APPENDIX-G. AGRO-ECONOMY AND RURAL SOCIETIES

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APPENDIX-G AGRO-ECONOMY AND RURAL SOCIETIES

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G.1. Tree Age Survey

G.1.1. Methodology

To grasp the average tree age and expected yield of fruit, tree age survey was conducted. Since the Project area has 71,000 rai of orchard with more than 5,000 farm households, the interview to all farms is a theoretical practice of little possibility.

Taking into consideration the situations above mentioned, the Provincial Agricultural Extension Office implemented actual survey in 1988 concerning to expected yield by tree age in the province. In this survey, 37 durian farms and 63 mangosteen farms who have 20,513 and 8,742 trees respectively were surveyed, and the total survey area corresponds to 1,030 rai of durian farm and 550 rai of mangosteen farm, respectively.

The tabulation and analysis were made by the Consultant based on above data and the area percentage by tree age for rambutan were estimated as a little bit younger than durian because the introduction of rambutan plantation is deems 10 - 15 years after durian plantation.

G.1.2. The Area Percentage by Tree Age

(1) Durian

Cha-nee variety shows the majority of the production and this variety is most popular in the Province. The survey indicates that about 80% of the Cha-nee trees are aged between 9 to 25 years with the peak yield at 200 kg/tree/year. And also it could generate the idea that this variety is planted constantly.

It is brightly observed that Mon-thong (HYV) was introduced recently and about 60% of trees are under 10 years old. The yield

of this variety at 220 kg/tree/year is higher than that of Cha-nee variety, however the life span is comparatively short due to its weakness against the diseases. The trees over 25 years bears about 120 kg/year of fruits, which is lower than Cha-nee variety by 30 kg.

The other variety represented by Kra-dum is deemed to be planted constantly, although they can not expect the high yield. The farmers prefer this variety because this variety is very strong against disease and they can anticipate the long life expectancy. The peak yield averaged at 130 kg/tree/year which corresponds to only 60% of that of Mon-thong variety.

The area percentage by tree age for all kinds of durian is estimated as; 5% for first year tree, 25% for second to fifth year tree, 5% for sixth to eight year tree, 60% for ninth to 25th year tree and 5% of over 25th year tree, respectively. It is considered that the area for young trees (under 9th year) account for 30% of the whole durian plantation area in Chanthaburi.

The production yield for all variety of durian is tabulated as; zero kg for first year tree, 5 kg for second to fifth year tree, 50 kg for sixth to eighth year tree, 190 kg for ninth to 25 th year tree and 130 kg for over 25th year tree, respectively. The result illustrates that the durian meet the peak yield between 15th to 20th year, and after this period the yield would gradually decrease, and cease its life with more or less 40 years, however the economic life span for all kinds of durian is considered as 25 years.

(2) Mangosteen

The production per tree is counted at 90 kg in 15 th to 30 th year tree and this figure is smaller than that of durian. Most of mangosteen is planted by seeds because of no variety mutation and it takes about 7 - 8 years to bear fruits, however farmers still prefer mangosteen plantation by the reasons discussed below;

- No severe disease
- Long life span
- Strongpoint against environment change

The area percentage by tree age is tabulated as follows;

- 1st year 5%
- 2nd to 6th year 15%
- 7th to 15th year 60%
- 16th to 30th year 20%
- 30th year over 0%

G.2. Production Cost

(1) Fruits

The production costs of durian, rambutan and mangosteen are estimated based on the data interviewed in the field survey. It is estimated that there would be approximately 2% of increase on cash production costs between "with" and "without" project situation, that is, mainly attributable to increase of hired labor, harvesting tools and agro-chemicals resulted from production increase under the project. While, the mushroom increase of non-cash costs incurred from depreciation of the project costs as well as operation and maintenance costs would be brought about, however, the unexpected expense for irrigation water in drought year will sharply reduced. (refer to Appendix J)

Due to the perenniality of the fruits tree, the production costs are measured through "time-series analysis", therefore, it is quite impossible to indicate the difference of the production costs between normal and drought year. It is estimated that in 1983 drought, ฿ 11-17/rai/day of irrigation water has been purchased by number of farms during continuous 3 months' period from January to

March, and this unexpected expense is, therefore, considered as the remarkable difference on the production costs between with and without project situation.

It is positive that yield per unit production area will increase for each variety as time goes by, and the gross farm income of Mong thong will exceed that of Chanee, and gross farm income of new varieties of Rong Rian and Para rubber will exceed that of see-chohmphoo and the local variety, respectively. Production costs (cash costs) per rai will be between 2,500 and 7,000 baths for both durian, 2,000 - 5,000 for both rambutan and 1,500 - 4,500 for mangosteen, respectively. Production costs in the first year will be high in durian and mangosteen, which will exceed 2,000 bahts. Costs in the unyield stage are estimated as 50 to 70% of the first year, while costs in the constant stage are estimated to be 200 to 300% of the unyield stage. It should be noted, however, that costs during the increasing stage are subject to self-will judgement of farmers.

(2) Other Orchard and Crop

Cassava, paddy and para rubber are the major crops/orchard which concern to the project. By the implementation of the project, these crops with considerable percentage are converted to fruits, which should be taken for negative and foregone benefits under with project situation. The production costs of these commodities are shown in Appendix J.

G.3 Rural Industry

The agro-related industries are given much weight in the whole manufacturing industries of Chanthaburi province. Main items of the agro-related industries in 1987 by Amphoe are as follows. They however are still not only on a small scale but also on a low grade in processing raw materials concerned. There is little expectation of particularly influential effect to the provincial financial condition under the existing circumstances.

Description	Muang	Thamai	Makham	Klung	Laem-shing	Pong-nam - ron	Total
Rice Mill	17	77	20	26	32	4	176
Cassava Flour mill	-	-	2	-	-	1	3
Cassava chipping mill	2	32	-	7	-	29	70
Sugar Factory	-	-	-	-	-	2	2
Sowing mill	2	1	1	-	1	-	5
Noodle manufacturing	5	2	-	2	-	-	9
Others	7	4	-	-	4	1	16
Total	33	116	23	35	37	37	281

Provincial authorities are taken into account in the endeavors towards of more employment with a view to correcting income gaps in the rural communities, and concentrate their strength upon forming 16 groups by Amphoe. Details of Groups organized so far are mentioned below.

Description	Muang	Thamai	Makham	Klung	Laem-Shing	Pong-nam - ron	Total
Durian Processing	-	-	1	1	-	-	2
Sedge hand/mat woven	3	2	2	1	3	1	12
Rattern Furniture/ Baskets	-	-	-	1	-	1	2
Steel hammering	-	1	-	-	-	1	2
Cement container Holding	-	-	-	-	-	2	2
Total	3	3	3	3	3	5	20

Source: Chanthaburi Provincial office

6.4 Education and Religion

(1) Education

The existing conditions in 1987 of school attendance of Chanthaburi province are as follows. Elementary education is compulsory in Thailand.

Classification	Male	Female	Total	The Standard School Age
University	994	959	1,953	19 - 20
Collage	372	487	859	19 - 20
Special H.S.	473	206	679	19 - 20
High School	2,531	2,577	5,108	16 - 18
Middle School	4,225	3,898	8,123	13 - 15
Primary School	26,061	23,900	49,961	7 - 12
Total	34,656	32,027	66,683	-

Remarks: 247 out of 271 schools in Chanthaburi Province are governed by either the National Primary Education Committee or the Private Education Committee as detailed below.

Descriptions	No. of place	No. of Teacher	No. of Student
National Primary Education Committee	232	2,434	44,395
Private Education Committee	15	367	8,809
Total	247	2,301	53,204

Source: Chanthaburi Education Office

(2) Religion

Most of inhabitants are Buddhist in Chanthaburi province likewise other provinces in Thailand. It seems that Christians are next in order of numbers and Moslems are comparatively small.

Descriptions	No. of Temple/Mosque	No. of Monk/Priest
Buddhism	214	3,220
Christianity	10	100
Islam	1	2
Total	225	3,322

Table G. 1 Result of Tree Age Survey

Durian (All Kinds)

Tree Age	Trees Planted	Equivalent Rai	Yield (kg/year/tree)	No. farms Reported
1	400	20	0	1
2	1,800	90	0	6
3	1,914	96	0	12
4	697	35	0	9
5	748	37	24	5
6	940	47	13	9
7	150	8	31	2
8	355	18	112	4
9	400	20	180	4
10	805	40	139	8
11	1,031	52	140	13
12	1,893	95	148	8
13	2,600	130	206	8
14	1,408	70	179	12
15	1,095	55	271	7
16	2,222	111	210	10
17	200	10	265	2
18	270	14	290	2
19	30	2	180	1
20	80	4	205	3
21	1,100	55	165	4
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25	50	3	375	1
26	250	13	162	1
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.				
35	35	2	175	1
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.				
40	40	2	60	1
Total	20,513	1,029	-	-

Average tree age = 10.78 Say 11 years

Area Percentage by Tree Age in the Province

1st Year	2%		5%
2nd to 5th Year	25%	Say ⟹	25%
6th to 8th Year	5%		5%
9th to 25th Year	64%		60%
25th Year over	4%		5%

Average Yield by Tree Age (kg/tree/year)

1st Year	0		0
2nd to 5th Year	4	Say ⟹	5
6th to 8th Year	46		50
9th to 25th Year	188		190
25th Year over	132		130

Table G. 2 Result of Tree Age Survey

Mangosteen

Tree Age	Trees Plants	Equivalent Rai	Yield (kg/year/tree)	No. of farm Reported
1	280	18	0	2
2	580	36	0	5
4	510	32	0	6
5	20	1	0	1
6	281	18	9	5
8	380	24	11	4
9	1,010	63	35	6
10	590	37	27	6
11	1,150	72	37	11
12	326	20	47	4
13	1,175	73	38	12
14	480	30	30	2
15	480	30	32	2
16	965	60	77	10
:				
20	120	8	110	2
:				
22	230	14	151	2
:				
25	15	1	80	1
26	120	8	107	2
:				
29	30	2	80	1
Total	8,742	547	-	-

Average tree age = 1,102 Say 11 years

Table G. 3 Result of Tree Age Survey (1)
Durian (Cha-nee)

Tree Age	Farm No.	Trees Planted	Equivalent Rai	Yield (kg/year/tree)
2	⑭	390	22	0
	㉒	50		0
3	⑧	120		0
	⑨	100	14	0
	⑩	50		0
4	㉞	78	4	0
5	⑬	100	5	0
6	⑲	70		13
	⑳	150		15
	㉑	100	29	0
	㉒	50		13
	㉟	200		50
7	㉑	100	5	12
8	②	20	4	140
	⑧	50		110
9	⑫	50	12	120
	㉔	180		200
10	⑦	200	23	150
	㉓	250		160
11	①	200		150
	⑩	100		150
	⑯	270	31	180
	㉞	50		150
12	⑤	200		175
	㉚	300		250
	㉛	450	83	200
	㊱	400		70
	㊲	300		70

Contn'd

13	⑰	300		125
	㉘	250		250
	㉕	600	88	250
	㉗	300		250
	③	300		200
14	⑪	100		150
	⑥	200		180
	⑦	50		240
	⑬	200	61	120
	⑭	60		160
	㉙	250		200
	㉝	350		250
15	④	200	28	200
	㉖	350		250
16	⑫	250		240
	②	80	72	160
	⑤	100		225
	⑰	200		180
	⑱	800		175
17	⑪	150	8	250
20	⑤	50	3	240
21	③	300	43	250
	㉟	550		120
25	④	50	3	375
26	⑮	250	13	162
	Total	10,868	543 rai	

Area Percentage by Tree Age in the Province

1st year	0%		0%
2nd to 5th year	4%	Say	5%
6th to 8th year	7%	⟹	10%
9th to 25th year	87%		80%
25th year over	2%		5%

Average Yield by Tree Age (kg/tree/year)

1st year	0		0
2nd to 5th year	0	Say	0
6th to 8th year	44	⟹	40
9th to 25th year	196		200
25th year over	162		150

Table G. 4 Result of Tree Age Survey (2)

Durian (Gahn-yao)

Tree Age	Farm No.	Trees Planted	Equivalent Rai	Yield (kg/year/tree)
4	㉞	12	1	0
11	①	15	2	150
	㉞	20		120
12	⑤	20	1	180
14	⑥	50	3	185
15	④	75	5	175
	㉔	20		360
17	㉘	50	1	280
19	⑮	30	2	180
20	⑤	10	1	240
21	㉟	50	1	120
	Total	352	17	

The samples of this variety is very small, therefore it is considered that calculation practice is a theoretical one of no use.

Table G. 5 Result of Tree Age Survey (3)

Durian (Mon Thong)

Tree Age	Farm No.	Trees Planted	Equivalent Rai	Yield (kg/year/tree)
1	⑲	400	20	0
2	⑳	100		0
	㉒	380	49	0
	⑭	500		0
3	⑩	150		0
	⑧	200	28	0
	⑨	200		0
4	②	100		0
	⑪	130	19	0
	㉞	152		0
5	⑬	88		60
	⑮	300	24	60
	㉑	100		0
6	③	200		0
	⑲	30	18	15
	㉒	120		14
7	⑫	50	3	50
8	②	85	14	60
	⑯	200		140
9	㉓	120	6	250
10	⑦	125	7	130
	⑪	20		120
11	⑮	150	10	120
	㉞	40		120
12	⑤	23	1	150

13	⑰	300		150
	⑫	50	43	240
	⑱	500		180
14	⑬	12	6	200
	㉚	100		280
15	㉕	100		350
	㉛	250	23	280
	㉜	100		280
16	②	15		160
	⑤	7	15	240
	㉗	150		280
	㉙	120		280
18	㉖	150	14	280
	㉝	120		300
35	④	35	2	175
40	⑥	40	2	60
	Total	6,012		

Area Percentage by Tree Age in the Province

1st year	7%		10%
2nd to 5th year	40%	Say	40%
6th to 8th year	11%	⟹	10%
9th to 25th year	40%		35%
25th year over	2%		5%

Average Yield by Tree Age (kg/tree/year)

1st year	0		0
2nd to 5th year	10	Say	10
6th to 8th year	47	⟹	50
9th to 25th year	220		220
25th year over	118		120

Table G. 6 Result of Tree Age Survey (4)

Durian (Kra-dum & Others)

Tree Age	Farm No.	Trees Planted	Equivalent Rai	Yield (kg/year/tree)
2	⑭	380	19	0
3	⑬	234		0
	⑩	100		0
	⑧	30	55	0
	⑨	100		0
	⑬	130		0
	⑮	500		0
4	⑥	150		0
	⑪	15	11	0
	㉞	13		0
	㉞	47		0
5	⑬	160	8	0
6	⑭	20	1	60
9	㉗	50	3	150
10	①	25		145
	⑦	20	11	180
	⑪	15		80
	㉕	150		150
11	①	30		125
	③	100	9	85
	⑱	50		200
	㉞	3		120
	㉞	3		150
12	⑰	200	10	90
14	⑥	30	2	18
	⑬	6		160
16	⑱	500	25	160

20	④	20	1	90
21	⑮	200	10	170
	Total	3,281		

Area Percentage by Tree Age in the Province

1st year	0%		5%
2nd to 5th year	45%	Say ⟹	45%
6th to 8th yeat	2%		5%
9th to 25th year	53%		45%
25%th year over	0%		0%

Average Yiled by Tree Age (kg/tree/year)

1st year	0		0
2nd to 5th year	0	Say ⟹	0
6th to 8th year	60		60
9th to 25th year	132		130
25th year over	0		n.a

Table G. 7 Result of Tree Age Survey (5)

Mangosteen

Tree Age	Farm No.	Trees Planted	Equivalent Rai	Yield (kg/year/tree)
1	⑲	200	18	0
	㉒	80		0
2	①	250		0
	②	120		0
	⑤	30	36	0
	⑨	100		0
	⑩	80		0
4	②	50		0
	⑤	20		0
	⑪	240	32	0
	㊹	70		0
	㊺	70		0
	㊾	60		0
5	⑧	20	1	0
6	②	20		0
	⑥	65		0
	㊱	80	18	30
	㊽	36		0
	㊶	80		0
8	①	50		0
	⑧	50		40
	㊵	100	24	8
	㊸	180		8
9	⑰	100		30
	㉑	150		40
	㉖	500	63	30
	㉜	80		30
	㉞	80		30
	㊿	100		70

10	③	20		50
	㉘	130		30
	㉟	80	37	30
	㊳	80		30
	㊵	80		30
	㊿	200		20
11	⑨	60		80
	⑪	60		40
	⑬	120		40
	㉛	200		30
	㊴	80		30
	㊶	80	72	30
	㊻	80		70
	㊶	50		50
	㊷	220		30
	㊸	120		30
	㊺	80		20
12	⑫	70		100
	㉓	80	20	30
	㉔	126		30
	㉙	50		40
13	⑭	200		50
	⑮	150		30
	⑱	80		30
	⑲	80		30
	⑳	80		40
	㉒	80	73	20
	㉝	51		30
	㊲	80		30
	㊷	80		30
	㊺	30		100
	㊽	64		80
	㊹	200		30
14	㉕	80	30	30
	㉗	400		30

15	㉚	400	30	30
	㊸	80		40
16	①	100		75
	②	10		80
	③	80		120
	④	85		120
	⑤	60	60	80
	⑯	200		30
	㊹	30		100
	㊼	200		100
	㊾	80		100
	㊽	120		40
20	⑧	30	8	80
	㊻	90		120
22	⑫	150	14	200
	㊼	80		60
25	⑥	15	1	80
26	⑥	40	8	80
	⑦	80		120
29	⑥	30	2	80
	Total	8,742 trees	547 rai	

Area Percentage by Tree Age in the Province

1st year	3%		5%
2nd to 6th year	16%	Say ⟹	15%
7th to 15th year	59%		60%
16th to 30th year	22%		20%
30th year over	0%		0%

Average Yield by Tree Age (kg/tree/year)

1st year	0		0
2nd to 6th year	0		0
7th to 15th year	37	Say ⟹	40
16th to 30th year	87		90
30th year over	n.a.		n.a.

Table G. 8 GENERAL ECONOMIC CONDITIONS OF CHANTHABURI PROVINCE

GPP, GRP and GDP at Current Market Price

(Unit : Million Bahts)

Provision Branches	Chanthaburi Province (GPP)			Eastern Region (GRP)			Whole Kingdom (GDP)		
	1984	1985	1986	1984	1985	1986	1984	1985	1986
1. Agriculture	2,429.8	2,307.2	2,349.6	19,112.9	18,088.8	19,179.1	191,230.5	178,535.0	183,057.6
- Crops	2,004.8	1,907.1	1,964.0	14,591.9	13,120.1	14,008.0	139,548.9	127,051.2	124,906.3
- Livestocks	135.9	110.2	132.0	2,145.0	2,248.6	2,103.6	26,328.2	24,572.4	26,668.9
- Fisheries	202.3	186.7	227.1	2,019.4	2,353.4	2,847.7	13,129.7	14,807.4	17,564.4
- Forestry	86.8	40.2	26.5	356.6	355.7	219.8	12,273.5	12,304.0	13,898.0
2. Industries	554.2	499.8	515.3	25,039.4	31,680.0	41,204.1	270,524.0	292,626.5	305,600.8
- Mining and Quarrying	28.1	28.0	27.8	4,731.1	8,734.8	8,084.9	21,292.4	29,239.5	23,346.7
- Manufacturing	198.2	198.5	205.9	17,806.9	20,412.5	30,412.5	196,259.8	209,013.2	226,571.6
- Construction	327.9	273.2	281.6	2,501.4	2,706.9	2,706.9	52,771.8	54,373.8	55,682.5
3. Public Utilities	564.6	484.8	536.7	6,411.8	8,338.6	8,669.1	102,472.3	119,230.2	130,009.9
- Elect. and Water Supply	102.0	127.5	152.3	1,338.1	1,712.8	2,017.8	18,383.9	24,070.1	29,182.2
- Trans. and Comm.	262.6	357.3	384.4	5,073.7	6,626.6	6,651.3	83,588.4	95,160.1	101,827.7
4. Commerce	1,526.2	2,019.3	2,167.7	16,113.6	17,056.3	18,293.4	274,906.8	288,266.3	306,252.6
- Trade	1,290.9	1,381.0	1,434.8	11,922.8	12,407.5	13,323.8	181,992.9	189,736.5	204,094.7
- Banking	435.0	527.1	560.2	3,758.0	3,758.0	3,985.5	80,577.0	84,921.8	87,249.3
- Ownership of Dwelling	100.3	111.2	122.7	319.5	890.3	984.1	12,336.9	13,608.0	14,908.6
5. Public Admin. and Defence	274.6	318.0	333.4	2,248.9	2,475.5	3,025.3	43,181.6	47,133.3	49,138.9
6. Serveces	600.1	612.4	656.3	7,764.8	8,404.1	8,943.0	115,561.1	115,561.1	124,326.2
Total : Gross Product	6,049.5	6,241.5	6,559.0	76,691.4	86,032.3	99,314.0	1,041,354.9	1,041,354.9	1,098,366.0
Per capita GP (Bahts)	16,574	16,778	17,036	24,627	27,131	30,483	20,148	20,148	20,860

Source : NESDB, 1986

Table G. 9 GENERAL ECONOMIC CONDITIONS 1986, OF MAIN EASTERN COASTAL PROVINCES

GRP and GDP at Current Market Price

(Unit: Million Bahts)

Provision Branches	Eastern Region (GRP)	Chon Buri Province (GDP)	Rayon Province (GDP)	Chanthaburi Province (GDP)	Trat Province (GDP)	Total of Four Provinces (GDP)
1.Agriculture	19,179.1	4,768.7	4,531.2	2,349.6	952.8	12,602.3
- Crops	14,008.0	3,298.9	3,151.6	1,964.0	672.1	9,086.6
- Livestocks	2,103.6	665.6	139.8	132.0	55.6	993.0
- Fisheries	2,847.7	802.7	1,118.7	227.1	162.2	2,310.7
- Forestry	219.8	1.5	121.1	26.5	52.9	212.0
2.Industries						
- Mining and Quarrying	8,084.9	1,181.9	1,908.6	27.8	7.7	3,126.0
- Manufacturing	30,412.3	28,138.5	355.7	205.9	108.5	28,808.6
- Construction	2,706.9	1,212.0	381.9	281.6	126.7	2,002.2
3.Public Utilities						
- Elect. and Water Supply	2,017.8	758.8	335.2	152.3	59.9	1,306.2
- Trans. and Comm.	6,651.3	1,761.3	872.2	384.4	860.2	3,878.1
4.Commerce						
- Trade	13,323.8	4,175.7	1,471.6	1,484.8	1,049.9	8,182.0
- Banking	3,985.5	1,638.7	525.8	560.2	131.8	2,856.5
- Ownership of Dwelling	984.1	241.5	121.1	122.7	56.8	542.1
5.Public Admin. and Defence	3,025.3	1,143.6	265.0	333.4	151.2	1,893.2
6.Services	8,943.0	5,504.6	512.8	656.3	381.1	7,054.8
Total : Gross Product	99,314.0	50,525.3	11,281.1	6,559.0	3,886.6	72,252.0
Per capita GP (Bahts)	30,483	63,474	27,381	17,036	23,273	

