No. 1

AGRICULTURAL COOPERATIVE PROMOTION PROJECT IN THE KINGDOM OF THAILAND

DETAIL DESIGN REPORT

ON

MODEL INFRASTRUCTURES IMPROVEMENT WORK (PAK-THONG-CHAI) (MUANG)

NOVEMBER 1988

JAPAN INTERNATIONAL COOPERATION AGENCY

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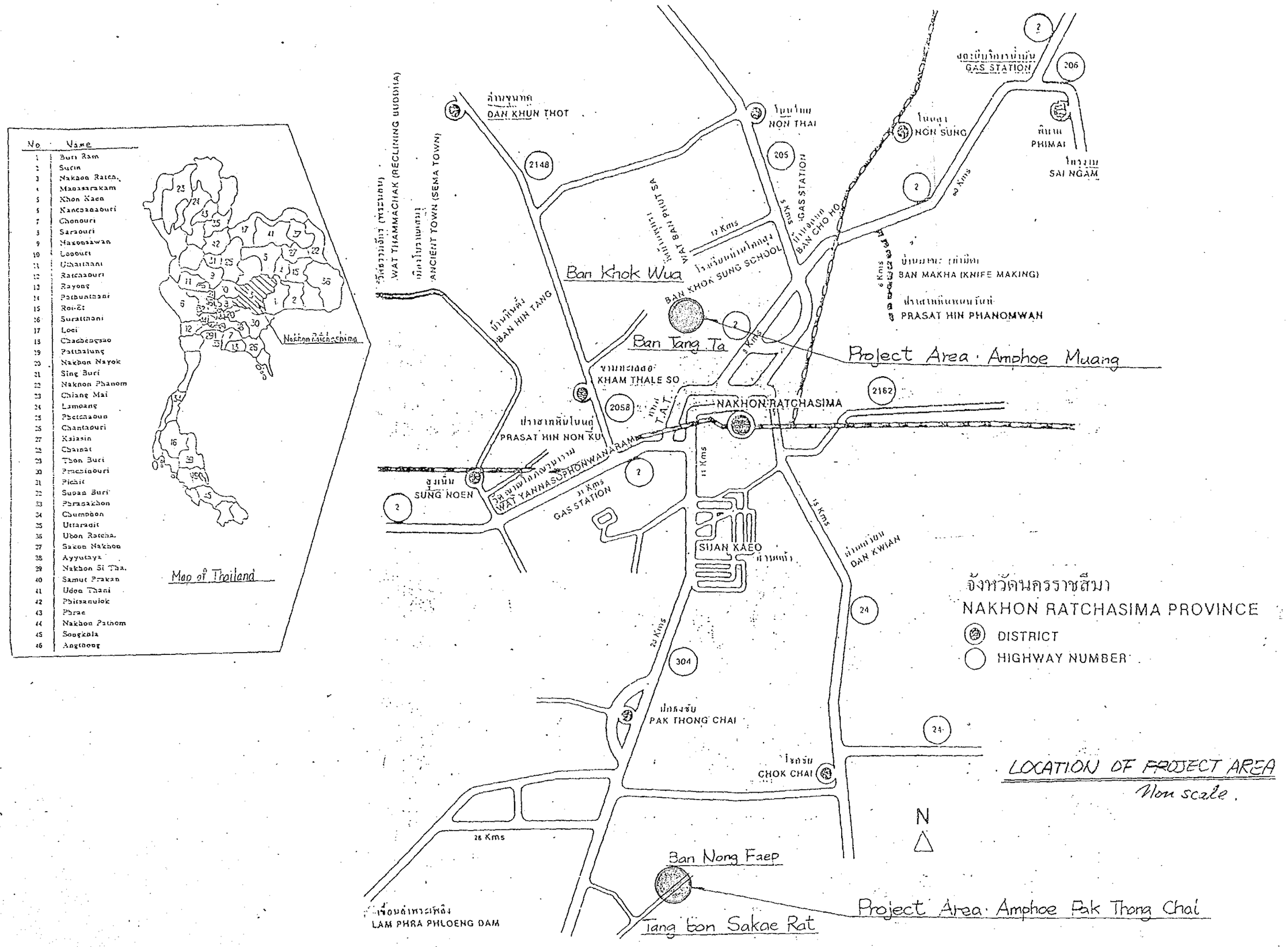

No. Name
1 Buri Ram
2 Surin
3 Nakhon Ratch.
4 Manasarakam
5 Khon Kaen
6 Kanchanaburi
7 Chonburi
8 Saraburi
9 Nakonsawan
10 Lopburi
11 Uthaithani
12 Ratchaburi
13 Rayong
14 Pathunthani
15 Roi-Et
16 Suratthani
17 Loei
18 Chachengsao
19 Pattalung
20 Nakhon Nayok
21 Sing Buri
22 Naknon Phanom
23 Chiang Mai
24 Lamoang
25 Phetchaoun
26 Chantaburi
27 Kalasin
28 Chainat
29 Thon Buri
30 Prachinburi
31 Pichit
32 Supan Buri
33 Phranakhon
34 Chumphon
35 Uttaradit
36 Ubon Ratcha.
37 Sakon Nakhon
38 Ayyutaya
39 Nakhon Si Tha.
40 Samut Prakan
41 Udon Thani
42 Phitsanulok
43 Phrae
44 Nakhon Pathom
45 Songkhla
46 Angthong
Nakhon Ratchasima
Map of Thailand
DAN KHUN THOT
NON THAI
NON SUNG
GAS STATION
PHIMAI
SAI NGAM
WAT THAMMACHAK (RECLINING BUDDHA)
ANCIENT TOWN (SEMA TOWN)
WAT BAN PHUT SA
BAN KHOK SUNG SCHOOL
BAN CHO HO
BAN MAKHA (KNIFE MAKING)
PRASAT HIN PHANOMWAN
BAN HIN TANG
Ban Khok Wua
Ban Tang Ta
Project Area · Amphoe Muang
KHAM THALE SO
NAKHON RATCHASIMA
T.A.T.
PRASAT HIN NON KU
WAT YANNASOPHONWANARAM
SUNG NOEN
GAS STATION
SUAN KAEO
DAN KWIAN
จังหวัดนครราชสีมา
NAKHON RATCHASIMA PROVINCE
DISTRICT
HIGHWAY NUMBER
PAK THONG CHAI
CHOK CHAI
LOCATION OF PROJECT AREA
Non scale.
N
Ban Nong Faep
Project Area · Amphoe Pak Thong Chai
Tang bon Sakae Rat
LAM PHRA PHLOENG DAM

MAIN WORKS OF THE PROJECT

Pak-Thong-Chai Area

ITEM		DIMENSION	QUANTITY
1. Big Pond		32,000 m^3	1 place
2. Pond	Type A	760 m^3	17 places
	Type B	1,500 m^3	1 place
3. Swine Raising Facilities (Breeding)		6.0 m x 6.0 m	3 houses
4. Poultry Facilities (Breeding)		13.3 m x 8.0 m	2 houses
5. Hatchery		4.0 m x 8.0 m	1 house
6. Hen House		3.0 m x 5.0 m	19 houses

Muang Area

1. Canal	860 m	1 place
2 Lateral Canal	328 m	1 place
3. Pond	760 m^3	6 places
4. Swine Raising Facilities (Breeding)	6.0 m x 6.0 m	2 houses
5. Vegetable Farm Facilities	5.0 m x 100.0 m	3 set

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CHAPTER 1 INTRODUCTION

1.1 Objective of the Survey

In accordance with the Record of Discussions on the Japanese technical cooperation for the Agricultural Cooperative Promotion Project in the Kingdom of Thailand (hereinafter referred to as "the project"), the Japan International Cooperation Agency (JICA) dispatched two (2) experts in order to carry out the detail design survey of model infrastructures in Muang model farming group and Pak-Thong-Chai model farming group among five (5) agricultural cooperatives related with the project. And, its objectives include livestock facilities, vegetable farm facilities and irrigation facilities, which will be the foundation of farming activities in two (2) model farming group as mentioned above.

The field survey were carried out from August 15, 1988 to September 23, 1988.

Continuously, based on the results of this field survey, the detailed design works have been carried out from September 24, 1988 to October 23, 1988 as the home work in Japan. This final report is the result of these works.

1.2 List of the Survey Members

Name	Assignment	Position
Mr. Keiji MIYA	Farming Program, Designing of Live-stock Facilities	Senior Design Engineer Manager of Overseas Div. Nippon Giken Inc.
Mr. Yuji OTSUKA	Designing of Irrigation Facilities	Design Engineer Technical Engineering Div. Nippon Giken Inc.

1.3 Progress of the Survey

1.3.1 Field Survey

Aug.	15th	Arrived in Bangkok
	16th	Visit JICA office and meeting Meeting with Japanese experts courtesy call on Cooperative Promotion Department (CPD) and meeting with CPD staff
	17th	Visit JICA office and meeting preparation for survey Movement to the project sites (Bangkok-Korat)
	18th	visit provincial CPD office visit Muang District Coopertative office and Pakthongchai District Cooperative office Reconnaissance in Muang and Pakthongchai
	19th-Sept. 18th	Survey in the project sites Movement to Bangkok (Korat-Bangkok)
Sept.	19th	Meeting with Japanese experts
	20th	Preparation of Interim Report
	21th	visit JICA office and meeting Visit the Embassy of Japan for Submission the report.
	22th	visit CPD for submission the report
	23th	Leave Bangkok for Japan

1.3.2 Home Work in Japan

Sept. 24th-Oct. 23th	Working on Detailed Design

1.4 List of the Main Interviewer and Participant in Final Meeting at CPD.

INTERVIEWER LIST

	Name	Position	Field Covered
(1)	Cooperatives Promotion Department (CPD), MOAC		
	Mr. Songyod Narkchamnarn	Director General	
	Ms. Wannee Ratanawaraha	Chief	Project Manager
	Ms. Rachneewan Prathumthong	Senior policy and analyst	Coop. management and communication
	Mr. Poonsin Chaitahan	Agronomist	Farm guidance
	Mr. Chuchad Losakul	Survey Engineer	Engineering
	Mr. Choosak Losagulpong	Civil engineer	
(2)	CPD Nakhon Rachasima Office		
	Mr. Sangchai Pavabunsiriwong	Chief	Asst. Project Manager
	Ms. Sumol Pakakan	Senior coop. technician	Asst. Project Manager
(3)	Regional Engineering Center 3		
	Mr. Panya Promdee	Chief	Engineering
	Mr. Anan Sangchai	Civil engineer	Engineering
	Mr. Sanit Pongthongcharoen	Surveyor	Engineering
	Mr. Somchai Sarananuson	Engine engineer	Engineering
	Mr. Montri Phobangwai	Engine engineer	Engineering
(4)	District Cooperative Office		
	Mr. Sa-nguan-sak Somparb	Muang dist. coop. officer	Coop. management
	Mr. Sangchan Nongchana	Pak-Thong-Chai dist. coop. officer	Coop. management
(5)	Agricultural Cooperative Ltd.		
	Mr. Too Kamon-na-kin	Muang, President	Coop. management
	Mr. Siripong Meeprasert	Muang, Manager	Coop. management
	Mr. Chan Tonsamrong	Pak-Thong-Chai, President	Coop. management
	Ms. Wanida Chuenarom	Pak-Thong-Chai, Manager	Coop. management
	Mr. Somsak Klein-sri-sook	Farm guidance staff	Farm guidance

PARTICIPANT LIST IN FINAL MEETING BETWEEN
CPD STAFF AND THE DETAIL DESIGN TEAM
22 September, 1988 (10:00 - 12:00 a.m.)

No.	Name	Position
1.	Mr. Keiji Miya	Expert for detailed design survey
2.	Mr. Yuji Otsuka	Expert (Design Engineer)
3.	Mr. Masahiro Omiya	Expert (Design Engineer)
4.	Mr. Hiroshi Takeuchi	Expert, Team Leader
5.	Mr. Y. Oizumi	Expert
6.	Mr. Wanlop Nisadol	Counterpart on Farm Guidance
7.	Mr. Chuchart Losakul	Survey Engineer 5
8.	Mr. Sanit Pong-Thong-Charean	Survey Engineer 6
9.	Mr. Chusak Losakulpong	Engineer 4
10.	Mr. Panya Promdee	Chief, Regional Engineering Center No.3
11.	Mr. Witaya Chitchantaraevong	Counterpart on Cooperative Management
12.	Mr. Apiwat Wongsomboon	Engine Engineer 5
13.	Mr. Samak Decomyoy	Engine Engineer 6
14.	Mr. Sutep Tanomkitnuwat	Civil Engineer 5
15.	Mr. Chaowalit Kanehana-Chuta	Administration Engineer 7
16.	Mr. Teerapat Kalalai	Director, Engineering Division
17.	Mr. Nikon Tongserm	Chief, Survey Section
18.	Mr. Vichak Reangvises	Engineer
19.	Miss Peerorat Aungurarat	Director, Planning Division
20.	Mrs. Wannee Ratanawaraha	Project Manager
21.	Miss Rachaneewan Prathom-Thong	Policy and Plan Analyst

1.5 Project Leader's Letter

September 22, 1988

Mr. Songyod NARKCHAMNARN

Director General

Cooperatives Promotion Department

Ministry of Agriculture and Cooperatives

The detailed design survey of model infrastructures on The Agricultural Cooperatives Promotion Project.

Dear Sir,

It is my pleasure to send herewith the detailed design survey of model infrastructures on The Agricultural Cooperatives Promotion Project (hereinafter referred to as "the project"). Presently, two(2) experts have been dispatched by JICA in order to carry out the detailed design survey of model infrastructures in both Muang model farming group and Pakthongchai model farming group among.

They have conducted with your staff the field survey on the related area in consideration of natural, social and economic conditions as the concept for the detailed design in the attached papers.

The working contents will be decided in consideration of the survey's result including the domestic work, the working budget by JICA, you will be informed its result through the JICA Thailand office.

Further, for the timely commencement of the construction work, I would like to request you to take the necessary formalities in due consultation with JICA Thailand office.

Finally, I appreciate your great cooperation.

Sincerely yours

H. Takeuchi

Hiroshi TAKEUCHI

Team Leader

The Agricultural Cooperative

Promotion Project

c.c : Mr. Tsutomu SAITO Resident Representative of JICA Thailand office

c.c : Embassy of Japan

The detailed design survey of model infrastructures on the Agricultural cooperatives promotion project.

1. LIST OF MEMBERS

ASSIGNMENT	NAME	PRESENT POSITION
Expert	Mr. Keiji Miya	Senior Design Engineer Manager of Overseas Div. Nippon Giken Inc.
Expert	Mr. Yuji Ohtsuka	Design Engineer Technical Engineering Div. Nippon Giken Inc.

2. Schedule of detailed design survey in Thailand

Aug.	15th	Arrived in Bangkok
	16th	Visit JICA office and meeting Meeting with Japanese experts courtesy call on Cooperative Promotion Department (CPD) and meeting with CPD staff
	17th	Visit JICA office and meeting preparation for survey Movement to the project sites (Bangkok - Korat)
	18th	visit provincial CPD office visit Muang District Cooperative office and Pakthongchai District Cooperative office Reconnaissance in Muang and Pakthongchai
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22th	visit CPD for submission the report
23th	Leave Bangkok for Japan

3. Basic concept for the detailed design

3-1. This detail design work is carried out in the area of Muang model farming group and PAKTHONGCHAI model farming group, which are two(2) among five(5) model farming group under the Program of the Agricultural Cooperative Promotion Project. And, in order to promote the compound farming program in two(2) model farming groups, its objectives include swine raising facilities, vegetable farm facilities and irrigation facilities, which will be the foundation of farming activities.

3-2. The detailed design is made in accordance with the plan proposed by CPD and Japanese experts. Which is justified with the purpose of Model Infrastructure Improvement Program promoted by JICA with the consideration of natural, social and economic conditions in the area.

3-3. The wishes and opinions of farmers concerned are respected in the process of determination on the location and scale of the facilities.

3-4. The opinion of the authority concerned to existing facilities is taken in the process of designing of the improvement and repair.

3-5. The working contents is fixed finally with the consideration of the result of the detailed design, the working budget and so on.

4. Facility plan

4-1. Community breeding facilities on swine and poultry raising.
The scale of community breeding facilities is planned as follows;

1) MUANG area

Piggery (multiplication use)...feedable head at ordinary time.. 10 heads

2) PAKTHONGCHAI area

Piggery (multiplication use)...feedable head at ordinary time...20 heads

henhouse (meat use)...feedable number at ordinary time...100 heads

The design of the breeding facilities will be carried out with the consideration of the following points ;

(a) improvement of feeding condition and circumstances.

(b) utilization of excrement for compost use.

(c) establishment on water supply (well or pond)

The planned site of the breeding facilities will be embanked up to the high water level to avoid flooding damages.

4-2. Vegetable farm facilities

MUANG area... vegetable farm facilities is planned.

This farm land (about 1.5 Rai) will install the mothproof net which is used for vegetable cultivation with small agricultural chemicals.

4-3. Irrigation Facilities

(a) canal

1) MUANG area...improvement of canal (about 1 km) is planned, in order to supply irrigation water to model farm land for vegetable.

2) PAKTHONGCHAI area...review on improvement of canal (about 6 km) is planned as water resource for rice and vegetable cultivation in dry season.

(b) pond

1) MUANG area...construction of three(3) ponds and improvement of three (3) ponds are planned as irrigation resource for vegetable cultivation in dry season.

2) PAKTHONGCHAI area...construction of eighteen (18) ponds and improvement of one (1) pond are planned as irrigation water resource for vegetable cultivation in the consideration of promotion of the compound farming management. The construction of farm land for vegetable and sites for community breeding facilities are planned to reclaim by use of excavated soil of the pond.

5. Proposal on construction costs.

The maximum estimated amount of construction costs for facility plan as mentioned above are ¥25,000,000 (about Bht 4,5000,000). After completion of the detailed design works, the contents of facilities which are constructed are fixed clearly.

6. working Schedule for detailed design survey.

Based on the basic concept of detailed design as mentioned above, the detailed design will be carried out according to the following schedule.

