reaches are proposed to receive supplemental irrigation water from the Pak Mun Project, totaling 5,400 ha of paddy fields to be included in the Pak Mun project.

F-2-4. Summary of Overall Basin Development

(1) Rehabilitation Scheme

Rehabilitation projects in the study area are summarized in Table F-9. A total of beneficial area by rehabilitation is reached to 5,090 ha.

Rehabilitation projects included with the on-farm development will produce promptly agricultural benefits by small amount of investment so that its implementation shall be given a high priority.

(2) New Development Scheme

New development projects by storage and run-of-river scheme in the Sebai-Sebok basin and under Pak Mun project are summarized in Table F-11. A total irrigable area inclusive of Pak Mun related projects is about 42,400 ha. After implementation of all those project, the irrigation rate in the basin will be improved to about 18% from 5.8% of present rate.

From the viewpoints of effective use of water resources and economical investment, implementation of medium scale projects shall be given a high priority for development.

F-2-5. Medium Scale Project

(1) Potential Project Sites

In the initial stage of this study, RID presented to the study team 33 potential storage projects as medium scale irrigation project, of which five projects have been studied on a preliminary level by RID for their technical soundness, in response to the strong request by the farmers.

Selection of potential project sites was made firstly by using topographic maps scaled 1:50,000 and aerial photographs. Then field reconnaissance survey was conducted. As a result of the selection of potential project sites, one site was added and eight sites were excluded from the list of potential project sites, leading to the selection of 26 potential projects of storage scheme. Eight sites were excluded due to the following reasons;

- Two sites are located within or in close proximity of the existing reservoirs constructed by RID or other agencies;
- Four sites might belong to the small scale irrigation project because of their small reservoir capacities and/or small catchment areas;
- Further investigation is not proposed for one site because potential beneficial area is located in close to other potential project; and
- Expected reservoir area of one site is cropped to rice for 330 ha, larger than the estimated irrigable area, and average storage water of the reservoir was assumed to be only one meter in depth.

The present conditions of 26 potential project sites are summarized in Table F-12 (1/7)~(7/7), and their locations are shown in the attached drawings.

Basin	Province	Nos. of Project	Catchment Area (sq.km)
Sebai	Yasothon	5	115.0
	Ubon Ratchathani	2	32.0
Sebok	Ubon Ratchathani	14	387.8
Tung Lung	Ubon Ratchathani	5	124.7
Total		26	659.5

(2) Preliminary Project Features

a) Reservoir Capacity

Each reservoir capacity was calculated based on the following materials.

- 11 projects (BA-5, BA-8, BA-9, BO-3, BO-11, BO-13, BO-17, BO-18, TL-1, TL-5, TL-6);
  Reservoir area topo-maps scaled 1:10,000 surveyed by RID, Topographical Survey Div.
- 4 projects (BA-1, BA-2, BA-6, BO-2);
  Pre-feasibility study reports prepared by RID, Planning Div.
- 11 projects (BA-4, BO-6, BO-8, BO-9, BO-10, BO-12, BO-14, BO-15, BO-19, TL-2, TL-3):
  Topographic maps scaled 1:50,000, and dam profile sections along the dam axis surveyed by RID, Topographical Survey Div.

Almost all reservoir capacities were determined by the limitation of topographical condition in the respective project sites. But those of

BA-8 and BO-13 were determined through reservoir operation studies as possible reservoir capacities were lager than annual inflow to the reservoirs.

b) Preliminary Project Features

The project features for each potential project were preliminarily planned as shown in Table F-13 (1/4) ~ (4/4), under the conditions described below:

- Dam type : Earth fill type dam with slope of 1:3.0 at upstream and 1:2.5 at downstream
- Width of dam crest : 6.0 m
- Free-board : 1.5 m from maximum high water level
- Sediment volume : 150 cu.m/year/sq.km x 100 years x watershed (sq.km)
- Design flood of spillway : A probable flood with a return period of 100 years
- Design discharge of spillway : Based on the results of flood routing analysis

The estimated height and embankment volume of dam very from 7.6 m to 18.5 m and 26,400 cu.m to 449,000 cu.m, respectively.