Source: NESDB, 1986

Table G. 10 EXPORTS OF FRESH FRUITS

Unit: Ton, Million Baht

Fruits	1983		1984		1985		1986	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Longan	7,320	207.2	8,802	250.5	4,942	163.0	10,612	312.5
Papaya	16,393	82.5	12,590	68.4	5,815	36.3	4,177	24.4
Durian	2,819	64.4	3,470	67.7	9,784	172.0	6,964	173.5
Orange	4,559	32.5	4,213	31.4	6,175	41.0	5,100	36.0
Mango	2,538	20.9	3,175	31.3	8,311	57.3	9,400	54.3
Banana	9,655	25.1	4,403	23.0	3,937	22.0	2,165	11.5
Pomelo	2,657	27.3	2,779	21.2	4,505	40.3	5,202	45.4
Litchi	-	-	559	20.9	184	6.7	428	12.0
Sugar Apple	845	5.6	1,211	12.0	1,706	13.4	2,021	11.5
Grape	1,343	20.5	918	11.6	1,473	18.2	224	4.0
Mangosteen and Guava	412	2.9	1,366	8.9	1,126	10.0	1,817	15.6
Lemon	188	2.2	430	4.4	452	4.2	86	0.8
Rambutan	273	3.6	341	4.0	1,169	11.4	1,865	14.0
Water melon	958	3.1	853	3.9	954	3.8	1,143	4.4
Pineapple	249	2.6	45	0.6	6,065	75.5	18,653	197.5
Strawberry etc.	49	1.0	12	0.3	10	0.5	8	0.3
Others	728	22.8	506	7.0	622	8.5	1,158	16.1
Total	50,986	524.2	45,673	567.1	52,280	684.1	71,023	933.8
%		100.0		108.2		130.5		178.1

Source: Department of Agricultural Extension
Fruit Section Horticulture Branch
Plant Promotion Division

Table G. 11 EXPORTS OF PROCESSED FRUITS

Unit: Ton, Million Bahts

	1983		1984		1985		1986	
	*1Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
C. Fruits Pickles*1	34	0.8	74	0.9	78	1.2	65	1.4
B. Fruits Pickles*2	1,330	24.9	1,002	19.2	1,832	31.5	2,611	47.1
Syruped and Candied Fruits	3,725	131.5	4,518	164.5	8,472	360.1	12,363	444.1
Candied Peel	few	few	few	few	few	few	12	0.8
Puree	54	1.4	29	0.9	92	3.6	29	0.8
Jam and marmalade	366	12.3	150	6.6	257	8.0	322	20.9
C. Pineapple	135,795	1,871.3	186,276	2,846.2	192,764	3,291.0	225,986	3,183.1
C. Rambutan	985	28.8	1,178	26.9	768	21.6	1,268	34.2
C. Litchi	few	few	6	0.2	3	0.2	38	1.0
C. Longan	1,712	59.4	1,225	42.2	1,062	38.3	2,944	96.3
C. Rambutan and Pineapple	1,276	35.0	748	21.0	963	28.8	1,410	40.5
C. Mango	233	5.3	334	7.1	368	8.6	949	21.6
C. Papaya	133	2.5	282	5.8	114	2.4	269	5.0
C. Guava	-	-	9	0.1	16	0.4	11	0.3
C. Other	1,524	45.9	1,946	49.6	3,346	88.6	6,332	159.9
B. Other	-	-	-	-	2	0.1	5	0.2
C. Orange J.*3	45	0.6	69	1.3	39	0.6	34	0.6
C. Pineapple J.	5,600	95.9	6,778	122.1	17,451	310.0	23,392	361.1
C. Mango J.	8	0.1	7	0.1	6	0.2	6	0.1
C. Other J.	81	1.5	166	5.4	660	23.6	893	29.8
Freezing Pineapple	12,111	134.8	15,065	179.4	10,658	158.7	18,653	197.5
Total	165,098	2,453.6	219,904	3,501.0	239,096	4,378.5	297,603	4,646.8
%		100.0		142.7		178.5		189.4

*1 C.: Canned *2 B.: Bottled *3 J.: Juice

Source: Commercial Statistical Center

Table G. 12 EXPORTS OF FRUITS BY COUNTRY

Unit: Ton, Million Bahts

Country	1985		1986		1986/1985
	Quantity	Value	Quantity	Value	Value
					%
U.S.A.	120,733	2,235.4	137,583	2,204.2	101.59
German	270,35	452.8	43,781	568.8	125.62
Canada	18,319	316.2	16,985	265.8	84.06
Japan	12,333	225.8	24,442	335.7	148.67
U.K.	4,234	91.5	8,653	147.2	160.87
Hong Kong	5,107	66.7	3,761	58.1	112.89
France	5,577	117.7	7,822	139.2	118.27
Other	45,758	872.4	54,576	927.8	106.38
Total	239,096	4,378.5	257,603	4,646.3	106.12

Source: Commercial Statistical Center

Table G. 13 Price Fluctuation of Durian and Rambutan at Chanthaburi Local Market during April to July 1985

Unit: Bahts/Rai

Week	Durian								Rambutan							
	Monthong				Chanee				Rongrian				Sichomphu			
	OPNG	HIGH	Low	CLG	OPNG	HIGH	Low	CLG	OPNG	HIGH	Low	CLG	OPNG	HIGH	Low	CLG
22-4/27	25	25	20	20	9½	11	8	9	10	9	8	9	6½	6	5½	6
29-5/4	25	27	22¼	26	12	14	9½	13½	8¼	10	8¾	10	6	9	5	7½
6-5/11	24	25	22	22½	11½	13	11	12½	9½	10	7½	7¾	6	6½	4½	4¾
13-5/18	24½	25	24	24½	13½	15	13	13½	8¼	10	8	9½	4¼	6¼	4	5½
20-5/25	25	28	25	27½	15½	16	15	15½	9½	11	9	9½	4¼	5	4	4¾
27-6/ 1	29	32	27	31	12½	15	12	14½	7¼	8½	7	8½	3¾	4	2½	3¼
3-6/ 8	31	32	28	28	13½	15	13	13½	8¼	10	8	8	3¾	4	3	4
10-6/15	25	30	25	28	12	13	10	9½	7	8	6½	6¾	3½	4	3	3¼
17-6/22	26½	25	25	25	9½	12	9	11	7½	8	6	7½	2¼	3½	2	3¼
24-6/29	25	25	25	25	9½	12	9	11	7¼	8	7	7¼	3¼	3½	2¾	3¼
1-7/ 6	5	32	25	31	18	18	13	13½	7¾	9	7½	7¾	3¼	5	2¾	3¾
8-7/13	27	30	27	30	13½	16	15	15	8	10	8	10	3	5	3	4¼
15-7/20	25	30	25	29	20	20	15	18	11½	12	10	10	5½	6	5	5
22-7/27	31½	35	30	35	20	20	17	17					5	6	5	6

OPNG .....Opening
HIGH .....Highest
Low .....Lowest
CLG .....Closing

FIGURE G.1 PRICE STRUCTURE OF PARA RUBBER

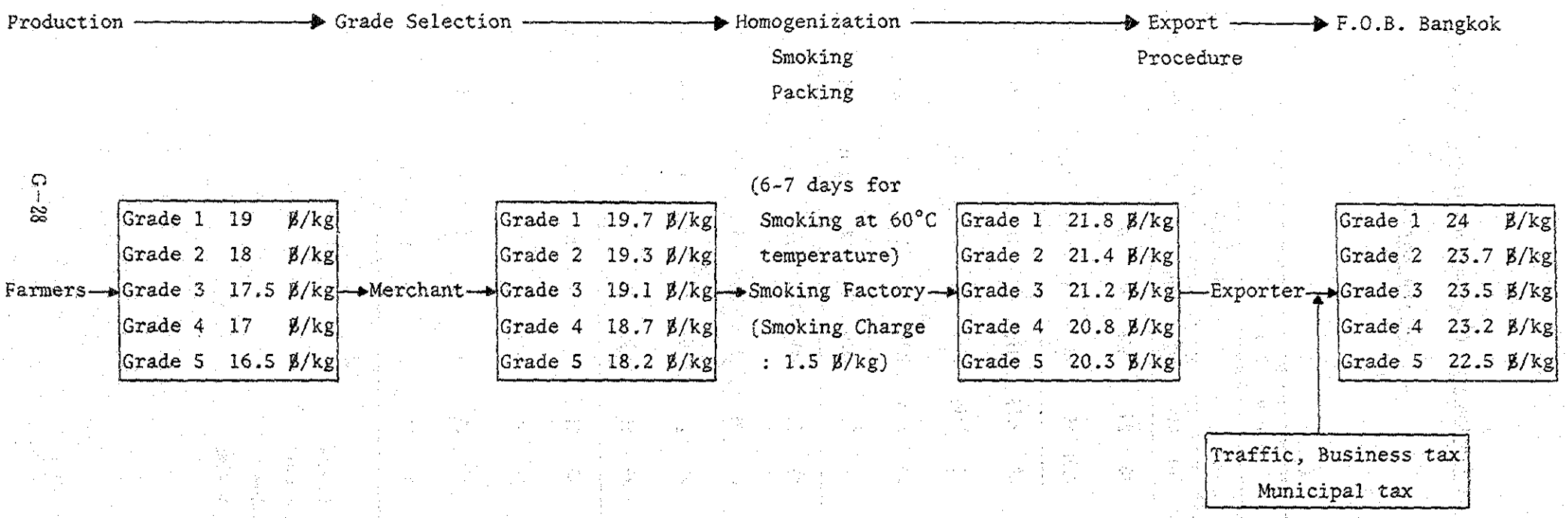
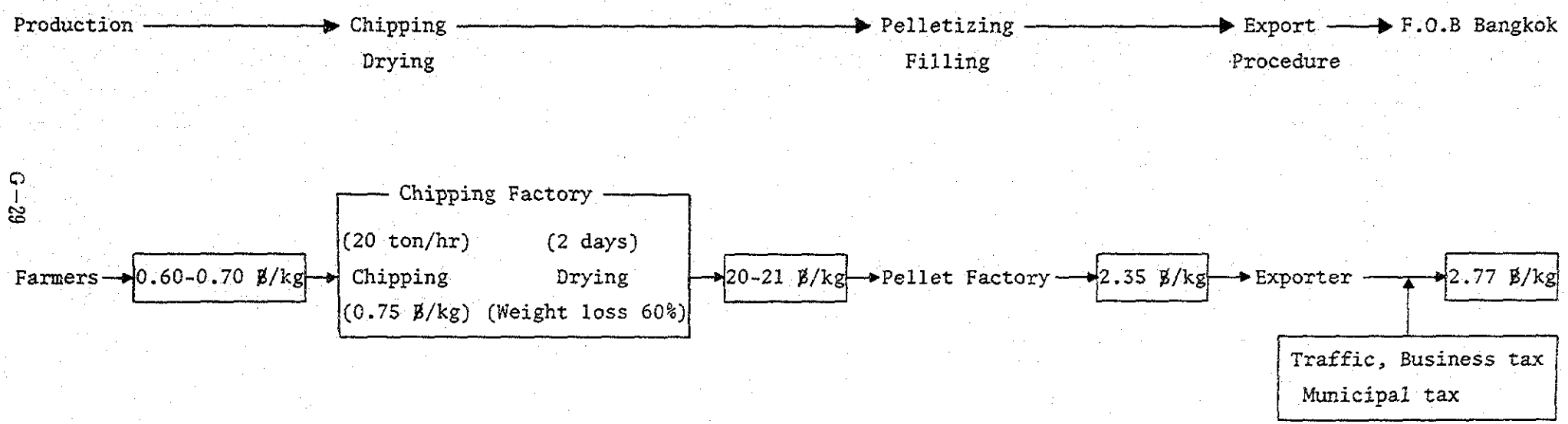


FIGURE G.2 PRICE STRUCTURE OF CASSAVA



APPENDIX-H. PRELIMINARY DESIGN OF FACILITIES

APPENDIX-H PRELIMINARY DESIGN OF FACILITIES

LIST OF CONTENTS

H.1.1 DIMENSION AND SPECIFICATIONS OF PROPOSED DAMSITES (Cont'd)

NO. OF DAM / DIMENSION AND SPECIFICATIONS	UNIT	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 8	NO. 9 MAIN DAM	NO. 9 SUDDLE DAM
1. LOCATION :MAP NO.		5435 III	5435 III	5435 III	5434 IV	5434 IV	5434 IV	5434 IV	5434 IV	5434 I	5434 I
:COORDINATES		87-46	79-38.5	87-40	87.5-36	78-31	87-26	91.5-17	99-17.5	2.5-15.5	3.5-13
2. DRAINAGE AREA	SQ.KM	34.6	20.9	17.9	70.2	44.5	18.3	14.6	103.4	65.8	-
3. BASIN RAINFALL:ANNUAL AVE.	mm	1711	2059	1711	1711	2321	1711	1683	1711	1684	-
:10-YEAR DROUGHT	mm	1362	1637	1362	1362	1723	1362	1340	1362	1343	-
: 5-YEAR DROUGHT	mm	1466	1763	1466	1466	1896	1466	1443	1466	1446	-
4. RUNOFF :ANNUAL AVE.	MCM	37.68	27.26	19.39	76.79	65.67	19.83	15.55	113.36	70.87	-
:10-YEAR DROUGHT	MCM	29.74	21.80	15.29	56.49	49.03	15.63	12.41	70.09	56.73	-
: 5-YEAR DROUGHT	MCM	32.40	23.43	16.66	63.39	53.88	17.03	13.36	84.82	61.05	-
5. RUNOFF COEFFICIENT	%	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	-
6. TOPOGRAPHY :RIVER BED ELEVATION	m	150	60	280	140	30	90	27.5	20	15	35
:LEFT BANK ABUTMENT SLOPE	DEG	5	3	26.5	18	7	18.5	22	11.5	11.5	11.5
:RIVER BED WIDTH	M	10	2	15	50	10	10	5	20	20	3
:RIGHT BANK ABUTMENT SLOPE	DEG	8	5	26.5	14	7	18.5	14	11.5	14	8
:SPAN-HEIGHT RATIO	-	24	30	4	7	59	8	20	50	17	100
7. GEOLOGY		Granite	Granite	Granite	Granite	Granite	Granite	Greyweck	Granite	Greywack	Greywack
8. RESERVOIR :SEDIMENTATION	MCM	0.56	0.33	0.29	1.2	0.75	0.29	0.23	1.65	1.05	-
:LIVE STORAGE CAPACITY	MCM	29.74	7.57	15.29	34.65	12.89	10.00	8.07	0.45	28.95	-
:TOTAL STORAGE CAPACITY	MCM	30.30	7.90	15.58	35.85	13.60	10.29	8.30	2.10	30.00	-
:WATER SURFACE AREA IN FWL	Ha	170	133	98	163	264	45	133	83	335	-
:LOW WATER LEVEL	m	LWL159.0	LWL 52.0	LWL293.5	LWL161.5	LWL 35.2	LWL 95.0	LWL 28.0	LWL 29.4	LWL 19.5	-
:FULL WATER LEVEL	m	FWL195.5	FWL 60.0	FWL327.0	FWL213.5	FWL 42.7	FWL140.0	FWL 40.0	FWL 30.0	FWL 40.0	-
:HIGH WATER LEVEL	m	HWL197.5	HWL 61.5	HWL328.5	HWL215.0	HWL 43.7	HWL141.5	HWL 41.5	HWL 32.0	HWL 42.0	-
9. LIVE STORAGE CAPACITY / DAM VOLUME	-	4.5	11.8	9.6	7.4	22.6	3.1	11.2	2.5	46.7	-
10. DAMBODY :DAM HEIGHT	m	54.5	18.5	55.5	37.5	16.2	58.5	20.5	19.0	32.0	14.0
:DAM CREST ELEVATION	m	EL 199.5	EL 63.5	EL 330.5	EL 217.5	EL 46.2	EL 143.5	EL 43.5	EL 34.0	EL 44.0	EL 44.0
:EL. OF MIN. CORE TRENCH	m	EL 145.0	EL 45.0	EL 275.0	EL 130.0	EL 25.0	EL 85.0	EL 23.0	EL 15.0	EL 12.0	EL 30.0
:CREST LENGTH	m	1450	990	320	618	955	550	630	290	390	570
:DAM VOLUME ×1000	CU.M	6600	640	1590	4701	570	3200	720	180	620	290
:UPSTREAM DAM SLOPE	-	3.0	3.0	3.0	2.5	3.0	3.0	3.0	3.0	3.0	3.0
:DOWNSTREAM DAM SLOPE	-	2.5	2.5	2.5	2.0	2.5	2.5	2.5	2.5	2.5	2.5
11. SPILLWAY :FLOOD DISCHARGE	CU.M/S	220	140	120	315	125	120	100	550	390	-
:OVERFLOW DEPTH	m	2.0	1.5	1.5	1.5	1.0	1.5	1.5	2.0	2.0	-

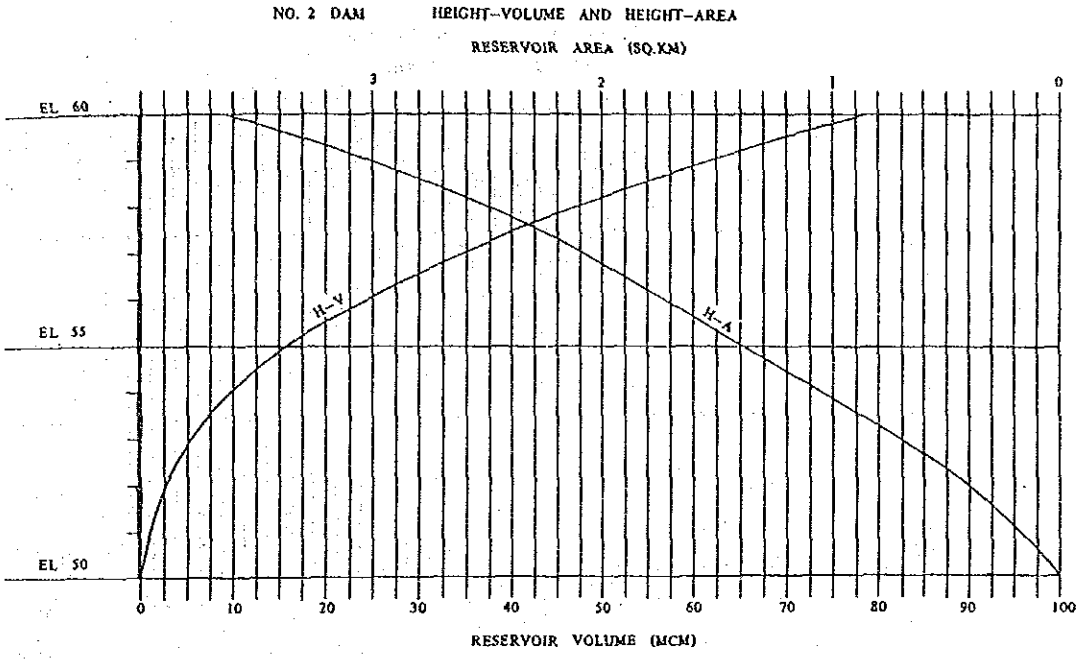
NOTES: (1) Reservoir size determined on the basis of 10-Year drought runoff.
(2) Specific sediment (qs) applied qs=160 cu.m/sq.km/year by data analysis, and the period for total sediment estimation is taken at 100 years.

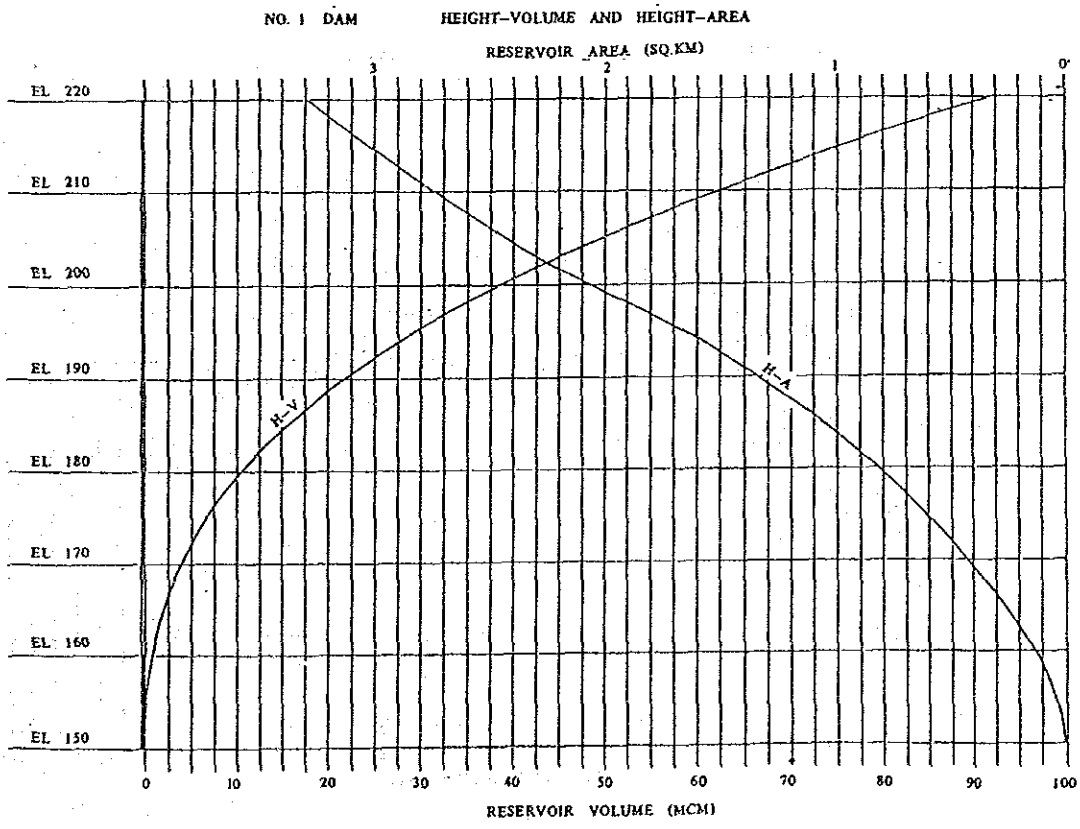
H.1.1 DIMENSION AND SPECIFICATIONS OF PROPOSED DAMSITES

DIMENSION AND SPECIFICATIONS	UNIT	NO. 10	NO. 11	NO. 12	NO. 13	NO. 14	NO. 15	NO. 16	NO. 17	NO. 18	NO. 19
1. LOCATION :MAP NO.		5434 IV	5434 IV	5434 III	5434 III	5434 III	5434 III	5434 III	5434 III	5434 III	5434 III
:COORDINATES		82.5-14	85-12	88-08	86-6.5	80.5-05	86-03	83-99	95-97	93-91	94-85.5
2. DRAINAGE AREA	SQ. KM	28.1	4.8	4.2	28.7	5.2	7.5	9.0	4.0	7.3	8.1
3. BASIN RAINFALL:ANNUAL AVE.	mm	2318	1571	1571	2430	2519	2834	2834	1571	3151	3151
:10-YEAR DROUGHT	mm	1650	868	868	1818	1688	2245	2245	868	2470	2470
: 5-YEAR DROUGHT	mm	1873	981	981	1994	1914	2408	2408	981	2668	2668
4. RUNOFF :ANNUAL AVE.	MCM	41.29	4.70	4.10	44.18	8.14	13.28	15.97	3.91	14.36	15.95
:10-YEAR DROUGHT	MCM	29.46	2.60	2.27	33.23	5.49	10.57	12.71	2.16	11.30	12.55
: 5-YEAR DROUGHT	MCM	33.41	2.94	2.57	36.38	6.22	11.32	13.61	2.46	12.19	13.54
5. RUNOFF COEFFICIENT	%	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0	65.0
6. TOPOGRAPHY :RIVER BED ELEVATION	m	20	20	15	15	35	15	5	20	40	20
:LEFT BANK ABUTMENT SLOPE	DEG	2	7	7	7	6	3	4	22	22	22
:RIVER BED WIDTH	M	5	3	3	3	2	3	3	3	3	20
:RIGHT BANK ABUTMENT SLOPE	DEG	2	6	7	7	6	3	4	22	14	22
:SPAN-HEIGHT RATIO	-	80	70	30	30	36	30	80	8	7.5	4
7. GEOLOGY		Granite	Granite	Greyweck	Granite	Granite	Granite	Shale	Granite	Granite	Granite
8. RESERVOIR :SEDIMENTATION	MCM	0.45	0.08	0.07	0.46	0.08	0.12	0.15	0.06	0.12	0.13
:LIVE STORAGE CAPACITY	MCM	7.85	2.52	2.25	2.73	4.12	1.90	2.88	2.10	7.88	2.12
:TOTAL STORAGE CAPACITY	MCM	8.30	2.60	2.32	3.19	4.20	2.02	3.03	2.16	8.00	2.25
:WATER SURFACE AREA IN FWL	Ha	340	97	58	78	88	50	150	30	30	15
:LOW WATER LEVEL	m	LWL 24.4	LWL 20.5	LWL -	LWL -	LWL 37.0	LWL -	LWL -	LWL 22.0	LWL 44.0	LWL -
:FULL WATER LEVEL	m	FWL 30.0	FWL 25.4	FWL 20.0	FWL 20.0	FWL 50.0	FWL 20.0	FWL 10.0	FWL 34.4	FWL100.0	FWL 40.0
:HIGH WATER LEVEL	m	HWL 31.5	HWL 26.4	HWL 21.0	HWL 21.0	HWL 51.0	HWL 21.0	HWL 11.0	HWL 35.4	HWL101.0	HWL 41.0
9. LIVE STORAGE CAPACITY / DAM VOLUME	-	11.7	18.7	11.2	11.8	7.0	31.7	26.2	5.7	1.6	10.6
10. DAMBODY :DAM HEIGHT	m	18.5	13.4	13.0	13.0	23.0	8.0	8.0	22.4	65.0	26.0
:DAM CREST ELEVATION	m	EL. 33.5	EL. 28.4	EL. 23.0	EL. 23.0	EL. 53.0	EL. 23.0	EL. 13.0	EL. 37.4	EL.103.0	EL. 43.0
:EL. OF MIN. CORE TRENCH	m	EL. 15.0	EL. 15.0	EL. 10.0	EL. 10.0	EL. 30.0	EL. 15.0	EL. 5.0	EL. 15.0	EL. 38.0	EL. 17.0
:CREST LENGTH	m	1360	390	510	560	660	470	640	310	670	180
:DAM VOLUME ×1000	CU.M	670	135	200	230	590	60	110	370	4840	200
:UPSTREAM DAM SLOPE	-	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
:DOWNSTREAM DAM SLOPE	-	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
11. SPILLWAY :FLOOD DISCHARGE	CU.M/S	180	40	30	180	40	60	70	30	60	60
:OVERFLOW DEPTH	m	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