6-1 field works in Thailand (Aug.15 1988 - Sept. 23, 1988)

I. Field survey

The field survey for design have been carried out at the proposed site. The field survey are as follows,

(1) Data collection: Collection and confirmation of data on the spot.

(2) Various survey

Topography :	Plane table surveying, routes surveying (Longitudinal leveling, cross leveling) and surveying of land acquisition on each planning sites of facilities.
Existing condition:	Meteorology, Hydrology, Soil, Soil mechanics, Groundwater, Water quality, Farm management, Irrigation and drainage network and facilities.
Confirmation :	Necessary procedure for construction of river, canal, irrigation and drainage facilities. Water level, discharge and gate control during Period of the construction.
Market :	A unit price of materials for construction. Requirement per unit work on labor and equipment for estimation of construction cost.
Others :	Inspection on construction machinery and equipment etc,

II. Preliminary design works

Based on the results of the field survey, the preliminary design works have been carried out.

6-2 Domestic works (Sept. 24,1988 - Oct. 23, 1988)

Based on the results of the works in Thailand, the final detailed design report will be prepared in Japan.

CHAPTER 2 FIELD INVESTIGATION

2.1 Topography and Geology

2.1.1 Topography

Amphoe Pak-Thong-Chai and Amphoe Muang belong to Chanwat Nakhon Ratchasima and are located at south west south of the Korat Plateau in the Northeast Thailand.

Pak-Thong-Chai area is located at about 30 km south of the Nakhon Ratchasima City (Korat) and paddy field area. In more detail, the proposed project area is located at about 10 km south of Amphoe Pak-Thong-Chai. This area is named "Ban Nong Feap". Muang area is located at about 5 km north of Korat and paddy field and upland field for vegetables area. This area is named "Ban Tang Ta". The water sources for irrigation at Pak-Thong-Chai area are rainfall reserved existing pond and paddy field, which are RID canal and ponds at Muang area.

The proposed project areas are shown in Fig. 1.

2.1.2 Geology

The Kora Plateau is composed of fine-graded sandstone and shale strata which are overlain in the vally depressions with alluvium and river terrace deposit.

The investigation of the solid profile was carried out through the excavation of four (4) test pits in Pak-Thong-Chai area and two (2) test pits in Muang area. Further, supplemental drilling by augerhole was carried out from the bottom of six (6) test pits as mentioned above and from the ground surface of other three (3) points. The results of the investigation are described in Paragraph 2.3.1.

2.2 Meteorology

2.2.1 Precipitation

Rainfall data was collected at near the project sites. Period of observation is shown in Table 1 and those data are summarized in Table 2.

Amount of rainfall at Pak-Thong-Chai area and Muang area vary from 880 mm to 1300 mm of which about 95% of annual rainfall is concentrated in Rainy Season from May to October.

Based on the result of rainfall analysis, the relationship between rainfall and crop cultivation are generally characterized as follows;

(1) There is no rainfall from November, so that the paddy harvesting is done after this time. Accordingly, the paddy planting is carried out during the rainy season, from May to October.

(2) The proposed vegetables are planted after paddy harvesting during the dry season from December to April. But, the effective rainfall can not be expected in this time.

2.2.2 Temperature and humidity

Since July 1985, the Pak-Thong-Chai and the Muang Cooperative office have started meteorological observation on the rainfall, temperature and humidity. But observation period is still too short for analysis.

Observation records of rainfall from 1977 at RID Pak-Thong-Chai station are available as shown in Table 2-1.

Average monthly temperature and the others meteorological data at NAKHON RATCHASIMA are also available as shown in Table 3.

Based on the above mentioned data, the crop evapotranspiration was calculated by using the Modified Penman Method. The result of the calculation is shown in Table 4.

2.3 Soil Mechanics

2.3.1 Field tests

Location of the test pits excavation are shown in Fig. 2. Depth and width of those test pits are 2m x 2m x 2m and supplemental drilling was also carried out as mentioned in Paragraph 2.1.2.

Pak-Thong-Chai area

Test Pit No.1 ----- proposed pond site
Test Pit No.2 ----- proposed pond site
Test Pit No.3 ----- proposed pond site
Test Pit No.4 ----- proposed pond site

Muang area

Test Pit No.1 ----- proposed piggery site
Test Pit No.2 ----- proposed pond site
Test Pit No.3 ----- near proposed pond site
Test Pit No.4 ----- near proposed pond site
Test Pit No.5 ----- proposed pond site

Soil profiles are shown in Fig. 3.

2.3.2 Soil test

The items of the soil testing are as follows;

1) Specific gravity test
2) Liquid limit test
3) Plastic limit test
4) Grain size analysis
5) Standard compaction test
6) Field density test

The soil sample was taken from the test pits as mentioned above (2.3.1) at 0.7 m -- 4.0 m depth below the ground surface which was considered as the typical soil in these areas.

According to the grainsize analysis, all of them (Pak-Thong-Chai area Test Pit No. 1 -- No. 4, Muang area Test Pig No. 1 -- No. 4) belong to finegrained soil.

On the other hand, based on the Japanese Unified Soil Classification System, the soil can be classified into the following categories, taking liquid and plastic limit test into account.

Pak-Thong-Chai area (pond site)

Test Pit No.1	(1.5 m depth) ----------	"ML"
Test Pit No.2	(1.5 m depth) ----------	"ML"
Test Pit No.2	(2.0 m depth) ----------	"CL"
Test Pit No.2	(3.1 - 3.5 m depth) ----------	"CL"
Test Pit No.3	(1.5 m depth) ----------	"SM"
Test Pit No.3	(3.5 - 4.0 m depth) ----------	"CL"
Test Pit No.4	(0.7 m depth) ----------	"SM"
Test Pit No.4	(1.2 m depth) ----------	"ML"

Muang area

Test Pit No.1	(1.2 m depth) ----------	"ML"
Test Pit No.2	(1.2 m depth) ----------	"MH"
Test Pit No.2	(2.5 - 2.8 m depth) ----------	"MH"
Test Pit No.3	(0.5 - 1.0 m depth) ----------	"ML"
Test Pit No.3	(2.0 - 2.5 m depth) ----------	"MH"
Test Pit No.4	(2.0 - 2.5 m depth) ----------	"MH"

The results of compaction test are shown as follows;

Test Pit No.	Depth (m)	Wopt (%)	rdmax (g/cm^3)
Pak-Thong-Chai area			
1	1.5	9.40	1.770
2	1.5	13.40	1.852
2	2.0	11.60	1.874
2	3.1 - 3.5	16.40	1.751
3	1.5	9.80	1.828
3	3.5 - 4.0	9.45	1.980
4	0.7	6.40	1.652
4	1.2	11.40	1.892
Muang area			
1	1.2	11.10	1.836
2	1.2	16.20	1.622
2	2.5 - 2.8	17.70	1.508
3	0.5 - 1.0	11.20	1.916
3	2.0 - 2.5	11.10	1.912
4	2.0 - 2.5	17.70	1.510

As for Pak-Thong-Chai area Test Pit No.2 (2.0 m depth), No.3 (3.5 - 4.0 m depth), No.4 (0.7 m depth) and all of Muang Test Pit, natural water content is larger than that of optimum moisture content as mentioned above. Therefore, the moisture content should be carefully checked during construction period.

2.4 Water Quality

The water quality test for irrigation and swine was carried out according to the following sites and their locations are shown in Fig. 2.

Point	Site		Location
Pak-Thong-Chai area			
A	Existing farm pound	--------	proposed pond area
B	Ground water	--------	existing well H = 30 m
C	Existing pond	--------	non-proposed pond
E	Ground water	--------	Test Pig No.3 H = 3.8 m
G	Riverhead	--------	Ramchiang-sa river
Muang area			
H	Irrigation	--------	RID canal
I	Existing pond	--------	near proposed pond
J	Drinking water	--------	reserved water tank
K	Ground water	--------	Test Pit No.1 H = 1.8 m

According to "United State Department of Agriculture (USDA)", water samples are classified into four groups as shown in Table 6 with respect to sodium hazard depending on the sodium absorption ratio (SAR) value and the specific conductance.

$$\text{The SAR is defined as; SAR} = \frac{Na^{+}}{\sqrt{(Ca^{++} + Mg^{++})/2}} \qquad \text{(USDA)}$$

Here, the concentration of the ions is expressed in per million (epm). The results of analysis of water samples are summarized as follows:

The Results of Analysis Water Samples

	Point Site	E.C. mmhos/cm 25°C degree	pH	SAR	Sodium Hazard	Salinity Hazard
Pak-Thong-Chai area						
A	Existing farm pond	0.08	6.8	4.1	S 1	C 1
B	Ground water	1.60	6.4	22.5	S 4	C 3
C	Existing pond	0.20	6.8	11.8	S 2	C 1
E	Ground water	1.01	7.0	43.8	S 4	C 3
G	Riverhead	0.10	6.6	4.0	S 1	C 1
Muang area						
H	Irrigation canal	0.36	6.8	5.7	S 1	C 2
I	Existing pond	4.60	7.1	166.9	S 4	C 4
J	Drinking water	0.08	7.0	0.3	S 1	C 1
K	Ground water	30.00	6.9	119.9	S 4	C 4

Based on the results of analysis, the water of river, existing pond in Pak-Thong-Chai area and existing irrigation canal in Muang area can be used for the irrigation.

On the other hand, ground water show high EC value and SAR value, so it can not be used for irrigation.

But the ground water at proposed pond site in Pak-Thong-Chai area is not so higt value, so the stored water will not increase the salinity caused by the ground water.

The ground water and the water of existing pond in Muang area are so higt value, therefore, the stored water of pond should be carefully checked for irrigation.

2.5 Irrigation and Drainage

2.5.1 Irrigation

Pak-Thong-Chai area

The project area id about 6 km far from Ramchiang-sa river. The water sources for irrigation are Ramchiang-sa river when the water level is high in rainy season. However, at present time, the water sources are rain water, because Ramchiang-sa river's water level is low. Therefore, the irrigation water cannot supply from river.

Muang area

The project area is surrounded by RID Canal. The water sources for irrigation are RID Canal in rainy season. However, in dry season (from November to April), the irrigation water supplied from RID Canal is not enough.

2.5.2 Drainage

The drainage system in the project areas (Pak-Thong-Chai and Muang) are not provided. Therefore, the excess water still remains in the fields and small ponds. Especially, in rain season, the drainage conditions become worse.

2.6 Topographical Survey

The topographical survey works were carried out to cover the livestock facilities farm and irrigation area. Item of the survey works are as follows;

(1) Level Survey for Bench Mark
Bench Mark set each proposed pond, canal and livestock facilities

(2) Survey Area

Pak-Thong-Chai area	--------	60 ha
Muang area	--------	18 ha

(3) Travers Survey

Closed travers survey for whole area

Concrete peg -------- 70 pegs

(4) Level Survey

Setting a base line and mesh line (25 m x 25 m, 50 m x 50 m)

Number of points -------- 500 points

(5) Plane Table Survey

For whole area

2.7 Farming Condition

Now, in Pak-Thong-Chai and Muang area, the compound farming which include rice, vegetable, swine and poultry raising is planned by farmers.

In order to make the model compound farming program as a target of the farming, the farming condition survey were carried out to farmers related to two (2) model farming group. The result of this survey is shown in Table 7.

Hereafter, this farming program will be prepared as standard the representative farmer in these model farming groups.

CHAPTER 3 FARMING PROGRAM

3.1 Existing Condition Farming

The investigation of existing condition of farming concerning each farmer which take part in the model farming group at both Pak-Thong-Chai and Muang agricultural cooperatives was carried out in the field study.

The existing condition on each farm-house relative to family labor in agriculture, agricultural land area and the number of livestock are as follows.

Model farming group	Number of farmhouse concerning model farming group	Family labor per A farm house	Each crop area per A farmhouse			m^2 (Rai)
			Rice	Cassave	Vegetable	Others (Fruit tree Cucalyptus)
	houses	men				
Pak-Thong -Chai	19	3.8	21,628 (13.5)	11,555 (7.2)	22 (0.01)	4,928 (3.1)
Muang	19	3.9	28,123 (17.5	8,842 (5.5)	3,048 (1.9)	511 (0.3)

	Number of Livestock per A Farm-house				
Total	Buffalo	Cattle	Pig	Chicken	Duck
	heads	heads	heads	birds	birds
38,133 (23.8)	1.7	0.1	0.4	19.9	-
40,524 (25.3)	-	-	1.4	24.8	35.9

An area under vegetable cultivation and number of swinery in Pak-Thong-Chai area, but Fruit tree and Cucalyptus much more than Muang area. The other side, number

of swinery in Muang are much more than Pak-Thong-Chai, but are only 1.4 heads per a farm-house.

Considering on the basis of these studying results, the feature of farming both two (2) area is as follows.

(1) Farming foundation is rice single cropping depended on rain water in the rainy season.

(2) The cropping rate of farm in the dry season especially is low because the irrigation system is insufficient.

(3) Family labor in agriculture is abundant, but the sufficient work in agriculture aren't for these family labors. That matter is remarkable in the dry season especially.

(4) It is difficult to expand the cultivated land.

(5) In recent years, many problems awaiting solution befall in vegetable growing, for example, the occurrence of harm by excessive use of agricultural chemicals, retardation of yield by excessive fertilization of chemical manure and so on.

3.2 Target of Farming Program

The consideration on the increase of agricultural income by the improvement of farming condition as is mentioned above is important for the promotion on the living level of the farmers and the strengthen of agricultural cooperative system.

It is necessary to establish the compound farming form with an eye to following matter.

(1) To utilize effectively in the agriculture the family labor by the promotion of the intensive farming.

(2) To raise the cropping rate of farm land by the promotion stability of the crop cultivation by mens of adjustment and improvement of irrigation facilities.

(3) To perform the vegetable growing in the little use of agricultural chemicals by means of equipment with moth defense net.

(4) To promote the improvement of soil fertility by means of the fertilization of farm yard manure to farm land.

The farmer who take part in the model farming group at both Pak-Thong-Chai and Muang agricultural cooperatives promote the compound farming by farming activity of farmers own accord and it is necessary to do extension to around farmers the actual effect of the compound farming.

The target of farming program on each two (2) agricultural cooperatives are as follows.

(1) Pak-Thong-Chai Area

The plan of compound farming form is follows.

RICE + VEGETABLE + SWINERY + POULTRY

The way to perform this compound farming is as follows.

(a) The rice cropping in the rainy season continue as ever.

(b) Nineteen (19) reservoirs are constructed in the farm land which belong to each farmers. The ground of poultry facilities and vegetable farm land are made at around reservoir.

The reservoirs are used as the water source of irrigation for vegetable growing and that of chicken farm.

(c) The cooperative poultry facilities for hatching and brooding are constructed. These facilities supply each farmers with chick.

The poultry raising houses for each farmers which necessary material are prepared by JICA are constructed by the farmers own effort under guidance of CPD.

(d) The cooperative swinery facilities for breeding are constructed. These facilities supply each farmers with piglet.

Owing to the performance these matter mentioned above, the increase of average annual income in agriculture (about 10,000B) is expected.

(2) Muang Area

The plan of compound farming form is follows.

RICE + VEGETABLE + SWINERY

The way to perform this compound farming is as follows.

(a) The rice cropping in the rainy season continue as ever.

(b) The facilities with the moth defense net is constructed at the model vegetable farm (1.5 Rai).

(c) The canal is improved and six (6) reservoirs are improved or constructed. The canal and reservoirs are used as the water source of irrigation for vegetable growing.

(d) The cooperative swinery facilities for breeding are constructed. These facilities supply each farmers with piglet. Owing to the performance these matter mentioned above, the increase of average annual income in agriculture (about 10,000B) is expected.

Consequently, the standard of farming scale per a farm-house is as follows.

Pak-Thong-Chai Area

Rice	(exist)	2 ha	(= 13 Rai)	single cropping in the rainy season yearly
Vegetable	(new)	400 m^2	(= 0.25 Rai)	triple cropping yearly
Swinery	(new)	8 heads		raising usually
Poultry	(new)	100 bird		raising usually

Muang Area

Rice	(exist)	2.8 ha	(= 17 Rai)	single cropping in the rainy season yearly
Vegetable		0.54 ha	(= 3.4 Rai)	triply cropping yearly
	(new)	0.24 ha	(= 1.5 Rai)	
	(exist)	0.30 ha	(= 1.9 Rai)	
Swinery	(new)	4 heads		raising usually

3.3 Effect on Compound Farming

The effect on the production introduced newly in the standard of farming scale mentioned above is as follows.

(1) Pak-Thong-Chai Area

A. Vegetable farm 400 m^2 (= 0.25 Rai)

Triple cropping yearly (chilli, watermelon, greens vegetable)

(a) Chilli

Yield	500 kg/Rai x 0.25 Rai	= 125 kg
Gross income	10฿/kg x 125 kg	= 1,250฿
Ratio of net income to gross income	50%	
Income of farm household	1,250฿ x 0.5	= 625฿ (1)

(b) Water melon

Yield	1,000 Pieces/Rai x 0.25 Rai	= 250 Pieces
Gross income	3฿/Piece x 250 Piece	= 750฿
Ratio of net income to gross income	50%	
Income of farm household	750฿ x 0.5	= 375฿ (2)

(c) Greens vegetable

Yield	800 kg/Rai x 0.25 Rai	= 200 kg
Gross income	4฿kg x 200 kg	= 800฿
Ratio of net income to gross income	50%	
Income of farm house-hold	800฿ x 0.5	= 400฿ (3)

Consequently, the increase of annual income by the vegetable cultivation is as follows.