F-2-6. Preliminary Study on Supplemental Irrigation

(1) General

About 82% of the existing paddy fields, which are not covered by the proposed basin development plan, will have to rely on rainfall for their irrigation because there are no possible reservoir sites and the discharge of free-flowing river stream nearby the areas is far less than irrigation water demand. The average annual rainfall over the basin varies from 1,400 to 1,800mm, being more than the crop water requirement by paddy of about 600mm ; however, effective use of rainfall is hardly attained without provision of storage reservoir due to uncertainty of rainfall pattern.

A preliminary study was made on the possibility of retaining rain water in a farm pond to be excavated in a paddy field area. The farm-pond may be

constructed in a natural depression, swampy area or paddy field. For irrigation of rainy season-paddy, it needs installation of a small pump and construction of irrigation canals and catch drains to lead rain water into the farm pond. The size of a study area was assumed to be 34ha(or, 210 rai) ; total area of 10 farmers who have 3.4 ha of paddy fields that is about the average farm size of the Sebai-Sebok basin.

(2) Case Study

a) Given Conditions

It is assumed that land necessary for construction of ponds and other facilities is to be provided by farmers concerned. Three optional sizes of the farm-pond were set for the preliminary study ; 10%, 7% and 5% of the study area which might be acceptable by farmers for irrigation purpose.

Paddy cropping and irrigation will be practiced under the following conditions ;

- Crop : Paddy of local varieties
- Crop calendar : Refer to Table E-3, transplanting in middle July and harvesting in middle November.
- Water requirement : Refer to Appendix E
- Rainfall : Records at station 72052 with the average annual rainfall of around 1,400mm
- Effective rainfall : Refer to Appendix E
- Irrigation efficiency : 0.9 at a farm level

b) Field Water Requirement

Field water requirements were calculated. Of 1,078mm of water needed for growing rainy season paddy including crop consumptive use, land preparation water and percolation losses, 709mm is fed by rainfall and 369mm of water (or, 34% of field water requirement) is to be supplemented by irrigation

Item	Month	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Total
ETo 1/	(mm)	143	157	143	132	143	148	
Kc 2/			0.5	1.50	1.17	1.15	0	
Cu 3/	(mm)	-	78.5	214.5	154.4	164.5	0	611.9
Land preparation	(mm)	125	125					250.0
Percolation	(mm)		32	62	60	62		216.0
Sub-total	(mm)	125.0	235.5	276.5	214.4	226.5	0	1,077.9
Rainfall	(mm)	188.4/2	235.4	292.6	254.8	93.7	8.1/2	
ER 4/	(mm)	141.4/2	176.6	200	191.1	70.3	0	768.7
FWR 5/	(mm)	54.3	58.9	76.5	23.3	156.2	0	369.2

1/ ; Evapotranspiration
2/ ; Crop factor
3/ ; Crop consumptive use
4/ ; Effective rainfall
5/ ; Field water requirement

c) Pond Operation Study

Water operation of farm-ponds with different storage capacities was examined to present the water balance of ponds between outflow from ponds including irrigation water release and loss water from ponds and inflow into ponds from the catchment area of 34ha(210rai), the same area to the service area. The storage capacities of ponds were based on a water depth of 2.0m. The pond operation study was made under the following conditions ;

- Runoff coefficiency

  Irrigation period ; Rainfall less effective rainfall

  Non-irrigation period ; Refer to Type D in Figure F-11.

- Evaporation from pond ; 70% of pan-evaporation
- Seepage through pond ; 2 mm/day
- Storage capacities ;

Case	Service Area (ha)	Pond Area (ha)	Storage (cu.m)
A	30.6	3.4	65,000
B	31.6	2.4	45,000
C	32.3	1.7	34,000

Table F-26 shows the inflow into ponds and outflow from ponds for the above 3 cases. The pond operation studies reveal that in the area where the average annual rainfall is around 1,400mm, the lowest in the Sebai-Sebok basin, the proposed farm ponds can not retain rain water enough to irrigate the rainy season paddy, and can supplement the field water requirements at the rates of 75%, 70% and 60% for CaseA, CaseB and CaseC, respectively. Additional studies were made by applying the average annual rainfall of around 1,800mm, the highest in the Sebai-Sebok basin, resulting in the supplementary rates of 100% for CaseA and CaseB 75% for CaseC. The rates of supplemental irrigation to the field water requirement are summarized below ;