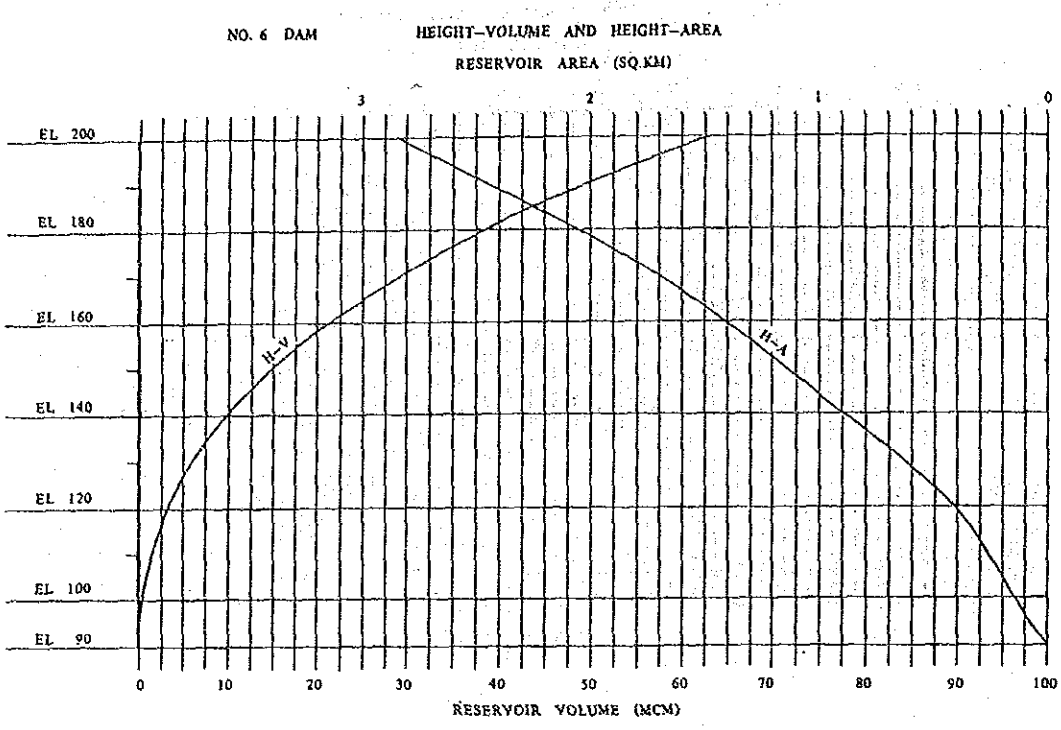
NOTES: (1) Reservoir size determined on the basis of 10-Year drought runoff.
(2) Specific sediment (qs) applied qs=160 cu.m/sq.km/year by data analysi and the period for total sediment estimation is taken at 100 years.

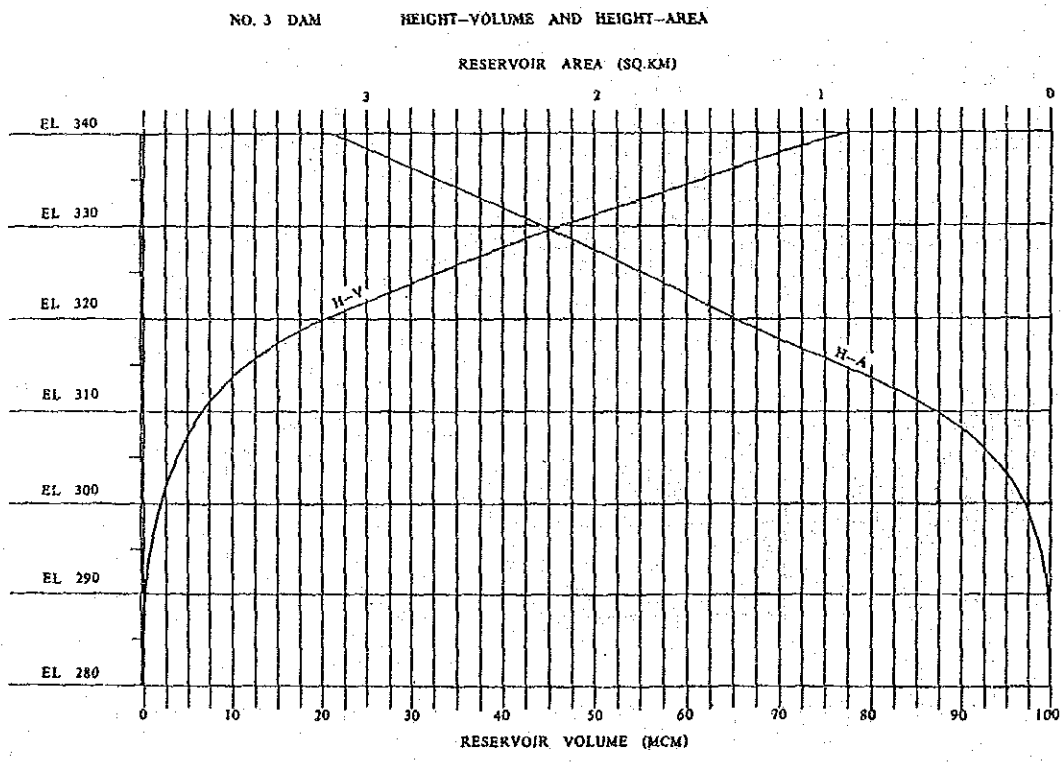
H.1.2 Height-Volume and Height-Area



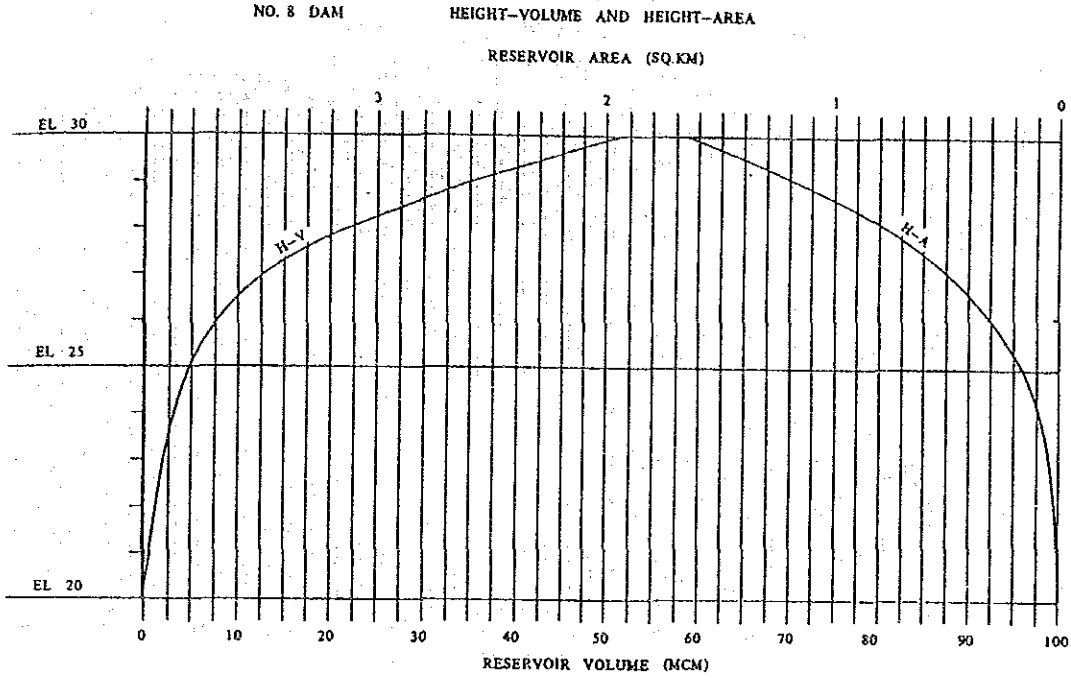


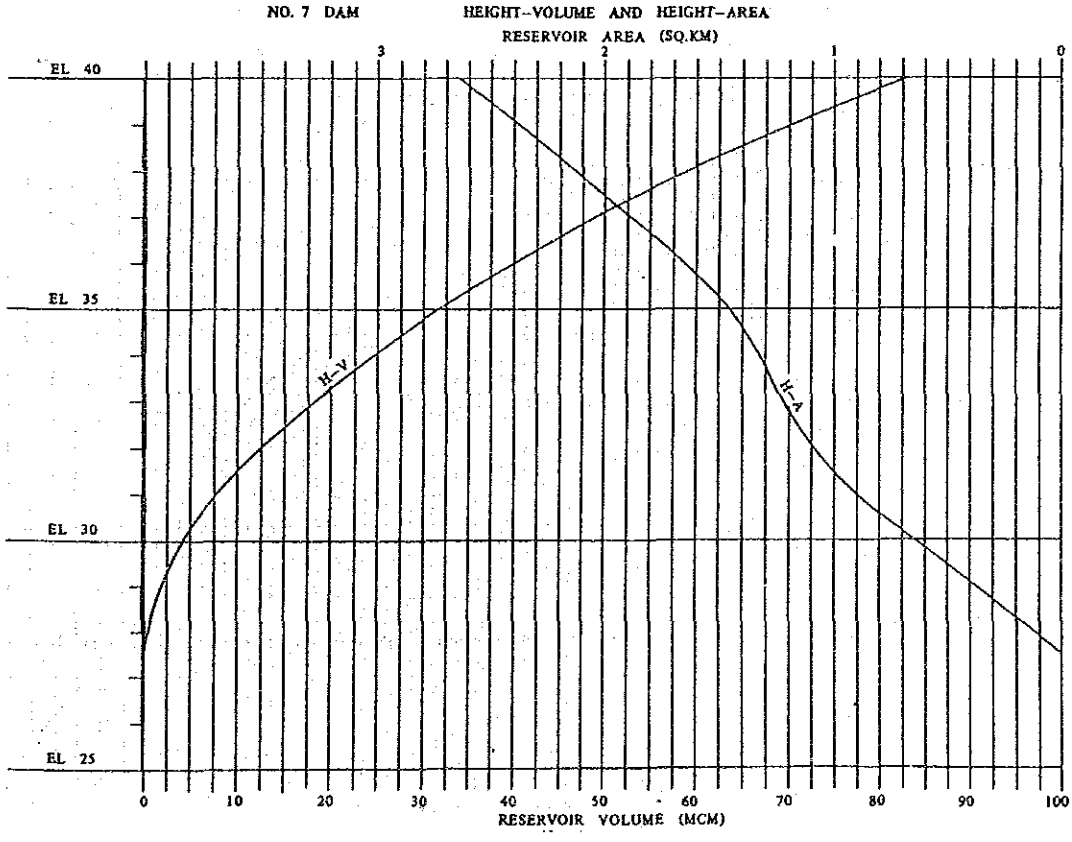
H.1.2 Height-Volume and Height-Area



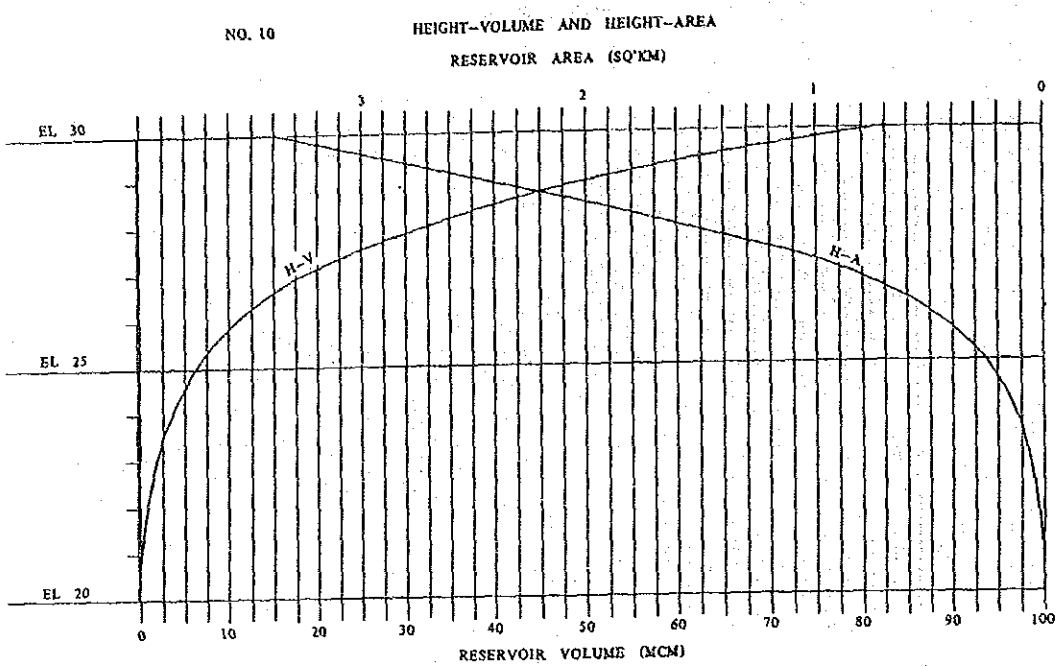


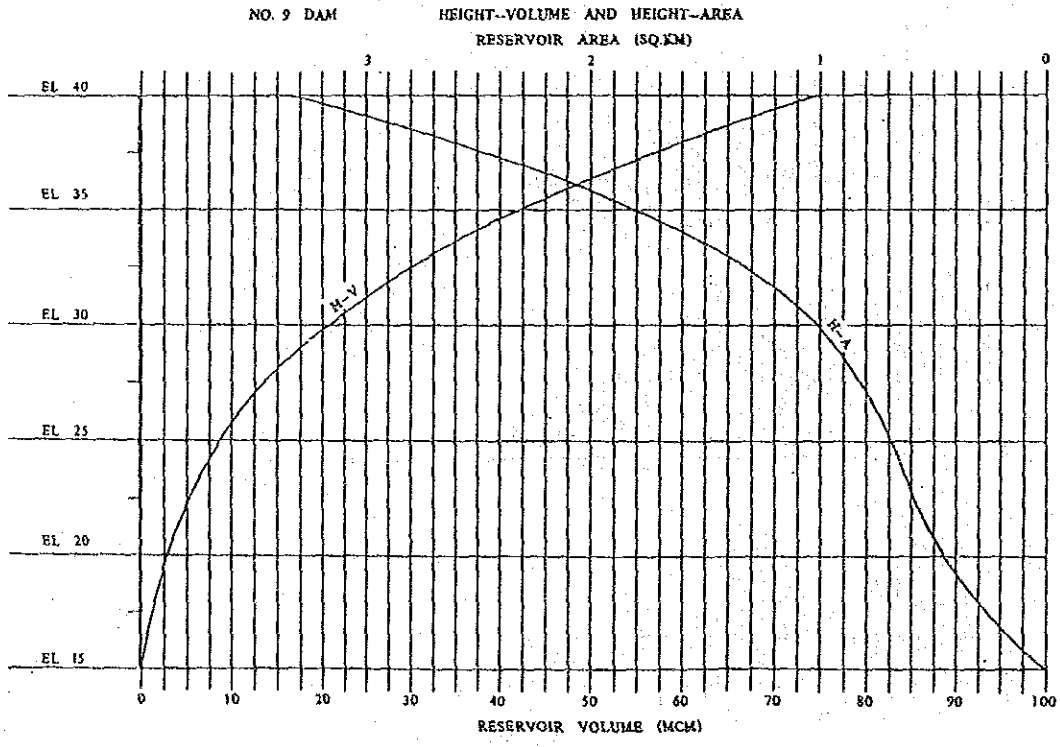
H.1.2 Height-Volume and Height-Area



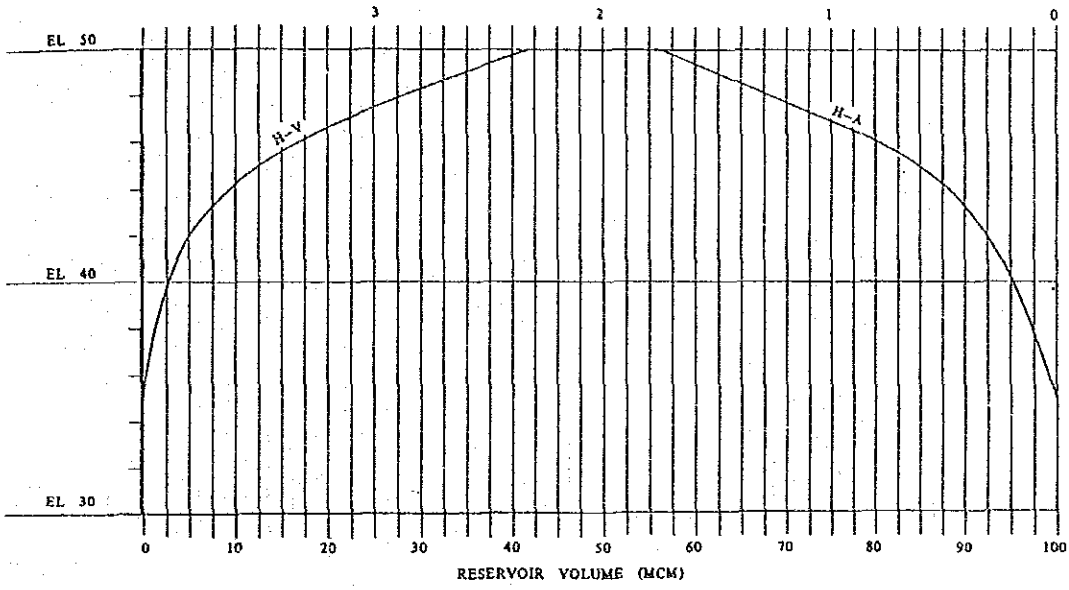


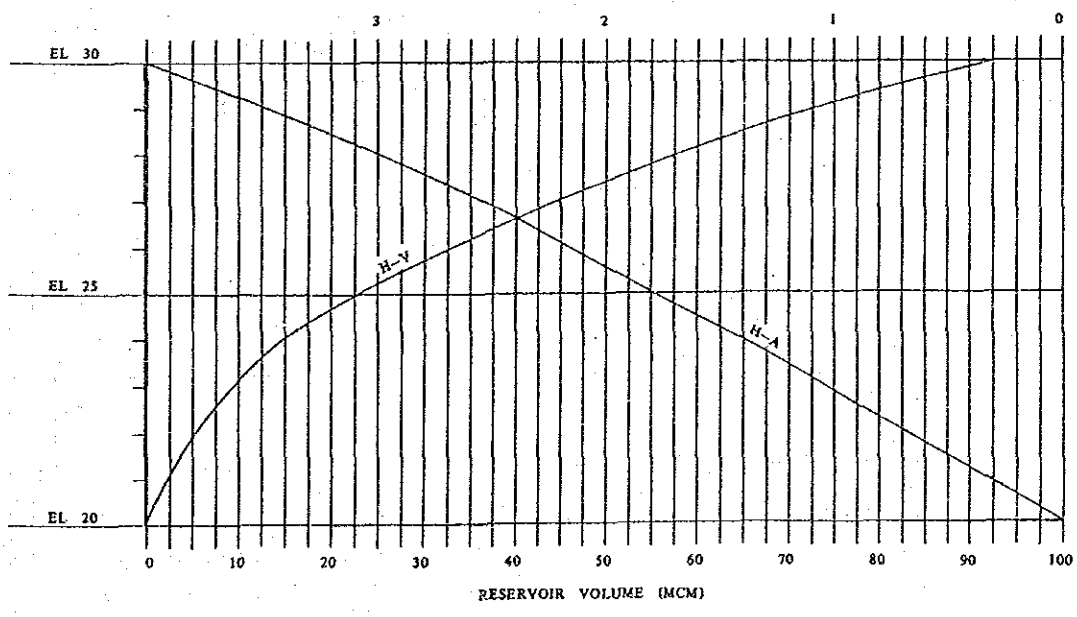
H.1.2 Height-Volume and Height-Area



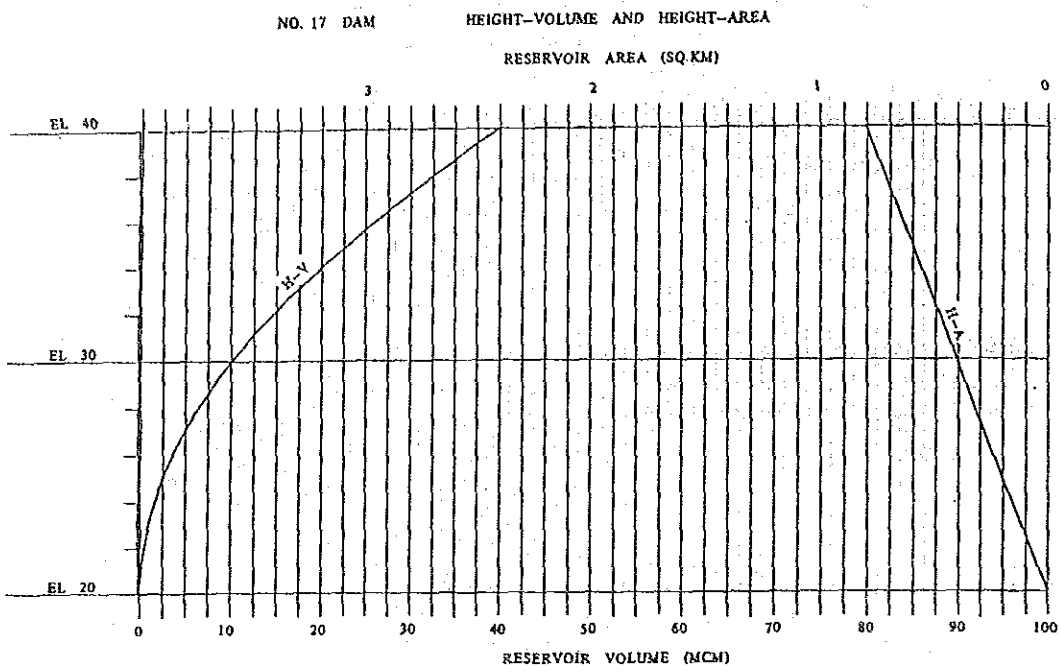


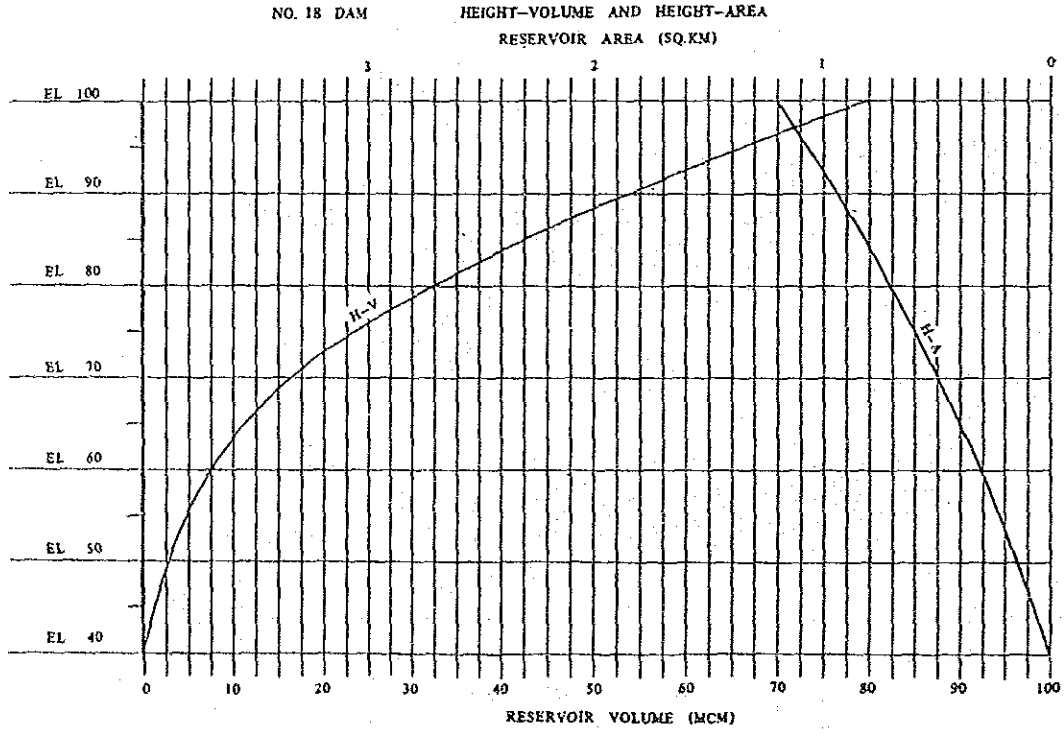
H.1.2 Height-Volume and Height-Area





H.1.2 Height-Volume and Height-Area





H.1.3 HEIGHT-VOLUME AND HEIGHT-AREA

(CALCULATION SHEET)