(1) + (2) + (3) = 1,400฿

B. Swinery

The cooperation swinery facilities for breeding.	Sow 19 heads boar 1 head total 20 heads raising usually.		
Heads of farrow per one time	11 heads/head of sow		
Ratio of growth	70%		
Heads of growth	11 heads x 0.7	=	8 heads/head of sow
	8 heads x 19 heads	=	152 heads
Delivery, 2 times yearly	152 heads x 2	=	304 heads
Number of farm-house	19 houses		

Raising heads per a house	152 heads ÷ 19 houses	=	8 heads
Term of raising	5 months (150 days)		
Times of annual raising	2 times		
Heads of annual selling	8 heads x 2	=	16 heads
Alive weight of annual selling	60 kg/head x 16 heads	=	960 kg
Gross income	20฿/kg x 960 kg	=	19,200฿
Ratio of net income to gross income	30%		
Income of farm house-hold	19,200฿ x 0.3	=	5,760฿

C. Poultry

Raising birds per a house	100 birds		
Term of raising	100 days		
Times of annual raising	3 times		
Birds of annual selling	100 birds x 3	=	300 birds
Alive weight of annual selling	2.5 kg/bird x 300 birds	=	750 kg
Gross income	15฿/kg x 750 kg	=	11,250฿
Ratio of net income to gross income	40%		
Income of farm house-hold	11,250฿ x 0.4	=	4,500฿

Consequently, the increase of annual income by the compound farming per a farm-house is as follows.

1,400฿ + 5,760฿ + 4,500฿ = 11,660฿

(2) Muang Area

A. Vegetable farm 2,400 m^2 (= 1.5 Rai)

Triple cropping yearly (chilli, watermelon, greens vegetable)

(a) Chilli

Yield	500 kg/Rai x 1.5 Rai	= 750 kg	
Gross income	10฿/kg x 750 kg	= 7,500฿	
Ratio of net income to gross income	50%		
Income of farm household	7,500฿ x 0.5	= 3,750฿	(1)

(b) Water melon

Yield	1,000 Pieces/Rai x 1.5 Rai	= 1,500 Pieces	
Gross income	3฿/Piece x 1,500 Pieces	= 4,500฿	
Ratio of net income to gross income	50%		
Income of farm household	4,500฿ x 0.5	= 2,250฿	(2)

(c) Greens vegetable

Yield	800 kg/Rai x 1.5 Rai	= 1,200 kg	
Gross income	4฿kg x 1,200 kg	= 4,800฿	
Ratio of net income to gross income	50%		
Income of farm house-hold	4,800฿ x 0.5	= 2,400฿	(3)

Consequently, the increase of annual income by the vegetable cultivation is as follows.

$$(1) + (2) + (3) = 8{,}400฿$$

B. Swinery

The cooperation swinery facilities for breeding.	Sow 10 heads boar 1 head total 11 heads raising usually.		
Heads of farrow per one time	11 head/head of sow		
Ratio of growth	70%		
Heads of growth	11 heads x 0.7	=	8 heads/head of sow
	8 heads x 10 heads	=	80 heads
Delivery, 2 times yearly	80 heads x 2	=	160 heads
Number of farm-house	19 houses		
Raising heads per a house	80 heads ÷ 19 houses	=	4 heads
Term of raising	5 months (150 days)		
Times of annual raising	2 times		
Heads of annual selling	4 heads x 2	=	8 heads
Alive weight of annual selling	60 kg/head x 8 heads	=	480 kg
Gross income	20฿/kg x 480 kg	=	9,600฿
Ratio of net income to gross income	30%		
Income of farm house-hold	9,600฿ x 0.3	=	2,880฿

Consequently, the increase of annual income by the compound farming per a farm-house is as follows.

$$8{,}400฿ + 2{,}880฿ = 11{,}280฿$$

CHAPTER 4 PLANNING AND DESIGN OF FACILITIES

4.1 Generality

One of the project aims is to promote compound farming management (combination between livestock raising and crop cultivation) in the project area in order to increase farms income and to establish the cooperative farming system.

For this purpose, construction of livestock raising facilities, vegetable farm facilities and irrigation facilities have been planned. The proposed plan include the following components.

Construction of Livestock Raising Facilities

(a) Livestock Raising Facilities -- construction of Piggery, Hen house, Compost barnyard, Hatchery and Urine treatment basin
(b) Related Facilities -- construction of Well

Construction of Vegetable farm Facilities installing of mothproof net

Construction of Irrigation Facilities

(a) Pond (include improvement)
(b) Canal (improvement)

The location of the proposed project sites are shown in Fig. 1-1~4.

4.2 Livestock Facilities Plan

4.2.1 Basic conception in planning

The livestock facilities plan include swine and poultry raising facilities which are used as community ones.

The scale of the facilities is planned as follows:

(1) Pak-Thong-Chai area

Swine raising facilities is planned to feed 20 heads at ordinary time.

The design of these facilities is carried out with the consideration of the following points;

(a) improvement of feeding condition and circumstance
(b) utilization of excrement for compost use
(c) establishment on water supply (well and pond)

(2) Muang area

Swine raising facilities is planned to feed 10 heads at ordinary time. Poultry raising facilities is planned to feed 100 heads.

4.2.2 Planning and design of livestock facilities

In order to integrate the livestock raising, the following facilities are planned.

(a) Piggery (Pak-Thong-Chai) -- feedable head at ordinary time ... 20 heads
(b) Piggery (Muang) -- feedable head at ordinary time ... 10 heads
(c) Hen house (Pak-Thong-Chai) -- feedable head at ordinary time ... 100 heads
(d) Compost barnyard (Muang, Pak-Thong-Chai)
(e) Hatchery (Pak-Thong-Chai)
(f) Water tank (Pak-Thong-Chai, Muang)
(g) Well (Muang)

(h) Urine treatment basin (Pak-Thong-Chai, Muang)

The major dimensions of the facilities are summarized as below:

Item	Dimension	Structure
Piggery (Pak-Thong-Chai	6m x 6m 3 units	floor -- concrete roof -- yahka (grass)
Piggery (Muang)	6m x 6m 2 units	floor -- earth roof -- yahka (grass)
Hen house (Pak-Thong-Chai)	13.3m x 8m 4 units	floor -- earth roof -- yahka (grass)
Compost barnyard (Pak-Thong-Chai) (Muang)	3m x 6m 1 unit	floor -- earth roof -- yahka (grass)
Hatchery (Pak-Thong-Chai)	4m x 8m 1 unit	floor -- concrete roof -- yahka (grass)
Water tank (Pak-Thong-Chai) (Muang)	1500 L, 4 units 1500 L, 2 units	
Well (Muang)	ϕ = 1.0m, Depth = 2-3m	
Urine treatment basin (Pak-Thong-Chai, Muang)	ϕ = 1.0m, Depth = 3-5m	R.C. concrete

4.3 Vegetable Farm Facilities Plan

In Muang area, model farm facilities for vegetable (about 1.5 Rai) are planned. This farm facilities install the mothproof net which is used for vegetable cultivation with small agricultural chemicals. It's dimensions are as follows:

mothproof net facilities (5 m x 100 m x 3 set) made by steel pipe

4.4 Irrigation Facilities Plan

4.4.1 Basic conception in planning

The irrigation facilities plan include the construction of pond, improvement of pond and canal for water resource to vegetable farm during dry season from November to April. The water resource for vegetable farm is direct use of rain water, the pond which reserve rain water from surrounding area and the canal. But, water of canal in dry season is unstable and there is no dependable canal water as stable resource for irrigation.

Therefore, in this area, keep of water resource by means of the construction and improvement of pond is important matter for vegetable farming in dry season. At Muang and Pak-Thong-Chai area, water is reserved in the pond in rainy season from May to October and is used as the resource of vegetable farm in dry season from November to April.

4.4.2 Irrigation water requirement

Potential Evapotranspiration (ETo) is estimated on the monthly basis by applying the Modified Penman Method based on the climatological data at Nakhon Ratchasima meteological station. The results of calculation are shown below, and its detailed estimation is shown in Table 6.

Potential Evapotranspiration

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Daily basis	4.5	5.4	6.0	6.2	5.8	5.4	5.2	5.0	4.3	4.5	4.6	4.3	-
Monthly basis	140	151	186	186	180	162	161	155	129	140	138	133	1861

After the determination of ETo, crop evapotranspiration (ET crop) can be estimated by multiplying the estimated ETo values by crop efficient (Kc). The Kc values vary depending upon a growing period of crops and locality. Thus, this Kc values are selected

for proposed crop in "Irrigation and Drainage Paper 24, FAO". But, in this time, the ET crop values adopt same ETo values.

Crop Evapotranspiration (ET crop)

	Nov	Dec	Jan	Feb	Mar	Apr	Ave.
ETo	4.6	4.3	4.5	5.4	6.0	6.2	5.0
ET crop	4.6	4.3	4.5	5.4	6.0	6.2	5.0

The value of effective rainfall is neglected as a safety factor in consideration of the irregular distribution of rainfall. Therefore, the irrigation water requirements can be obtained from following equation.

$$V = \frac{ET\ crop}{1000} \times A \times N$$

where; V : Volume of water requirement m^3
A : Cropped acreage of crop 20 m x 20 m
ET crop : Crop evapotranspiration Ave. 5.0 mm/day
N : Number of days 180 days (from Nov. to Apr.)

$$V = \frac{5.0}{1000} \times 20 \times 20 \times 180 = 360\ m^3$$

4.4.3 Planning and design of irrigation facilities

The proposed irrigation facilities to be constructed are as follows:

Pond (include Big Pond)
Canal (include Lateral canal)

(1) Pond

The pond is constructed as follows;

1) Pak-Thong-Chai area ..... construction of eighteen (18) ponds and improvement of one (1) pond are planned as irrigation water resource for vegetable cultivation in the consideration of promotion of the compound farming management. The construction of farm land for vegetable and sites for community breeding facilities are planned to reclaim by use of excavated soil of the pond.

2) Muang area ..... construction of three (3) ponds and improvement of three (3) ponds are planned as irrigation resource for vegetable cultivation in dry season.

The pond size is calculated as follows;

The evaporation from pond surface will be about same irrigation water requirement. The necessary volume of pond (720 m^3 (360 x 2) which is double volume of irrigation water requirement.

a) Pak-Thong-Chai area

Pond Surface	20 m x 20 m
Depth	3.5 m
Side slope	1:2.0
Pond Bottom	6 m x 6 m

$$\text{Volume} = \frac{20 \times 20 + 6 \times 6}{2} \times 3.5 = 763\ m^3 > 720\ m^3$$

b) Muang area

Pond Surface	15 m x 30 m
Depth	3.0 m
Side slope	1:2.0
Pond Bottom	3 m x 18 m

$$\text{Volume} = \frac{15 \times 30 + 3 \times 18}{2} \times 3.0 = 756\ m^3 > 720\ m^3$$

(2) Big Pond

The big pond is existing pond at Pak-Thong-Chai. The plan is new size as follows;

Present and Plan of Big Pond

Item	Present	Plan
Top Elevation	EL 208.5 m → EL 211.1 m	EL 211.0 m
Bottom Elevation	EL 208.0 m → EL 209.2 m	EL 208.0 m
Depth	1.0 m → 1.9 m	3.0 m
Side slope	1:1.5 → 1:30	1:2.0
Volume	17000 m^3	32000 m^3

(3) Canal

The canal is existing canal at Muang. The plan is new size as follows;

Present and Plan of Big Pond

Item	Present	Plan
Width (bottom)	6.0 m	2.0 m
Width (top)	9.0 m	14.0 m
Depth	1.5 m	3.0 m
Side slope	1:1.0	1:2.0

(4) Lateral canal

Present and Plan of Standard at Lateral Canal

Item	Present	Plan
Width (bottom)	0.5 m	0.3 m
Width (top)	2.5 m	2.3 m
Depth	0.5 m	0.5 m
Side slope	1:2.0	1:2.0
Bottom slope	-	1:2,000

CHAPTER 5 CONSTRUCTION PLANNING

5.1 Construction Method

The project involves mainly earth works such as construction of ponds and canal so that a huge number of earth volume should be carried out by machines.

Construction equipments were already donated by JICA under the Agricultural Cooperative Promotion Project for the purpose of construction of project works and improvement of heavy equipments operation technique and construction administration ability for CPD's personal.

Therefore, for this project, the construction of ponds, canal (earth works) and embankment for livestock facilities sites will be executed by CPD force by using the donated construction equipments.

Also the construction of livestock facilities and concrete works for appendant structure will be executed by CPD force.

5.2 Construction Schedule

The time required for construction of the project would be about 6 months including about one month of preparation of tender documents tender calling and tender award and Final Inspection.

The construction schedule for the project was worked out on the basis the following consideration:

(a) Workable days

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

(b) Conversion rate of earth volume

The conversion rate of earth volume for making the earth moving plan is decided as 1 vs 1.

(c) Earth moving plan

In principle, the earth materials necessary for embankment are supplied by a excavated earth materials in the site.

(d) Application of manpower and construction machinery

Manpower is applied for the detail work, because the work scale is the comparatively small and the employment opportunity for local labour can be increased.

The construction equipment is selected as follows;

Dump Truck (11 ton)	transportation
Bull Dozor (11 ton)	excavation and spreading
Back-hoe Shovel (0.5 m^3)	excavation and loading
Tire Roller (12 ton)	compaction
Vibration Roller (3 ton)	compaction
Portable Concrete Mixer	mixing of concrete

The proposed construction schedule is shown as follows;

CHAPTER 6 COST ESTIMATE

6.1 GENERALITY

The construction cost of the project is estimated by using bill of quantities taken from the detail designs, drawings, and reasonable unit costs. The construction cost is including tax, profit and overhead, and also including contingency for price escalation and physical measures of bill of quantities.

The bill of quantities of the construction works are shown in Table 8.

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

Unit cost of each work item is estimated by using labour cost and material cost which are current prices surveyed in September 1988.

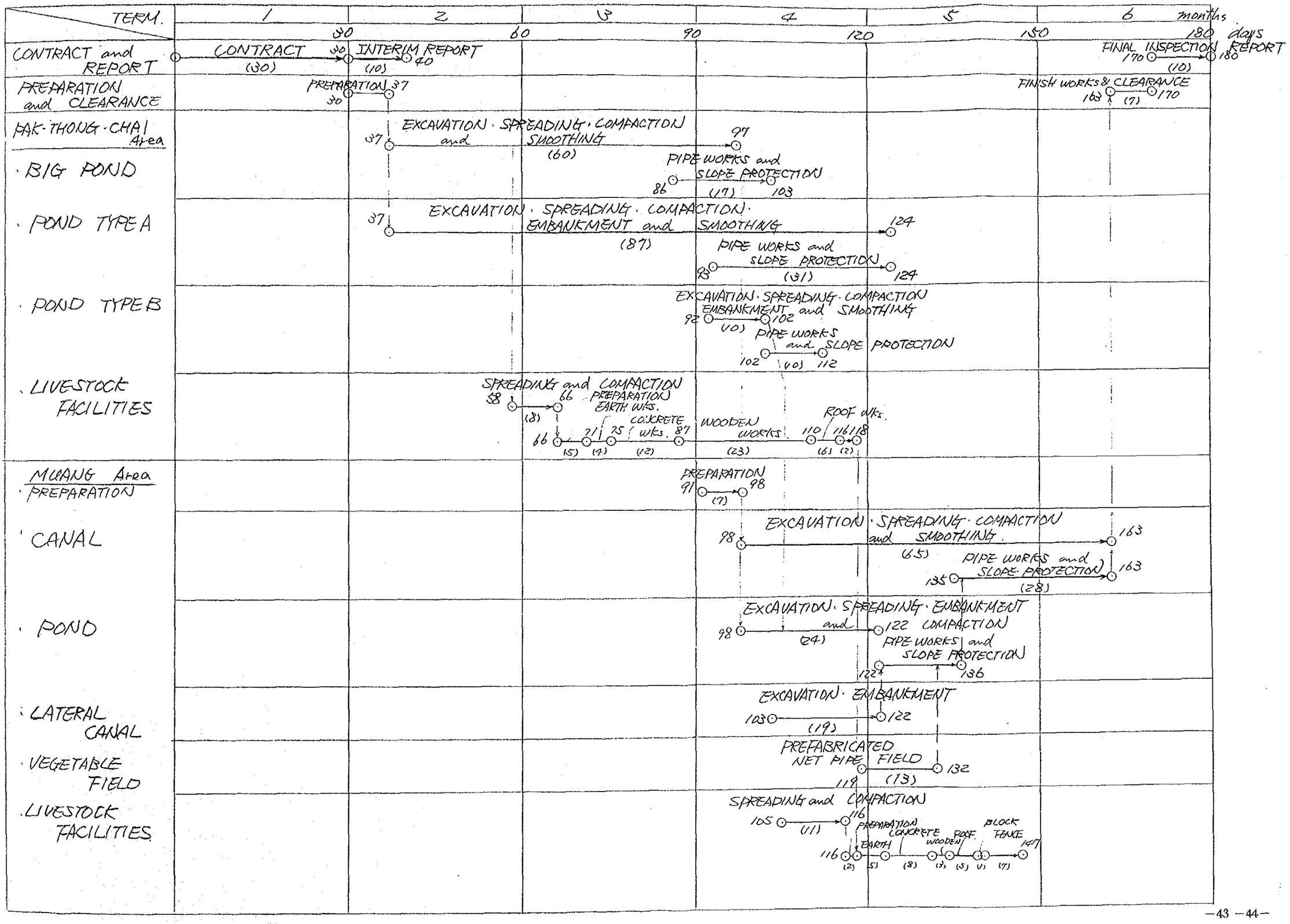
The exchange rate used in the estimate is 1B = ¥5.292

6.2 Construction Cost

The total construction cost of the project of Pak-Thong-Chai area and Muaug area is developed, are estimated at Baht 4,735,000 (¥25,000,000 equivalent) including price contingencies.

The construction cost are summarized as follows and surveyed prices of labour and material are shown in Table. 9 to 13, respectively.