Rate of Supplementation (%)

	Annual Rainfall	
Case	1,400 mm	1,800 mm
A	75	100
B	70	100
C	60	75

In case that farmers agree to offer only 5% of their own paddy fields for construction of a farm pond. The farm pond is able to provide for supplemental irrigation water equivalent to 60 to 75% of the field water requirements of rainy season paddy. However, by timely, effective supply of storage water to meet irrigation demand according to the growing stage of paddy, yields of paddy might be increased to a considerable extent, but not to 100% of the potential maximum yield of paddy.

In the Sebai-Sebok basin where annual rainfall is comparatively abundant, retation of rain water at a farm level by means of excavating a farm pond might be a technically feasible countermeasure to supplement rainfed environment. The key to successful implementation of a farm pond plan is to give an incentive to farmers to join the plan.

F-3. Five Project with High Priority

Dam and reservoir plans for the five priority projects of Lam Se, Huai Khum Kham, Huai Kham Pak Wan, Huai Na Khai and Huai Soob selected among 26 potential projects are presented bellow ;

F-3-1. Reservoir Plan

Dimension of each reservoir was planned as shown in Table F-14, under the following conditions.

- The reservoir area - capacity curves of the proposed five projects were prepared as shown in Figure F-4 (1/5) - (5/5) basing on the topo-survey maps scaled 1:10,000 for Lam Se, Huai Khum Kham, Huai Kham Phak Wan and Huai Na Khai, and scaled 1:4,000 for Huai Soob all of which were provided by RID's Topographical Survey Division in June, 1989.
- The reservoir capacities of Lam Se, Huai Khum Kham, Huai Na Khai and Huai Soob were determined by the limitation of topographical conditions in the respective project sites. While that of Huai Kham Phak Wan was set up by the reservoir operation study because of larger reservoir capacity than the average annual runoff.
- The sediment volumes in the reservoirs were estimated by the following equation.

  Sediment volume = 150 (m^3/km^2/year) x catchment area (km^2) x 100 (years)

- L.W.L of four reservoirs were established corresponding to the surface of sediment, but that of Huai Na Khai was decided considering the ground level of its service area to irrigate as wider as possible.

F-3-2. Dam Design

(1) Seismology

According to "A Seismic Zoning Map for Thailand and Neighbouring Regions" as shown in Figure F-5, the project sites locate in the Zone 0 "No damage area of earthquake".

While the earthquake records "Statistics of Earthquakes in Thailand 1975 - 1985 " provided by the Meteorological Department (MD) indicates that the earthquakes of more than 4.0 Magnitude occurred 38 times in Thailand

during 13 years from 1975 to 2530 (2518 to 2530), and happened in the northern part especially nearby Burma.

The maximum acceleration at a site can be presumed by applying the Okamoto's formula as shown below:

$$\text{Log}_{10}\ \frac{Ac}{640} = \frac{(D+40)}{100} \times (-7.604 + 1.7244\,M - 0.1036\,M^2)$$

where, Ac : Maximum acceleration (Gal)
M : Magnitude
D : Distance from the dam site to the earthquake epicenters (km)

In case that M = 8 and D = 400 km were substituted in the above formula, the maximum acceleration becomes 7.5 Gal and the ratio K of seismological acceleration to gravity acceleration is 0.008.

Basing on the said records, the biggest acceleration during 13 years was calculated as follows:

Earthquake epicenter

Date	:	17 Feb., 1975 (2518)	
Location	:	Latitude	17.6 N
		Longitude	97.9 E
		Depth	6 km
Magnitude	:	5.6	
Maximum acceleration at Ubon Ratchathani Province	:	9.2×10^{-9} (gal)	

In addition, according to the information by MD, the earthquake which happened at the nearest place from the project sites was as follows:

Earthquake epicenter

Date	:	18 Oct., 1985	
Location	:	Laos	
		Latitude	18.03 N
		Longitude	104.79 N
		Depth	21 km
Magnitude	:	4.7	
Maximum acceleration at Ubon Ratchathani province	:	4.27×10^{-7} (gal)	

From the results of the above study, the project areas are not considered to be affected by any earthquake; however considering the importance of such structure as a dam, the ratio K of seismological acceleration shall be 0.05 g as minimum one.