NO. 1 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
150	—	0	—	—	—
160	10	125,000	62,500	625,000	625,000
180	20	850,000	487,500	9,750,000	10,375,000
200	20	2,050,000	1,450,000	29,000,000	39,375,000
220	20	3,300,000	2,675,000	53,500,000	92,875,000

NO. 2 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
50	—	25,000	—	—	—
52.5	2.5	275,000	150,000	375,000	375,000
55	2.5	700,000	487,500	1,218,750	1,593,750
60	5.0	1,825,000	1,262,500	6,312,500	7,906,250

NO. 3 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
280	—	25,000	—	—	—
300	20	50,000	37,500	750,000	375,000
320	20	700,000	375,000	7,500,000	8,250,000
340	20	1,575,000	1,137,500	22,750,000	31,000,000

H.1.3 HEIGHT-VOLUME AND HEIGHT-AREA

(CALCULATION SHEET)

NO. 6 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
90	—	0	—	—	—
100	10	75,000	37,500	375,000	375,000
120	20	200,000	137,500	2,750,000	3,125,000
140	20	450,000	325,000	6,500,000	9,625,000
160	20	700,000	575,000	11,500,000	21,125,000
180	20	1,025,000	862,500	17,250,000	38,375,000
200	20	1,425,000	1,225,000	24,500,000	62,875,000

NO. 7 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
27.5	—	0	—	—	—
30.0	2.5	325,000	162,500	406,250	406,250
32.5	2.5	575,000	450,000	1,125,000	1,531,250
35.0	2.5	725,000	650,000	1,625,000	3,156,250
40.0	5.0	1,325,000	1,025,000	5,125,000	8,281,250

NO. 8 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
20	—	0	—	—	—
25	2.5	75,000	37,500	187,500	187,500
27.5	2.5	300,000	187,500	468,750	656,250
30	2.5	825,000	562,500	1,406,250	2,062,500

H.1.3 HEIGHT-VOLUME AND HEIGHT-AREA

(CALCULATION SHEET)

NO. 9 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
15	—	0	—	—	—
20	5	450,000	225,000	1,125,000	1,125,000
30	10	1,000,000	725,000	7,250,000	8,375,000
40	10	3,350,000	2,175,000	21,750,000	30,125,000

NO. 10 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
20	—	0	—	—	—
25	5	250,000	125,000	625,000	625,000
27.5	2.5	1,250,000	750,000	1,875,000	2,500,000
30	2.5	3,400,000	2,325,000	5,812,500	8,312,500

NO. 11 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
20	—	0	—	—	—
25	5	900,000	450,000	2,250,000	2,250,000
27.5	2.5	1,375,000	1,137,500	2,843,750	5,093,750
30	2.5	2,000,000	1,687,500	4,218,750	9,312,500

H.1.3 HEIGHT-VOLUME AND HEIGHT-AREA

(CALCULATION SHEET)

NO. 12 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
20	4.0	575,000			2,300,000

NO. 13 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
20	4.0	775,000			3,100,000

NO. 14 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
35	—	0	—	—	—
40	5	100,000	50,000	250,000	250,000
45	5	300,000	200,000	1,000,000	1,250,000
50	5	875,000	587,500	2,937,500	4,187,500

NO. 15 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
20	4.0	500,000			2,000,000

NO. 16 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
10	2.0	1,500,000			3,000,000

H.1.3 HEIGHT-VOLUME AND HEIGHT-AREA

(CALCULATION SHEET)

NO. 17 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
20	—	0	—	—	—
25	5	100,000	50,000	250,000	250,000
30	5	200,000	150,000	750,000	1,000,000
40	10	400,000	300,000	3,000,000	4,000,000

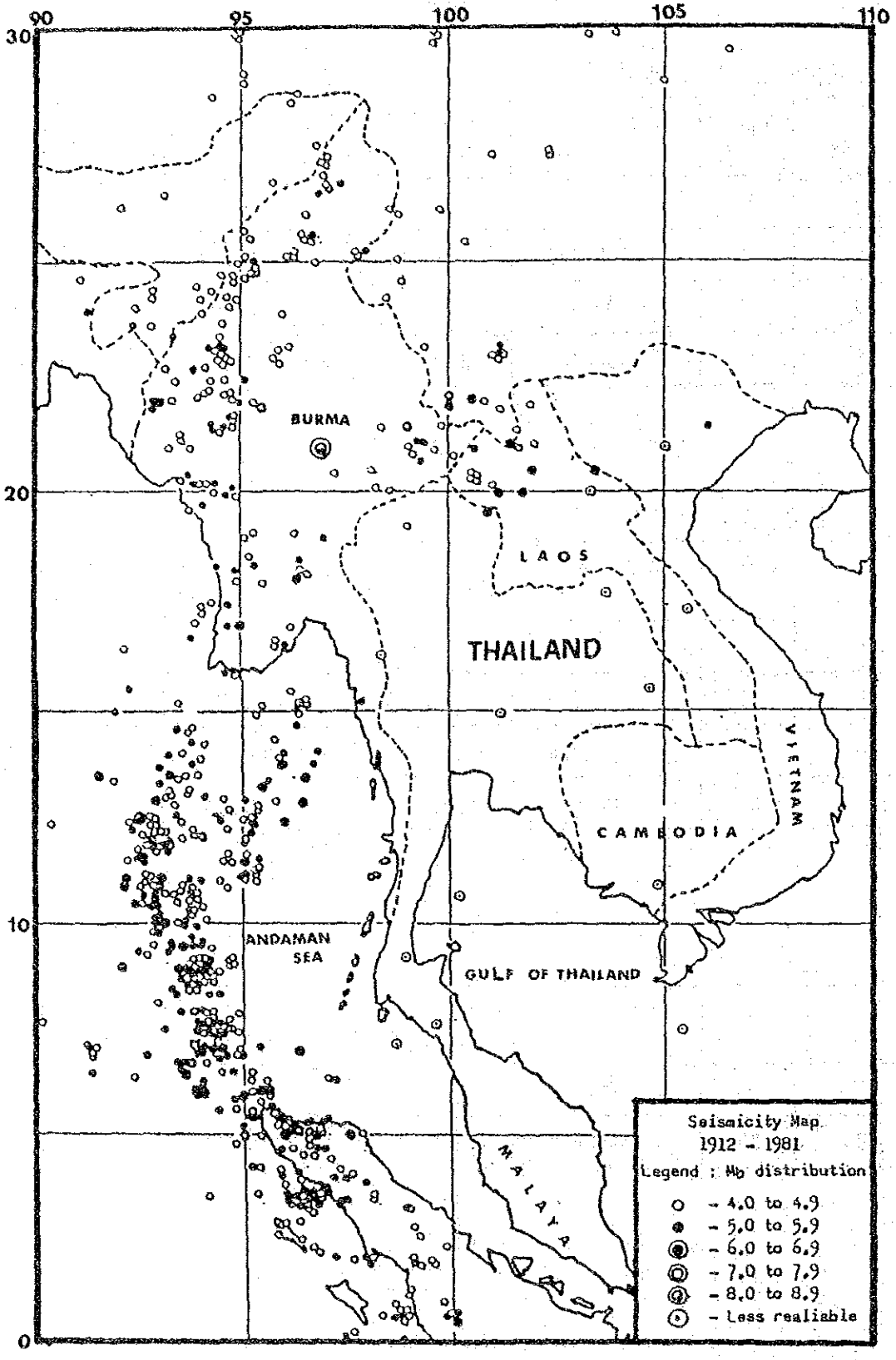
NO. 18 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
40	—	0	—	—	—
60	20	75,000	37,500	750,000	750,000
80	20	175,000	125,000	2,500,000	3,250,000
100	20	300,000	237,500	4,750,000	8,000,000

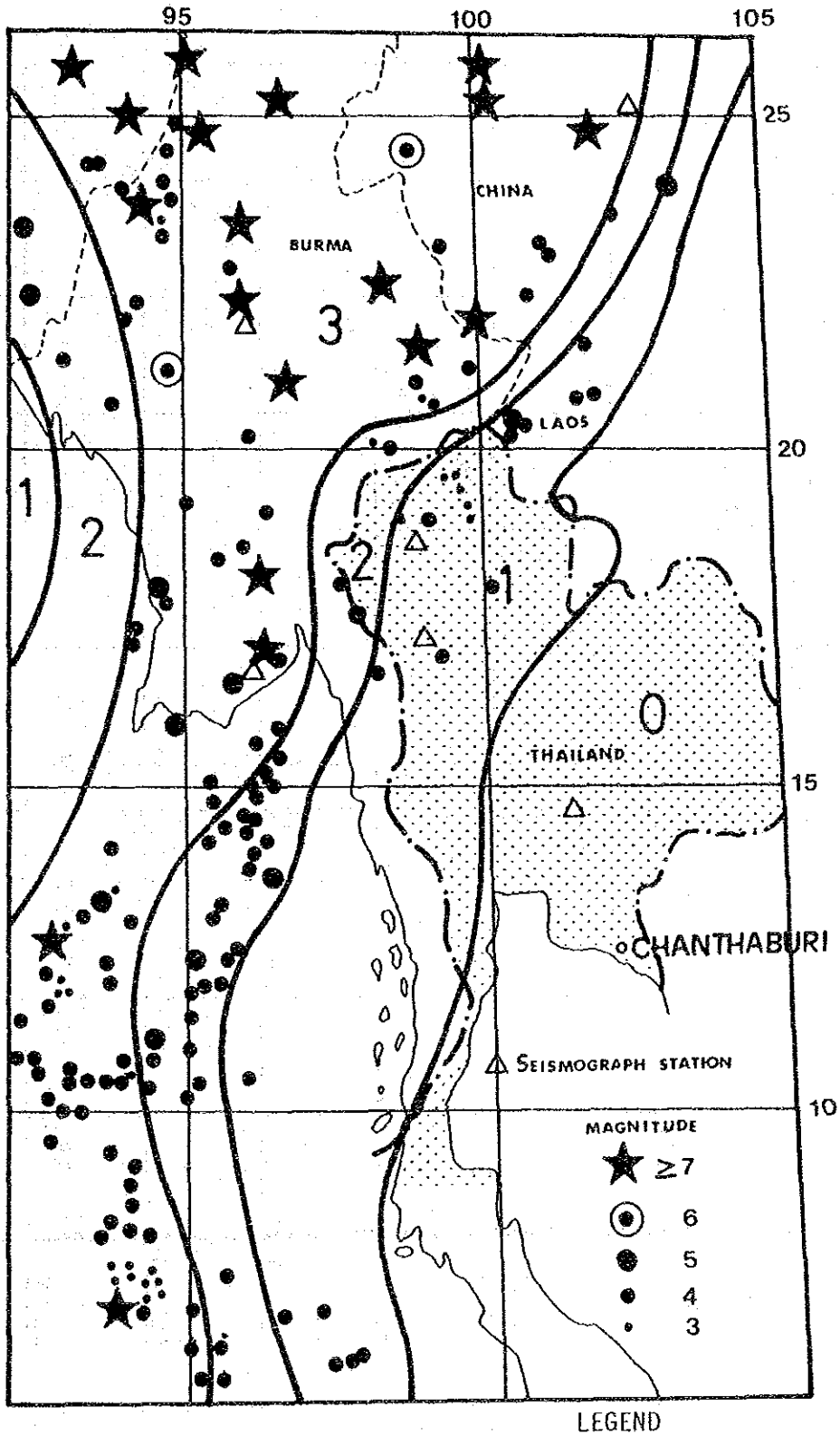
NO. 19 DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
20	—	75,000	—	—	—
40	20	150,000	112,500	2,250,000	2,250,000

H.1.4 **SEISMICITY MAP**



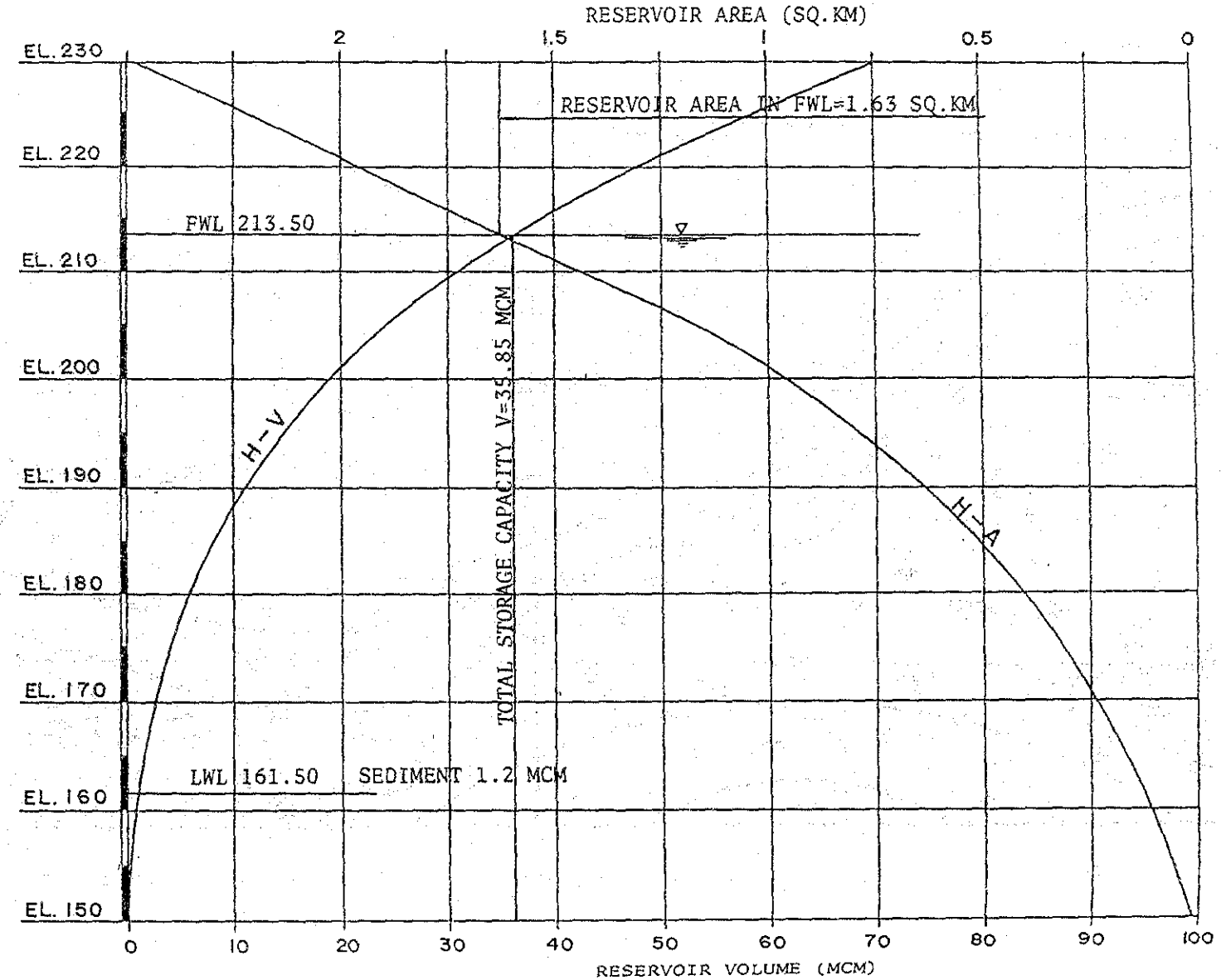
H.1.5 **A SEISMIC PROBABILITY MAP**



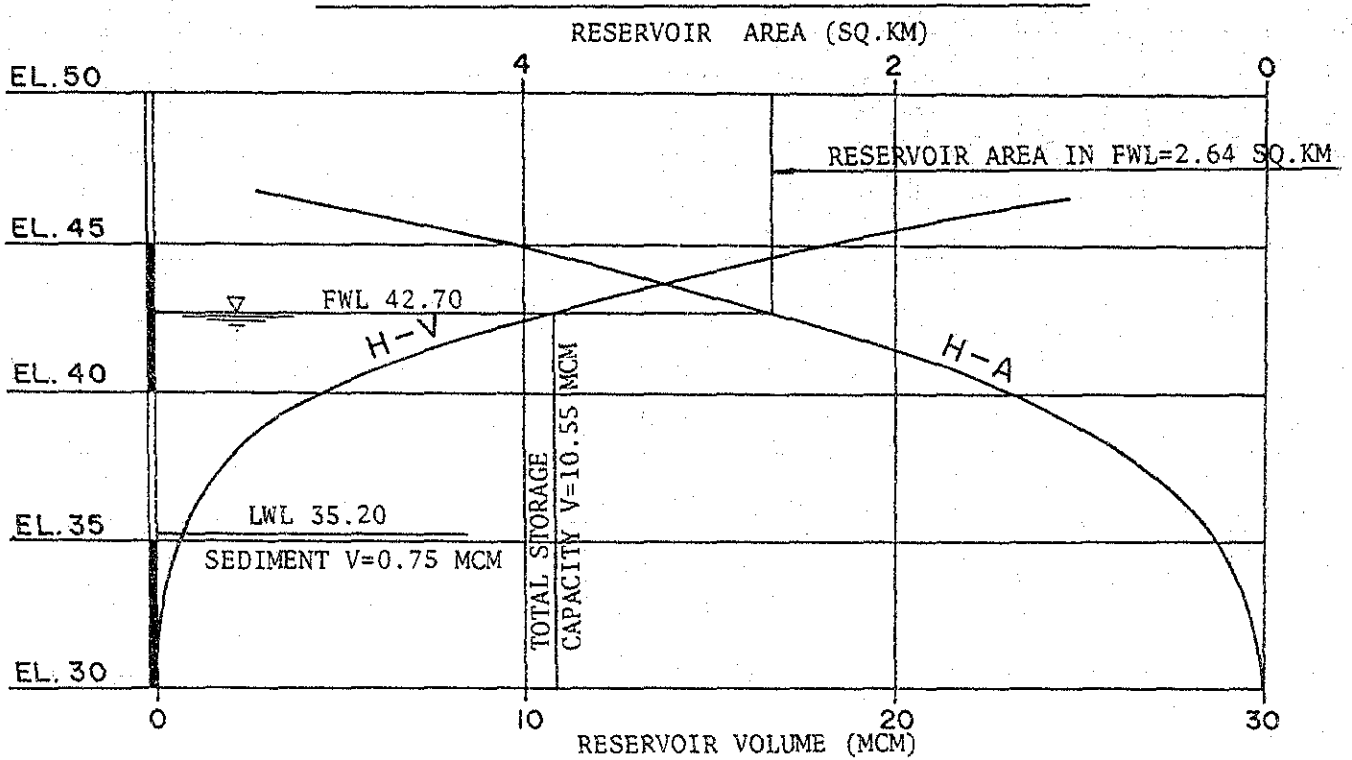
LEGEND

ZONE 0 : No damage
ZONE 1 : Minor damage
ZONE 2 : Moderate damage
ZONE 3 : Major damage

H.1.6 KHLONG TA LIU DAM HEIGHT-VOLUME AND HEIGHT-AREA



H.1.7 KHLONG SAN SAI DAM HEIGHT-VOLUME AND HEIGHT-AREA



H.1.8 HEIGHT-VOLUME AND HEIGHT-AREA

(CALCULATION SHEET)

KHLONG TA LIU DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
150	—	7,360	—	—	—
155	5	39,360	23,360	116,800	116,800
160	10	112,960	76,160	761,600	878,400
170	10	238,400	175,680	1,756,800	2,635,200
180	10	406,400	322,400	3,224,000	5,859,200
190	10	635,760	521,080	5,210,800	11,070,000
200	10	957,920	796,840	7,968,400	19,038,400
210	10	1,454,240	1,206,080	12,060,800	31,099,200
220	10	1,960,400	1,707,320	17,073,200	48,172,400
230	10	2,491,760	2,226,080	22,260,800	70,433,200

KHLONG SAN SAI DAM

EL m	ΔH m	AREA m²	AVE. AREA m²	VOLUME m³	ACCUM. VOLUME m³
30	—	0	—	—	—
35	5	222,880	111,440	557,200	557,200
40	5	1,406,560	814,720	4,073,600	4,630,800
45	5	4,046,960	2,726,760	13,633,800	18,264,600

H.1.9 Basic Condition for Preliminary Design of Dam

1) Basic Data

Basic data of topography, geology and fill materials etc. required for planning of the storage dam and reservoir were collected in the Feasibility Study stage and are shown as follows:

Topographic map

Damsite	: 1 : 1,000
Reservoir area	: 1 : 4,000

Geological map : 1 : 250,000

Geological survey

Khlong Ta Liu dam	: Drilling; 3 holes, 224m in total Permeability test; 3 holes, 67 times Standard penetration test; 4 holes,41times
Khlong San Sai dam	: Drilling; 4 holes, 100 mm in total Permeability test; 20 items Standard penetration test; 4 holes, 41 times

Impervious material test

Physical test	: Specific gravity Moisture content Grazing analysis, consistency
Mechanical test	: Compaction test Triaxial compressive test Permeability test Consolidation test

2) Seismic Intensity

Design seismic intensity is 0.05 as obtained in Chapter 3, 3.2.2 seismicity.

