-3
TANK (V=20㎥)
V-4
POND II
a-1
a-2
PONDI
a-3
KEEP W.L BETWEEN EL= AND EL=
V-5
V-6
KEEP W.L BETWEEN EL= AND EL=
ORCHARD I A=4.5 ha
V-7
d-1
e-1
e-2
b-1
d-2
b-2
c-1
ORCHARD II A=14.0 ha
PAVILION A=9.0 ha
g-1
ORCHARD A=10.0 ha
k-1
VALUVE(OPEN)
VALUVE(CLOSE)
f-1
DEMON FARM I A=4.8 ha
V-8
PRIVATE ZONE II A=6.3 ha
l-1
V-9
j-1
PRIVATE ZONE I A=4.0 ha
HUAY YAI TANK I
V-10
DEMON FARM II A=7.2 ha

(1) Open the valve (a-1) and close the valve (a-2)

(2) Open the valve (a-2), close the valve (a-1), open the valve (V-6) and start the pump.

When the water head at K.C.O. Reservoir is insufficient to discharge with gravity, operational hours to supply the water into Pond II can be extended to the night time so that pump operation time also can be saved.

3. Irrigation Facility

(1) Valve operation on the main pipe

According to the water utilization plane, it is operated these valves which are (V-8), (V-10) and (F-1) valve at beginning of irrigation season. The following table is shown the valve operation manner.

	(V-8) Valve	(F-1) Valve	(V-10) Valve
Case 1 - 2	Open	Close	Open
Case 3	Close	Open	Open

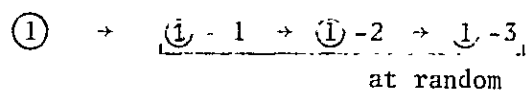
(2) Facility in demonstration farms

a. Sprinkler irrigation

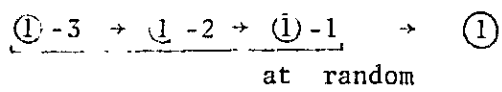
The valve (① - ⑩) which is shown at figure-2 is operated with the rotation plane. The each valve controls 3 to 4 sprinkler lines which is named a block. And the each sprinkler line has a valve (① - 1, ① - 2, ① - 3) also. The order of valve operation must observe the rule which is shown on following.

For example

(Open)



(Close)



In the case of operating of the hydrant, don't use the valve of up stream to low stream. And the opposite case, it is closed it from the valve of low stream to up stream.

b. Hydrant

In the case of operating of the hydrant, don't use the sprinkler, at same time. So it must close the valve of each line.

c. The structure and performance of sprinkler and hydrant, are shown by following figure-3.