(2) Construction Materials

a) Core and Random Materials

RID carried out such soil investigations for the dam embankment materials in the reservoir areas as test pits and auger boring with a total number of 62 and 222, respectively.

Based on the results of reconnaissance survey and soil investigation, the characteristics of the each borrow area are summarized as follows ;

Lam Se :

Major soils consist of CL, SC, SM and ML lacking gravel and cobble. Abundant volume of impervious materials such as CL, SC and ML, and some GC are available.

Huai Khum Kham :

Major soils consist of GC, CL ML and SM. Large volume of GC and CL materials are expected to be obtained.

Huai Kham Phak Wan :

Major soils with thin layer above rock surface consist of SM, GC, CL and ML materials. Weathered sandstone and shale available for construction materials in random zone with adequate compaction, but easily collapsed with water in case of remaining of rock shape, are underlain below soils.

Huai Na Khai :

The characteristic of the borrow area is similar to that of Huai Kham Phak Wan because of shallowness of the bed rock. Small amount of impervious materials such as GC, SC and CL is distributed.

Huai Soob :

In spite of sandy ground surface, comparatively large amount of impervious materials such as SC, GC and CL are underlain in the borrow area.

In order to avoid dispersive soil for the embankment material, the crumb tests of clayey and silty soils were performed in the borrow areas as preliminary inspection. The results indicated that all soils belonged to the grade 1 "Non-dispersive".

However, according to the results of dispersive clay identification test in the RID laboratory, only two samples of Lam Se project were identified as dispersive soil. Such material is presumed to exist in the low plain along Lam Se.

In addition, the quantities of materials in the each borrow area are approximately estimated basing on the test pits, the auger borings and the reservoir area maps scaled 1:10,000 as below;

Assumed Quantities of Soil Mareials

(unit ; 1,000 cu.m)

Material (Unified Classification)	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob
CL	1,585	403	402	617	598
SC	216	16	34	88	212
GC	-	578	250	133	284
ML	165	103	324	47	-
SM	188	283	228	271	757
GM	-	54	135	111	26
Total	2,254	1,437	1,373	12,67	1,877

b) Riprap, Sand and Gravel Materials

Such construction materials as riprap, sand and gravel are available by procuring from the sites as shown in Table F-15.

c) Soil Laboratory Test

A total of 34 of dispersive clay identification test, 48 of physical soil test and 19 of mechanical soil test were carried out at the RID Laboratory to grasp the properties of materials as shown below.

Number of Soil Test

Test Item	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob	Total
1. Dispersive Clay Identification Test	6	7	8	5	8	34
2. Physical Soil Test						
- Field Moisture	4	5	6	5	9	29
- Specific Gravity	7	9	10	9	13	48
- Atterberg Limit	7	9	10	9	13	48
- Grain Size Analysis	7	9	10	9	13	48
3. mechanical Soil Test						
- Compaction Test	3	4	4	4	4	19
- Direct Shear Test	3	4	4	4	4	19
- Permeability Test	3	4	4	4	4	19

The results of soil tests are summarized in Table F-16 (1/3) ~ (3/3). The mechanical soil tests by unified soil classification are also summarized in Table F-17.

(3) Dambody

a) Dam Type

Selection of suitable dam type shall be made basing on such overall views as the scale of dam, site's topography and geology, quality and quantity of available construction materials, etc.

In case of five sites, the earth fill type dam shall be applicable taking account of the following conditions :

- The sites are gentle slope. (The dam span and height ratio at the most steep slope site is about 30).
- Obtaining construction materials especially impervious materials for fill dam nearby the sites is possible in quantity and quality.

  Dispersive soils which are to be avoided for the fill dam embankment were not found in the borrow areas except only a few area along Lam Se.

- Earth fill type dam is the most economical one among the various dam types. (refer to Table F-18 and F-19, and Figure F-6 (1/4) ~ (4/4).
- Easiness of construction works.

Furthermore, judging from the quantity and quality of materials in the borrow areas together with excavated materials from the structure's sites, and the geological conditions of dam foundations, each site will select the following dam type.