3) Design Flood Discharge

Design flood discharge of each dam is as follows:

Khlong Ta Liu dam
Spillway : 315 cu.m/s
Diversion tunnel : 225 cu.m/s

Khlong San Sai dam
Spillway : 125 cu.m/s

4) Design Intake Capacity

Design intake capacity is obtained are the below from water balance calculation.

Khlong Ta Liu dam : 3.835 cu.m/s
Khlong San Sai dam : 0.674 cu.m/s

H.1.10 Design Criteria of Dam

(1) Determination of Dam Crest Elevation

Dam crest elevation is determined by the following method.

Dam crest elevation = F.W.L + Hd + Fb + 0.5

Where, F.W.L. ... Formal water level (m)
Hd ..... Overflow depth of spillway (m)
Fb ..... Freeboard (m)
0.5 ..... Protecting layer for non-overflow section (m)

1) Freeboard

The fill dam shall not be overtopped from the dam crest for safety; therefore a freeboard should be added to the design flood level (F.W.L + Hd). The freeboard is calculated on the following factors.

- Waves in a reservoir generated by winds (by S.M.B Method and Savilla Method)
- Waves in a reservoir generated by earthquakes (by Sato's formula)

According to the climatological data for the Chanthaburi river basin for 30 years, the average annual wind velocity is too small as 0.3 m/s. But 20 m/s is applied to determined freeboard from the viewpoint of safety side.

The wave height is determined by combination S.M.B Method and Savilla Method.

The wave height of both dams is as follows;

	Fetch	Wave Height
Khlong Ta Liu dam :	3,500 m	1.7 m
Khlong San Sai dam:	5,400 m	1.9 m

The wave generated by earthquake are as follows;

$$he = \frac{1}{2} \cdot \frac{k \cdot \tau}{\pi} \cdot \sqrt{g \cdot H_o}$$

Where; K : Seismic intensity K = 0.05
τ : Period of seismic waves in second
H_o : Reservoir water depth in FWL
g : Acceleration of gravity 9.8 m/s^2

	Water Depth in FWL	Wave Height
Khlong Ta Liu dam:	70.5 m	0.21
Khlong San Sai dam:	12.2 m	0.09

Freeboard obtained from the waves and earthquake is as follows;

Khlong Ta Liu dam : 1.7 + 0.21 = 1.91 = 2.0 m
Khlong San Sai dam: 1.9 + 0.09 = 1.99 = 2.0 m

2) Dam Slopes and Crest Widths

Dam slopes of both dams are determined under consideration of the results of fill material survey and tests, quality of rock material and topography and geology of damsites.

	Upstream	Downstream
Khlong Ta Liu dam :	1 : 2.5	1 : 2.0
Khlong San Sai dam:	1 : 3.0	1 : 2.5

The width of dam crest adopts 10 m in Khlong Ta Liu dam and 8 m in Khlong San Sai dam upon consideration of workability, economy, settlement and deformation of dambody.

3) Overflow Water Depth of Spillway

The overflow water depth is calculated in consideration of reservoir routine effect which usually use in the design of spillway in Thailand.

From the result of the above mentioned, overflow water depth of both dam's spillway is as follows;

Khlong Ta Liu dam : Hd = 1.5 m
Khlong San Sai dam: Hd = 1.0 m

H.1.11 Dam Type and Zoning

(1) Khlong San Sai Dam

- The dam height decided by the irrigation water requirement is 16.2 m.
- Only impervious material is obtained at the damsite.
- The slopes of both abutments is very gentle as 1 on 18. And the surface of bedrock is about 10 m below from the ground level. The overburden on the bedrock is thick layer, but the foundation of dam can be placed on the overburden having more than N-value 20 because of small dam.

(2) Khlong Ta Liu Dam

- The dam height decided by the irrigation water requirement is 87.5 m.

  The zone type fill dam (rockfill dam) is generally adopted for higher dam than 30 m.
- Impervious, semi-pervious and pervious materials are found out in vicinity of the damsite.
- The slopes of both abutments is not so steep to a fill dam as 1 on 4.
- The surface of bedrock at the riverbed is about 10 m below from the ground level. The impervious zone is required to place directly on the bedrock because of high dam. So, the impervious zone is limited in width having a function to intercept seepage water from viewpoints of dam stability and economy.

As a conclusion, the following dam type at both damsites is adopted.

A earthfill dam (hamogeneous dam) is most suitable for the Khlong San Sai damsite. A vertical drain is installed inside of dam to drain seepage water for stability.

A zone type fill dam (rockfill dam) is adopted for the Khlong Ta Liu damsite.

The zoning of dam is taken into account on the basis of topography, geology of dam foundation and quantity and quality of fill materials as shown below.

- The impervious zone should be placed on the center of dam depend on topography. And the size of the impervious zone should be decided by the water pressure and the width of the foundation treatment on the core trench.
- The filter zone should be placed on both sides of impervious zone in order to prevail & piping through the impervious zone.
- The pervious and semi-pervious zone should be placed on the both outsides for dam stability.

H.1.12 Foundation Treatment

(1) Khlong Ta Liu Dam

Excavation

One of essential characteristics as foundation of a impervious zone of the center-core type dambody is that improvement of permeability of foundation is treated economically as well as strength required. In this damsite, it is easy to improve permeability of foundation by grouting because the foundation is composed mainly of hard granite and its permeability derives from cracks, whereas it is difficult where its permeability derives from interstices of grains as in heavily weathered granite and improvement of permeability can be achieved by an expensive special method. Therefore, in the core trench, overburdan and heavily weathered part of granite are to be excavated and removed as possible. Much loosened superficial rock basement which shows high permeability is also removed from economical point of view. Excavation depth may vary 10 to 13 m in the bottom of valley, and five 5 to 15 m in abutments.

On the upper right abutment, it should be well considered through further geological investigation whether the heavily weathered part is to be all removed or to be partially left and improved by a special treatment method for seapage control, since that part extends to the depth about 20m below ground surface at the drilling point B-3

Strength is a main characteristic required for foundation of the dambody excluding impervious zone, and it is acceptable if the strength is the same as or more than that of the dambody. Among rocks and layers underlying the site, heavily weathered rocks which have changed to earthy or sandy materials are to be removed where the dambody shows larger height. As for overburden, only soft portions which have much fine materials are to be removed, because other almost part is composed of gravel of hard granite and shale and has sufficient strength.

Control of Seepage Flow

Control of seepage through foundation is to be made by grout curtain and grout blanket by means of the stage method with cement ordinarily applied.

Grout curtain comprises a main curtain, which extends under the dambody and inflow part of the spillway, and supplemental curtains which are made on both sides of the main curtain under the central part of the dambody.

Depth of the main curtain is defined as follows:

$$d = \frac{1}{3} h + 25$$

Where;

d : depth of curtain (in meter)
h : depth of water from F.W.L to ground surface (in meter)

Depth of the supplemental curtain is assumed as a half as of the main curtain.

Grout blanket is made to plug high permeable seepage routes which may exist in the contact part to the impermeable zone of the dambody, and has much importance about safety of a dam. The blanket is planned to cover the whole area of the core trench with depth of five (5) meter.

Treatment of Fault

It is presumed that there are some faults of various dimension across of drilled cores the core trench, judging from conditions and topographic characters. Among them relatively large ones are treated by means of replacement of superficial loosened part for earth material and consolidation by grouting.

(2) Khlong San Sai Dam

Excavation

Almost area of the damsite is underlain by heavily weathered granite which is about 10 m thick and shows N-values ranging 10 to 20. This layer is rather weak, but strong enough for foundation of the dam of homogeneous type with gentle slope and small height. Therefore only overburden and superficial soft part is to be excavated and removed.

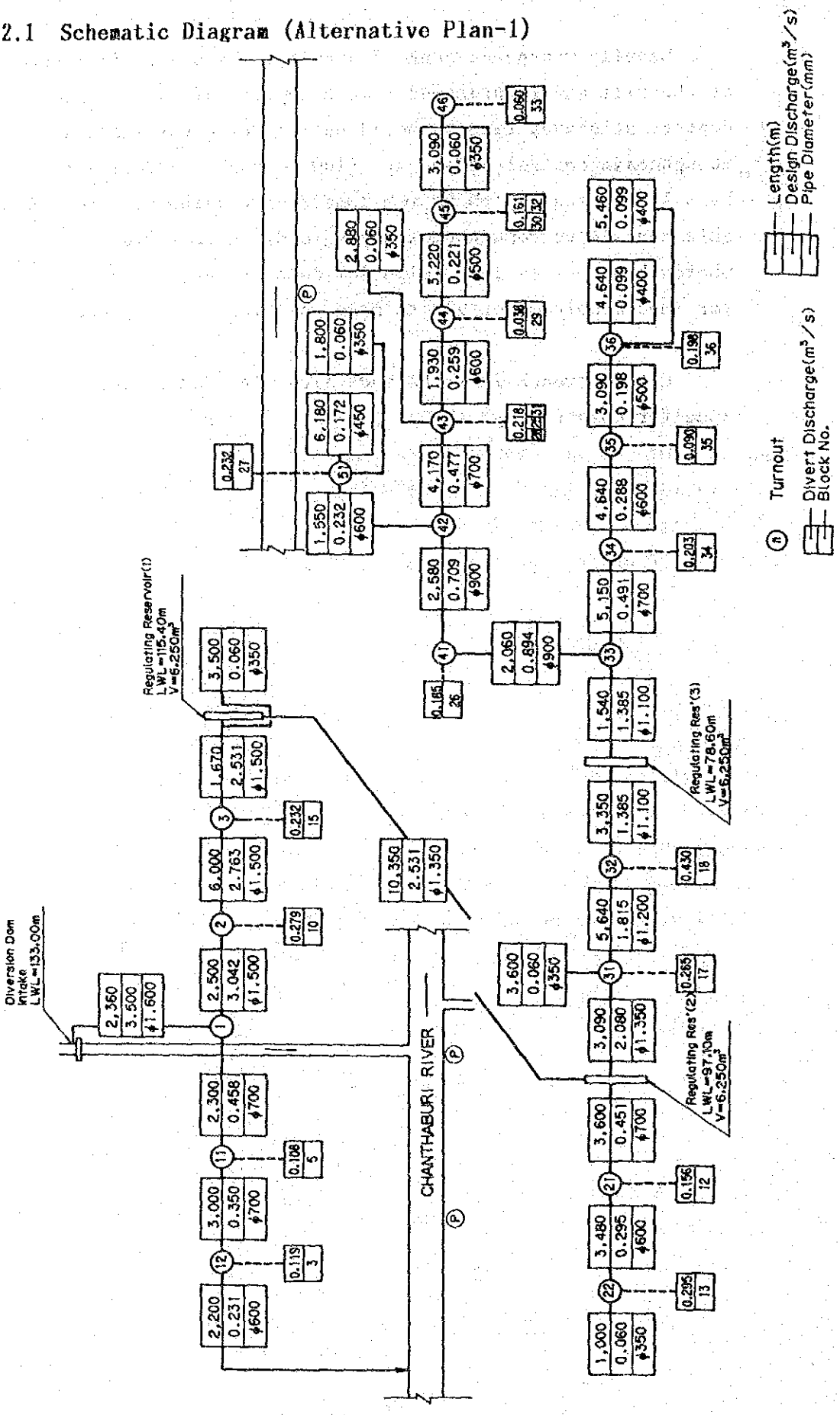
Control of Seepage Flow

Heavily weathered zone of granite, which extends surface of the site and is presumed almost impermeable due to much content of clayey fines, should be used as a natural blanket, though main control of seepage flow through foundation is made by a long seepage path of the impermeable dambody. Therefore this zone is to remain unexcavated and, in the alluvial area where this zone is lost, alluvial deposits are to be replaced for impermeable materials to make the blanket integrated.

Cutoff trench is to be made along the dam axis across the zone for more safety.

H.2 Preliminary Design of Main Conveyance System

H.2.1 Schematic Diagram (Alternative Plan-1)

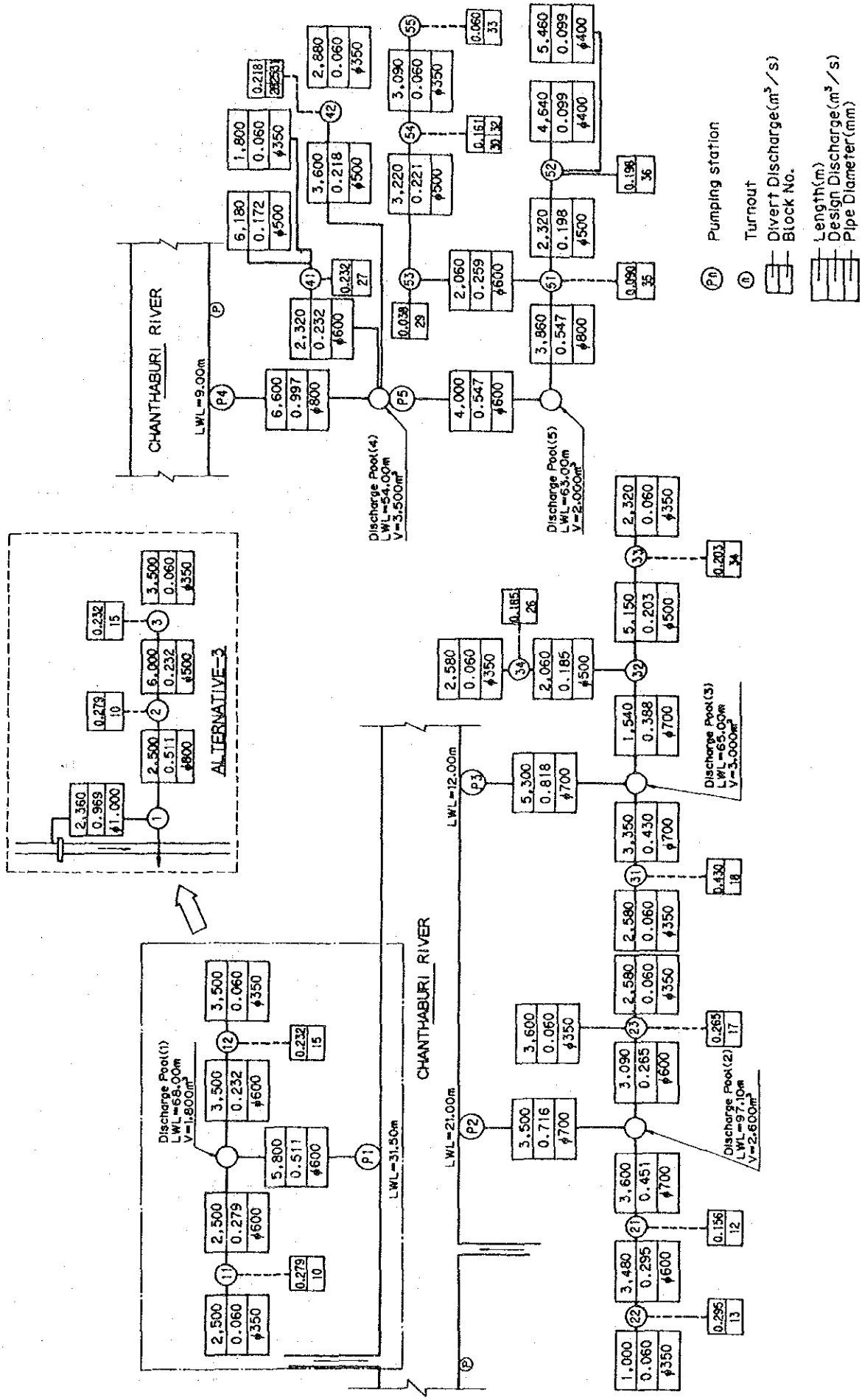


H.2.2 Hydraulic Calculation (Alternative Plan-1)

Station No.	Length (1) (m)	Discharge (2) (m3/s)	'C' Value (3)	Diameter (4) (m/m)	Velocity (5) (m/s)	Hydraulic Gradient (6) (m/1000m)	Loss Head (7)=(1)x(6) (m)	Effective Water Head 8)=(8)-(7) (El.m)	Ground Height (9) (El.m)	Note
Diversion Dam Intake								133.0		
Turnout-1	2,360	3.500	130	1,600	1.74	1.75	4.20	128.8		S.P
Turnout-2	2,500	3.042	130	1,500	1.72	1.60	4.00	124.8		S.P
Turnout-3	6,000	2.763	130	1,500	1.56	1.24	7.50	117.3		S.P
Left Bank Regulating Res.	1,670	2.531	130	1,500	1.43	1.08	1.90	115.4		S.P
Sub-Total	13,560						19.20			
Left Bank Regulating Res.								115.4		
Right Bank Regulating Res-1	10,350	2.531	130	1,350	1.76	1.76	18.30	97.1		S.P
Turnout-1								130.4		
Turnout-11	2,300	0.458	130	700	1.20	1.86	4.30	126.1		PC
Turnout-12	3,000	0.350	130	700	0.91	1.14	3.50	122.6		PC
	2,200	0.231	140	600	0.82	1.00	2.20	120.4		A.C
Sub-Total	7,500						10.00			
Left Bank Regulating Res.								115.4		
	3,500	0.060	140	350	0.63	1.24	4.40	111.0		A.C
Right Bank Regulating Res-1								97.1		
Turnout-21	3,600	0.451	130	700	1.18	1.76	6.40	90.7		S.P
Turnout-22	3,480	0.295	140	600	1.05	1.45	5.10	85.6		A.C
	1,000	0.060	140	350	0.63	1.24	1.30	84.3		A.C
Sub-Total	8,080						12.80			
Right Bank Regulating Res-1								97.1		
Turnout-31	3,090	2.080	130	1,350	1.45	1.29	4.00	93.1		S.P
Turnout-32	5,640	1.815	130	1,200	1.61	1.65	9.40	83.7		S.P
Right Bank Regulating Res-2	3,350	1.385	130	1,100	1.46	1.50	5.10	78.6		S.P
Sub-Total	12,080						18.50			

Station No.	Length (1) (m)	Discharge (2) (m3/s)	"C" Value (3)	Diameter (4) (m/m)	Velocity (5) (m/s)	Hydraulic Gradient (6) (m/1000m)	Loss Head (7)=(1)x(6) (m)	Effective Water Head 8)=(8)-(7) (El.m)	Ground Height (9) (El.m)	Note
Turnout-31								93.1		
	3,600	0.060	140	350	0.63	1.24	4.50	88.6		A.C
Right Bank Regulating Res-2								78.6		
Turnout-33	1,540	1.385	130	1,100	1.46	1.50	2.40	76.2		S.P
Turnout-34	5,150	0.491	130	700	1.28	2.06	10.70	65.5		S.P
Turnout-35	4,640	0.268	140	600	1.02	1.40	6.50	59.0		A.C
Turnout-36	3,090	0.198	140	500	1.01	1.76	5.50	53.5		A.C
	4,640	0.099	140	400	0.79	1.55	7.20	46.3		A.C
Sub-Total	19,060						32.30			
Turnout-33								76.2		
Turnout-41	2,060	0.894	130	900	1.41	1.14	2.40	73.8		S.P
Turnout-42	2,580	0.709	130	900	1.11	1.24	3.20	70.6		S.P
Turnout-43	4,170	0.477	130	700	1.24	1.86	7.80	62.8		S.P
Turnout-44	1,930	0.259	140	600	0.92	1.14	2.30	60.5		A.C
Turnout-45	3,220	0.221	140	500	1.13	2.06	6.70	53.8		A.C
Turnout-46	3,090	0.060	140	350	0.63	1.24	3.90	49.9		A.C
Sub-Total	17,050						26.30			
Turnout-36								53.5		
	5,460	0.099	140	400	0.79	1.55	8.50	45.0		A.C
Turnout-42								70.6		
Turnout-51	1,550	0.232	140	600	0.82	0.95	1.50	69.1		A.C
	6,180	0.172	140	450	1.09	1.45	9.00	60.1		A.C
Sub-Total	7,730						10.50			
Turnout-43								62.8		
Sub-Total	2,880	0.060	140	350	0.63	1.24	3.60	59.2		A.C
Turnout-51								69.1		
	1,800	0.060	140	350	0.63	1.24	2.30	66.8		A.C

H.2.3 Schematic Diagram (Alternative Plan- 2 and 3)



H.2.4 Hydraulic Calculation (Alternative Plan-2)

Station No.	Length (1) (m)	Discharge (2) (m3/s)	"C" Value (3)	Diameter (4) (m/m)	Velocity (5) (m/s)	Hydraulic Gradient (6) (m/1000m)	Loss Head (7)=(1)x(6) (m)	Effective Water Head 8)=(8)-(7) (El.m)	Ground Height (9) (El.m)	Note
Pump Station P-1										
Discharge Pool-1	5,800	0.511	130	600	1.81	5.36	31.10	68.0		S.P
Turnout-11	2,500	0.279	140	600	0.99	1.24	3.10	64.9		A.C
	2,500	0.060	140	350	0.63	1.24	3.10	61.8		A.C
Sub-Total	10,800						37.30			
Discharge Pool-1								68.0		
Turnout-12	3,500	0.232	140	600	0.82	0.96	3.40	64.6		A.C
	3,500	0.060	140	350	0.63	1.24	4.40	60.2		A.C
Sub-Total	7,000						7.80			
Pump Station P-2										
Discharge Pool-2	3,500	0.716	130	700	1.86	4.26	15.00	97.0		S.P
Turnout-21	3,600	0.451	130	700	1.17	1.76	6.40	90.6		S.P
Turnout-22	3,480	0.295	140	600	1.04	1.45	5.10	85.5		A.C
	1,000	0.060	140	350	0.63	1.24	1.30	84.2		A.C
Sub-Total	11,580						27.80			
Discharge Pool-2								97.0		
Turnout-23	3,090	0.265	140	600	0.94	1.14	3.60	93.4		A.C
	2,580	0.060	140	350	0.63	1.24	3.20	90.2		A.C
Sub-Total	5,670						6.80			
Turnout-23								93.4		
	3,600	0.060	140	350	0.63	1.24	4.50	88.9		A.C
Pump Station P-3										
Discharge Pool-3	5,300	0.818	130	700	2.13	5.26	27.90	65.0		S.P
Turnout-31	3,350	0.430	130	700	1.12	1.65	5.60	59.4		S.P
	2,580	0.060	140	350	0.63	1.24	3.20	56.2		A.C
Sub-Total	11,230						36.70			
Discharge Pool-3								65.0		
Turnout-32	1,540	0.388	130	700	1.01	1.29	2.00	63.0		S.P
Turnout-33	5,150	0.203	140	500	1.04	1.81	9.40	53.6		A.C
	2,320	0.060	140	350	0.63	1.24	2.90	50.7		A.C
Sub-Total	9,010						14.30			