Table. CONSTRUCTION SCHEDULE



PROJECT COST

Item No.	Item	Quantities	Construction Cost (฿)	Remarks
I	Construction Cost			
1	Direct Cost			
1-1	PAK - THONG - CHAI Area			
1-1-1	Construction of livestock facilities			
1)	Piggery	3 set	120,000	
2)	Compost barnyard	1 set	12,000	
3)	Water tank	1 set	36,000	
4)	Urine treatment Basin & Drain	1 set	43,000	
5)	Hen House (breeding)	2 set	93,000	
6)	Hatchery	1 set	24,000	
	sub total		327,000	(1)
1-1-2	Construction of Hen House			
1)	Hen House	1 set	19,000	
2)	Material	18 set	236,000	
	sub total		255,000	(2)
1-1-3	Construction of irrigation facilities			
1)	Big pond	1 set	625,000	
2)	Pond (TYPE A)	17 set	496,000	
3)	Pond (TYPE B)	1 set	54,000	
	sub total		1,175,000	(3)
	total		1,757,000	(4) = (1) + (2) + (3)

PROJECT COST

Item No.	Item	Quantities		Construction Cost (₿)	Remarks
1-2	MUANG Area				
1-2-1	Construction of swine raising farm				
1)	Piggery	2	set	114,000	
2)	Compost barnyard	1	set	12,000	
3)	Water tank	1	set	13,000	
4)	Urine treatment Basin & Drain	1	set	30,000	
5)	Well	1	set	4,000	
	sub total			173,000	(5)
1-2-2	Construction of irrigation facilities				
1)	Canal	860	m	826,000	
2)	Appendant structure	14	set	441,000	
3)	Pond	4,600	m^3	146,000	
4)	Lateral canal	328	m	11,000	
	sub total			1,424,000	(6)
1-2-3	Installation of Vegetable Farm	300	m	63,000	(7)
	total			1,660,000	(8) = (5) + (6) + (7)
	IN - DIRECT COST			683,000	(9) = {(4) + (8)} × 20%

PROJECT COST

Item No.	Item	Quantities	Construction Cost (₿)	Remarks
	Ground Total		4,100,000	(10) = (4) + (8) + (9)
II	Reserved Cost (physical Contingency)		410,000	(11) = (10) ×10.0%
III	Others		225,000	(12) = {(10)+(11)} ×5.0%
	PROJECT COST		4,735,000	(13) = (10) + (11) + (12)
			1₿ = ¥ 5.292	

APPENDIX

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FIGURES

DRAWINGS

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2-2, 3	MONTHLY AND ANNUAL RAINFALL (CPD • MUANG 7 PAK-THONG-CHAI)
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Table - 1

OBSERVATION PERIOD OF RAINFALL (DAILY)

STATION	PERIOD (YEAR)
CPD Muang	1985.7 — 1988.7
CPD Pak Thong Chai	1985.7 — 1987.12 (1987.1 -7 Non)
RID Pak Thong Chai	1977.4 — 1988.7
MDMC Korat	1987.1 — 1988.8

MDMC: Meteorological Department Ministry of Communications

OBSERVATION PERIOD OF AVERAGE TEMPERATURE (DAILY)

STATION	PERIOD (YEAR)
CPD Muang	1985.6 — 1988.7
CPD Pak Thong Chai	1985.6 — 1988.1

OBSERVATION PERIOD OF AVERAGE TEMPERATURE (MONTHLY)

STATION	PERIOD (YEAR)
MDMC Korat	1958.1 — 1988.8 (1943-1957 ave.)

Table 2-1

MONTHLY AND ANNUAL RAINFALL (1977 - 1988)

Station RID · LAM PHRA PHLOENG Project
Irrigation Section 2 PAK THONG C

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1977	—	—	—	40.3	167.8	33.2	137.8	177.7	265.1	117.5	5.6	0.0	9
1978	0.0	0.0	0.0	88.5	128.3	0.0	124.7	19.6	47.8	0.0	7.7	0.0	4
1979	0.0	8.4	20.8	57.7	122.1	140.4	59.7	76.6	271.6	35.6	0.0	0.0	79
1980	0.0	0.0	13.2	157.1	113.0	149.7	100.9	160.9	307.7	225.5	16.5	0.0	12
1981	0.0	0.3	5.2	100.1	167.5	28.2	147.0	31.8	138.0	68.4	190.1	0.0	8
1982	0.0	0.0	44.2	79.2	108.2	45.8	35.5	103.6	345.1	64.9	11.0	0.0	80
1983	0.0	6.7	89.1	32.2	113.6	74.4	225.3	224.4	179.8	249.3	101.0	5.6	130
1984	0.0	63.0	9.2	110.2	105.0	66.0	119.1	71.6	165.5	81.1	0.0	0.0	78
1985	52.2	0.0	9.2	261.3	137.5	29.3	158.4	58.3	194.2	214.4	37.1	0.0	115
1986	3.6	0.0	3.3	120.8	204.3	45.8	143.6	122.7	186.1	187.0	0.0	0.0	101
1987	0.0	0.0	7.2	27.0	113.7	92.8	14.3	61.5	239.6	0.0	0.0	0.0	55
1988	0.0	10.2	50.9	81.0	206.4	120.5	84.1	—	—	—	—	—	55
Total	55.8	88.6	252.3	1155.4	1687.4	826.1	1350.9	1108.7	2309.5	1248.7	369.0	5.6	109
Ave.	5.1	8.1	22.9	96.3	140.6	68.8	112.5	100.8	210.0	113.1	33.5	0.5	91

Table 2-2

MONTHLY AND ANNUAL RAINFALL (1985 - 1988)

Station. CPD Muang

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1985	—	—	—	—	—	—	85.5	80.5	337.5	165.5	22.0	0.0	691.0
1986	0.0	3.5	1.0	51.0	99.5	14.0	59.5	115.0	52.0	244.0	0.5	0.5	640.5
1987	0.0	0.0	0.0	—	—	—	54.0	114.0	380.5	99.5	62.0	0.0	710.0
1988	0.0	62.5	16.5	76.5	164.0	77.0	133.5	—	—	—	—	—	530.0
Total	0.0	66.0	17.5	127.5	263.5	91.0	332.5	309.5	770.0	509.0	84.5	0.5	2571.5
Ave.	0.0	22.0	5.8	63.8	131.8	45.5	83.1	103.2	256.7	169.7	28.2	0.2	910.0

Table 2-3.

MONTHLY AND ANNUAL RAINFALL (1985 - 1987)

Station. CPD Pak thong chai

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1985	—	—	—	—	—	—	170.1	45.5	151.5	186.5	30.2	0.0	533.8
1986	0.0	0.0	5.0	68.6	51.3	29.5	83.2	38.9	93.0	194.7	0.0	0.0	564.2
1987	—	—	—	—	—	—	—	31.7	120.2	43.0	108.5	0.0	303.4
Total	0.0	0.0	5.0	68.6	51.3	29.5	253.3	116.1	364.7	374.2	138.7	0.0	1401.4
Ave.	0.0	0.0	5.0	68.6	51.3	29.5	126.7	38.7	121.6	124.7	46.2	0.0	612.3

Table 2-4 : MONTHLY AND ANNUAL RAINY DAYS FOR THE PERIOD 1951 - 1980

Station ..... Nakhon Ratchasima ..... Index Station ..... 48431 .....

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1951	1	2	7	7	17	20	15	15	18	14	7	0	123
1952	0	2	13	7	20	13	12	19	16	19	2	0	123
1953	5	9	7	6	22	17	20	12	21	13	6	1	139
1954	4	2	3	5	18	16	18	16	19	8	0	1	110
1955	0	1	5	6	11	21	17	19	19	7	7	1	116
1956	0	4	8	13	9	13	19	19	18	11	3	0	117
1957	0	6	8	7	14	16	17	12	26	13	3	0	122
1958	1	4	5	4	13	19	14	22	18	16	1	0	117
1959	0	5	8	7	15	9	22	15	21	10	5	2	119
1960	0	1	5	9	15	15	14	19	16	14	9	0	117
1961	0	3	9	7	18	16	13	18	14	16	2	0	116
1962	1	0	5	13	17	14	16	19	21	12	1	2	121
1963	0	0	7	10	11	15	19	20	21	19	8	0	130
1964	0	1	5	7	22	10	19	12	24	14	5	1	120
1965	0	7	7	8	20	12	14	21	21	12	4	0	126
1966	1	8	7	7	21	6	14	21	18	11	3	2	119
1967	0	1	1	14	13	14	15	12	22	8	4	0	104
1968	1	3	7	9	19	17	13	12	21	9	0	0	111
1969	6	0	5	5	17	21	15	12	20	14	2	0	119
1970	3	0	4	10	18	16	18	17	18	12	3	9	128
1971	1	3	4	7	17	15	16	17	17	10	0	2	109
1972	0	3	3	12	6	23	11	14	22	13	8	3	118
1973	0	1	5	7	18	12	18	13	21	12	7	0	114
1974	1	3	9	10	13	13	14	18	20	15	5	1	122
1975	8	2	10	2	21	17	10	14	21	16	5	2	128
1976	0	7	9	6	17	11	16	26	19	14	4	0	129
1977	0	0	3	6	10	10	16	20	17	7	2	1	92
1978	0	4	8	10	16	10	19	15	21	8	3	0	114
1979	0	2	0	10	14	20	9	12	15	1	1	0	84
1980	0	3	6	5	14	18	14	13	20	15	5	0	113
AVERAGE	1.2	2.9	6.1	7.9	15.9	15.0	15.6	16.5	19.5	12.1	3.8	0.9	117.4

Remark : - = No Report

X = Missing

Original by :- MONTHLY AND ANNUAL RAINFALL OF THAILAND
30-YEAR RERIOD
METEOROLOGICAL DEPARTMENT
MINISTRY OF COMMUNICATIONS.

Table 2-5 MONTHLY AND ANNUAL RAINFALL FOR THE PERIOD 1951 - 1980

Station ..... Nakhon Ratchasima (Korat)
Index Station 48 ..431.....
Latitude .....14° 58'..... N.
Longitude.....102° 05'..... E.

Elevation of station above MSL.....187.....Meters
Height of raingauge .....1.00..... "
(Above MSL .....188.00..... Meters)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1951	5.4	0.8	79.9	30.4	232.2	81.3	223.9	88.7	254.0	293.6	77.2	0.0	1367.4
1952	0.0	1.6	91.5	30.6	324.3	99.0	75.9	146.6	111.8	311.4	0.6	0.0	1193.3
1953	11.7	107.3	125.0	25.5	132.5	81.3	198.9	97.7	400.0	125.3	27.0	0.7	1332.9
1954	28.2	82.5	54.3	60.8	237.2	82.9	131.7	186.7	255.5	70.4	0.0	1.3	1191.5
1955	0.0	18.8	30.7	145.3	146.6	242.0	121.7	58.6	306.8	57.5	174.3	0.5	1302.8
1956	0.0	18.2	63.5	103.6	150.3	156.7	263.2	159.7	165.7	156.0	3.9	0.0	1260.8
1957	0.0	43.2	81.8	82.8	93.6	58.8	197.4	60.7	246.9	209.8	3.9	0.0	1098.9
1958	6.6	16.9	13.1	75.4	96.9	119.5	167.2	241.3	322.0	210.3	0.9	0.0	1272.1
1959	0.0	27.1	29.7	72.0	91.1	106.0	152.1	110.5	565.9	235.2	7.1	3.5	1400.2
1960	0.0	0.1	65.3	42.0	53.5	101.4	108.7	97.9	242.7	295.7	24.8	0.0	1032.1
1961	0.0	9.9	87.2	81.2	222.8	95.2	71.3	46.8	127.8	206.6	0.8	0.0	949.6
1962	2.5	0.0	23.3	100.2	143.2	107.5	154.4	173.7	333.4	265.8	37.0	12.9	1353.9
1963	0.0	0.0	123.3	159.0	105.7	96.3	118.1	181.0	263.8	219.6	91.6	0.0	1358.4
1964	0.0	3.7	26.2	34.3	319.0	69.2	163.1	161.0	257.5	227.3	30.0	0.1	1291.4
1965	0.0	94.7	26.3	93.7	197.7	45.2	87.1	192.3	251.9	72.3	16.8	0.0	1078.0
1966	0.1	56.5	65.9	61.7	313.4	50.5	191.2	155.7	286.0	123.5	11.9	1.4	1317.8
1967	0.0	0.3	2.7	95.6	180.9	135.5	86.4	110.6	182.2	61.2	65.0	0.0	920.4
1968	1.0	45.9	34.5	85.7	175.9	146.8	142.8	174.4	242.7	36.3	0.0	0.0	1086.0
1969	22.1	0.0	43.3	24.1	147.2	223.9	83.1	59.1	300.8	201.1	20.9	0.0	1125.6
1970	1.5	0.0	50.6	46.1	187.1	123.4	92.7	157.7	231.0	89.2	2.7	33.8	1015.8
1971	1.7	9.8	50.2	87.8	113.6	211.9	92.7	122.3	262.2	62.1	0.0	6.5	1020.8
1972	0.0	5.3	74.4	147.9	31.6	185.9	50.4	56.5	425.5	192.7	60.4	16.7	1247.3
1973	0.0	1.8	32.2	128.4	60.0	162.4	146.2	47.0	269.0	77.9	15.4	0.0	960.3
1974	6.6	54.2	139.1	50.7	182.5	74.3	110.9	102.8	251.9	227.0	111.9	0.1	1312.0
1975	16.1	0.3	24.6	17.2	181.4	121.5	199.4	62.4	228.1	129.7	51.0	9.7	1041.4
1976	0.0	30.6	62.3	21.2	102.5	43.4	126.7	141.0	217.2	236.2	7.1	0.0	988.2
1977	0.0	0.0	22.7	85.2	76.9	64.6	66.0	289.6	186.3	83.8	3.0	6.1	884.2
1978	0.0	45.6	28.9	29.6	111.6	62.0	86.6	76.1	199.3	89.1	30.5	0.0	759.3
1979	0.0	6.7	0.0	51.0	99.9	86.1	57.8	62.2	229.5	48.4	1.1	0.0	642.7
1980	0.0	6.0	82.6	29.8	196.6	251.4	161.1	166.4	282.9	115.1	23.6	0.0	1315.5
AVERAGE	3.5	22.9	55.2	70.0	157.6	116.2	131.0	126.9	263.3	157.7	30.0	3.1	1137.4
EXTREME	28.2	107.3	139.1	159.0	324.3	251.4	263.2	289.6	565.9	311.4	111.9	33.8	1400.2
YEAR	1954	1953	1974	1963	1952	1980	1956	1977	1959	1952	1974	1970	1959

Remark : - = No Report
X = Missing

Table 3 CLIMATOLOGICAL DATA FOR THE PERIOD 1956 - 1985

Station NAKHON RATCHASIMA (Korat)
Index Station 48431
Latitude 14° 58' N.
Longitude 102° 05' E.

Elevation of station above MSL 187 meters
Height of barometer above MSL 188 meters
Height of thermometer above ground 1.25 meters
Height of wind vane above ground 11.30 meters
Height of raingauge 1.00 meters

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Pressure (+1000 or 900 mbs.)													
Mean	14.00	11.73	10.08	08.50	07.06	06.10	06.14	06.14	07.76	10.73	13.16	14.38	09.65
Ext. Max.	27.06	24.58	23.88	21.46	15.78	13.86	14.86	13.36	15.26	19.70	23.10	24.82	27.06
Ext. Min.	03.01	00.66	00.66	98.06	99.22	97.28	97.38	97.26	98.98	01.88	03.68	03.58	97.26
Mean daily range	5.87	6.18	6.01	5.48	4.86	4.35	4.29	4.48	4.68	4.78	4.88	5.39	5.10
Temperature (°C)													
Mean	23.0	25.9	28.3	29.2	28.5	28.2	27.7	27.4	26.7	26.0	24.4	22.7	26.5
Mean Max.	30.7	33.5	36.0	36.5	35.1	34.1	33.4	33.0	31.9	30.8	29.7	29.5	32.9
Mean Min.	16.3	19.7	22.2	23.8	24.2	24.1	23.7	23.6	23.2	22.4	19.9	16.9	21.7
Ext. Max.	37.8	40.6	42.3	42.7	41.4	40.1	40.0	38.1	38.0	35.3	35.3	35.8	42.7
Ext. Min.	6.7	11.4	11.6	16.9	20.7	21.2	21.1	20.5	19.7	16.2	9.1	6.2	6.2
Relative Humidity (%)													
Mean	65.8	63.6	62.8	66.8	74.4	74.6	75.8	77.0	82.4	80.3	75.3	67.6	72.2
Mean Max.	87.5	85.3	84.8	86.1	90.3	90.0	90.6	91.3	94.7	93.8	91.2	89.1	89.6
Mean Min.	41.7	40.2	38.8	43.4	52.3	54.0	55.7	57.8	63.2	62.0	55.6	47.3	51.0
Ext. Min.	22.0	14.0	12.0	19.0	23.0	23.0	35.0	35.0	41.0	31.0	27.0	20.0	12.0
Dew Point (°C)													
Mean	15.6	17.8	19.7	21.7	23.1	22.9	22.7	22.8	23.2	22.1	19.4	16.4	20.6
Evaporation (mm.)													
Mean - Pan	140.6	149.7	190.8	192.1	176.1	170.9	168.1	158.2	131.3	133.7	130.0	137.7	1879.2
Cloudiness (0-10)													
Mean	3.4	4.2	4.6	5.5	7.1	7.9	8.3	8.5	8.1	6.5	4.9	3.9	6.1
Sunshine Duration (hr.)													
Mean	283.0	244.5	249.0	245.0	244.5	207.2	194.2	185.4	165.1	225.1	257.8	276.0	2776.8
Visibility (km.)													
0700 L.S.T.	3.3	3.1	3.4	4.7	7.3	9.0	8.9	8.9	7.5	6.2	4.9	3.7	5.9
Mean	6.2	5.4	5.4	6.7	9.1	10.1	10.0	9.8	9.4	9.1	8.3	7.2	8.1
Wind (knots)													
Prevailing wind	NE	NE	SW	SW	SW	SW	SW	SW	W	NE	NE	NE	--
Mean wind speed	1.7	1.8	2.0	2.0	2.0	2.6	2.7	2.7	1.7	2.0	2.2	2.1	-
Max. wind speed	26 NNE	50 SW	42 SW	48 NW	50 SSW	58 SW	41 W	35 SE	33 S, WSW	54 SE	44 NE,E	40 NE	58 SW
Rainfall (mm.)													
Mean	4.8	22.7	43.9	68.3	145.2	111.6	132.6	130.4	261.5	154.1	30.0	3.6	1108.7
Mean rainy days	1.0	2.9	5.6	8.0	15.4	14.1	15.4	16.4	19.7	12.3	4.0	0.9	115.7
Greatest in 24 hr.	71.2	59.7	97.3	91.8	75.8	114.8	104.1	72.3	143.7	136.0	84.3	20.6	143.7
Day/Year	25/65	23/65	10/74	4/73	14/67	27/69	10/73	27/64	12/68	25/76	6/81	3/70	12/68
Number of days with													
Haze	28.8	27.5	29.4	23.6	6.1	0.9	0.1	0.2	1.1	6.0	13.3	24.1	161.1
Fog	0.5	0.8	0.6	0.1	0.1	0.0	0.1	0.1	0.3	0.8	0.7	0.5	4.6
Hail	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Thunderstorm	0.3	2.3	7.4	14.3	17.0	9.1	9.9	8.3	13.4	7.8	1.0	0.0	90.8
Squall	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.3