Project Site	Application
- Lam Se	Homogeneous dam with earth blanket
- Huai Khum Kham	Zone fill dam with curtain grout
- Huai Kham Phak Wan	ditto
- Huai Na Khai	ditto
- Huai Soob	ditto

b) Design Values and Conditions

i) Design Values

Unit weight;

Core zone together with earth blanket zone shall be compacted with more than 98 percentage of optimum dry density because of important zone of seepage. But outer-shell zones will be controlled with more than 95 percentage of that.

Shearing strength;

Direct shear tests under the conditions of compacted 95 percent of optimum dry density were conducted aiming to obtain the shearing strength of embankment materials. In the direct shear test, the design shearing strength is generally evaluated with less than 80 percent value of that due to mechanism of the test.

From the results of soil test, the unit weight and shearing strength by soil group are summarized as below;

Soil	Gs [2]	D value[1] = 95%		D value = 98%		Direct Shear	
		rt [3]	rsat [4]	rt	rsat	C [5]	φ [6]
		(t/m³)	(t/m³)	(t/m³)	(t/m³)	(t/m²)	(°)
CL~ML	2.73	2.01	2.07	2.04	2.10	1.0	20[7]
GC	2.79	2.06	2.11	2.10	2.15	1.0	24
SC~ML	2.75	2.07	2.14	2.11	2.18	1.0	26
GM	2.77	2.19	2.20	2.23	2.26	1.0	28

1) D value ; Compacted dry density /Optimum dry density x 100
2) Gs ; Specific gravity
3) rt : Wet unit weight
4) rsat ; Saturated unit weight
5) C ; Cohesion
6) φ : Angle of shear resistance
7) The value was decided referring to the previous design data

ii) Design conditions

Referring to the existing dams in the northeastern (Table F-21 and Figure F-7) and basing on the previous experience, the design conditions of dam are as follows;

- Width of dam crest : 6.00 m
- Free board : 2.00 m from H.W.L
- Slope : 1:3.0 for upstream
  : 1;2.5 for downstream
- Coefficiency of earthquake: 0.05g

c) Stability Analysis

Basing on the design values aforementioned and dam typical sections shown in the attached drawings, the stabilities of dambody were analyzed by applying a computer under the following conditions.

- Method : Slip circle slice method
- Cases : Two cases (up and downstream)
- Conditions

- Water level : Normal full water level (N.W.L)
- Seismic force : 0.05 g (100%)
- Seepage : Seepage flows in steady state at N.W.L.
  Proportion of (Kv/Kh) = 1/5
- Such zones as riprap, rockfill and drain were not considered in stability due to small zone.

The results of analysis are shown in Figure F-8 (1/10) ~(10/10) and summarized in the table below.

Safety Factor of Critical Circle Slice

Dam	Upstream	Downstream
- Lam Se	1,232	1,239
- Huai Khum Kham	1,213	1,442
- Huai Khan Phak Wan	1,340	1,579
- Huai Na Khai	1,281	1,517
- Huai Soob	1,258	1,489

The results indicate that all dams meet the minimum requirement ; the safety factor of more than 1.2, therefore the designed slopes are safe from sliding.

(4) Foundation Treatment

Foundation of the fill type dam shall fill the following requirements :

- Sufficient shear strength ;
- Minimal deformation settlement ;
- Minimal seepage ; and
- No seepage failure and liquefaction.

In order to meet the conditions mentioned above, the foundation shall be treated as below:

a) Excavation

i) Stripping

Thickness of top-soil contained with organic materials in the sites varies normally 0.1 to 0.3 m but somewhere reaches to 0.5m. Therefore, the thickness of stripping shall be 0.5 m.

ii) Foundation of dam-body

Considering the scale of dam, the dam-body shall be placed on the ground with N value of more than 15 - 20.

iii) Earth blanket and core trench

- From the viewpoint of seepage control in the foundation, the surface layer with more than n x 10^{-3} cm/sec of K value shall be excavated as an earth blanket foundation.
- Excavation line of core trench for grouting shall be established on the ground of more than CL class rock taking account effectiveness of grouting.

b) Grouting

Since the rock surfaces at the sites of Huai Khum Kham, Huai Khan Phak Wan, Huai Na Khai and Huai Soob are shallow, and their layers have comparatively high permeability, the grouting method is applied to the seepage control of those foundations. Based on the previous experience, the grouting plan is made as follows:

- Distribution

  ° Interval of row : 1.50 m

  ° Interval of hole : 3.00 m

- Depth

  ° Curtain grout A row :
  - To cover 20-50 Lu area but not more than max water depth.
  - D = C + H/3
    (C = H max/3, H: water depth)

  ° Curtain grout B, C row :
  - To cover 50-100 Lu area but not more than 2/3 of max water depth.