Station No.	Length (1) (m)	Discharge (2) (m3/s)	"C" Value (3)	Diameter (4) (m/m)	Velocity (5) (m/s)	Hydraulic Gradient (6) (m/1000m)	Loss Head (7)=(1)x(6) (m)	Effective Water Head 8)=(8)-(7) (El.m)	Ground Height (9) (El.m)	Note
Turnout-32								63.0		
Turnout-34	2,060	0.185	140	500	0.94	1.45	3.00	60.0		A.C
	2,580	0.060	140	350	0.63	1.24	3.20	56.8		A.C
Sub-Total	4,640						6.20			
Pump Station P-4										
Discharge Pool-4	6,600	0.997	130	800	1.98	3.97	26.30	54.0		S.P
Turnout-41	2,320	0.232	140	600	0.82	0.95	2.30	51.7		A.C
	6,180	0.172	140	500	0.88	1.24	7.70	44.0		A.C
Sub-Total	15,100						36.30			
Turnout-41								51.7		
	1,800	0.060	140	350	0.63	1.24	2.30	49.4		A.C
Discharge Pool-4								54.0		
Turnout-42	3,600	0.218	140	500	1.11	1.86	6.70	47.3		A.C
	2,880	0.060	140	350	0.63	1.24	3.60	43.7		A.C
Sub-Total	6,480						10.30			
Pump Station P-5										
Discharge Pool-5	4,000	0.547	130	600	1.94	4.43	17.80	63.0		S.P
Turnout-51	3,860	0.547	130	800	1.09	1.34	5.20	57.8		S.P
Turnout-52	2,320	0.198	140	500	1.01	1.76	4.10	53.7		A.C
	4,640	0.099	140	400	0.79	1.55	7.20	46.5		A.C
Sub-Total	14,820						34.30			
Turnout-52								53.7		
	5,460	0.099	140	400	0.79	1.55	8.50	45.2		A.C
Turnout-51								58.8		
Turnout-53	2,060	0.259	140	600	0.92	1.14	2.40	55.4		A.C
Turnout-54	3,220	0.221	140	500	1.13	2.06	6.70	48.7		A.C
Turnout-55	3,090	0.060	140	350	0.63	1.24	3.90	44.8		A.C
Sub-Total	8,370						13.00			

CONSTRUCTION COSTS FOR ALTERNATIVE PLANS

(unit: million Bahts)

Facilities	Alternative Plan-1		Alternative Plan-2		Alternative Plan-3	
	Quantity	Cost	Quantity	Cost	Quantity	Cost
1. Storage Dam (No.4 dam and No.5 dam)	2 dams	665.0	2 dams	665.0	2 dams	665.0
2. Diversion Dam (Downstream of No.4 dam)	1 dam	16.5	1 dam	4.5	1 dam	8.8
3. Regulating barrage for control of river water level	-	-	4 units	30.4	3 units	23.4
4. Main conveyance pipeline (upto 200ha of commandable area)	111,620m	559.6	123,060m	251.7	119,620m	260.9
5. Main pumping station	- -	- -	5 stations (20 pumps)	210.0	4 stations (16 pumps)	174.0
6. Regulating Reservoir (Discharge pool)	3 units V = 46,160	11.6	5 units V =129,000	32.4	4 units V =111,000	27.9
7. Facility for other pumping area (Pump, pipeline and connection)	1,430.7ha	102.9	1,430.7ha	102.9	1,430.7ha	102.9
8. Lateral/sub-lateral pipeline	10,796.7ha	86.6	10,796.7ha	86.6	10,796.7ha	86.6
9. Connection pipeline	10,796.7ha	39.7	10,796.7ha	39.7	10,796.7ha	39.7
10. Terminal end facilities (Pond, pump, sprinkler system)	3,538.2ha	329.4	3,538.2ha	329.4	3,538.2ha	329.4
Total		1,811.3		1,752.6		1,718.6
(Ratio)		(100.0)		(96.8)		(94.9)

Operation and Maintenance Cost by Each Alternatives

Item	Alternative - I	Alternative - II	Alternative - III
1. Operator wages			
- Main P.S.	-	5x2personsx฿120,000/yr = ฿ 1,200,000	4x2personsx฿120,000/yr = ฿ 960,000
- Sub P.S.	4x1personx฿180,000/yr = ฿ 720,000	4x1person x฿180,000/yr = ฿ 720,000	4x1person x฿180,000/yr = ฿ 720,000
Sub-Total	฿ 720,000	฿ 1,920,000	฿ 1,680,000
2. Electricity Charge	฿ 1,671,000	฿ 13,559,000	฿ 11,924,000
3. Facility Maintenance Cost	฿ 1,029,000	฿ 3,129,000	฿ 2,769,000
Total	฿ 3,420,000	฿ 18,608,000	฿ 16,373,000

Note : Maintenance Cost of pumping plants per annuam assumes about one percent of initial investment cost.

Operation and Maintenance Cost by Each Alternatives (Electricity)

Item	Alternative - I	Alternative - II	Alternative - III
1. Motor Capacity			
1.1. Main Pumping Station	(-)	(5,670KW)	(4,890KW)
No.1 P.S.	-	260KW x 3 = 780KW	-
No.2 P.S.	-	490KW x 3 = 1,470KW	490KW x 3 = 1,470KW
No.3 P.S.	-	500KW x 3 = 1,500KW	500KW x 3 = 1,500KW
No.4 P.S.	-	530KW x 3 = 1,590KW	530KW x 3 = 1,590KW
No.5 P.S.	-	110KW x 3 = 330KW	110KW x 3 = 330KWF
1.2. Sub-Pumping Station	(797KW)	(797KW)	(797KW)
No.1 P.S.	110KW x 2 = 220KW	110KW x 2 = 220KW	110KW x 2 = 220KW
No.2 P.S.	210KW x 2 = 420KW	210KW x 2 = 420KW	210KW x 2 = 420KW
No.3 P.S.	75KW x 2 = 150KW	75KW x 2 = 150KW	75KW x 2 = 150KW
No.4 P.S.	7KW x 1 = 7KW	7KW x 1 = 7KW	7KW x 1 = 7KW
Total Capacity	797KW	6,467KW	5,687KW
2. Average Load (%)	80	80	80
3. Pumping Hour (hr)	2,800 x 0.8 = 2,240	2,800 x 0.8 = 2,240	2,800 x 0.8 = 2,240
4. Unit Charge (฿/KWH)	1.17	1.17	1.17
5. Electricity Charge (฿/,000)	1,671	13,559	11,924

H.2.7 Disbursement Schedule of Construction Cost (Alt.-1)

Disbursement Schedule of Construction Cost (Alt.-1)

Unit: Million Baht

Item	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
1. Dam with Structure	66.5	199.5	199.5	199.5	-	665.0
2. Diversion Dam	-	8.0	8.5	-	-	16.5
3. Regulating Weir	-	-	-	-	-	-
4. Main Pipeline	-	139.9	139.9	139.9	139.9	559.6
5. Main Pumping Station	-	-	-	-	-	-
6. Regulating Reservoir	-	-	4.0	4.0	3.6	11.6
7. Sub-Pumping Station	-	25.7	25.7	25.7	25.8	102.9
8. Lateral/Sub-lateral	-	21.7	21.7	21.7	21.5	86.6
9. Connection Pipe	-	-	-	20.0	19.7	39.7
10. On-farm Facility	-	-	108.7	108.7	112.0	329.4
Total	66.5	394.8	508.0	519.5	322.5	1,811.3

H.2.8 Disbursement Schedule of Construction Cost (Alt.-2)

Disbursement Schedule of Construction Cost (Alt.-2)

Unit: Million Baht

Item	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
1. Dam with Structure	66.5	199.5	199.5	199.5	-	665.0
2. Diversion Dam	-	2.2	2.3	-	-	4.5
3. Regulating Weir	-	-	10.0	10.0	10.4	30.4
4. Main Pipeline	-	63.0	63.0	63.0	62.7	251.7
5. Main Pumping Station	52.5	52.5	52.5	52.5	-	210.0
6. Regulating Reservoir	-	-	10.0	10.0	12.4	32.4
7. Sub-Pumping Station	-	25.7	25.7	25.7	25.8	102.9
8. Lateral/Sub-lateral	-	21.7	21.7	21.7	21.5	86.6
9. Connection Pipe	-	-	-	20.0	19.7	39.7
10. On-farm Facility	-	-	108.7	108.7	112.0	329.4
Total	119.0	364.6	493.4	511.1	264.5	1,752.6

H.2.9 Disbursement Schedule of Construction Cost (Alt.-3)

Disbursement Schedule of Construction Cost (Alt.-3)

Unit: Million Baht

Item	1st Year	2nd Year	3rd Year	4th Year	5th Year	Total
1. Dam with Structure	66.5	199.5	199.5	199.5	-	665.0
2. Diversion Dam	-	4.4	4.4	-	-	8.8
3. Regulating Weir	-	-	7.0	9.4	7.0	23.4
4. Main Pipeline	-	65.2	65.2	65.2	65.3	260.9
5. Main Pumping Station	43.5	43.5	43.5	43.5	-	174.0
6. Regulating Reservoir	-	-	10.0	10.0	7.9	27.9
7. Sub-Pumping Station	-	25.7	25.7	25.7	25.8	102.9
8. Lateral/Sub-lateral	-	21.7	21.7	21.7	21.5	86.6
9. Connection Pipe	-	-	-	20.0	19.7	39.7
10. On-farm Facility	-	-	108.7	108.7	112.0	329.4
Total	110.0	360.0	485.7	503.7	259.2	1,718.6

H.2.10 Breakdown of Pipeworks (Alternative Plan-1)

Diameter(mm)	Length (m)	Unit Cost (B/m)	Cost (B)
(Diversion Dam ~ Left Bank Discharge Reservoir)			
φ 1,600 (t=15.9)	800	15,683	12,546,400
φ 1,600 (t=13.1)	1,560	13,263	20,690,280
φ 1,500 (t=15.9)	9,170	14,579	133,689,430
φ 1,500 (t=13.1)	1,000	12,313	12,313,000
φ 350	3,500	808	2,828,000
Sub-Total	16,030		182,067,110
(Turnout 1 ~ Upstream End)			
φ 700	5,300	3,072	16,281,600
φ 600	2,200	2,001	4,402,200
Sub-Total	7,500		20,683,800
(Left Bank Discharge Reservoir~ Right Bank Discharge Reservoir-1)			
φ 1,350 (t=13.1)	7,850	11,044	86,695,400
φ 1,350 (t=12.7)	2,500	10,758	26,895,000
Sub-Total	10,350		113,590,400
(Right Bank Discharge Reservoir-1 ~ Upstream End)			
φ 700	3,600	3,072	11,059,200
φ 600	3,480	2,001	6,963,480
φ 350	1,000	808	808,000
Sub-Total	8,080		18,830,680
(Right Bank Discharge Reservoir-1 ~ Right Bank Discharge Reservoir-2)			
φ 1,350	3,090	10,758	33,242,220
φ 1,200	5,640	8,563	48,295,320
φ 1,100	3,350	7,408	24,816,800
φ 350	3,600	808	2,908,800
Sub-Total	15,680		109,263,140
(Right Bank Discharge Reservoir-2 ~ Downstream End)			
φ 1,100	1,540	7,408	11,408,320
φ 900	4,640	5,275	24,476,000
φ 700	9,320	3,072	28,631,040
φ 600	8,120	2,001	16,248,120
φ 500	6,310	1,494	9,427,140
φ 450	6,180	1,225	7,570,500
φ 400	10,100	1,111	11,221,100
φ 350	7,770	808	6,278,160
Sub-Total	53,980		115,260,380
Total	111,620		559,695,510

H.2.11 Breakdown of Pipeworks (Alternative Plan-2)

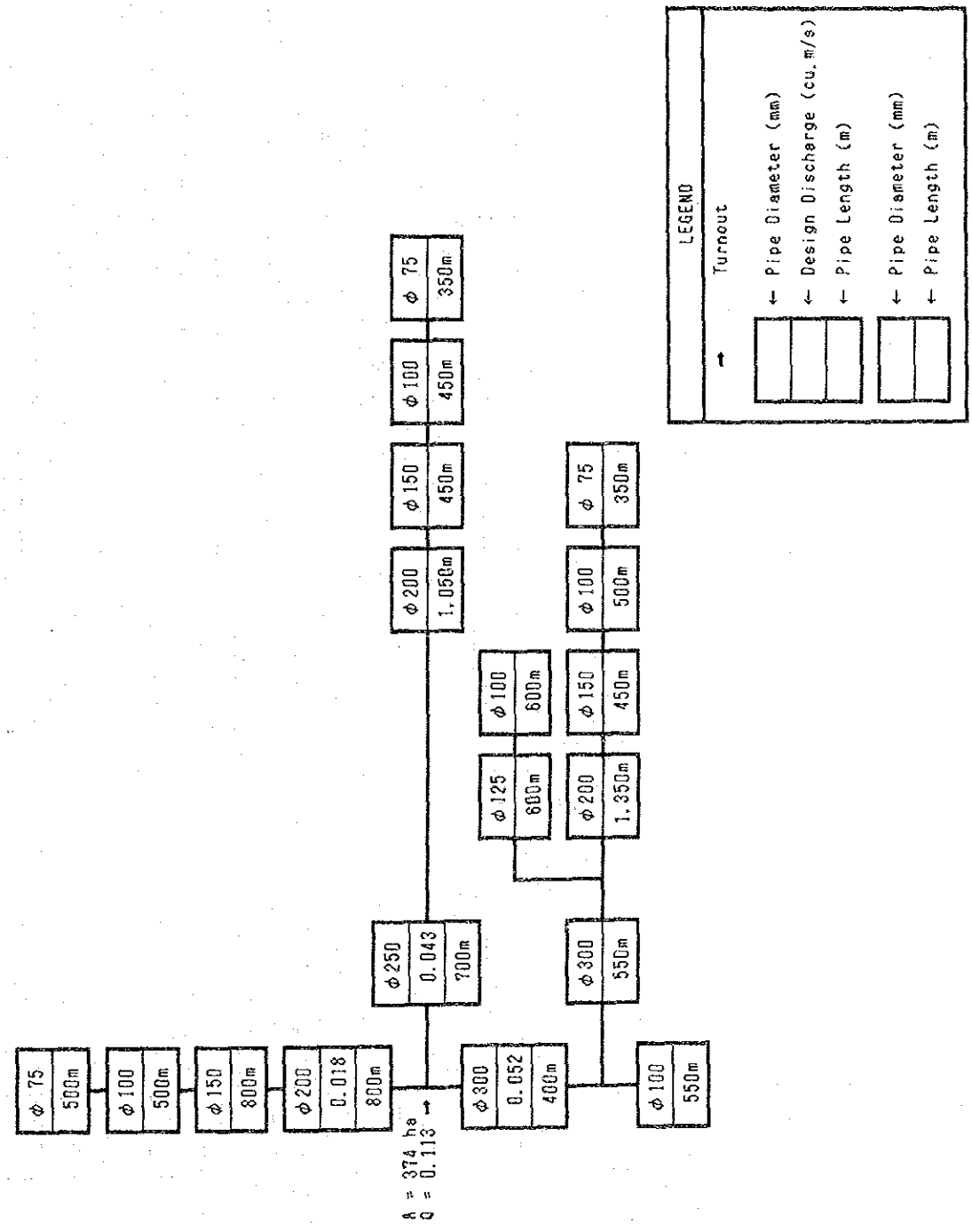
Diameter(mm)	Length (m)	Unit Cost (B/m)	Cost (B)
(Pumping Station No.1)			
φ 600 (t=6.4mm,SP)	5,800	2,681	15,549,800
φ 600	6,000	2,001	12,006,000
φ 350	6,000	808	4,848,000
Sub-Total	17,800		32,403,800
(Pumping Station No.2)			
φ 700 (t=7.9mm)	3,500	3,666	12,831,000
φ 700	3,600	3,072	11,059,200
φ 600	6,570	2,001	13,146,570
φ 350	7,180	808	5,801,440
Sub-Total	20,850		42,838,210
(Pumping Station No.3)			
φ 700 (t=7.9mm)	5,300	3,666	19,429,800
φ 700	4,890	3,072	15,022,080
φ 500	7,210	1,494	10,771,740
φ 350	7,480	808	6,043,840
Sub-Total	24,880		51,267,460
(Pumping Station No.4)			
φ 800 (t=7.9mm)	6,600	4,403	29,059,800
φ 600	2,320	2,001	4,642,320
φ 500	9,780	1,494	14,611,320
φ 350	4,680	808	3,781,440
Sub-Total	23,380		52,094,880
(Pumping Station No.5)			
φ 800	3,860	4,051	15,636,860
φ 600 (t=6.4mm)	4,000	2,681	10,724,000
φ 600	2,060	2,001	4,122,060
φ 500	5,540	1,494	8,276,760
φ 400	10,100	1,111	11,221,100
φ 350	3,090	808	2,496,720
Sub-Total	28,650		52,477,500
(Diversion Dam ~ Upstream End)			
φ 700	5,300	3,072	16,281,600
φ 600	2,200	2,001	4,402,200
Sub-Total	7,500		20,683,800
Total	123,060		251,765,650

H.2.12 Breakdown of Pipeworks (Alternative Plan-

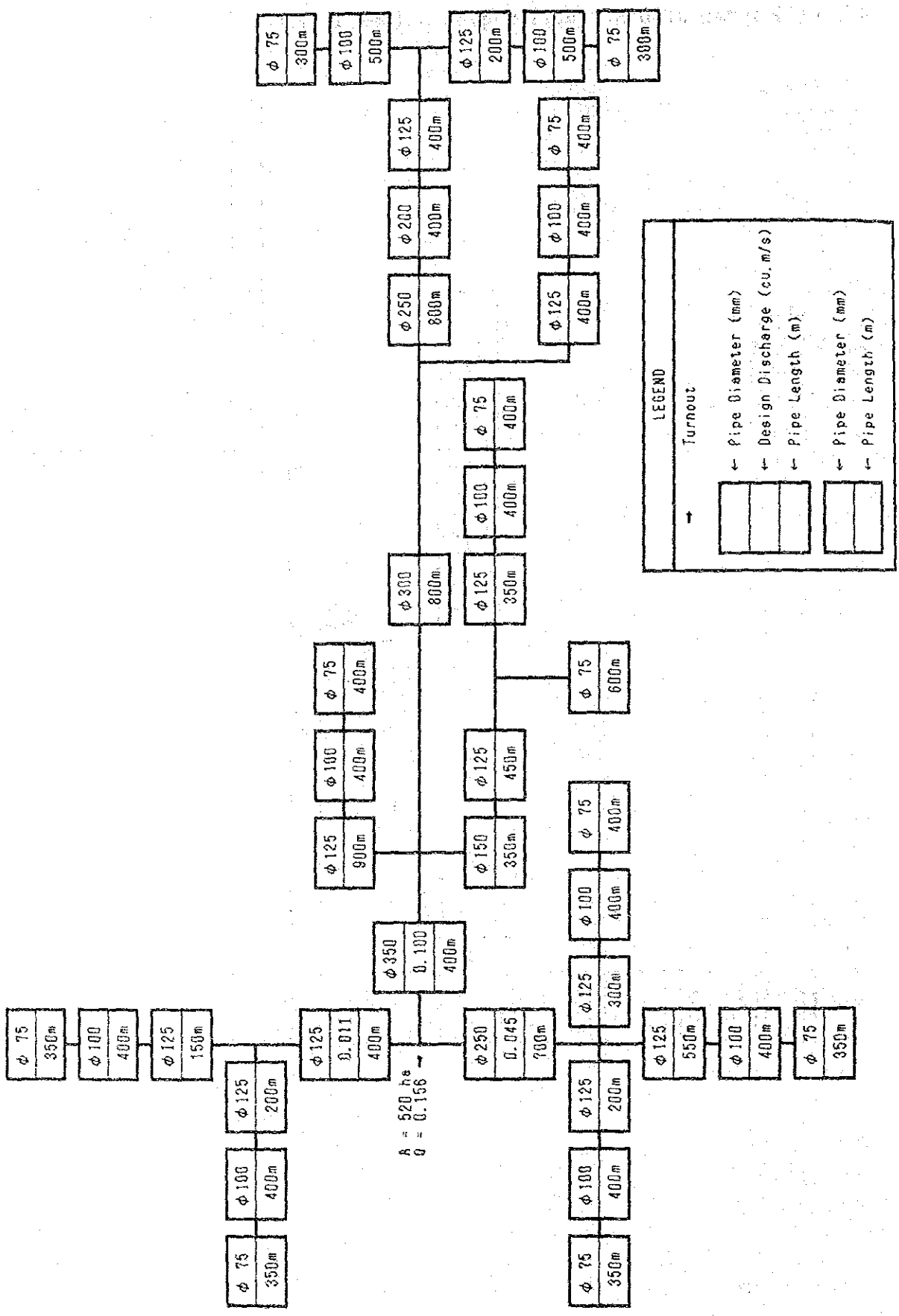
Diameter(mm)	Length (m)	Unit Cost (B/m)	Cost (B)
(Diversion Dam~Downstream End : Gravity)			
φ 1,000 (t=10.3mm)	800	6,675	5,340,000
φ 1,000 (t=9.5mm)	1,560	6,257	9,760,920
φ 800 (t=7.9mm)	2,500	4,403	11,007,500
φ 500	6,000	2,104	12,624,000
φ 350	3,500	808	2,828,000
Sub-Total	14,360		41,560,420
(Pumping Station No.1)			
φ 700 (t=7.9mm)	3,500	3,666	12,831,000
φ 700	3,600	3,072	11,059,200
φ 600	6,570	2,001	13,146,570
φ 350	7,180	808	5,801,440
Sub-Total	20,850		42,838,210
(Pumping Station No.2)			
φ 700 (t=7.9mm)	5,300	3,666	19,429,800
φ 700	4,890	3,072	15,022,080
φ 500	7,210	1,494	10,771,740
φ 350	7,480	808	6,043,840
Sub-Total	24,880		51,267,460
(Pumping Station No.3)			
φ 800 (t=7.9mm)	6,600	4,403	29,059,800
φ 600	2,320	2,001	4,642,320
φ 500	9,780	1,494	14,611,320
φ 350	4,680	808	3,781,440
Sub-Total	23,380		52,094,880
(Pumping Station No.4)			
φ 800	3,860	4,051	15,636,860
φ 600 (t=6.4mm)	4,000	2,681	10,724,000
φ 600	2,060	2,001	4,122,060
φ 500	5,540	1,494	8,276,760
φ 400	10,100	1,111	11,221,100
φ 350	3,090	808	2,496,720
Sub-Total	28,650		52,477,500
(Turnout-1~Upstream End : Gravity)			
φ 700	5,300	3,072	16,281,600
φ 600	2,200	2,001	4,402,200
Sub-Total	7,500		20,683,800
Total	119,620		260,922,270

H.3 Preliminary Design of Distribution Systems

H.3.1 Diagram of Distribution System (Sample Area-2)



H.3.2 Diagram of Distribution System (Sample Area-4)



APPENDIX-I. PROJECT COST

APPENDIX-I PROJECT COST

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Table I.1.1 Total Project Cost