Remark : 1. Sunshine Duration 1957 - 1969
2. Evaporation 1961 - 1985

Original by : CLIMATOLOGICAL DATA OF THAILAND 30-YEAR PERIOD
METEOROLOGICAL DEPARTMENT MINISTRY OF COMMUNICATION

Table 4-1 CALCULATION OF EVAPOTRANSPIRATION

Table 4-1 CALCULATION OF EVAPOTRANSPIRATION

(1) Modified Penman Method ($ETo = C\{W \cdot Rn + (1-W) \cdot f(u) \cdot (ea - ed)\}$)

		Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
I. METEOROLOGICAL DATA														
Air Temperature (°C) (Mean)		23.0	25.9	28.3	29.2	28.5	28.2	27.7	27.4	26.7	26.0	24.4	22.7	
Relative Humidity (%) (Mean)		65.8	63.6	62.8	66.8	74.4	74.6	75.8	77.0	82.4	80.3	75.3	67.6	
Wind Velocity (m/s)		0.92	0.97	1.08	1.08	1.08	1.40	1.46	1.46	0.92	1.08	1.19	1.14	
Sun Shine Duration (n/N)		0.81	0.75	0.67	0.65	0.62	0.53	0.48	0.47	0.45	0.62	0.75	0.79	
II. CALCULATION														
ea		28.10	33.41	38.49	40.56	38.95	38.26	37.17	36.54	35.07	33.60	30.56	27.59	
$ed = ea \times RHmean/100$		18.49	21.25	24.17	27.09	28.98	28.54	28.17	28.14	28.90	26.98	23.01	18.65	
$(ea - ed)$		9.61	12.16	14.32	13.47	9.97	9.72	9.00	8.40	6.17	6.62	7.55	8.94	
$u(\frac{km}{day} = \frac{1000}{86400}\frac{m}{sec})$ 86.4		79.49	83.81	93.31	93.31	93.31	120.96	126.14	126.14	79.49	93.31	102.82	98.50	
$f(U) = 0.27(1+U/100)$		0.48	0.50	0.52	0.52	0.52	0.60	0.61	0.61	0.48	0.52	0.55	0.54	
$(1-W)$		0.28	0.25	0.22	0.22	0.22	0.22	0.23	0.23	0.24	0.25	0.26	0.28	
W		0.72	0.75	0.78	0.78	0.78	0.78	0.77	0.77	0.76	0.75	0.74	0.72	
Ra	(mm/day)	12.20	13.45	14.80	15.65	15.90	15.80	15.80	15.70	15.05	14.00	12.60	11.80	
$Rs = (0.25 + 0.50n/N)Ra$	(")	7.99	8.41	8.66	9.00	8.90	8.14	7.74	7.61	7.15	7.84	7.88	7.61	
$Rns = (1-\alpha)Rs$ $\alpha = 0.25$		5.99	6.31	6.50	6.75	6.68	6.10	5.80	5.71	5.36	5.88	5.91	5.71	
$Rnl = f(T) \cdot f(ed) \cdot F(n/N)$	f(T)	15.20	15.88	16.36	16.54	16.40	16.34	16.24	16.18	16.04	15.90	15.50	15.14	
	f(ed)	0.15	0.13	0.12	0.11	0.10	0.11	0.11	0.11	0.10	0.12	0.12	0.15	
	f(n/N)	0.83	0.78	0.71	0.69	0.66	0.58	0.53	0.53	0.51	0.66	0.78	0.81	
Rnl	(mm/day)	1.89	1.61	1.39	1.26	1.08	1.04	0.95	0.94	0.82	1.26	1.45	1.84	
$Rn = Rns - Rnl$		4.10	4.70	5.11	5.49	5.60	5.06	4.85	4.77	4.54	4.62	4.46	3.87	
C		1.05	1.06	1.06	1.07	1.01	1.04	1.03	1.03	1.04	1.04	1.04	1.04	
$ETo = C\{W \cdot Rn + (1-W) \cdot f(u) \cdot (ea-ed)\}$		4.45	5.35	5.96	6.23	5.84	5.44	5.15	5.00	4.33	4.50	4.56	4.30	

Table 4-2 Comparison of Eto Penman method - Pan evaporation method

		month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CLIMATOLOGICAL DATA OF THAILAND 1956 - 1985	Pan Evaporation	mm/month	140.6	149.7	190.8	192.1	176.1	170.9	168.1	158.2	131.3	133.7	130.7	137.7
	Pan Evaporation	mm/day	4.54	5.35	6.15	6.40	5.68	5.70	5.42	5.10	4.38	4.31	4.36	4.44
	*1 ETo	mm/day	3.86	4.55	5.23	5.44	4.83	4.84	4.61	4.34	3.72	3.66	3.71	3.77
CLIMATOLOGICAL DATA OF THAILAND 1987	Pan Evaporation	mm/month	150.9	137.5	194.7	195.8	176.2	161.3	194.1	159.7	126.0	120.0	106.6	139.3
	Pan Evaporation	mm/day	4.87	4.91	6.28	6.53	5.68	5.38	6.26	5.15	4.20	3.87	3.55	4.20
	*2 ETo	mm/day	4.19	4.17	5.34	5.55	4.83	4.57	5.32	4.38	3.57	3.29	3.02	3.57
CLIMATOLOGICAL DATA OF THAILAND 1951 ~ 1980	Pan Evaporation	mm/month	146.4	152.0	193.0	194.4	182.9	173.7	168.9	157.8	132.2	137.2	134.8	140.5
	Pan Evaporation	mm/day	4.72	5.43	6.22	6.48	5.90	5.78	5.45	5.15	4.41	4.42	4.49	4.53
	*3 ETo	mm/day	4.01	4.62	5.29	5.51	5.02	4.91	4.63	4.38	3.75	3.76	3.82	3.85
ETo calculated by penman method		mm/day	4.45	5.35	5.96	6.23	5.84	5.44	5.15	5.00	4.33	4.50	4.56	4.30

*1, *2, *3, ETo (Reference crop evapotranspiration) = Kp · Epan

where Epan = pan evaporation in mm/day and represents the mean daily value of the period considered.

Kp = pan coefficient

= 0.85 (see FAO IRRIGATION AND DRINAGE PAPER 24 Table 18 ; case A, RH mean high, wind Light, wind ward side distance of green crop 1000 m)

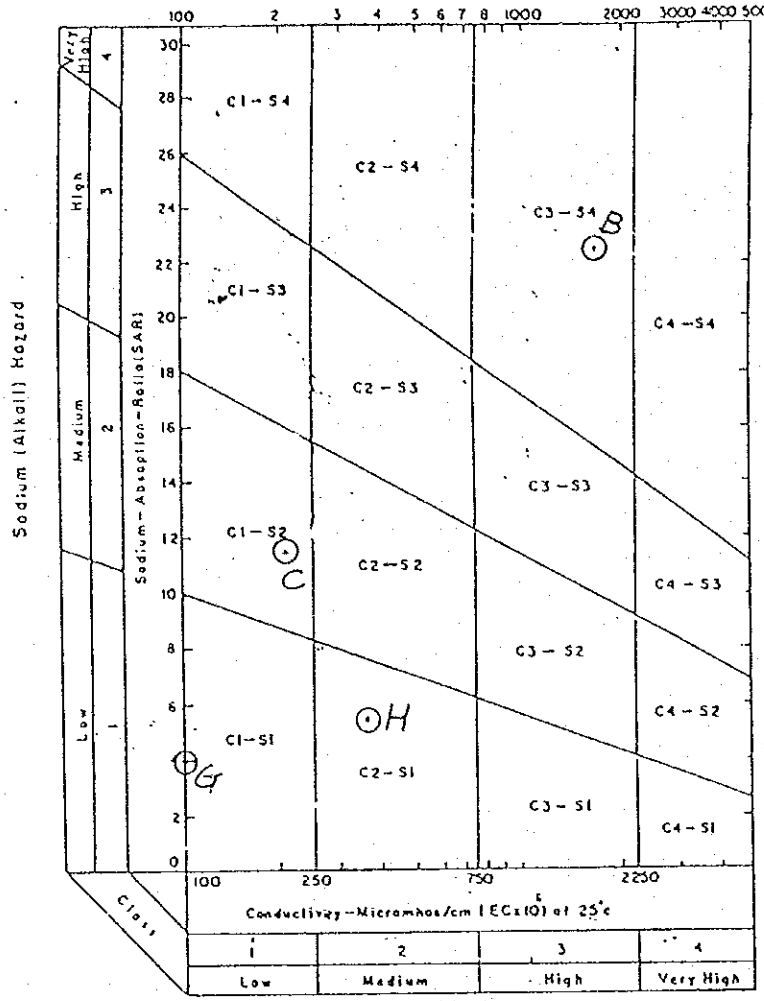
Table. 5.

Suitability or soil for banking and foundation

Symbol	Suitability for banking	Compaction	Dry density (t/m³)	Permeability cm/sec.	Suitability for foundation	Adjustment for permeability
GW	Very good used for pervious zone of bank or dam	Good by tractor, rubber tired roller, steel wheel roller	2.00 ∿ 2.16	$> 10^{-2}$	Good	Cut off wall required
GP	Good used for pervious zone of bank or dam	Good by tractor, rubber tired roller, steel wheel roller	1.84 ∿ 2.00	$> 10^{-2}$	Good	Cut off wall required
GM	Fair not so suitable as impervious zone, but used for impervious core or blanket	Good by close management, by rubber tired roller, sheeps food roller etc.	1.92 ∿ 2.16	10^{-3} ∿ 10^{-6}	Good	Toe trench required ∿ needless
GC	Barely fair used for impervious core	Fair by rubber tired roller, sheeps foot roller	1.84 ∿ 2.08	10^{-6} ∿ 10^{-4}	Good	Needless
SW	Very good used for pervious zone with slope protection	Good by tractor	1.76 ∿ 2.08	$> 10^{-1}$	Good	Upstream blanket, toe drain or drain well required
SP	Fair used for gentle slope banking	Good by tractor	1.60 ∿ 1.92	$> 10^{-1}$	Good-poor according their density	Upstream blanket, toe drain or drain well required
SM	Barely fair not so suitable for impervious zone, used for impervious core or bank	Good careful operation required. by rubber tired roller, sheeps foot roller	1.72 ∿ 2.00	10^{-3} ∿ 10^{-6}	Good-poor according their density	Upstream blanket, toe drain or drain well required
SC	Barely fair used for impervious core of flood protection bank	Fair by sheeps foot roller, rubber tired roller	1.68 ∿ 2.00	10^{-6} 10^{-7}	Good-poor	Needless
ML	Poor used on proper adjustment	Good ~ poor careful operation is important. by rubber tired roller, sheeps foot roller	1.52 ∿ 1.92	10^{-3} ∿ 10^{-6}	Very poor in danger of liquefaction	Toe drain ∿ needless
CL	Barely fair used for impervious core or blanket	Fair ~ good by sheeps foot roller, rubber tired roller	1.52 ∿ 1.92	10^{-6} ∿ 10^{-8}	Good-poor	Needless
OL	Unsuitable for banking materials	Fair ~ poor by sheeps foot roller	1.28 ∿ 1.60	10^{-4} ∿ 10^{-6}	Fair-poor in danger large settlement	Needless
MH	Poor used for core in hydraulic fill but unsuitable for roll fill	Poor ~ unsuitable by sheeps foot roller	1.12 ∿ 1.52	10^{-4} ∿ 10^{-6}	Poor	Needless
CH	Fair for gencle slope, used for thin core, blanket	Fair ~ poor by sheeps foot roller	1.20 ∿ 1.68	10^{-6} ∿ 10^{-8}	Fair-poor	Needless
OH	Unsuitable for banking materials	Poor ~ unsuitable by sheeps foot roller	1.04 ∿ 1.60	10^{-4} ∿ 10^{-6}	Very poor	Needless
Pt	Can't use for construction materials	Practically impossible	-	-	Can't use for foundation	-

Table. 6

WATER QUALITY CLASSIFICATION



A: EC 80
SAR 4.1

E: EC 1,010
SAR 43.8

I: EC 4,600
SAR 166.9

J: EC 80
SAR 0.3

K: EC 30,000
SAR 119.9

S_1	Low sodium water can be used for irrigation in almost all soils with little danger of the development of harmful levels of exchangeable sodium. However, sodium sensitive crops such as stonefruit trees and avocados may accumulate injurious concentrations of sodium.	C_1	Low salinity water can be used for irrigation with most crops on most soils with little likelihood, that soil salinity will develop. Some leaching is required but this occurs under normal irrigation practices, except in soils of extremely low permeability.
S_2	Medium water will present an appreciable sodium hazard in fine textured soils having high cation exchange capacity, especially under low leaching conditions unless gypsum is present in the soil. This water may be used on coarse textured or organic soils with good permeability.	C_2	Medium salinity water can be used if a moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.
S_3	High sodium water may produce harmful levels of exchangeable sodium in most soils, and will require special soils management; good drainage, high leaching, and organic matter conditions. Gypsiferous soils may not develop harmful levels of exchangeable sodium from such waters. Chemical amendments may be required for replacement of exchangeable sodium, except that amendments may not be feasible in the case of waters of very high salinity.	C_3	High salinity water cannot be used on soils with restricted drainage, even with adequate drainage, special treatment for salinity control may be required, and plants with good salt tolerance should be selected.
S_4	Very high sodium water is generally unsatisfactory for irrigation pruposes, except at low and perhaps medium salinity where the solution of calcium from the soil or used of gypsum or other amendments may make the use of these waters feasible.	C_4	Very high salinity water is not suitable for irrigation under ordinary conditions, but may be used occasionally under very special circumstances. The soils must be permeable, drainage condition must be adequate, irrigation water must be applied in excess to provide considerable leaching and very salt-tolerance crops should be selected.

Table 7-1 (1)

PAK THONG CHAI AGRICULTURAL COOPERATIVE CO, LTD.

NO.	ITEM: MEMBER NAME	FAMILY CONSTITUTION: MALE 15<	MALE 14>	MALE TOTAL	FEMALE 15<	FEMALE 14>	FEMALE TOTAL	SUM TOTAL	AGRICULTURE-MAIN POWER	HOUSE: CONSTRUCTION YEAR	STORY	LAND PROPERTY: LIVING m²	AGRICULTURE m²	MISCELLANEOUS	TOTAL	CULTIVATION: PADDY	CASSAVA	CORN	FRUITS	VEGETABLE	OTHER	TOTAL	TYPE OF LANDRENTAL: BORROW AREA	LEND AREA	RESOURCE OF AGRICULTURAL WATER: NATURAL ANNUAL	NATURAL SEASON	CANAL ANNUAL	CANAL SEASON	POND ANNUAL	POND SEASON	DEEP WELL ANNUAL	DEEP WELL SEASON
1.	MRS. SOMPORN PIMPOKARN	5	2	7	2	—	2	9	3	1957	2	1,600	32,000	—	33,600	16,000	—	—	—	400	EUCALYPTUS 16,000	32,400	—	—	—	○	—	○	—	○	—	—
2.	MR. SAGNA DEEKING	5	—	5	2	—	2	7	6	1957	1	3,200	48,000	—	51,200	20,800	—	—	—	—	19,200	40,000	—	—	—	○	—	○	—	○	—	—
3.	MR. SAWADI KHUNAPAPAKNOM	1	1	2	1	1	2	4	2	1979	2	1,200	56,000	—	57,200	—	—	—	—	—	12,800	12,800	—	—	—	○	—	○	—	—	—	—
4.	MR NOI POTIKLING	2	2	4	2	1	3	7	5	1972	1	4,800	32,000	—	36,800	17,600	17,600	—	—	16	12,800	48,016	—	—	—	○	—	○	—	—	—	—
5.	MRS. WON PHINKLING	1	—	1	3	—	3	4	4	1975	1	1,600	116,400	—	48,000	22,400	22,400	—	—	—	3,200	48,000	—	—	—	○	—	○	—	—	—	—
6.	MRS. CHOM PUNKLING	3	—	3	3	1	4	7	6	1979	1	—	70,400	—	70,400	32,000	25,600	—	—	—	8,000	65,600	—	—	—	○	—	○	—	—	—	—
7.	MRS. PERM PIMKLING	3	1	4	3	—	3	7	5	1957	1	1,200	78,000	—	79,200	44,800	32,000	—	—	20	—	76,820	—	—	—	○	—	○	—	—	—	—
8.	MR. CHODHI PHENKLING	1	—	1	1	1	2	3	2	1980	2	1,600	110,400	—	112,000	27,200	—	—	—	—	EUCALYPTUS 24,000	51,200	—	—	—	○	—	○	—	—	—	—
9.	MR. NIN LAMKLING	2	2	4	2	2	4	8	4	1957	1	4,800	38,400	—	43,200	27,200	—	—	—	—	—	27,200	—	—	—	○	—	○	—	○	—	—
10.	MRS. BANGON CHERDKLING	2	2	4	3	1	4	8	5	1977	1	3,200	111,400	—	17,600	14,400	—	—	—	—	—	14,400	—	—	—	○	—	○	—	—	—	—
11.	MR JAI KHEDSAMRONG	2	1	3	5	2	7	10	5	1957	1	800	64,000	—	64,800	48,000	16,000	—	—	24	—	64,024	24	—	—	○	—	○	—	○	—	—
12.	MR. KERD SIDHUTHONGSANONDHA	3	1	4	4	2	6	10	7	1957	1	4,000	73,200	—	77,200	40,000	24,000	—	—	16	EUCALYPTUS 8,000	80,016	8,000	—	—	○	—	○	—	—	—	—
13.	MR. ATT CHARNSAMRONG	2	1	3	2	2	4	7	4	1978	2	1,600	51,200	—	52,800	19,200	32,000	—	—	—	—	51,200	—	—	—	○	—	○	—	○	—	—
14.	MR. LOP KLONGKING	1	1	2	2	1	3	5	3	1976	2	800	38,400	—	39,200	6,400	32,000	—	—	8	—	38,408	—	—	—	○	—	○	—	—	—	—
15.	MR. SANAM UKATOKE	4	—	4	4	—	4	8	5	1956	1	7360	194,732	—	202,092	35,104	12,080	—	—	—	EUCALYPTUS 16,000	63,184	—	—	—	○	—	○	○	—	—	—
16.	MRS. MUN NOANKLING	1	—	1	2	—	2	3	3	1977	1	1,600	32,000	—	33,600	4,800	—	—	—	—	—	4,800	—	—	—	○	—	○	—	○	—	—
17.	MR. PRAYAD BUTRAKASEM	1	—	1	1	—	1	2	2	1983	2	—	—	—	—	19,200	16,000	—	—	32	—	35,232	35,232	—	—	0	—	0	—	—	—	—
18.	MR. KHAMPENG CHEEMSAMRONG	1	2	3	2	1	3	6	2	1977	1	1,600	20,800	—	22,400	30,400	6,400	—	—	—	—	36,800	17,600	—	—	○	—	○	—	—	—	—
19.	MR. LIAM PODHIKLING	1	4	5	1	1	2	7	3	1961	1	2,400	33,600	—	36,000	17,600	16,000	—	—	16	—	33,616	—	—	—	○	—	○	—	○	—	—
20.	MR. NOI PEIMKLING	2	1	3	2	1	3	6	5	1985	1	1,000	43,200	—	44,200	16,000	27,000	—	—	—	EUCALYPTUS 3,200	43,200	—	—	—	○	—	○	—	—	—	—
21.	MRS. CHANG PRASERTKUL	2	2	4	2	—	2	6	4	—	1	4,800	12,800	—	17,600	12,800	—	—	—	—	—	12,800	—	—	—	○	—	○	—	—	—	—
22.	MR. LIAM CHODHIKLING	6	—	5	1	—	1	6	5	1957	1	8000	28,800	—	36,800	16,000	12,800	—	—	16	—	28,816	—	—	—	○	—	○	○	—	—	—
23.	MR. PEI PODHIKLING	1	—	1	1	—	1	2	1	1966	1	32,00	32,000	76000	572,00	32,000	—	—	—	—	—	32,000	—	—	—	○	—	○	—	—	—	—
24.	MR. CHANA PAKLING	2	—	2	1	1	2	4	2	1983	1	2,560	32,400	—	4,0960	22,400	16,000	—	—	—	—	38,400	—	—	—	○	—	○	—	—	—	—