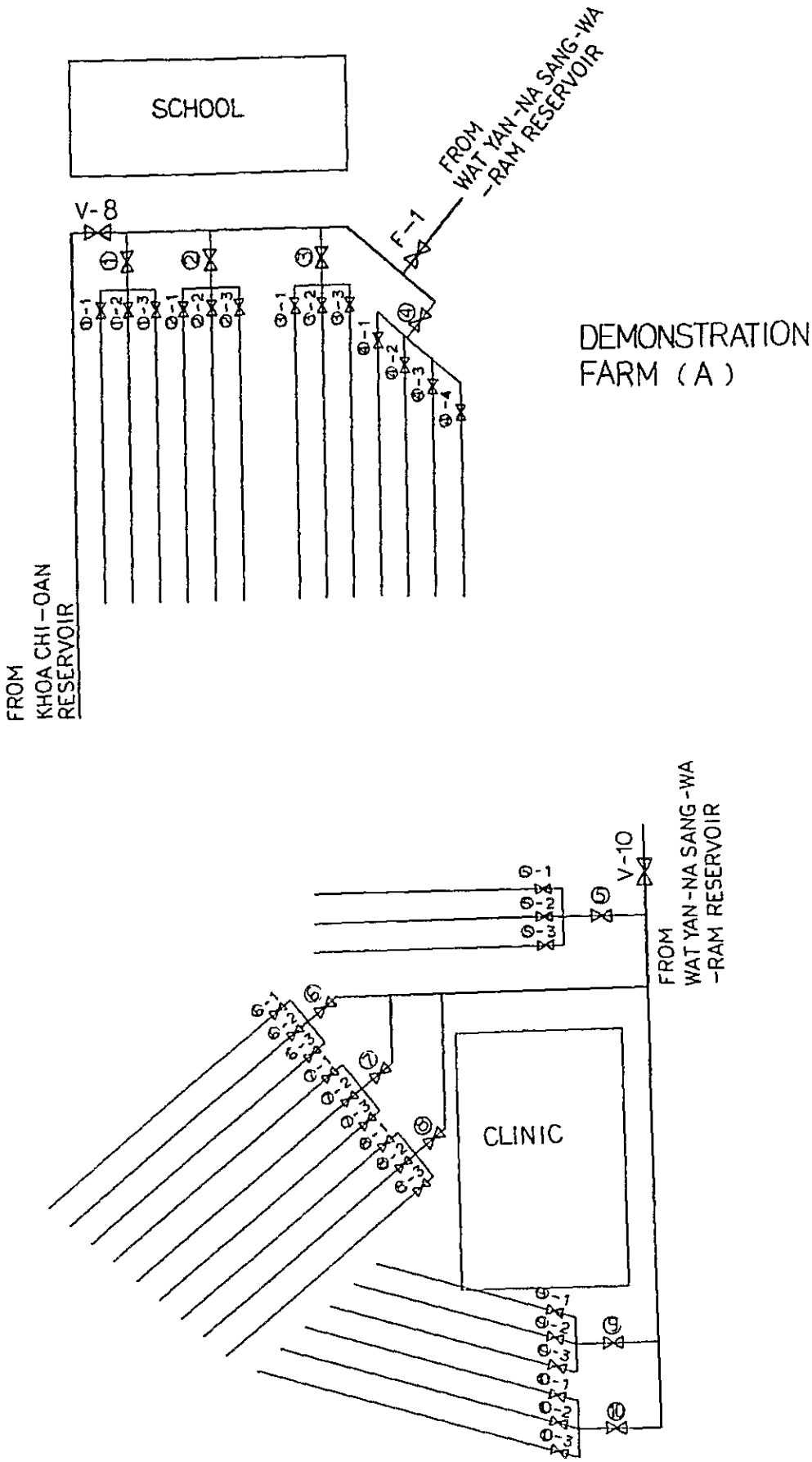
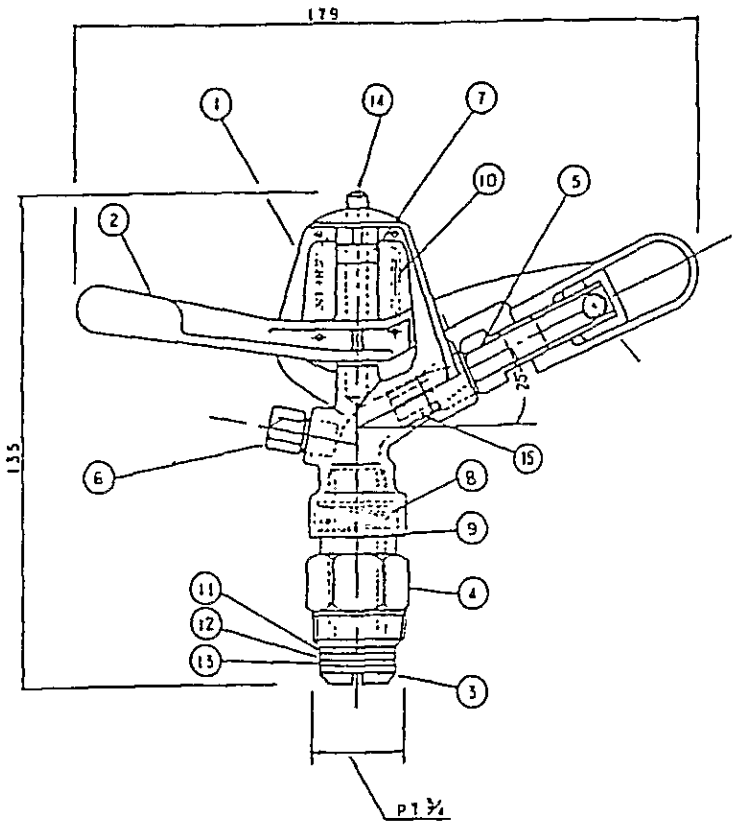