- D = C + H/4 (C = Hmax/4)

° Blanket grout D, E row : - To cover over 100 Lu area but not more than 1/2 of max water depth.

- D = C (C = Hmax/4)

- Grouting works shall be conducted from the pre-excavation line. After completion of grouting works, the rock of 1.0 m depth shall be excavated till the final excavation line.

c) Earth Blanket

The cover soil in the Lam Se site is rather deep as shown in the attached drawings, and comparatively impervious except some part on the river-bed, so that the earth blanket will be adopted for the seepage control of foundation.

Maximum required length of earth blanket on the river-bed was approximately estimated to 140 m from the dam axis basing on allowable water volume of seepage through the foundation.

(5) Spillway

a) Design Discharge

Design discharge of spillway was calculated taking into account effective storage of the design flood above normal water surface. The relationship between inflow and outflow in a reservoir can be expressed by the following equation:

$$Vtn = Vtn-1 + \left[\frac{Qtn + Qtn-1}{2} - \overline{Qdtn} \right] \times \Delta T$$

where ;

Vtn	;	storage accumulated at tn time
Vtn-1	;	storage accumulated at tn-1 time
Qtn	;	inflow at tn time (cu.m/s)
Qdtn	;	average outflow during T (tn -tn-1) (cu.m/s)
t	;	interval of time from tn to tn-1

Applying the above formula, discharge of spillway was calculated, and the inflow and outflow hydrographs of Huai Soob reservoir are shown in Figure F-10 as an example.

Project	Catchment Area (km^2)	Design Flood (cu.m/sec)	Design Discharge (cu.m/sec)
Lam Se	22.4	222	67
Huai Khum Kham	36.8	239	104
Huai Kham Phak Wan	13.5	157	56
Huai Na Khai	31.3	316	78
Huai Soob	18.5	239	134

b) Type of Spillway

Taking into account the topographical and geological conditions at each site and economy of structure, the duck bill type weir is employed.

(6) Outlet

a) Design Discharge

Design discharges are determined basing on the peak water demands of the service areas as follows:

Project	Outlet	Design Discharge (cu.m/sec)
Lam Se	Left	0.90
	Right	0.85
Huai Khum Khan	Left	2.29
	Right	1.87
Huai Kham Phak Wan	Left	1.52
Huai Na Khai	Left	3.36
Huai Soob	Left	0.61
	Right	0.86

b) Conduit Pipe

In case that the conduit pipe would be builded on the ground i.e. embedded in the dambody, tension stress and/or deformation

settlement will be caused around the area contacted with the pipe. The conduit pipe therefore, shall be embedded in the original ground (rock-bed).

(8) Project Features

As the results of planning of each project, the project features are shown in Table F-22.

F-3-3. Environmental Impact

Environmental impacts on the surrounding areas of the proposed reservoir might be studied and assessed in the near future in line with "Guidelines for Preparation of Environmental Impact Evaluation" provided by the National Environment Board (NEB) in April 1979.

In this report, the preliminary evaluation for the construction of dams is made based on the results of field survey, as below ;

(1) Preliminary Evaluation

a) Major Beneficial Impacts

i) Physical resources

- to make effective use of valuable water resources by ponding the excess water during the rainy season.
- in the area, rainfed farming with low agricultural production practices widely. Illegal and disorderly distraction of forest area are occasionally caused in order to expand cultivation area for improvement and stabilization of farmer's living standard. Irrigated agriculture will not only rise up directly agriculture yield but also play an important role of conservation of such natural resources as water, land and forest.
- to renew original function of downstream river by releasing constant water from reservoir.
- to conserve land resources by flood control in reservoir, although chronic river-bed erosion and soil washed are caused in the existing rivers by rainy season flood.

ii) Ecological resources

- to supply any amount of protein food to the villagers by implementing inland fishery programs in the reservoir, while almost all existing rivers are dried up at present during the dry season.