Table 7-1(2)

PAK THONG CHAI : AGRICULTURAL COOPERATIVE CO, LTD.

NO.	ITEM / MEMBER NAME	FAMILY CONSTITUTION								HOUSE		LAND PROPERTY				CULTIVATION							TYPE OF LAND RENTAL		RESOURCE OF AGRICULTURAL WATER							
		MALE			FEMALE			SUM TOTAL	E-MAN POWER AGRICULTURE	CONSTRUCTION YEAR	STORY	LIVING	AGRICULTURE	MISCELLANEOUS	TOTAL	PADDY	CASSAVA	CORN	FRUITS	VEGETABLE	OTHER	TOTAL	BORROW AREA	LEND AREA	NATURAL		CANAL		POND		DEEP WELL	
		15<	14>	TOTAL	15<	14>	TOTAL																		ANNUAL	SEASON	ANNUAL	SEASON	ANNUAL	SEASON	ANNUAL	SEASON
25	MR. MEK NOMAI	1	1	2	3	2	5	7	3	1984	1	—	22,400	—	22,400	12,800	—	—	—	—	—	12,800	—	—	—	0	—	0	—	—	—	—
	TOTAL:	54	24	78	55	20	75	153	96		32	67,920	1211532	16,000	1295452	540704	288380	—	—	548	EUCA 123200	991732	60856	—	—	25	—	25	2	7	—	—
	AVERAGE	2.16	0.96	3.12	2.20	0.80	3.00	6.12	3.84	1967	1.28	2716.8	48461.3	640	51818.1	21628.2	11555.2	—	—	21.92	4928	39669.3	2434.2	—	—	1	—	1	0.08	0.28	—	—

Table 9-1 (3)

PAKTHONGCHAI . AGRICULTURAL COOPERATIVE CO. LTD

NO.	FISH BREEDING			DOMESTIC ANIMALS							AGRICULTURAL MACHINERY AND TRANSPORTATION					LIVING ARTICLE									STORE HOUSE CATTLE HOUSE			LOAN				PARTIAL CHARGE IN COOPERATIVE	POSITION IN MEMBER	REMARKS
	NUMBER	SIZE W×L×D. (M)	KIND	BUFFALO	COW	PIG	DUCK	CHICKEN (MEAT)	CHICKEN (PROPAGATE)	OTHER	TRUCK	MOTOR CYCLE	BICYCLE	TRACTOR	OTHER	TELEVISION	RADIO	REFRIGERATOR	SEWING MACHINE	FAN	GAS STOVE	IRON	RICE COOKER	FARMING HOUSE	PIGSTY	OTHER	COOPERATIVE	PRIVATE	OTHER	ARREARAGE			
1	1	10×10×2	SERPENT HEAD (400)	1	—	1	1	50	—	1	1	1 (150C.C.)	1	HAND-OPERATED 1 (10 H.P.)	MULTI PURPOSE CAR (1)	1	1	1	1	2	1	1	1	1	—	—	5,000	—	—	5,000	—	COMMITTEE OF TEMPLE DEVELOPEMENT	
2	—	—	—	3	—	—	—	20	—	1	—	—	1	—	—	—	1	1	—	1	1	—	—	1	—	BUFFALO (1)	15,000	—	—	15,000	SECRETARY GROUP	BOARD OF TUMBON COMMITTEE	
3	—	—	—	—	—	—	—	25	—	1	1	1 (80C.C.)	—	—	—	1	—	1	—	3	—	—	—	—	—	CHICKEN HOUSE (1)	27,000	—	—	27,000	SECRETARY GROUP	COMMITTEE OF CHILDHOOD DEVELOPEMENT	
4	—	—	—	3	—	—	—	50	—	—	—	—	1	—	—	—	2	—	—	—	—	—	—	1	—	BUFFALO (1)	14,000	—	—	14,000	—	COMMITTEE OF TEMPLE DEVELOPEMENT	
5	—	—	—	—	—	1	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	11,130	2,800	—	13,930	—	—	
6	—	—	—	4	—	2	—	10	—	1	—	—	—	—	—	1	1	—	—	—	—	—	—	1	1	BUFFALO HOUSE (1)	20,350	—	—	20,350	—	COMMITTEE IN WOMEN GROUP	
7	—	—	—	1	—	2	—	10	—	—	—	—	1	—	WATER PUMP ϕ 6 H.P	1	1	—	—	1	—	—	—	1	1	—	10,000	—	—	10,000	—	—	
8	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	1	1	1	1	1	—	—	—	1	—	CHICKEN HOUSE (1)	30,000	—	—	30,000	—	TUMBON CHIEF	
9	—	—	—	—	—	—	—	5	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	20,000	—	—	20,000	MEMBER REPRESENTATIVE in GENERAL MEETING.	—	
10	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7,000	—	—	7,000	—	—	
11	1	4×4×4	SERPENT HEAD (100)	2	—	—	—	25	—	—	—	1 (90cc.)	1	—	—	—	1	—	—	—	—	—	—	1	—	BUFFALO (1)	10,000	20,000	—	30,000	—	—	
12	—	—	—	2	—	3	—	20	—	—	—	—	1	—	—	—	1	—	—	1	—	1	—	1	1	1	7,000	—	—	7,000	SECRETARY GROUP	COMMITTEE OF THE VILLAGE	
13	—	—	—	—	—	—	—	8	—	—	—	—	—	HAND OPERATOR (1)	WATER PUMP ϕ2 (1)	—	—	—	—	1	—	—	—	1	—	—	20,000	—	—	20,000	—	—	
14	—	—	—	—	—	—	—	8	—	—	—	—	3	—	—	—	1	—	—	—	—	—	—	—	1	—	10,000	—	—	10,000	—	—	
15	—	—	—	5	2	—	—	50	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	1	1	CONT CHICKEN BUFFALO	10,700	900	—	11,600	DIRECTOR OF COOPERATIVE	COMMITTEE OF EDUCATION	
16	—	—	—	—	—	—	—	30	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	5,000	—	—	5,000	MEMBER REPRESENTATIVE IN GENERAL MEETING	—	
17	—	—	—	—	—	—	—	12	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	CHICKEN HOUSE (1)	6,800	—	—	6,800	—	—	
18	—	—	—	1	—	1	—	5	—	—	—	—	—	—	WATER PUMP ϕ5"	1	1	—	—	—	—	—	—	1	—	BUFFALO HOUSE (1)	12,000	—	—	12,000	—	—	
19	1	6×7×3	SERPENT HEAD (300)	1	—	—	—	20	—	—	—	—	—	—	ϕ5" 55 H.P	—	—	—	—	—	—	—	—	1	—	—	14,973	—	—	14,973	—	—	
20	1	4×5×3	HIGH FENCE (200)	1	—	—	—	30	—	—	—	1 (80C.C.)	—	—	—	—	—	—	—	1	—	—	—	1	—	CHICKEN HOUSE (1)	5,000	20,000	—	25,000	—	BOARD OF TUMBON COMMITTEE	
21	—	—	—	—	—	—	—	10	—	—	—	—	—	—	—	—	1	—	1	1	—	—	—	1	—	—	10,000	1,000	—	11,000	—	—	
22	—	—	—	3	—	—	—	30	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	BUFFALO HOUSE (1)	8,000	—	—	8,000	—	—	
23	—	—	—	4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	5,000	—	—	5,000	—	—	
24	—	—	—	—	—	—	—	14	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	—	30,000	1,000	—	31,000	—	—	

Table 7-1 (4)

PAKTHONGCHAI . AGRICULTURAL COOPERATIVE CO. LTD

NO.	FISH BREEDING			DOMESTIC ANIMALS							AGRICULTURAL MACHINERY AND TRANSPORTATION					LIVING ARTICLE								STORE HOUSE CATTLE HOUSE			LOAN				PARTIAL CHARGE IN COOPERATIVE	POSITION IN MEMBER	REMARKS
	NUMBER	SIZE WXLXD.	KIND	BUFFALO	COW	PIG	DUCK	CHICKEN (MEAT)	CHICKEN (PROPAGATE)	OTHER	TRUCK	MOTOR CYCLE	BICYCLE	TRACTOR	OTHER	TELEVISION	RADIO	REFRIGERATOR	SEWING MACHINE	FAN	GAS STOVE	IRON	RICE COOKER	FARMING HOUSE	PIGSTY	OTHER	COOPERATIVE	PRIVATE	OTHER	ARREARAGE			
25	—	—	—	5	—	—	—	15	—	—	—	—	1	—	—	1	2	—	—	—	—	—	—	1	—	BUFFALO HOUSE (1)	—	—	—	—	—	—	
TAL	4	—	—	43	2	9	—	497	—	—	—	4	13	3	H.P. 4 M.C. 1.	7	17	2	3	12	—	2	—	20	4	B. 10 C. 5 DOH 1	313953	45700	—	359653			
ERAGE	0.16	-	-	1.72	0.08	0.36	—	19.88	—	—	—	0.16	0.52	0.12	N.P.0.16 M.C.0.04	0.28	0.68	0.08	0.12	0.48	—	0.08	—	0.80	0.16	BU 0.40 CHI 0.10 COW 0.04	12558.1	1828	—	14386.1			

Table 7-2 (1)

MUANG NAKOHNRATCHASIMA AGRICULTURAL COOPERATIVE CO, LTD

NO.	ITEM: MEMBER NAME	FAMILY CONSTITUTION: MALE 15<	MALE 14>	MALE TOTAL	FEMALE 15<	FEMALE 14>	FEMALE TOTAL	SUM TOTAL	AGRICULTURE-MAN POWER	HOUSE: CONSTRUCTION YEAR	STORY	LAND PROPERTY: LIVING (m²)	AGRICULTURE (m²)	MISCELLANEOUS (m²)	TOTAL	CULTIVATION: PADDY (m²)	CASSAVA	CORN	FRUITS (m²)	VEGETABLE (m²)	OTHER	TOTAL	TYPE OF LAND RENTAL: BORROW AREA	LEND AREA	RESOURCE OF AGRICULTURAL WATER: NATURAL ANNUAL	NATURAL SEASON	CANAL ANNUAL	CANAL SEASON	POND ANNUAL	POND SEASON	DEEP WELL ANNUAL	DEEP WELL SEASON
1.	Miss KRABE INCOKESOON	4	-	4	6	2	8	12	8	1936	1	4,804	26,472	-	31,276	19,200	-	-	3,672	3,600	-	26,472	-	-	O	-	O	-	-	-	-	-
2.	MR. CHALONG BOONMUANNAI	3	1	4	3	3	6	10	6	1977	2	800	23,600	-	24,400	33200	-	-	-	4400	-	37600	-	-	-	O	-	-	-	O	-	-
3.	MR. LENGE NOPKHUNTOD	4	1	5	3	-	3	8	7	1957	1	800	53,736		54,536	42228	-	-	-	11,508	-	53,736	-	-	-	O	-	O	-	-	-	-
4.	MRS. RABIAD CHOMKOE	1	4	5	2	1	3	8	2	1985	2	1600	32,000		33,600	32,000	-	-	-	-	-	32,000	20,800	-	-	O	-	O	-	-	-	-
5.	MR. THAVIL PETCHMUANNAI	1	1	2	3	1	4	6	3	1957	1	3200	16000		19,200	-	-	-	-	-	-	-	-	-	-	O	-	O	-	-	-	-
6.	MR. PAYAD SAWADPUDCHA	3	1	4	1	4	5	9	4	1958	1	800	54,400		55200	12,800	40000	-	800	800	-	54,400	22,400	-	-	O	-	O	-	-	-	-
7	MR. BOONTHAM HINMUANNAI	1	1	2	1	1	2	4	2	1978	1	800	74,248		75,048	58,248	-	-	-	16000	-	74,248	-	-	-	O	-	O	-	-	-	-
8	MRS. LIAN NAKMUANNAI	2	-	2	2	-	2	4	4	1957	1	800	33600		34,400	30,400	-	-	-	3,200	-	33600	-	-	-	O	-	O	-	-	-	-
9	MRS PUD SATRA	1	1	2	3	1	4	6	2	1977	1	800	8800	-	9600	27200	-	-	-	2,400	-	29600	20800	-	-	O	-	O	-	-	-	-
10	MR. SOMBAT INCOKSOON	2	-	2	6	1	7	9	6	1978	1	-	19,480	-	19,480	21,880	-	-	-	1,600	-	23480	8000	-	-	O	-	O	-	-	-	-
11	MRS. JUAN KAEWMUANNAI	2	-	2	3	-	3	5	4	1953	1	1,600	32,000	-	33600	36,800	-	-	-	1,600	-	38400	6400	-	-	O	-	O	-	-	-	-
12	MRS. AENG KERDMUANNAI	2	1	3	3	1	4	7	3	1959	1	800	10192	-	10992	32592	-	-	-	1,600	-	34192	24000	-	-	O	-	O	-	-	-	-
13	MR. THONG BUADSANTIAG	2	1	3	3	-	3	6	2	1975	1	800	40000	-	40800	36800	-	-	-	3200	-	40000	-	-	-	O	-	O	-	-	-	-
14.	MRS SUKUAN PRANEPOLKANG	1	1	2	2	-	2	4	2	1971	1	800	40000	-	40800	36800	-	-	800	2400	-	40000	-	-	-	O	-	O	-	-	-	-
15	MRS. PRAKONG NUANTAKU	1	-	1	1	2	3	4	2	1984	1	800	-	-	800	16000	-	-	-	800	-	16,800	16,800	-	-	O	-	O	-	-	-	-
16	MR. RANGSAN PUMUANWAI	1	2	3	1	1	2	5	2	1956	1	1,600	14544	-	16144	19,712	-	-	4432	1600	-	25744	11200	-	-	O	-	O	-	-	-	-
17	MR. SARA SOMCHABOG	2	1	3	4	-	4	7	2	1975	2	800	32016	-	32816	35200	-	-	-	1616	-	36816	4,800	-	-	O	-	O	-	-	-	-
18	MR. PIAN SINGHAMUANNAI	4	-	4	4	1	3	7	5	1978	1	1200	-	-	1,200	11284	-	-	-	-	-	11284	11284	-	-	O	-	O	-	O	-	-
19	MR. CHALONG SOOPKAMPANG	4	1	5	4	1	5	10	8	1958	1	3200	161600	-	164800	32,000	128000	-	-	1600	-	161,600	-	-	-	-	-	-	-	-	-	-	-
	TOTAL	41	17	58	53	20	73	131	74		22	26004	672088		698,692	534348	168000		9704	57914		769972	146484	-	1	17	1	16	-	2	-	-
	AVERAGE	2.76	0.89	3.05	2.79	1.05	3.84	6.89	3.89	1967	1.16	1368.6	35404.0		36773.3	28123.4	8842.1		510.7	3048.6		40524.8	7709.7	-	0.05	0.89	0.05	0.84	-	0.10	-	-

Tabe 7-2 (2)