SCHOOL
FROM
WAT YAN-NA SANG-WA
-RAM RESERVOIR
V-8
F-1
DEMONSTRATION
FARM (A)
FROM
KHOA CHI-OAN
RESERVOIR
V-10
FROM
WAT YAN-NA SANG-WA
-RAM RESERVOIR
CLINIC
DEMONSTRATION FARM (B)

Fig.-2

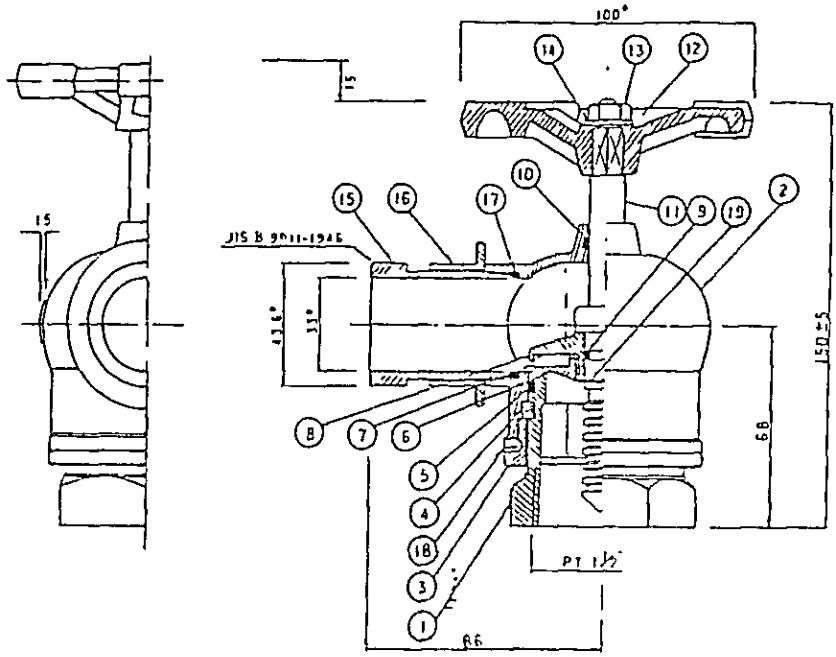


1	HEAD	BC - 6	9	BELLOWS ASSEMBLY	TEFLON
2		BC - 6	10	TENSION SPRING	SUS 304
3	SPINDLE	BsBM	11	BEARING SEAL	NBR
4	BEARING	BsBM	12	LOWER BEARING SEAL	TEFLON
5	NOZZLE	BsBM	13	LOWER BEARING SEAL	ASBESTRAVER
6	FROST NOZZLE	BsBM	14	FULCRUM PIN	SUS 304
7	LEVER BUSHING	BsBM	15	STRAIGHTENER	DERLIN
8	BEARING SPRING	SUS 304			

PERFORMANCE

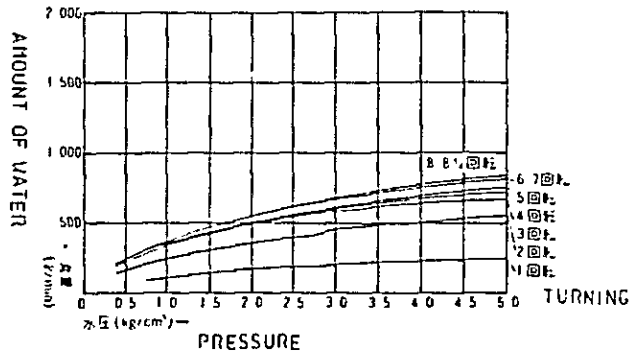
NOZZLE m/m / P		4.8×2.4 (3/16"×3/32")	
PSI	kg/cm²	D m	Q ℓ/min
25	1.76	27.5	23.9
	2.00	27.9	25.5
30	2.10	28.1	26.2
35	2.46	28.7	28.4
	2.50	28.7	28.6
40	2.81	29.3	30.6
	3.00	29.6	31.9
45	3.16	30.0	32.4
	3.50	30.4	34.1
50	3.52	30.5	34.2
55	3.87	30.8	35.8
	4.00	30.9	36.4
60	4.22	31.1	37.3