- to make the surrounding and upstream areas of reservoir a green belt zone i.e. conservation areas where are effective for wild animal and forest preservation, and prevention of land erosion by utilizing ponded water.

- to build a wider green area of agricultural vegetation together with land conservation by introducing irrigated agriculture.

iii) Quality of life values

- to develop and improve regional transportation means by building appurtenant and access roads to and around the project sites.
- to utilize effectively ponded water as fire prevention water for forest.
- to create preferable conditions for living by erection of recreation and resort areas with nice view of a reservoir and waterfront.

b) Major Research Subject

In principle, the reservoir construction in the project will not cause large environmental problems on the surrounding areas since the project scale is comparatively small. However, health problems caused by the reservoir construction shall be researched and studied in future.

Such tropical and subtropical diseases as malaria, schistosomiasis and filaria disease are endemic in high temperature swamp areas where will be formed by the construction of a reservoir.

A carrier of malaria, mosquito will not oviposit in the reservoir itself but in surrounding area such as appurtenant canals. Black fly carrying filaria disease propagates at low flow areas nearby the spillway and floodway. Schistosomiasis intermediating aquatic snail invades into man at water-side.

In some cases, a new constructed reservoir becomes a propagating area for amoebic bacill and/or other infectious disease bacill.

In order to prevent such carriers as fly, mosquito and mollusk from living in the new constructed reservoir, the following countermeasures shall be taken;

i) to educate rural people about health, sanitation, social rule, preventive medicine, etc.

ii) to remove plants before ponding water in the reservoir

iii) to fill, dredge and/or drain the surrounding low land of the reservoir at the time of low water level not to make marsh.

iv) to operate the reservoir so as to fluctuate in water level at the term of oviposition.

v) to plant toxic grass and trees for snails which are carriers of schistosomiasis.

vi) to spread insecticide not hazardous for humen and animals.

(2) Environmental Research

As aforementioned, this project aims to improve the living standard of rural people relying on increase of agricultural production by effective use of water resources. In addition to the above, it will play a role of flood control, renewal of fishery and conservation of land and forest resources by reservoir construction.

Lake front and its vicinity form a preferable circumstance for human life as a recreation area. Moreover, the areas are useful for conservation of forest and preservation of wild -animal. While, the construction of dams and reservoirs will have impact on the environment of the surrounding area. There will occur noise problem, water quality corruption and deforestation during the construction period of the dam, and social and economical impacts for resettling submerged villages. From the view points mentioned above, the reservoir construction has both merits and demerits. Therefore environmental research and study are required before and/or during the preparation of detailed reservoir plan.

The guideline aforementioned states that an initial step to be taken in the first or preliminary stage of project planning is to carry out an Initial Environmental Examination (IEE) for the review by NEB, and that if IEE indicates a need of a follow-up study, then an appropriate EIS (Environmental

Impact Statement) report is to be prepared in sufficient scope and detail by the agency or individual who proposes the project. IEE is essentially an initial examination of the environmental effects potentials of a proposed project, which would be done within a very limited budget based mostly on the preliminary information at hand or no information that can be readily obtained. The environmental parameters to be included in the IEE are the same as in a full-scale EIS study, however, the objective is not to make the actual detailed evaluation for each environmental parameter, but rather to reach a decision on whether such evaluations are needed.

The EIS study is therefore to be undertaken during the stages of the planning and construction and also the dam filling and stabilizing, with the recommended time schedule prepared by NEB as given in Figure F-10. Environmental parameters to be included in the EIS report for dam/reservoir project are thus summarized in Table F-23 (1/2) ~ (2/2).

F-3-4. Recommendation for Detail Design

Before and/or during the detail design stage, the following survey works and tests for dam design are recommended to be carried out.

(1) Topographic Survey

Major requirements consist of profiles and cross sections along the center of structures and the topographic maps of borrow areas. Those requirements are shown in Table F-24.