Unit : 1,000

Cost Item	Khlong To Liu Sub-Area			Khlong San Sai Sub-Area			Grand Total		
	Foreign C.	Local C.	Total	Foreign C.	Local C.	Total	Foreign C.	Local C.	Total
A. Direct Project Cost									
1. Civil works									
1.1 Storage Dam	693,189	137,306	830,495	55,289	14,213	69,502	748,478	151,519	899,997
1.2 Diversion Dam	14,036	8,564	22,600	–	–	–	14,036	8,564	22,600
1.3 Main Pipeline	417,100	194,100	611,200	–	–	–	417,100	194,100	611,200
1.4 Regulating Reservoir	7,164	9,936	17,100	–	–	–	7,164	9,936	17,100
1.5 Pumping Station	36,110	16,390	52,500	11,670	5,330	17,000	47,780	21,720	69,500
Sub - total	1,167,599	366,296	1,533,895	66,959	19,543	86,502	1,234,558	385,839	1,620,397
2. Land Acquisition	–	14,342	14,342	–	27,751	27,751	–	42,093	42,093
3. Agri-Supporting S.	21,000	29,547	50,547	–	–	–	21,000	29,547	50,547
4. Operation / Maintenance	11,880	2,970	14,850	–	–	–	11,880	2,970	14,850
5. Administration Cost	–	122,700	122,700	–	9,100	9,100	–	131,800	131,800
6. Engineering Services	147,253	36,813	184,066	13,800	3,500	17,300	161,053	40,313	201,366
Sub - total	180,133	206,372	386,505	13,800	40,351	54,151	193,933	246,723	440,656
Total (1 - 6)	1,347,732	572,668	1,920,400	80,759	59,894	140,653	1,428,491	632,562	2,061,053
7. Physical Contingencies	134,768	57,232	192,000	8,041	6,106	14,147	142,809	63,338	206,147
Total (1 - 7)	1,482,500	629,900	2,112,400	88,800	66,000	154,800	1,571,300	695,900	2,267,200
8. Price Escalation	67,000	168,600	235,600	5,600	18,600	24,200	72,600	187,200	259,800
Grand Total	1,549,500	798,500	2,348,000	94,400	84,600	179,000	1,643,900	883,100	2,527,000
B. Indirect Project Cost									
1. Lateral / Sub-Lateral	70,665	32,291	102,956	1,795	819	2,614	72,460	33,110	105,570
2. Connection Pipe	27,426	13,701	41,127	696	348	1,044	28,122	14,049	42,171
3. On-farm Facility	161,232	69,098	230,330	9,276	3,975	13,251	170,508	73,073	243,581
Total (1 - 3)	259,323	115,090	374,413	11,767	5,142	16,909	271,090	120,232	391,322
4. Physical Contingency	25,932	11,509	37,441	2,700	680	3,380	28,632	12,189	40,821
5. Engineering Cost	31,445	13,401	44,846	1,530	570	2,100	32,975	13,971	46,946
Total (1 - 5)	316,700	140,000	456,700	15,997	6,392	22,389	332,697	146,392	479,089
6. Price Escalation	14,400	40,500	54,900	703	2,208	2,911	15,103	42,708	57,811
Grand Total	331,100	180,500	511,600	16,700	8,600	25,300	347,800	189,100	536,900

Table I.1.2 Project Implementation Program

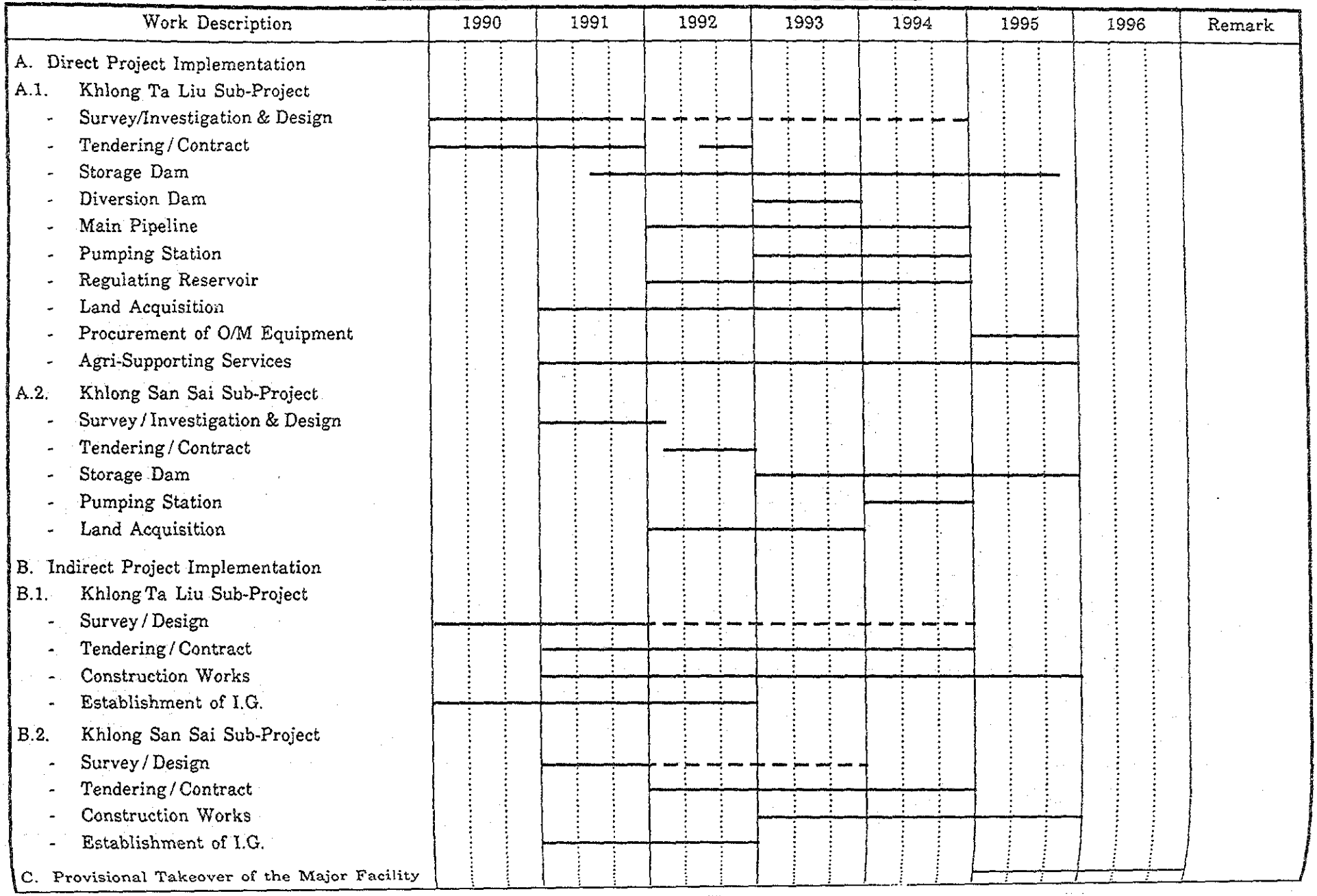

Table I.1.3 Project Cost of Khlong Ta Liu Sub-Project

Unit : Millon Baht

Cost Item	1990		1991		1992		1993		1994		1995		Total		
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	Total
A. Direct Project Cost															
1. Civil works															
1.1 Storage Dam	–	–	44.69	22.42	64.61	15.30	183.25	30.33	336.17	58.06	64.47	11.20	693.19	136.31	830.50
1.2 Diversion Dam	–	–	–	–	–	–	14.04	8.56	–	–	–	–	14.04	8.56	22.60
1.3 Main Pipeline	–	–	–	–	166.84	77.64	125.13	58.23	125.13	58.23	–	–	417.10	194.10	611.20
1.4 Regulating Reservoir	–	–	–	–	2.39	3.32	2.39	3.31	2.38	3.31	–	–	7.16	9.94	17.10
1.5 Pumping Station	–	–	–	–	–	–	15.05	6.85	21.06	9.54	–	–	36.11	16.39	52.50
Sub - total	–	–	44.69	22.42	233.84	96.26	339.86	107.28	484.74	129.14	64.47	11.20	1,167.60	366.30	1,533.90
2. Land Acquisition	–	–	–	13.10	–	0.50	–	0.50	–	0.24	–	–	–	14.34	14.34
3. Agri - Supporting Services	–	–	14.00	15.10	7.00	9.20	–	1.80	–	1.80		1.65	21.00	29.55	50.55
4. Operation / Maintenance Equipment	–	–	–	–	–	–	–	–	–	–	11.88	2.97	11.88	2.97	14.85
5. Administration Cost	–	12.27	–	18.40	–	24.54	–	24.54	–	24.54	–	18.41	–	122.70	122.70
6. Engineering Services	70.00	14.00	19.30	5.70	19.30	5.70	15.45	4.60	15.40	4.60	7.80	2.21	147.25	36.81	184.06
Sub - total (2 - 6)	70.00	26.27	33.30	52.30	26.30	39.94	15.45	31.44	15.40	31.18	19.68	25.24	180.13	206.37	386.50
Total (1 - 6)	70.00	26.27	77.99	74.72	260.14	136.20	355.31	138.72	500.14	160.32	84.15	36.44	1,347.73	572.67	1,920.40
7. Physical Contingencies	7.00	2.63	7.80	7.47	26.01	13.62	35.53	13.87	50.01	16.03	8.42	3.61	134.77	57.23	192.00
Total (1 - 7)	77.00	28.90	85.79	82.19	286.15	149.82	390.84	152.59	550.15	176.35	92.57	40.05	1,482.50	629.90	2,112.40
8. Price Escalation	0.85	1.84	1.89	10.86	9.55	30.64	17.48	42.97	30.93	64.13	6.30	18.16	67.00	168.60	235.60
Total (1 - 8)	77.85	30.74	87.68	93.05	295.70	180.46	408.32	195.56	581.08	240.48	98.87	58.21	1,549.50	798.50	2,348.00
B. Indirect Project Cost															
1. Lateral / Sub-lateral Pipeline	–	–	7.07	3.23	14.13	6.46	21.20	9.69	14.13	6.46	14.14	6.45	70.67	32.29	102.96
2. Connection Pipeline	–	–	2.74	1.37	5.49	2.74	8.23	4.11	5.49	2.74	5.48	2.74	27.43	13.70	41.13
3. On-farm Facility	–	–	16.12	6.91	32.25	13.82	48.37	20.73	32.25	13.82	32.24	13.82	161.23	69.10	230.33
Total (1 - 3)	–	–	25.93	11.51	51.87	23.02	77.80	34.53	51.87	23.02	51.86	23.01	259.33	115.09	374.42
4. Engineering Services	15.00	6.70	3.30	1.34	3.30	1.34	3.30	1.34	3.30	1.34	3.24	1.34	31.44	13.40	44.84
5. Physical Contingencies	–	–	2.57	1.15	5.23	2.34	7.70	3.43	5.23	2.34	5.20	2.25	25.93	11.51	37.44
Total (1 - 5)	15.00	6.70	31.80	14.00	60.40	26.70	88.80	39.30	60.40	26.70	60.30	26.60	316.70	140.00	456.70
6. Price Escalation	0.20	0.40	0.70	1.80	2.00	5.50	4.00	11.10	3.40	9.70	4.10	12.00	14.40	40.50	54.90
Total (1 - 6)	15.20	7.10	32.50	15.80	62.40	32.20	92.80	50.40	63.80	36.40	64.40	38.60	331.10	180.50	511.60
C. Grand Total (A + B)	93.05	37.84	120.18	108.85	358.10	212.66	501.12	245.96	644.88	276.88	163.27	96.81	1,880.60	979.00	2,859.60

Table I.1.4	Project Cost of Khlong San Sai Sub-Project												Unit : Millon Baht		
Cost Item	1990		1991		1992		1993		1994		1995		Total		
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	Total
A. Direct Project Cost															
1. Civil works															
1.1 Storage Dam	–	–	–	–	–	–	12.80	3.20	36.92	9.50	5.58	1.50	55.30	14.20	69.50
1.2 Pumping Station	–	–	–	–	–	–	–	–	11.67	5.33	–	–	11.67	5.33	17.00
Sub - total	–	–	–	–	–	–	12.80	3.20	48.59	14.83	5.58	1.50	66.97	19.53	86.50
2. Land Acquisition	–	–	–	–	–	20.00	–	7.75	–	–	–	–	–	27.75	27.75
3. Administration Cost	–	–	–	–	–	1.60	–	1.90	–	5.07	–	0.53	–	9.10	9.10
4. Engineering Services	–	–	7.00	1.80	–	–	2.30	0.60	2.30	0.60	2.20	0.50	13.80	3.50	17.30
Sub - total (2-4)	–	–	7.00	1.80	–	21.60	2.30	10.25	2.30	5.67	2.20	1.03	13.80	40.35	54.15
Total (1 - 4)	–	–	7.00	1.80	–	21.60	15.10	13.45	50.89	20.50	7.78	2.53	80.77	59.88	140.65
5. Physical Contingencies	–	–	0.70	0.20	–	2.20	1.50	1.35	5.11	2.10	0.72	0.27	8.03	6.12	14.15
Total (1 - 5)	–	–	7.70	2.00	–	23.80	16.60	14.80	56.00	22.60	8.50	2.80	88.80	66.00	154.80
6. Price Escalation	–	–	0.20	0.30	–	4.90	0.90	4.20	3.80	8.20	0.70	1.00	5.60	18.60	24.20
Total (1 - 6)	–	–	7.90	2.30	–	28.70	17.50	19.00	59.80	30.80	9.20	3.80	94.40	84.60	179.00
B. Indirect Project Cost															
1. Lateral / Sub-lateral Pipeline	–	–	–	–	–	–	0.90	0.41	0.90	0.41	–	–	1.80	0.82	2.62
2. Connection Pipe	–	–	–	–	–	–	0.40	0.20	0.30	0.15	–	–	0.70	0.35	1.05
3. On-farm Facility	–	–	–	–	–	–	3.10	1.40	3.10	1.30	3.07	1.28	9.27	3.98	13.25
Total (1 - 3)	–	–	–	–	–	–	4.40	2.01	4.30	1.86	3.07	1.28	11.77	5.15	16.92
4. Engineering Services	–	–	1.40	0.35	0.40	0.09	0.30	0.08	0.30	0.08	0.30	0.08	2.70	0.68	3.38
5. Physical Contingencies	–	–	0.10	0.05	0.10	0.01	0.50	0.21	0.50	0.16	0.33	0.14	1.53	0.57	2.10
Total (1 - 5)	–	–	1.50	0.40	0.50	0.10	5.20	2.30	5.10	2.10	3.70	1.50	16.00	6.40	22.40
6. Price Escalation	–	–	–	0.10	–	–	0.20	0.60	0.30	0.80	0.20	0.70	0.70	2.20	2.90
Total (1 - 6)	–	–	1.50	0.50	0.50	0.10	5.40	2.90	5.40	2.90	3.90	2.20	16.70	8.60	25.30
C. Grand Total (A + B)	–	–	9.40	2.80	0.50	28.80	22.90	21.90	65.20	33.70	13.10	6.00	111.10	93.20	204.30

Table I.2.1 CONSTRUCTION COST OF STORAGE DAM

KHLONG TA LIU DAM

(Unit:'1000 Baht)

Items of Works	Foreign Currency	Local Currency	Total Cost
1. Temporary Works	40,300	8,855	49,155
2. Diversion Works	36,636	20,652	57,288
3. Foundation Treatment Works	49,773	13,166	62,939
4. Fill of Dam	508,868	92,337	601,205
5. Spillway Works	52,517	1,668	54,185
6. Intake Works	5,095	628	5,723
GRAND TOTAL	693,189	137,306	830,495

KHLONG SAN SAI DAM

Item of Works	Foreign Currency	Local Currency	Total Cost
1. Temporary Works	2,334	600	2,934
2. Fill of Dam	30,967	6,256	37,223
3. Spillway Works	16,850	6,953	23,803
4. Intake Works	5,138	404	5,542
GRAND TOTAL	55,289	14,213	69,502

Table I.2.2 DISBURSEMENT SCHEDULE OF DAM CONSTRUCTION COST

(Unit: Millon Baht)

Items of Works	1991		1992		1993		1994		1995		Total		
	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	FC	LC	Total
A. Khlong Ta Liu Dam													
1. Temporary Works	8.06	1.77	8.06	1.78	8.06	1.77	8.06	1.77	8.06	1.77	40.30	8.86	49.16
2. Diversion Works	36.63	20.05	-	-	-	-	-	-	-	-	36.63	20.65	57.28
3. Foundation Treatment	-	-	49.77	13.16	-	-	-	-	-	-	49.77	13.16	62.94
4. Fill of Dam	-	-	-	-	152.66	27.70	305.32	55.40	50.89	9.24	508.87	92.34	601.21
5. Spillway Works	-	-	5.25	0.17	21.00	0.67	21.00	0.67	5.27	0.16	52.52	1.67	54.19
6. Intake Works	-	-	1.53	0.19	1.53	0.19	1.79	0.22	0.25	0.03	5.10	0.63	5.73
Total	44.69	22.42	64.61	15.30	183.25	30.33	336.17	58.06	64.47	11.20	693.19	137.31	830.50
B. Khlong San Sai Dam													
1. Temporary Works	-	-	-	-	0.70	0.20	0.90	0.20	0.73	0.20	2.33	0.60	2.93
2. Fill of Dam	-	-	-	-	3.10	0.60	24.78	5.15	3.10	0.60	30.98	6.25	37.23
3. Spillway Works	-	-	-	-	5.00	2.10	10.10	4.15	1.75	0.70	16.85	6.95	23.80
4. Intake Works	-	-	-	-	4.00	0.30	1.14	0.10	-	-	5.14	0.40	5.54
Total	-	-	-	-	12.80	3.20	36.92	9.50	5.58	1.50	55.30	14.20	69.50

Table I.2.3 UNIT COST OF DAM CONSTRUCTION

(Unit: Baht)

Description	Unit	Total Unit Cost	Unit Cost FC	Unit Cost LC
Common Excavation of Khlong Ta Liu Dam	cu.m	53	44	9
Common Excavation of Khlong San Sai Dam	cu.m	35	29	6
Rock Excavation of Dam Foundation	cu.m	133	108	25
Rock Excavation of Quarry Site	cu.m	179	153	26
Excavation of Tunnel	cu.m	53078	33976	19102
Fill of Impervious Zone of Khlong Ta Liu Dam	cu.m	67	56	11
Fill of Impervious Zone of Khlong San Sai Dam	cu.m	42	35	7
Fill of Filter-Drain	cu.m	74	62	12
Fill of Semi-Impervious Zone	cu.m	68	58	10
Fill of Pervious Zone	cu.m	64	54	10
Concrete Lininig of Tunnel	m	14381	8760	5621
Reinforced Concrete	cu.m	926	567	359
Plain Concrete	cu.m	882	537	345
Reinforcing Bar	ton	11863	11084	779
Wooden Formwork	sq.m	52	14	38
Drilling by Ø46 mm	m	1010	926	84
Drilling by Ø66 mm	m	1128	1000	128
Grouting	stage	1151	370	781
Permeability Test	No.	130	35	95

Table I.3.1. Construction Cost of Diversion Dam

(unit: ¥1,000)

Item	Quantity	F.C.	L.C.	Total
Excavation	3,000 m^3	63	27	90
Backfill	600 "	15	6	21
Plain Concrete	1,650 "	1,043	1,564	2,607
Reinforced Concrete	280 "	498	748	1,246
Masonry	200 "	185	79	264
Riprap	500 "	161	69	230
Bridge (R.C.)	100 m^2	200	300	500
Steel Gate	67.5 ton	11,813	5,062	16,875
Miscellaneous	L.S	59	708	767
Total		14,037	8,563	22,600

Table I.4.1. Construction Cost of Main Pipeline

(unit: ฿1,000)

Name of Pipeline	Length (m)	Cost Breakdown		Total
		Foreign Currency	Local Currency	
1L	2,360	25,220	11,380	36,600
1R	7,500	9,570	10,160	19,730
2L	10,170	110,600	49,700	160,300
2L-1L	3,500	2,060	950	3,010
3L	10,350	86,270	38,810	125,080
3L-1L	12,080	80,200	36,130	116,330
3L-1L-1L	3,600	2,120	980	3,100
3L-1R	8,080	14,350	6,450	20,800
3L-2L	19,060	35,020	15,970	50,990
3L-2L-1R	5,460	4,510	2,090	6,600
3L-2L-1L	17,050	36,400	16,550	52,950
3L-2L-1L-1L	7,730	8,020	3,660	11,680
3L-2L-1L-1R	1,800	1,060	490	1,550
3L-2L-1L-2L	2,880	1,700	780	2,480
Total	111,620	417,100	194,100	611,200

Table I.4.2 UNIT COST OF IRRIGATION FACILITIES (1)

(Unit: Baht)

Description	Unit	Total Unit Cost	Unit cost FC	Unit cost LC
Common Excavation	cu.m	18	12.6	5.4
Excavation of Sand&Gravel	cu.m	30	21	9
Trench Excavation for Pipeline	cu.m	20	14	6
Backfill	cu.m	35	24.5	10.5
Reinforced Concrete	cu.m	4450	1780	2670
Concrete Lininig	cu.m	1800	720	1080
Plain Concrete	cu.m	1580	632	948
Sand	cu.m	128	0	128
Masonry	cu.m	1320	924	396
Riprap	cu.m	460	322	138
Pipe Installation				
PVC Pipe				
Ø 50 mm	m	57	38	19
Ø 75 mm	m	95	65	30
Ø100 mm	m	133	91	42
Ø125 mm	m	188	130	58
Ø150 mm	m	246	169	77
Asbestos Pipe				
Ø200 mm (15kg/sq.cm)	m	381	266	115
Ø250 mm (do)	m	524	357	167
Ø300 mm (do)	m	684	467	217
Ø350 mm (do)	m	783	535	248
Ø400 mm (do)	m	1096	751	345
Ø450 mm (do)	m	1220	836	384
Ø500 mm (do)	m	1535	1042	493
Ø600 mm (do)	m	2004	1364	640
Pre-Stressed Concrete Pipe				
Ø700 mm (15kg/sq.cm)	m	2553	1077	1476

Table I.4.2 UNIT COST OF IRRIGATION FACILITIES(2)

(Unit: Baht)

Description	Unit	Total Unit Cost	Unit Cost FC	Unit Cost LC
Steel Pipe				
Ø 250 mm (t=6)	m	1113	776	337
Ø 300 mm (")	m	1301	905	396
Ø 350 mm (")	m	1499	1042	457
Ø 400 mm (")	m	1698	1179	519
Ø 450 mm (")	m	1903	1320	583
Ø 500 mm (")	m	2145	1476	669
Ø 600 mm (")	m	2555	1758	797
Ø 700 mm (t=6.4)	m	3103	2138	965
Ø 800 mm (t=7.1)	m	3913	2699	1214
Ø 900 mm (t=8.7)	m	5764	3568	1596
Ø1000 mm (t=9.5)	m	6210	4275	1935
Ø1100 mm (t=10.3)	m	7292	5023	2269
Ø1200 mm (t=11.1)	m	8519	5863	2656
Ø1350 mm (t=12.7)	m	10769	7425	3344
Ø1350 mm (t=13.1)	m	11055	7625	3430
Ø1500 mm (t=13.1)	m	12283	8468	3815
Ø1500 mm (t=15.9)	m	14549	10055	4494
Ø1600 mm (t=13.1)	m	13283	9152	4131
Ø1600 mm (t=15.9)	m	15703	10846	4857

Table I.4.3 UNIT RATE OF CONSTRUCTION MATERIAL (1)

(Unit: Baht)

Items of Material	Unit	Total Unit Rate	Unit Rate FC	Unit Rate LC
Portland Cement	ton	1700	1020	680
Round Bar	ton	12800	8960	3840
Deformed Bar	ton	13300	9310	3990
Timber(Soft)	cu.m	7100	1420	5680
Timber(Hard)	cu.m	8800	1760	7040
Plywood Form(t=10mm)	no	600	480	120
Fine Aggregate	cu.m	110	66	44
Coarse Aggregate	cu.m	250	150	100
Crushed Stone	cu.m	230	138	92
Dynamite	kg	84	67.2	16.8
Detonator	no	12	9.6	2.4
Gasoline	lit.	7.9	6.3	1.6
Diesel Oil	lit.	6.25	5.0	1.25
Lubricating Oil	lit.	40	32	8
Brick	1000 no	500	0	500
PVC Pipe				
Ø 50	m	29	20	9
Ø 75	m	66	46	20
Ø 100	m	104	73	31
Ø 125	m	158	111	47
Ø 150	m	216	151	65
Asbestos Pipe				
Ø 200 (15kg/sq.cm)	m	259	181	78
Ø 250 (do)	m	371	260	111
Ø 300 (do)	m	522	365	157
Ø 350 (do)	m	611	428	183
Ø 400 (do)	m	914	640	274
Ø 450 (do)	m	1028	720	308
Ø 500 (do)	m	1293	905	388
Ø 600 (d0)	m	1733	1213	520