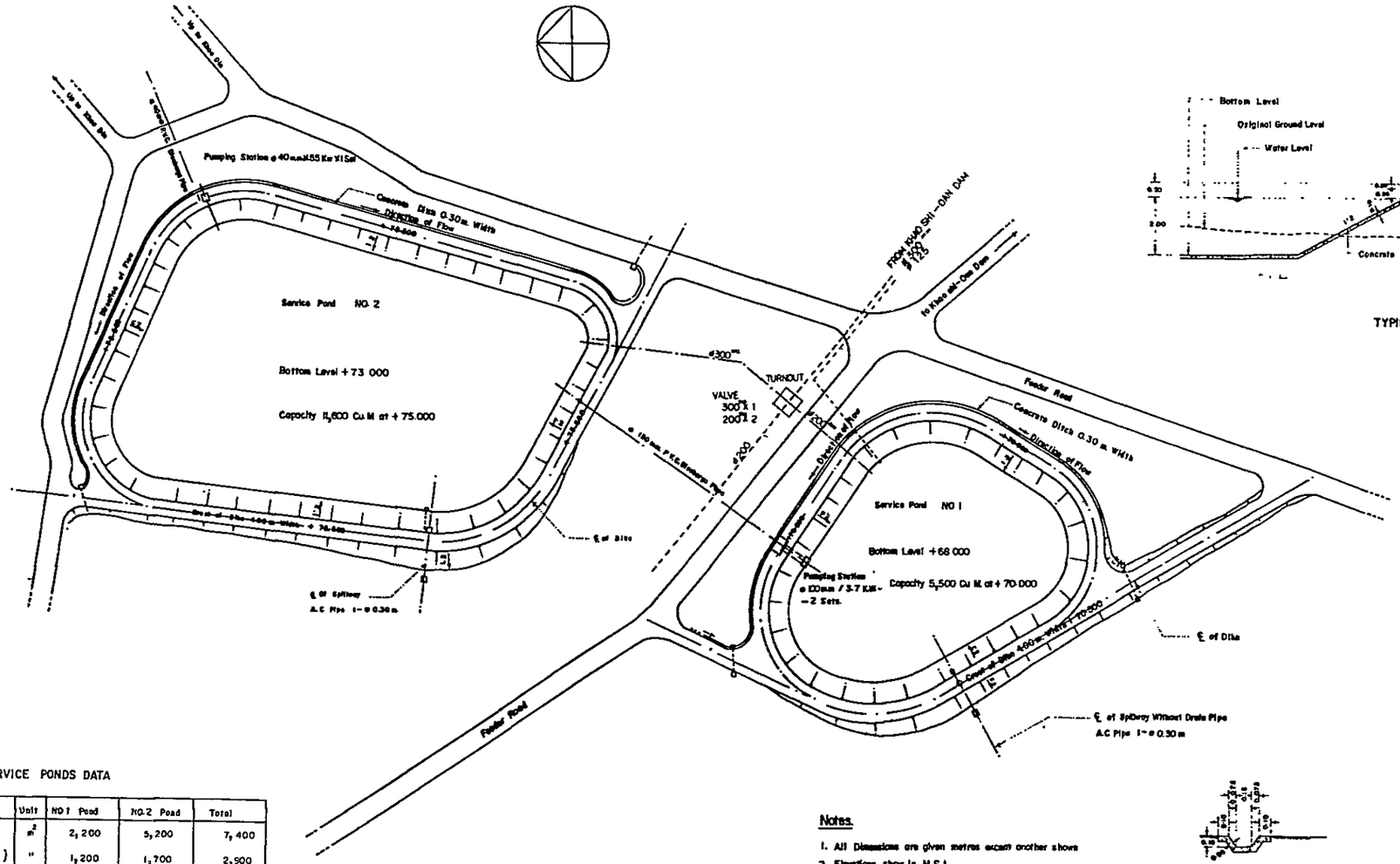
Fig.-3

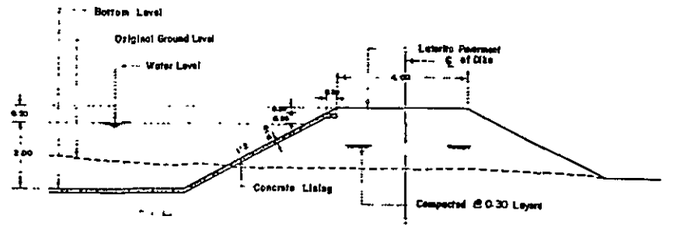


1	INSTALLATION BASE	AC 7 A	11	VALVE STICK	BsBM
2	VALVE CASE	AC 7A	12	HANDLE	FC15
3	CLASP HOLDER	AC7 A	13	NUT	BsBM
4	DINDING METAL	BC 6	14	METAL BASE	BsBM
5	O-SHAPED RING	NBR	15	SOCKET	AC 7A
6	VALVE BEARING	AC 7A	16	RUBBER RING	AC 7A
7	ELASTIC VALVE	NBP	17	O-SHAPED RING	NBR
8	VALVE HOLDER	AC 7A	18	SCREW	BsBM
9	O-SHAPED RING	NBR	19	E-SHAPED RING	SUS
10	O-SHAPED RING	NBP			

MODEL(φ40)
CHARACTERISTIC OF FUNCTION
AMOUNT OF WATER/ TURNING







TYPICAL CROSS SECTION OF DIKE SCALE 1:75