MUANG NAKOHNRATCHASIMA AGRICULTURAL COOPERATIVE CO. LTD

NO.	FISH BREEDING			DOMESTIC ANIMALS							AGRICULTURAL MACHINERY AND TRANSPORTATION					LIVING ARTICLE									STORE HOUSE CATTLE HOUSE			LOAN				PARTIAL CHARGE IN COOPERATIVE	POSITION IN MEMBER	REMARKS
	NUMBER	SIZE WXLXD. (M)	KIND	BUFFALO	COW	PIG	DUCK	CHICKEN (MEAT)	CHICKEN (PROPAGATE)	OTHER	TRUCK	MOTOR CYCLE	BICYCLE	TRACTOR	OTHER	TELEVISION	RADIO	REFRIGERATOR	SEWING MACHINE	FAN	GAS STOVE	IRON	RICE COOKER	FARMING HOUSE	PIGSTY	OTHER	COOPERATIVE	PRIVATE	OTHER	ARREARAGE			
1	—	—	—	—	—	—	—	—	—	—	1	1 (125 c.c.)	1	—	WATER PUMP ϕ1½" 3 H.P.	1	2	—	—	3	—	1	1	1	1	—	—	5000	—	5000	—	ASST. VILLAGE CHIEF	
2	—	—	—	—	—	2	30	40	—	—	—	—	3	—	WATER PUMP ϕ6" 5 H.P.	1	1			2		1	1	1	1	CHICKEN +(14) DUCK	16924	—	—	16924	SECRETARY OF GROUP.	COMMITEE OF THE VILLAGE	
3	—	—	—	—	—	—	30	40	—	—		2 c.c. (80,100)	1	HAND OPERATED TRACTOR (1)	WATER PUMP ϕ2" 5 H.P.	1	1	—	1	1	—	—	—	1	1	H—H (1+1)	80000	—	—	80000	—	H——H	
4	—	—	—	—	—	1	10	20	—	—	—	1 (80 c.c.)	1	H—H	—	1	1	1	1	2	1	—	—	1	1	H—H (1+1)	—	—	—	—	—	—	
5	—	—	—	—	—	2	10	20	—	—	—	—	1	—	WATER PUMP ϕ2" 5 H.P.	—	1	—	—	1	—	—	—	1	1	H—H (1+1)	—	—	—	—	—	COMMITTEE OF THE VILLAGE	
6	—	—	—	—	—	1	30	25	—	—	—	—	2	—	—	1	1	—	—	1	—	—	—	1	1	H—H (1+1)	10000	—	—	10000	—	BOARD OF TUMBON COMMITT	
7	—	—	—	—	—	2	30	40	—	—	—	1 (80 c.c.)	1	—	WATER PUMP ϕ6" 5 H.P.	1	1	—	1	—	—	—	—	1	1	H—H (1+1)	10000	—	—	10000	—	—	
8	—	—	—	—	—	2	—	40	—	—	—	—	1	HAND OPERATED TRACTOR (1)	H—H	1	1	—	—	2	—	—	—	1	1	H—H (1+1)	—	—	—	—	—	—	
9	—	—	—	—	—	2	30	36	—	—	—	—	1	—	—	1	1	—	—	1	—	—	—	1	1	H—H (1+1)	10000	—	—	10000	—	COMMITEE OF THE VILLAGE	
10	—	—	—	—	—	—	—	8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	CHICKEN (1)	20000	—	—	20000	—	ASST. VILLAGE CHIEF, COMMITEE OF THE VILLAGE	
11	—	—	—	—	—	2	10	30	—	—	—	1 (80 c.c.)	1	HAND OPERATED TRACTOR (1)	—	1	1	—	—	1	—	—	—	1	1	1	CHICKEN +(10) DUCK	10000	—	—	10000	—	COMMITTEE OF THE VILLAGE	
12	—	—	—	—	—	5	50	40	—	—	—	1 (80 c.c.)	3	H—H (1)	WATER PUMP ϕ3" 5 H.P.	1	1	—	—	2	—	—	—	1	1	H—H (1+1)	25000	—	—	25000	—	—	
13	3	1X15X2	TAPIAN (3X15X)	—	—	2	—	20	—	—	—	—	1	H—H (1)	WATER PUMP ϕ2" 5 H.P.	1	1	—	—	2	1	—	—	1	1	H—H (1+1)	25000	—	—	25000	—	COMMITTEE FOR TEMPLE DEVELOPMENT	
14	2	10X15X2	NIL (1300 + 1200)	—	—	2	50	30	—	—	—	—	2	H—H (1)	ϕ3" 5 H.P.	1	1	—	—	2	—	—	—	1	1	H—H (1+1)	12000	—	—	12000	—	COMMITTEE OF THE VILLAGE	
15	—	—	—	—	—	—	—	10	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—	CHICKEN HOUSE (1)	—	—	—	—	—	COMMITTEE OF TUMBON	
16	—	—	—	—	—	2.5	400	26	—	—	—	2 (80 c.c.)	—	—	MILL ENGINE (1)	1	1	—	—	1	1	—	—	1	1	CHICKEN DUCK (1+1)	20000	—	—	20000	—	COMMITTEE OF THE VILLAGE	
17	—	—	—	—	—	2	—	16	—	—	—	—	3	—	—	1	2	—	2	1	—	—	—	1	1	CHICKEN HOUSE (1)	20000	—	—	20000	GROUP LEADER	VILLAGE CHIEF	
18	—	—	—	—	—	—	2	—	—	—	—	—	2	—	—	1	1	—	1	1	—	—	—	1	—	DUCK HOUSE (1)	—	—	—	—	—	—	
19	—	—	—	—	—	—	—	30	—	—	—	1 (70 c.c.)	1	—	WATER PUMP ϕ2" 5 H.P.	1	1	—	—	2	1	—	—	1	1	CHICKEN HOUSE (1)	40000	—	—	40000	—	—	
20	5	—	—	—	—	27.5	682	471	—	—	—	10	26	7	WATER PUMP 10 ENGINE 1	16	19	1	7	25	4	2	2	19	17	CH 17 DU 14	298924	5000	—	303924	—	—	
AGE	0.26	—	—	—	—	1.45	35.89	24.79	—	—	—	0.53	1.37	0.37	H.P. 0.53 ENG. 0.05	0.84	1	0.05	0.37	1.32	0.21	0.10	0.10	1	0.89	CH 0.89 DU 0.74	157328	263.2	—	15996	—	—	

Table. 8

BILL OF QUANTITIES

FOR

CONSTRUCTION OF MODEL INFRASTRUCTURE

ON

AGRICULTURAL COOPERATIVE PROMOTION PROJECT

IN

THAILAND

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-i-1	Construction og livestock facilities					
1)	Piggery					
	• Base Embankment common soil	cum	17.2	7.0	120	
	Excavation common soil	〃	10.9	35	381	
	Smoothing face for bed	sqm	64.0	1.4	90	
	Hauling L=20m	cum	6.2	25	155	
	Compaction	〃	12.5	25	312	
	Plain concrete	〃	4.7	1,250	5,875	
	Hauling L=20m	〃	4.7	25	118	
	Smoothing face for concrete	sqm	10.7	1.25	13	
	Curing	〃	10.7	4.90	52	
	Wooden form	〃	4.3	415	1,785	
	R. steel bar φ6m/m	t	0.134	17,320	2,321	
	Plain concrete of pillar base	cum	0.3	1,250	375	
	Hauling	〃	0.3	25	8	
	Pillar base wooden form	sqm	3.2	415	1,328	
	Mortar	cum	0.07	1.000	70	
	• Installation of concrete block					
	Concrete block	sqm	5.3	170	901	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
	• Carpentry					
	Wooden structure	cum	1.59	10,020	15,932	
	• Roofing					
	Grass (yahka) roofing	sqm	73.6	70.5	5,189	
	• Others					
	Plain concrete for feed Box	cum	0.4	1,250	500	
	Wooden form	sqm	8.9	415	3,694	
	Mortar	cum	0.03	1,000	30	
	Miscellaneous	%	2		785	
	Total				40,034	
	× 3				120,102	
				Round oll	120,000	

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
I-1-1						
2)	Compost barnyard					
	• Base Embankment	cum	8.8	7.0	61	
	Compaction	〃	8.8	25.0	220	
	Plain concrete	〃	0.14	1,250	175	
	-do- Hauling L=20m	〃	0.14	25	4	
	Wooden form	sqm	2.88	415	1,195	
	• Carpentry					
	Wooden structure	cum	0.64	10,020	6,413	
	• Roofing					
	Grass roofing	sqm	57.6	70.5	12,129	
	Miscellaneous	%	2		243	
	Total				12,372	
				Round off	12,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-1-1						
3)	Water tank					
	• Water tank 1,500	pieces	4	3,500	14,000	
	• Base Timber (wood)	cum	0.80	10,020	8,016	
	• Others Check Valve φ 1'	〃	1	295	295	
	〃 φ 2'	〃	1	990	990	
	Steel Pipe φ 4'	m	5.5	212	1,166	
	〃 Elbow 90° φ 4'	pieces	3	228	684	
	〃 Pipe φ 2'	m	28	87	2,436	
	〃 〃 φ 1'	〃	46	42	1,932	
	〃 Elbow 90° φ 2'	pieces	4	48	144	
	〃 〃 90° φ 1'	〃	4	17	192	
	〃 Cross pipe φ 2'	〃	3	72	216	
	• Roof Wood	cum	0.23	10,020	2,304	
	Calvanized Iron Sheet	sqm	29.0	122.5	3,552	
	Miscellaneous	%	2		718	
	Total				36,645	
				Round off	36,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-1-1						
4)	Urine Treatment Basin & Drain					
	Excavation common soil	cum	1.7	35	59	
	Embankment	〃	2.0	26.25	53	
	Compaction	〃	2.0	26.25	53	
	Plain concrete	〃	4.2	1,250	5,250	
	Wooden form	sqm	85.5	415	35,482	
	Curing	〃	12.2	4.90	59	
	Embankment	cum	0.6	26.25	15	
	Compaction	〃	0.6	26.25	15	
	RC - Pipe φ1,000m/m d = 0.4m	pieces	5	250	1,250	
	Miscellaneous	%	2		845	
	Total				43,081	
				Round off	43,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-1-1						
5)	Hen House (Breeding)					
	• Base Embankment	cum	60.2	7.0	421	
	Excavation	〃	23.9	35	836	
	Coading & Hauling L=20m	〃	23.9	25	597	
	Compaction	〃	60.2	25	1,505	
	Plain concrete of pillar base	〃	1.2	1,250	1,500	
	〃 wooden form	sqm	12.2	415	5,063	
	• Installation of concrete block					
	Concrete block	sqm	6.4	170	1,088	
	• Carpentry					
	Wooden structure	cum	2.7	10,020	27,054	
	Wire mesh #1/2'	sqm	87.0	17	1,479	
	• Roofing					
	Grass (yahka) roofing	sqm	86.0	70.5	6,063	
	Miscellaneous	%	2		912	
	Total				46,518	
	×2				93,036	
				Round off	93,000	

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-1-1 6)	Hatchery					
	• Base Embankment	cum	13.0	7.0	91	
	Excavation common soil	〃	5.4	35	189	
	smoothing face for bed	sqm	32.0	1.4	45	
	Sand	cum	4.9	150	735	
	Hauling L=20m	〃	4.9	25	123	
	Compaction	〃	13.0	25	325	
	Plain concrete	〃	0.6	1,250	750	
	Hauling L=20m	〃	0.6	25	15	
	Smoothing face for concrete	sqm	8.0	1.25	10	
	Curing	〃	8.0	4.90	39	
	Wooden form	〃	4.9	415	2,034	
	R. Steel bar φ 6m/m	t	0.02	17,320	346	
	Plain concrete of pillar base	cum	0.2	1,250	250	
	〃 Hauling	〃	0.2	25	5	
	Plain concrete for pillar base					
	〃 wooden form	sqm	1.8	415	747	
	• Installation of concrete block					
	Concrete block	sqm	4.8	170	816	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₪)	(₪)	
1-1-1 6)						
	• Carpentry					
	Wooden structure	cum	1.1	10,020	11,022	
	Wire mesh #1/2'	sqm	33.9	17.0	576	
	Flat sheet t = 6m/m	〃	5.0	62.5	313	
	• Roofing					
	Grass (yahka) roofing	sqm	72.0	70.5	5,076	
	Miscellaneous	%	2		470	
	Total				23,977	
				Round off	23,000	

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-1-2						
1)	Hen House					
	Wood Timber	cum	1.22	10.020	12.224	
	Roofing (yahka)	sqm	42	70.5	2.961	
	Concrete block	sqm	5.6	170	952	
	Wire mesh #1/2'	m	40	67.5	2.700	
	Miscellaneous	%	2		377	
	Total				19.214	
				Round off	19.000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₪)	(₪)	
1-1-2						
2)	Hen House (Material)					
	Wood Timber	cum	1.22	8,000	9,760	
	Roofing (yahka)	sqm	42	34	1,428	
	Concrete block	pieces	180	3	540	
	Wire mesh #1/2'	sqm	68	17	1,156	
	Miscellaneous	%	2		258	
	Total				13,142	
	×18				236,556	
				Round off	236,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-1-3	Construction of irrigation facilities					
1)	Construction of Big Pond					
	• Earth works					
	Excavation common soil	cum	14,924	13.6	202,966	11t Bull-dozer
	Embankment common soil	〃	4,183	13.6	56,888	〃
	Spreading common soil	〃	5,914	7.0	41,398	〃
	Compaction common soil	〃	5,914	17.0	100,538	Tire Roller
	Loading	〃	9,010	15.2	136,952	0.5 back-hoe
	Hauling	〃	9,010	3.5	31,535	11t Dump truck
	Smoothing face	sqm	5,771	1.4	8,079	L = 500m
	Drainage by pump	days	35	329	11,515	
	• Pipe works					
	RC Pipe φ 800m/m	m	27	600	16,200	
	Excavation common soil	cum	27	35	945	
	Spreading common soil	〃	13	26.25	341	
	Compaction common soil	〃	13	26.25	341	
	Smoothing face	sqm	27	1.4	37	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-1-3						
1)	• Slope protection					
	Excavation common soil	cum	10	35	350	
	Stone (Boulder)	〃	6	250	1,500	
	Concrete	〃	4	1,000	4,000	
	Miscellaneous	%	2		12,272	
	Total				625,857	
				Round off	625,000	

Item No.	Description	Unit	Quantity	Unit Price (₿)	Price (₿)	Remarks
I-1-3						
2)	Construction of Pond (TYPE A)					
	• Earth works					
	Excavation sand	cum	633	11.4	7.216	0.5㎥ Back-hoe
	〃 common soil	〃	232	13.6	3.155	
	Spreading common soil	〃	302	7.0	2,114	
	Compaction	〃	302	7.0	2,114	
	Embankment common soil	〃	200	15.2	3,040	
	Spreading sand	〃	633	7.0	4,431	
	〃 common soil	〃	199	7.0	1,393	
	Smoothing face	〃	931	1.4	1,303	
	• Pipe works					
	RC - Pipe φ 400m/m	m	10	100	1,000	
	Excavation common soil	cum	3.6	35	126	
	Spreading common soil	〃	2.3	26.25	60	
	Compaction	〃	2.3	26.25	60	
	Smoothing face	sqm	6.0	1.4	8	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₪)	(₪)	
I-1-3 2)	(TYPE A)					
	• Slope protection					
	Excavation common soil	cum	4.4	35	154	
	Stone (Boulder)	〃	2.6	250	650	
	Concrete	〃	1.8	1,000	1,800	
	Miscellaneous	%	2		572	
	Total				29,196	
	×17				496,332	
				Round off	496,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-1-3						
3)	Construction of Pond (TYPE B)					
	• Earth works					
	Excavation sand	cum	1,089	11.4	12,414	
	〃 common soil	〃	552	13.6	7,507	
	Spreading common soil	〃	414	7.0	2,898	
	Compaction common soil	〃	414	7.0	2,898	
	Embankment common soil	〃	264	15.2	4,012	
	Spreading sand	〃	1,089	7.0	7,623	
	〃 common soil	〃	1,457	7.0	10,199	
	Smoothing face	sqm	1,349	1.4	1,888	
	• Pipe works					
	RC - Pipe ϕ 400m/m	m	10	100	1,000	
	Excavation common soil	cum	3.6	35	126	
	Spreading common soil	〃	2.3	26.25	60	
	Compaction common soil	〃	2.3	26.25	60	
	Smoothing face	sqm	6.0	1.4	8	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-1-3 3)	(TYPE B)					
	• Slope protection					
	Excavation common soil	cum	4.4	35	154	
	Stone (Boulder)	〃	2.6	250	650	
	Concrete	〃	1.8	1,000	1,800	
	Miscellaneous	%	2		1,066	
	Total				54,363	
				Round off	54,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price (₿)	Price (₿)	Remarks
1-2-1	Construction of swine raising farm					
1)	Piggery 3					
	• Base Embankment common soil	cum	45.7	7.0	320	
	Excavation common soil	〃	10.9	35	382	
	Smoothing face for bed	sqm	64.0	1.4	90	
	Sand	cum	6.2	150	930	
	Hauling L=20m	〃	6.2	25	155	
	Compaction	〃	41.0	25	1,025	
	Plain concrete	〃	4.7	1,250	5,875	
	Hauling L=20m	〃	4.7	25	118	
	Smoothing face for concrete	sqm	10.7	1.25	13	
	Curing	〃	10.7	4.90	52	
	Wooden form	〃	4.3	415	1,785	
	R. steel bar φ6m/m	t	0.134	17,320	2,321	
	Plain concrete of pillar base	cum	0.3	1,250	375	
	Wooden form	sqm	3.2	415	1,328	
	Hauling	cum	0.3	25	8	
	Mortar	〃	0.07	1,000	70	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-2-1						
1)	• Installation of concrete block					
	Concrete block	sqm	5.3	170	901	
	• Carpentry					
	Wooden structure	cum	1.59	10,020	15,932	
	• Roofing					
	Grass (yahka) roofing	sqm	73.6	70.5	5,189	
	• Others					
	Plain concrete for feed box	cum	0.4	1,250	500	
	Wooden form	sqm	8.9	415	3,694	
	Mortar	cum	0.03	1,000	30	
	Plain concrete for Fence poll base	〃	1.83	1,250	2,288	
	Wooden form	sqm	24.4	415	439	
	Installation of Fence	m	181	67.5	12,217	
	Miscellaneous	%	2		1,121	
	Total				57,158	
	× 2				114,316	
				Round off	114,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-2-1						
2)	Compost barnyard					
	• Base Embankment	cum	25.2	7.0	176	
	Compaction	〃	25.2	25.0	630	
	Plain concrete	〃	0.14	1,250	175	
	-do- Hauling L=20m	〃	0.14	25	4	
	Wooden form	sqm	2.88	415	1,195	
	• Carpentry					
	Wooden structure	cum	0.64	10,020	6,413	
	• Roofing					
	Grass roofing	sqm	57.6	70.5	4,061	
	Miscellaneous	%	2		253	
	Total				12,907	
				Round off	12,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price (₿)	Price (₿)	Remarks
1-2-1						
3)	Water tank					
	• Water tank 1,500ℓ	pieces	2	3,500	7,000	
	• Base Timber (wood)	cum	0.48	10,020	4,810	
	• Others					
	Check Valve φ 2′	pieces	2	295	590	
	Steel Pipe φ 2′	m	0.6	41	25	
	〃 Elbow φ 2′	pieces	2	17	34	
	Miscellaneous	%	5		622	
	Total				13,081	
				Round off	13,000	