Table I.4.3 UNIT RATE OF CONSTRUCTION MATERIAL (2)

(Unit: Baht)

Items of Material	Unit	Total Unit Rate	Unit Rate FC	Unit Rate LC
Pre-stressed Concrete Pipe				
Ø 700(15kg/sq.cm)	m	2220	888	1332
Steel Pipe				
Ø 250(t=6)	m	934	654	280
Ø 300(t=6)	m	1113	779	334
Ø 350(t=6)	m	1302	911	391
Ø 400(t=6)	m	1491	1044	447
Ø 450(t=6)	m	1681	1177	504
Ø 500(t=6)	m	1870	1309	561
Ø 600(t=6)	m	2246	1572	674
Ø 700(t=6.4)	m	2750	1925	825
Ø 800(t=7.1)	m	3478	2435	1043
Ø 900(t=8.7)	m	4692	3284	1408
Ø 1000(t=9.5)	m	5663	3964	1699
Ø 1100(t=10.3)	m	6699	4689	2010
Ø 1200(t=11.1)	m	7847	5493	2354
Ø 1350(t=12.7)	m	10008	7006	3002
Ø 1350(t=13.1)	m	10294	7206	3088
Ø 1500(t=13.1)	m	11442	8009	3433
Ø 1500(t=15.9)	m	13708	9596	4112
Ø 1600(t=13.1)	m	12367	8657	3710
Ø 1600(t=15.9)	m	14787	10351	4436

Table I.4.4 LABOUR RATES

LABOUR	RATES(Baht/day)
Foreman	180
Skilled Labour	120
Common Labour	70
Heavy Equipment Operator	140
Dump Track Driver	100
Carpenter	130
Steel Worker	90
Stone Worker	90
Electrician	140
Mechanician	140
Driller	140

Table I.4.5 PROPORTION OF FOREIGN AND LOCAL CURRENCIES

DESCRIPTION	FC(%)	LC(%)
Portland Cement	60	40
Steel Bar	70	30
Steel Formwork	70	30
Timber	20	80
Gasoline	80	20
Diesel Oil	80	20
Lubricating Oil	80	20
Explosive	80	20
Spare Parts	80	20
Labour	0	100
Construction Equipment	80	20
Steel Pipe	70	30
PVC Pipe	70	30
Asbestos Pipe	70	30
Pre-Stressed Concrete Pipe	40	60

Table I.5.1. Construction Cost of Pumping Station

(unit: ฿1,000)

Item	Specification	F.C.	L.C.	Total
- No.1 Pumping Station				
Civil Work		2,450	1,450	3,900
Pumping Plants	ϕ200mmx110KWx3 units	12,600	5,400	18,000
Sub-total		15,050	6,850	21,900
- No.2 Pumping Station				
Civil Works		5,310	2,790	8,100
Pumping Plants	ϕ250mmx210KWx3 units	15,750	6,750	22,500
Sub-total		21,060	9,540	30,600
- No:3 Pumping Station				
Civil Works		2,220	1,280	3,500
Pumping Plants	ϕ150mmx75KWx3 units	9,450	4,050	13,500
Sub-total		11,670	5,330	17,000
Total		47,780	21,720	69,500

Table I.6.1. Construction Cost of Regulating Reservoir

(unit: ฿1,000)

Item	Quantity	F.C.	L.C.	Total
Excavation	14,000 m^2	176	76	252
Backfill	3,000 "	74	31	105
Side-wall Lining	650 "	468	702	1,107
Reinforced Concrete	850	1,513	2,270	3,783
Miscellaneous	L.S.	157	233	390
Total		2,388	3,312	5,700

Table I.7.1. Procurement of Equipment for Operation and Maintenance

(unit: ฿1,000)

Item		Quantity	F.C.	L.C.	Total
Bulldozer	15 ton	1	2,400	600	3,000
Backhoe	0.4 m^3	2	3,200	800	4,000
Trackcrane	5 ton	2	2,720	680	3,400
Track	6 ton	2	1,120	280	1,400
Pickup	2 ton	3	720	180	900
Wagon Jeep		2	800	200	1,000
Motor Cycle		5	120	30	150
Office Equipment		L.S.	800	200	1,000
Total			11,880	2,970	14,850

I.7.2. Land Acquisition Cost for Khlong Ta Liu

(unit: Baht)

Description	Quantity	Unit Cost	Amount
- Access Road	5.0 ha	56,000	280,000
- Pipeline	55.8 ha	28,000	1,562,000
- Reforestation Promotion	1.0 L.S.		12,500,000
Total			14,342,000

I.7.3. Land Acquisition Cost for Khlong San Sai

(unit: Baht)

Description	Quantity	Unit Cost	Amount
- House Re-Construction	55 H.H.	90,000	4,950,000
- Crop Compensation			
1. Residential land	7 ha		-
2. Cassava	270 "	9,400	2,538,000
3. Rubber	22 "	51,600	1,135,000
4. Durian	10 "	35,600	356,000
5. Rambutan	14 "	35,600	498,000
6. Mangosteen	2 "	37,000	74,000
Sub-total	325 "		4,601,000
- Land Cost	325	56,000	18,200,000
Total			27,751,000

Table I.8.1. Lateral/Sub-Lateral Cost

(unit: ฿1,000)

Item	Acreage (ha)	F.C.	L.C.	Total
- Unit cost per hectare	1	(5.926)	(2.708)	(8.634)
- Khlong San Sai	302.8	1,795	819	2,614
- Khlong Ta Liu	11,924.6	70,665	32,291	102,956
Total	12,227.4	72,460	33,110	105,570

I.8.2. Connection Pipe Cost

(unit: ฿1,000)

Item	Acreage (ha)	F.C.	L.C.	Total
- Unit cost per hectare	1	(2.300)	(1.149)	(3.449)
- Khlong San Sai	302.8	696	348	1,044
- Khlong Ta Liu	11,924.6	27,426	13,701	41,127
Total	12,227.4	28,122	14,049	42,171

I.8.3. Terminal End Facilities Cost

(unit: ฿1,000)

Item	Acreage (ha)	F.C.	L.C.	Total
- Unit cost per hectare	1	(48.191)	(20.653)	(68.844)
- Khlong San Sai	192.5	9,276	3,975	13,251
- Khlong Ta Liu	3,345.7	161,232	69,098	230,330
Total	3,538.2	170,508	73,073	243,581

APPENDIX-J. PROJECT ECONOMY AND FINANCIAL ANALYSIS

APPENDIX-J. PROJECT ECONOMY AND FINANCIAL ANALYSIS

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J.1. Financial Analysis

J.1.1. Assumptions on Financial Analysis

The key assumptions on which the financial analysis of the project is based are as follows;

(1) General Assumptions

- Since the orchard trees have the perenniality, the financial analysis represented by the farm budget analysis shall, basically, be done in serial order adopting the time-series analysis.
- Since however, it is actually deserved that the farmers, - once they have noticed that a orchard tree has passed over is peak -, plant immediately a new sapling nearby that tree. Therefore, the farm income from orchard production is, generally, nearly constant after the complete maturity of trees.
- Hence, it is considered that the time-section analysis adopting three time sections onto the project life; viz. the present 1988, and future 2005, keeps the nature of the analysis unchanged.
- The time section of present situation (1988) was adjusted allowing for the yield differential arising from tree maturity. Basically, the present situation used in the project analysis shall be the situation at which the present yield can be adopted, however the yield in 1988 is not yet came up to the present yield, because the bulk of trees are in the initial stage of maturity although they are classified as matured trees.
- Since the goal of this farm budget analysis intends to estimate the affordability to pay for the project, the numeration of farm income (especially income from orchard production) is made in "at-least" basis; viz. i) in the future (2005), the portion of immatured area is same as the present situation except mangosteen and the attainment of average yield would realized only by the matured area at the present situation, ii) 50 years of project life is on the common multiple of 25 years (economic life span of durian and rambutan), therefore the same acreage of matured area was applied on durian and rambutan.

(2) Specific Assumptions

1) Production Costs (Tables J.1.3 to J.1.7)

- Financial price for farm inputs are based the market price in the area mentioned in Table J.1.1 of Appendix J.

- Quantities of inputs required are based on the interviews to the farmers and statistical data and adjusted to average allowing for plant conditions of the farm.

- Land tax on which tabulation is based in the prevailing land tax in Amphoe Makham; as is determined by Tambon, but Amphoe average was adopted.

- Working hours by each farming practice are based on the interview to the farmers and multiplied by 50 Baht of prevailing labor wage rate in the area.

- Loan interest and depreciation amount (represented by others) are the average of 32 farms surveyed and adjusted to per rai basis.

2) Farm Gate Price

- Farm gate prices of major farm outputs used in the financial analysis are based the average of recent three years from 1986 to 1988, which are mainly sourced from Regional Agricultural Extension Office and Agricultural Statistics Office in Chanthaburi, Table J.1.2 in Appendix J denotes the details.

- Farm gate prices applied in the financial analysis do not correspond with that used in the economic analysis, because the prices on the latter are derived from the F.O.B price which reflects the average at most one year.

3) Farm Household Model (Tables J.1.8 to J.1.10)

- The basis on which typical farm household models are classified are farming systems, location, farm and

family size and farm incomes and expenditures inventoried through the farm economy survey totally conducted on 140 farm households in the area.

4) Land Resources (Tables J.1.8 to J.1.10)

- Land resources are categorized by each farm model allowing for the tree stages mentioned above.

- Conversion plans under with project situation are incorporated into the future land resources taking into account the conversion rate mentioned in Main report.

5) Production Disposal (Tables J.1.11 to J.1.16)

- Total production is computed as being multiplied yield by land resource area mentioned above.

- Within this total amount, a portion of the productions are consumed by the family members.

- The remnant is sold at the farm gate price mentioned above.

6) Farm Expenditure (Tables J.1.26)

- Farm expenditures except the production costs are estimated by each farm household based on the results from the farm economy survey.

7) Cash Production Costs and Financial Analysis (Tables J.1.17 to J.1.25 and Tables J.1.27 to J.1.29)

The cash production costs were estimated by farm model under the present and future situation based on their land resources above mentioned, and the surveyed production costs by fruit and crop under the same situation. The following assumptions were made to estimate the cash production costs and financial analysis. The following assumptions relate to those described in Tables J.1.27 to J.1.29.

1. Market Production-- Total crop production minus family consumption.

2. Family Consumption-- Farm production consumed in household.

3. Farm Labor -- Based on prevailing practices in the area. Hired human labor is ₱45 per day and hired machinery is ₱80 per hour.

4. Planting Materials -- Actual cost of planting materials.

5. Interest:
   5.1. Interest -- as mentioned in item 1) above.
   5.2. Land Tax -- -ditto- .
   5.3. Others -- including depreciation costs, farmers' association, farm debt, crop insurance, etc.

6. Total Production Cost -- Sum of items 3 to 5 above.

7. Net Farm Income -- Market production plus family consumption minus total production cost.

8. Cash Income
   8.1. Cash Income -- Market production.
   8.2. Cash Income (Off-farm) -- Average off-farm income by farm model.
   8.3. Cash Income (Non-farm) -- Including subsidiary job and remittance from family members, etc., averaged by farm model.

9. Total Cash Income -- sum of item 8 above.

10. Cash Expenditure
    10.1. Cash Expenditure -- Cash production costs.
    10.2. Cash Expenditure (Other) --- as mentioned in item 6) above.

11. Total Cash Expenditure -- sum of item 10 above.

12. Family Cash Balance -- Total cash income minus total cash expenditure.

J.1.2. Beneficiaries' Willingness-to-Pay

The beneficiaries' willingness-to-pay was surveyed during the field work. The farmers are not suffered from lack of water this year, however the willingness-to-pay for irrigation water deemed to be rather high because many farmers have been learned the severe lesson from the subsistence damage in drought year. Some examples are introduced below;

- Some farmers spent for irrigation water more than ฿2,000/rai in drought year but in spite of that effort their production at that year recorded less than 60% of normal year.

- In drought year number of farmers bought the irrigation water from merchants almost every day from Jan. to Mar., and the merchants sold the irrigation water to the farmers at the price of ฿250-350/12 ton,

- The irrigation water was also sold in spot by two tonnes tank at the price of ฿15-40/tank, and

- In irrigation association at Kratin, they have their own irrigation system. To become an association member and to get one water outlet some ฿45,000 is necessary with additional ฿5,500 of annual operation and maintenance charge. Despite of expensive charge there are so many new applicants.

Taking into account the above mentioned site situation and direct interview to the farmers, the willingness-to-pay for irrigation water on orchard production was assumed at ฿1,000-2,000/rai (Say ฿1,500/rai) in normal year and ฿2,000-4,000/rai (Say ฿3,000/rai) in drought year, respectively.

J.1.3. Government's Subsidization

Even though the financial viability and economic feasibility would have ensured under the project evaluation, the Government's subsidization should be essentially required when allowing for the aspect on measurement of financial and economic benefits. The reasons are discussed below;

- Parallax on costs/benefits from the viewpoint of national and individual economy.

  This express the primary reason. The production increase brings about the augmentation of consumer surplus and in this sense the Government's subsidization is considerable.

- Parallax on discount rate from the viewpoint of national and individual economy.

  The social discount rate is one of the parameter which express the value from the Government side. Since it would be general that the Government gives much significance on the future consumption, the individual discount rate is considered as being higher than that of the Government's. The parallax on discount rate arises much difference on project feasibility, hence, this difference should be subsidized by the Government.

- Difference of time horizon between social and individual view

  The Government's policies have to stand up for the long-term view which sometimes overpass the individual time horizon. Although the benefits which lie in the farm future are being excluded from individual time horizon, but the Government would surely counts them.

- Unbalanced private invest after the project implementation

  The unbalanced investment effectiveness and investment implication would be imperatively incurred after the project implementation. Even though the project would illustrate the financial viability and economic feasibility as a whole, as far as the beneficiaries with lesser invests and implications are being existed, the project without the Government subsidization is impossible to establish.

J.2. Economic Analysis

J.2.1. Assumptions on Economic Analysis

The main assumptions on which the economic analysis of the project is based are;

- The economic project life is 50 years
- Implementation schedule is based on Table 3 in Main Report.
- The financial project costs (local currency costs) are adjusted using the standard and other specific conversion factors to reflect economic costs.
- The farm gate economic prices of major traded commodities are based on World Bank projected world market prices expressed in 1985 constant dollars, converted to local currency at the official exchange rate of US$1.00 = ฿25.50 in 3rd, Oct 1988, and adjusted to resource costs allowing for quality differential (where applicable) and marketing and processing costs.
- The farm gate, economic prices of minor traded and non-traded inputs are based on financial prices and adjusted to economic price by standard conversion factor.

- The farm gate prices of minor traded and non-traded outputs such as specific fruits and cassava are based on the F.O.B price, Bangkok in 1988 sourced from Department of Custom and adjusted to economic farm gate price in the same manner as major traded commodities mentioned above.

- The economic costs of skilled labor are equal to financial costs.

- The economic costs of unskilled labor are based on financial costs adjusted to reflect the opportunity cost of unskilled labor as mentioned in J.2.2.

- No residual and salvage values for the facilities or equipment provided under the project are taken into account.

- All institutional and technical support costs are included in the economic project cost.

- Economic life span for fruits tree is 25 years for durian and rambutan, 50 years for mangosteen and 30 years for Para rubber and no prolongments of economic life span under the project are allowed for.

- Economic life for pump and related facilities for the purpose of replacement is 15 years.

J.2.2. Human Labor

Unskilled rural labor is costed at the market wage rate for the peak period in the financial analysis since labor is hired only in this period. The economic cost of unskilled labor is based on a weighted average of the financial costs of three period of the year; viz. peak, slack and minimum employment period for the present, the future without and the future with project situations.

- Peak Period

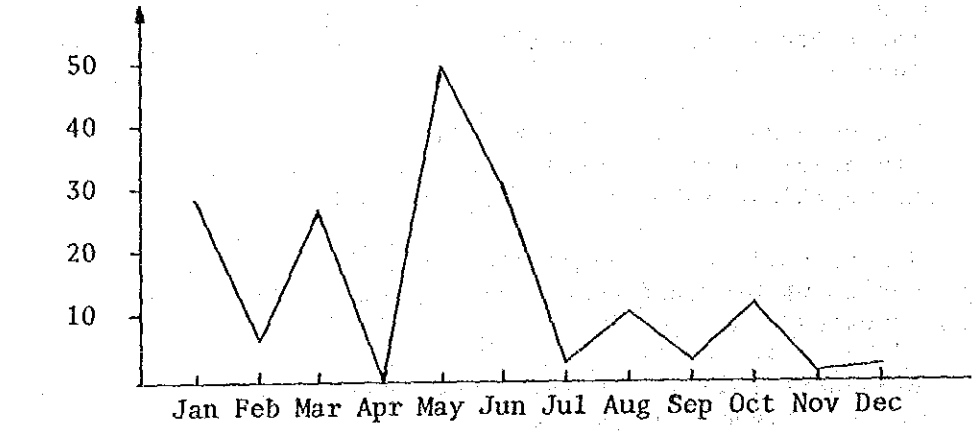
  Unskilled rural labor costs between ฿50/man-day and ฿60/man-day in the peak period. It is estimated that women undertake about 25 percent of the farm work.

- Slack Period

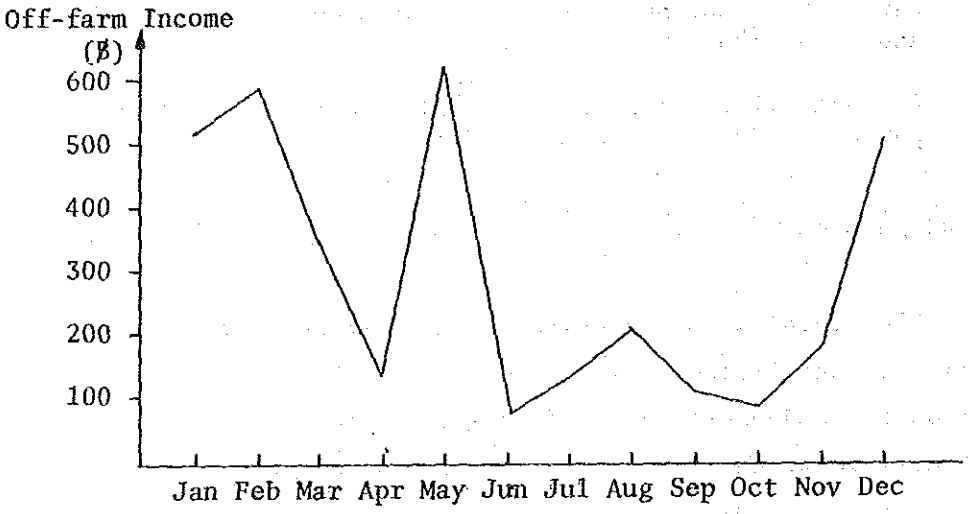
  Unskilled rural labor costs about ฿42/man-day during the slack period with a range of ฿40 to ฿45/man-day.

Labor Requirement

- Hired Labor per Farm for "Large Farms" by Crop and Month



- Off-farm Hired Labor Income by Month for "Small Farms"



- Weighted Average

Jan ... $\frac{27}{167} + \frac{529}{3,626} = 0.31$

Feb ... $\frac{6}{167} + \frac{564}{3,626} = 0.19$

Mar ... $\frac{25}{167} + \frac{355}{3,626} = 0.25$

Apr.... $\frac{0}{167} + \frac{139}{3,626} = 0.04$

May ... $\frac{49.5}{167} + \frac{616}{3,626} = 0.47$

Jun ... $\frac{31}{167} + \frac{83}{3,626} = 0.21$

Jul ... $\frac{3}{167} + \frac{143}{3,626} = 0.06$

Aug ... $\frac{10}{167} + \frac{204}{3,626} = 0.12$

Sept ... $\frac{1}{167} + \frac{118}{3,626} = 0.04$

Oct ... $\frac{12}{167} + \frac{89}{3,626} = 0.10$

Nov ... $\frac{1}{167} + \frac{286}{3,626} = 0.08$

Dec ... $\frac{1}{167} + \frac{500}{3,626} = 0.14$

∴ Peak... May, Jan, Mar, Jun, Feb Dec, Aug.

∴ Slack.. Oct, Nov, Jul

∴ Minimum ... Sept, Apr

- Minimum Employment Period

  An adult consumes the equivalent of ฿2.82 kg of rice per day for a subsistence demand of 2,500 calories per day. The economic prices of rice are ฿4.0/kg and ฿4.61/kg for 1988 and 2000, respectively. The calories content of rice is 3,560 cal./kg. Unskilled rural labor is valued at ฿2.82/man-day and ฿3.24/man-day for 1988 and 2000 respectively during the minimum employment period.

The weighted average cost reflects the economic cost of unskilled labor based on the peak and slack period valued at financial market values and minimum employment consumption valued at economic prices, these are shown in succeeding page.

Demand for and Value of Unskilled Labor

	Present Situation		Future Situation			
			W/O		W/	
Season	% of Total Annual Demand	Cost of Labor (฿/md)	% of Total Annual Demand	Cost of Labor (฿/md)	% of Total Annual Demand	Cost of Labor (฿/md)
Peak	58%	55	58%	55	58%	61
Slack	25%	42	25%	42	25%	45
Munimum	17%	2.82	17%	3.24	17%	3.24
Total	100%	42.88	100%	42.95	100%	47.18
Weighted Average						

฿42.88, ฿42.95 and ฿47.18, are adjusted to ฿39.45, ฿39.51 and ฿43.41 using the standard conversion factor of 0.92.

J.2.3. Conversion Factors and Opportunity Cost of Capital

The standard conversion factor and the other group and specific conversion factors used in the project analysis are illustrated in below;

- Standard conversion factor 0.92
- Consumption Goods Conversion Factor 0.94
- International Goods Conversion Factor 0.94
- Capital Goods Conversion Factor 0.84
- Construction Conversion Factor 0.90
- Transportation Conversion Factor 0.87

The opportunity cost of capital used in the discount rate for the computation of benefit-cost ratio is 13%.

J.2.3. Project Risk

The risks of the project depend to a large extent on the assumptions on yields, adaption rates, prices and implementation schedules. These factors might endanger the economic viability of the project.

The collection of project charge from the beneficiaries is another main risk as well as collection of operation and maintenance charge. It is assumable that the farmers who are enjoying the enough irrigation water in the present are reluctant to pay for it except the drought year and also 10 years of repayment period would somewhat be a burden for them. This factor might also endanger the financial viability of the project.

Benefits and EIRRs would be higher if the export of fruits is favorably accelerated and also they would be higher if economic life span of the fruit trees are prolonged by the project.

It is assumed in the calculation of benefits that, upon having enough irrigation water and adequate tree management, the yield of fruits would increase approximately 20%, however if this assumption is not realized, the economic viability would be significantly reduced. It is strongly recommended that yields are evaluated during the implementation of the project.

Some risks are anticipated on conversion of Para rubber to fruit tree. It depends solely on the farmers' intention. As of now, f.o.b price of para rubber meets a business upturn and the rubber planting farmers are given several advantages under Government's tactics, therefore, 20% of conversion rate to fruit plantation may be more or less high.

Toward about 55 households of evacuee incurred from No. 5 dam construction, the Government must compensate their estate and guarantee their future. The earliest land acquisition by the Government lessen the financial risk of the project.

It is considered that the fruit trees would be to a large extent affected by meteorological, soil chemical and the other delicate environmental conditions, therefore even if the project would have implemented in the manner, the project benefits might not arise in a right way, however on the other hand, the metempirical benefits could also expected, and as is the biggest risk of the project.