SERVICE PONDS DATA

Description	Unit	NO 1 Pond	NO 2 Pond	Total
Bottom Area	m^2	2,200	5,200	7,400
Slope Area (for inside facing)	"	1,200	1,700	2,900
Total Facing Area	"	3,400	6,900	10,300
Dike Top Elevation	m	70.50	75.50	
High Water Level	"	70.00	75.00	
Bottom Elevation	"	68.00	73.00	
Available Water Depth	"	2.00	2.00	
Free Board	"	0.50	0.50	
Storage Capacity	m^3	5,500	11,600	17,100

PLAN SCALE 1:500

Notes.

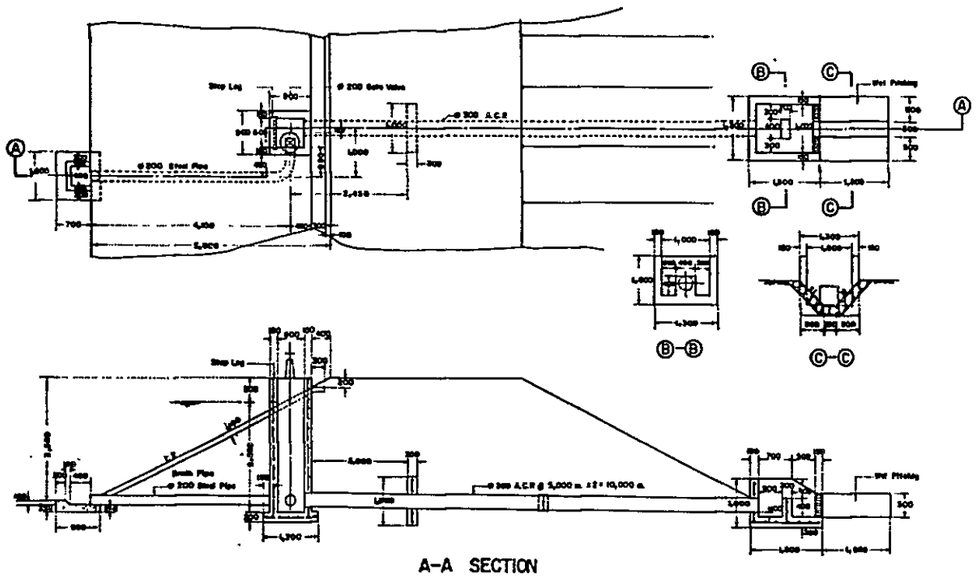
1. All Dimensions are given metres except another shown
2. Elevations show in M.S.L