Item No.	Description	Unit	Quantity	Unit Price (₪)	Price (₪)	Remarks
1-2-1						
4)	Urine Treatment Basin & Drain					
	Excavation common soil	cum	1.4	35	49	
	Embankment	〃	5.8	26.25	152	
	Compaction	〃	5.8	26.25	152	
	Plain concrete	〃	3.0	1,250	3,750	
	Wooden form	sqm	59.5	415	24,692	
	Curing	〃	12.2	4.90	59	
	Embankment	cum	1.5	26.25	39	
	Compaction	〃	1.5	26.25	39	
	RC - Pipe φ1,000m/m d = 0.4m	pieces	5	250	1,250	
	Miscellaneous	%	2		604	
	Total				30,786	
				Round off	30,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-2-1						
5)	Well					
	Excavation	cum	3.3	35	115	
	Embankment	〃	5.7	26.25	150	
	Compaction	〃	5.7	26.25	150	
	RC - Pipe φ1,000m/m	pieces	14	250	3,500	
	Miscellaneous	%	2		78	
	Total				3,993	
				Round off	4,000	

Item No.	Description	Unit	Quantity	Unit Price (₿)	Price (₿)	Remarks
1-2-2						
1)	Construction of canal					
	• Earth works of canal					
	Excavation common soil	cum	15,800	15.2	240,160	
	Loading	〃	7,400	15.2	112,480	
	Houling L = 500m	〃	7,400	3.5	25,900	
	Spreading	〃	8,400	7.0	81,200	
	Compaction	〃	8,400	25.0	290,000	
	Gravel	〃	204.0	250	51,000	
	Drainage by pump	days	30	329	9,870	
	Miscellaneous	%	2		16,212	
	Total				826,822	
				Round off	826,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-2-2						
2)	Appendant structure					
	・Pipe works					
	Excavation common soil	cum	4.3	35	151	
	Spreading common soil	〃	2.8	26.25	224	
	Compaction common soil	〃	2.8	26.25	224	
	Smoothing face	sqm	4.8	1.4	5	
	RC - pipe φ400m/m	m	10	100	1,000	
	Miscellaneous	%	2		32	
	sub total				1,636	
	× 9				14,724	
				Round off	14,000	

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-2-2						
2)	Water division					
	• Earth works					
	Excavation common soil	cum	41.3	35	1,446	
	Spreading common soil	〃	183.7	7.0	1,286	
	Compaction common soil	〃	183.7	25.0	4,593	
	Gravel φ 5～20 m/m	〃	2.0	250	500	
	Boulder of slope protection	〃	12.3	250	3,075	
	Mortal protection	〃	8.2	1,000	8,200	
	RC - pipe φ1,200m/m	m	11	1,200	13,200	
	• Concrete works					
	Plain concrete	cum	30.1	1,250	37,625	
	Wooden form	〃	86.6	415.0	35,939	
	R - steel bar	t	1.650	13,500	22,275	
	Wire for biding	〃	0.165	20,000	3,300	
	Miscellaneous	%	2		2,628	
	sub total				134,067	
	×2				268,134	
				Round off	268,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-2-2						
2)	• Cross road					
	Excavation common soil	cum	16.8	35	588	
	Spreading common soil	〃	256.2	7.0	1,793	
	Compaction common soil	〃	256.2	25.0	6,405	
	Gravel	〃	2.0	250	500	
	RC - pipe ϕ 1.200m/m	m	17	1,200	20,400	
	Boulder of slope protection	cum	10.1	250	2,525	
	Mortal protection	〃	6.7	1,000	6,700	
	Miscellaneous	%	2		778	
	sub total				39,689	
	× 3				119,067	
				Round off	119,000	
	• Gate 1.2 m × 1.2m	set	2	20,000	40,000	
	total				441,000	

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
1-2-2				(₿)	(₿)	
3)	Construction of pond					
	• Earth works					
	Excavation common soil	cum	756	11.4	8,618	
	Spreading	〃	238	7.0	1,666	
	Embankment	〃	354	15.2	5,380	
	Compaction	〃	354	7.0	2,478	
	Smoothing face	sqm	1,297	1.4	1,815	
	• Pipe works					
	RC - Pipe φ 400m/m	m	13.4	100	1,340	
	Excavation common soil	cum	4.8	35	168	
	Spreading common soil	〃	3.1	26.25	81	
	Compaction common soil	〃	3.1	26.25	81	
	Smoothing face	sqm	8.0	1.4	11	
	• Slope protection					
	Excavation common soil	cum	4.0	35	140	
	Stone Boulder	〃	2.4	250	600	
	Concrete	〃	1.6	1,000	1,600	
	Miscellaneous	%	2		479	
	Total				24,457	
	× 6				146,742	
				Round off	146,000	

BILL OF QUANTITIES

Item No.	Description	Unit	Quantity	Unit Price	Price	Remarks
				(₿)	(₿)	
1-2-2						
4)	Lateral canal					
	Excavation common soil	sum	180	35	6,300	
	Embankment	〃	180	26.25	4,725	
	Miscellaneous	%	2		220	
	Total				11,245	
				Round off	11,000	

Item No.	Description	Unit	Quantity	Unit Price (₿)	Price (₿)	Remarks
1-2-3	Installation of Vegetable Farm					
	Steel pipe 1'	pieces	42	250	10,500	
	Wire sling 3.0m/m	m	300	3	900	
	〃 4.5m/m	〃	410	4	1,640	
	Clamping	pieces	42	5	210	
	Pull clamping	〃	42	15	630	
	Coupling	〃	42	20	840	
	Nylon mesh sheet	㎡	1,000	3.5	3,500	
	Transportation	%	10	26.5	1,822	
	Miscellaneous	%	2		400	
	sub total				20,442	
	Labour	md	10	70	700	
	Total				21,142	
	× 3				63,426	
				Round off	63,000	

Table 9. LIST OF LABOUR WAGES (as Nokorn Ratchasima)

No.	Item	Cost (Baht)
1.	Common Labour	70
2.	Foreman, earth work	180
3.	Foreman, concrete work	215
4.	Foreman, other civil work	215
5.	Foreman, mechanical work	215
6.	Foreman, Electrical work	215
7.	Foreman, steel work	180
8.	Technician, capernter	180
9.	Technician, Electrician	180
10.	Technician, steel worker	180
11.	Technician, form worker	180
12.	Technician, concrete worker	180
13.	Technician, mechanical	180
14.	Technician, mason	180
15.	Operator, buildozer	180
16.	Operator, backhoe	180
17.	Operator, loader	180
18.	Operator, tamping roller	180
19.	Operator, other light equipment	145
20.	Driver, dump truck	145
21.	Driver, truck	145
22.	Driver, light vehicles	120

Table.10 Unit Cost of Materials (1)

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No.	Item	Unit	Cost	Remarks
			(Baht)	
1	Aggregate			
	(a) Sand	m³	150	
	(b) Gravel	m³	250	5～ 20 m/m
	(c) Boulder	m³	250	40～150 m/m
	(d) Laterite	m³	150	
2	Timber		Hard Wood	
	(a) 1"×1"	m³	8.000	
	(b) 1"×2"	m³	8.000	
	(c) 1 1/2"×3"	m³	8.000	
	(d) 1 1/2"×4"	m³	8.000	
	(e) 1 1/2"×5"	m³	8.000	
	(f) 1 1/2"×6"	m³	8.000	
	(g) 2"×2"	m³	8.000	
	(h) 2"×4"	m³	8.000	
	(i) 2"×6"	m³	8.000	
	(j) 2"×8"	m³	8.000	
	(k) 2"×10"	m³	8.000	
	(l) 3"×3"	m³	8.000	
	(m) 4"×4"	m³	8.000	
	(n) 5"×5"	m³	8.400	
	(o) 6"×6"	m³	8.400	
	(p) 8"×8"	m³	8.400	
3	Steel Reinforcement			
	(a) D 12 m/m	t		
	(b) D 16 m/m	t		
	(c) D 20 m/m	t	13.500	
	(d) D 25 m/m	t		
	(e) D 28 m/m	t		

Table, 10 Unit Cost of Materials (2)

No.	Item	Unit	Cost	Remarks
			(Baht)	
4	Steel Round Bar			
	(a) ϕ 6 m/m	t		
	(b) ϕ 9 m/m	t		
	(c) ϕ 12 m/m	t	13,000	
	(d) ϕ 15 m/m	t		
	(e) ϕ 19 m/m	t		
	(f) ϕ 25 m/m	t		
5	Wire for biding steel bar No.18	kg	20	
6	Nail , Bolt , Nut	kg	40	
7	Cement (1 bag= 50 kg)			
	Portland Cement	bag	85	
8	Fuel			
	(a) Gasoline	lit	9.10	
	(b) Diesoline	lit	6.50	
9	Concrete Block (400×200 × 70)	pec	3.00	
	〃 (400×200 ×100)	pec	4.50	
10	RC Pipe			
	(a) ϕ 150×1,000	pec	50	
	(b) ϕ 200×1,000	pec	60	
	(c) ϕ 300×1,000	pec	65	
	(d) ϕ 400×1,000	pec	100	
	(e) ϕ 600×1,000	pec	480	
	(f) ϕ 800×1,000	pec	600	
	(g) ϕ 1,000×1,000	pec	1,000	
	(h) ϕ 1,200×1,000	pec	1,200	
	(i) ϕ 1,000× 400	pec	250	

Table 10 Unit Cost of Materials (3)

No.	Item	Unit	Cost (Baht)	Remarks
11	PVC PIPE (TIS 17-2523 CLASS TV)			
	(a) 1/2"	stick	59	
	(b) 3/4"	stick	72	
	(c) 1"	stick	114	
	(d) 1 1/2"	stick	191	
	(e) 2"	stick	293	
	(f) 2 1/2"	stick	482	
	(g) 3"	stick	673	
	(h) 4"	stick	1,083	
12	Steel Pipe (GSP . L = 6.00 m)			
	1/2"	pc	133	Not including
	3/4"	pc	171	Transportation
	1"	pc	250	1 TRIP = 2,800
	1 1/4"	pc	320	(13 Ton)
	1 1/2"	pc	367	
	2"	pc	521	
	2 1/2"	pc	670	
	3"	pc	875	
	4"	pc	1,272	
	5"	pc	1,800	
	6"	pc	2,400	

13 ELBOW Pipe (inch)

	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5
45°	10	11	16	24	32	48	98	145	260	755
90°	8	10	17	27	32	48	85	130	228	655

14 T - Bar Pipe (inch)

	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5
90°	16	20	34	54	64	96	170	260	456	1,310

15 Cross Pipe (inch)

	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4	5
90°	24	30	51	81	96	144	255	390	684	1,965

Table 10 Unit Cost of Materials (4)

No.	Item	Unit	Cost	Remarks
			(Baht)	
16	VALVE			
	(1) GATE VALVE (150 LB.)			
	2"	pc	1,365	
	1 1/2"	pc	860	
	1 1/4"	pc	640	
	1"	pc	445	
	3/4"	pc	325	
	1/2"	pc	225	
	3/8"	pc	200	
	(2) GATE VALVE (125 LB.)			
	4"	pc	4,250	
	3"	pc	1,820	
	2 1/2"	pc	1,250	
	2"	pc	720	
	1 1/2"	pc	490	
	1 1/4"	pc	375	
	1"	pc	275	
	3/4"	pc	195	
	(3) CHECK VALVE (125 LB.)			
	4"	pc	4,750	
	3"	pc	2,000	
	2"	pc	990	
	1 1/2"	pc	640	
	(4) CHECK VALVE (150 LB.)			
	1"	pc	295	
	(5) GLOBE VALVE (150 LB.)			
	2"	pc	1,150	
	3/4"	pc	245	
	(6) GLOBE VALVE (125 LB.)			
	2 1/2"	pc	2,575	
	2"	pc	1,450	
	1 1/4"	pc	650	
	1"	pc	450	
	3/4"	pc	370	

Table 10 Unit Cost of Materials (5)

No.	Item	Unit	Cost	Remarks
			(Baht)	
17	Water Tank (V = 1,500 liter)	pec	3,500	
18	Grass (Yah-ka) (200 × 1,200)	pec	8	
19	Calvanized iron sheet (665 × 2,130 t = 0.2m/m)	pac	100	
20	Hand Pump (include pipe)	pec	1,200	
21	Flat sheet (1.20m × 2.40m)	pec	180	
22	Wire Mesh 1/2" (45m × 0.9m)	pec	680	
23	Fence Concrete Pole			
	(1) Concrete Pole	pec	90	
	(2) Wire	30m	110	—×—×—×—
24	Gate	pec	15,000	
25	Sling			
	(1) 3.0 m/m	200m	600	
	(2) 4.5 m/m	200m	800	
26	Pull clamping	pec	15	
27	Clamping	pec	5	
28	Nylon Mesh Sheet (20m × 1 m)	pec	70	
29	Coupling 1"	pec	20	

Table // LIST OF UNIT COST

No.	Item	Unit	Uint COST(Baht)
1	Excavation by Manpower		
	Sand	m³	23
	Common Soil	m³	35
	Gravel	m³	46
2	Hauling by Manpower		
	L = 20m	m³	25
	L = 40m	m³	33
	L = 60m	m³	37.5
	L = 80m	m³	42.8
	L = 100m	m³	50
	L = 120m	m³	60
3	Compacting		
3-1	Compacting by Manpower	m³	26.25
3-2	Compacting by Compactor	m³	17.50
4	Smoothing of face excavated of filled up by Manpower	m²	1.4
5	Concrete + Labour		
5-1	Plain concrete	m³	1,250
5-2	Lean concrete	m³	1,000
5-3	Lining concrete	m³	1,300
6	Morter (C:S=1:3)+ Labour	m³	1,000
7	Wooden form of concrete by Manpower	m²	415
8	Processing and assembling of steel bar + Labour	ton	17,320
9	Wooden scaffolding by Manpower	m²	300
10	Draiage by pump + Labour	day	329

No.	Item	Unit	Uint COST(Baht)
11	Smoothing face of concrete by Manpower	m^2	1.25
12	Curing for concrete by Manpower	m^2	4.90
13	Installation of concrete block + Labour	m^2	170
14	Roofing Grass + Labour	m^2	70.5
15	Roofing iron sheet + Labour	m^2	122.5
16	Wooden structure for house + Labour	m^2	10.020
17	Installtion of fence by Manpower	m	67.5

Table /2 LIST OF UNIT COST BY USING CONSTRUCTION EQUIPMENTS

No.	Item	Unit	Unit COST (Baht)	
			CPD	Contractor
EQ-1	Excavation by Bull-dozer (11ton)			
	Sand	m³	11.4	17.6
	Common soil	m³	13.6	21.1
	Gravel and weathered rock	m³	19.4	30.2
EQ-2	Excavation by Bull-dozer (21ton)			
	Sand	m³	15.9	20.0
	Common soil	m³	19.0	23.9
	Gravel and weathered rock	m³	27.0	34.0
EQ-3	Excavation by Back-hoe Shovel (0.55m³)			
	Sand	m³	11.4	17.1
	Common soil	m³	15.2	22.8
	Gravel and weathered rock	m³	18.2	27.4
EQ-4	Loading by Tractor Shovel			
	Sand	m³	17.6	22.2
	Common soil	m³	23.5	29.6
	Gravel and weathered rock	m³	28.2	35.5
EQ-5	Hauling by Dump Truck (8ton)			
	Sand	m³/km	7.0	8.8
	Common soil	m³/mk		
	Gravel and weathered rock	m³/km	8.0	10.0
EQ-6	Spreading by Bull-dozer (12ton)			
	Sand	m³/km	7.0	8.8
	Common soil	m³/km		
	Gravel and weathered rock	m³/km	8.0	10.0
EQ-7	Compaction by Tire Roller (12ton)	m³	17.0	21.4
EQ-8	Compaction by Vibration Roller (1-3 ton)	m³	25.0	31.5
EQ-9	Compaction by Bull-dozer (12ton)	m³	7.0	8.0

Table-13 HOURLY PRODUCTION

1. Bull-dozer

(1) For excavation

Spec.	Work Item	Q (m³/hr)
	Excavation	
Eq1-1	Sand	60
Eq1-2	Common soil	50

(2) For Spreading

Spec.	Work Item	thickness(cm)	Q (m³/hr)
12 ton	Spreading		
Eq8-1	Sand	25	70
Eq8-2	Common soil	25	55

2. Back-hoe Shovel

Spec.	Material	Q (m³/hr)
	Excavation	
Eq3-1	Sand	60
Eq3-2	Common soil	50
Eq3-3	Gravel or weathered rock	30

3. Tractor Shovel

Spec.	Material	Q (m³/hr)
Eq5-1 1.2 m³	Sand	60
Eq5-2	Common soil	50
Eq5-3	Gravel or weathered rock	30

4. Dump Truck

Spec.	Material	Q (m³/hr)
Eq6-1	Sand	36
Eq6-2	Common soil	
Eq6-3	Gravel or weathered rock	25

5. Compacting Equipment

Spec.	Material	Q (m³/hr)
Eq 9	Tire Roller	100
Eq10	Vibration roller (1-3 ton)	20
Eq11	Bull dorzer (12 ton)	50

6. Concrete Work 1.5 m³/day