DETAIL OF CONCRETE DITCH SCALE 1:20

Royal Irrigation Department
Ministry of Agriculture & Co-operatives
Klong Ban Amphoe Basin Project
Amphoe Bang-Le-Mung Changwad Chonburi
Drawn: Wat Yos Sangwarom
SERVICE PONDS

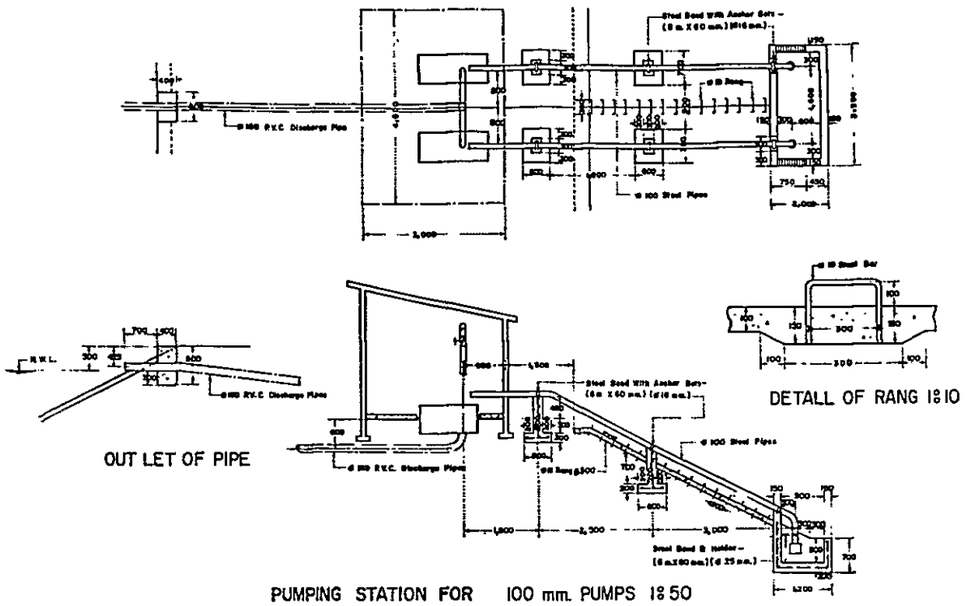
Designed		Submitted	
Drawn		Passed	
Traced		Recommended	
Checked		Approved	

Irrigation Engineering Office No. Bureau of Design — Date — 0001



A-A SECTION

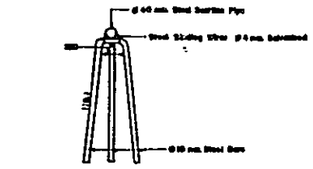
DETAIC OF SPILL WAY 1:50



OUT LET OF PIPE

DETALL OF RANG 1:10

PUMPING STATION FOR 100 mm. PUMPS 1:50



DETALL OF SADDLE 1:10

DETAIL OF RANG & SADDLE 1:10

PUMPING STATION FOR Ø40 mm. PUMP 1:50

Note

1. Detail of pump base and mechanical portion shall be determined base on the manufactured instruction.
2. All reinforcing bars are d 12 mm. @ 300 m.m.
3. All dimension are given in m.m.

Royal Irrigation Department			
Ministry of Agriculture & Co-operatives			
Klong Ban Amphoe Basin Project			
Amphoe Bang-La-Mung Changwat Chonburi			
Shown : Spillway, Pumping Stations At SERVICE Pmde			
Designed		Submitted	
Drawn		Passed	
Traced		Recommended	
Checked		Approved	
Irrigation Proposed Office no. Station of Design		18 Jan 68 Date	0002