(2) Soil and Geological Survey

a) Geological investigation

In this feasibility study stage, reconnaissance survey and borehole drilling with about 300m interval along the dam axes were conducted. In order to grasp geological conditions of dam foundations continuously and in detail, seismic exploration and dense borehole drilling are required as shown in Table F-25.

b) Soil investigation

Amount of impervious materials in the investigated borrow areas of Huai Kham Phak Wan and Huai Na Khai sites are not adequate in volume, therefore those two sites are required to be investigated

newly to find out new borrow areas. Additional investigation for other three sites shall be conducted in detail. Minimum requirements are shown in Table F-25.

TABLE F-1 : REGIONAL CHARACTERISTIC OF GROUNDWATER

Region	Major Aquifer	Typical Field	Quality	Remarks
(1) Northern Highlands	Alluvium deposit and old terrace deposit/Chiang Mai, Lampang, Mae Chan and Phra	- Shallow well 25 m^3/hr (10 m drawdown) - Deep well (50 m depth 50 m^3/hr - Old terrace (200 m depth) 150-200 m^3/hr (30 m drawdown)	Good for drinking and agriculture	
(2) Upper Central Plain	- Alluvium deposit/Ping, Yom and Nan rivers - Old terrace deposit (200-300 m thickness)	- Depth: 60 m /10-70 m^3/hr Northwest-west/30 m^3/hr Central-west/250 m^3/hr	Available as potable water Good	
(3) Lower Central Plain	Flood Plain (150 x 200 km) /Chao Phrays and The Chin rivers	Depth: 120 m /300-400 m^3/hr		- Land subsidence - Flood problem
(4) Khorat, Plateau (Northeastern)	(4-1) Upper Khorat/Flood plain (4-2) Lower Khorat (4-3) Western side of Plateau Larbonate aquifer (4-4) Alluvium deposit/Chin, Mun river (4-5) Alluvium deposit/Mae Khong river	Freshwater Depth: 60 m /5-50 m^3/hr Depth: 30-60 m /5-25 m^3/hr 10-100 m^3/hr 25 m^3/hr (50 m drawdown) Depth: 40 m /100 m^3/hr	Mostly salty water Good Good	
(5) Mae Klong Basin	Lower part of basin Alluvium plain	40 m^3/hr	Available for agriculture	- Shallow unconfined aquifer
(6) Peninsula	Coastal plain (450 x 22 km^2)	10-200 m^3/hr		
(7) Eastern	- Alluvium and terrace deposit - Limestone aquifer (near Cambodia)	7-10 m^3/hr 10-20 m^3/hr	Good as potable water	Least groundwater potential

Source: Thailand Natural Resources Profile, TDRI, May 1987

TABLE F-2 : RESERVOIR CAPACITY IN NORTHEASTERN REGION & REGION 5

RID Region	Basin	L/M Project (MCM)	S Project (MCM)	O Project (MCM)	Total (MCM)	Share (%)	Area (km^2)
Region 4		340.29	148.88	4.07	493.24	10	50,500
Region 5	- Song Khram	566.05	39.05	5.55	610.65	12.6	13,297 at Kh.22
	- Nam Kam	58.07	31.65	11.95	101.67	2.1	3,424 at Kh.19
	- Chin/Lam Pao	1,386.20	14.88	--	1,401.08	28.8	47,818 at E.20
	- Nam Yang	53.23	21.88	--	75.11	1.5	3,946 at E.19
	- Lam Sieo	20.21	1.61	--	21.82	0.5	672 at M.35
	- Sebai	65.45	26.35	--	91.80	1.9	3,950
	- Sebok	24.94	7.66	--	32.60	0.7	3,730
	- Dom Yai	17.00	13.35	--	30.35	0.6	134 at M.80
	- Tank Project	99.20	57.73	5.50	162.43	3.3	
	Sub-total	2,290.35	214.16	23.00	2,527.51	52	57,800
Region 6		1,642.87	190.08	4.07	1,837.02	38	60,600
Total		4,273.51	553.12	31.14	4,857.77	100	168,900

Note: a) Data source; Water Resources in Thailand (RID)
(completed to the end of 1987 and under construction in 1988)
/Large-Medium Scale Projects, Small Scale Irrigation Project

TABLE F-3 : CONSTRUCTION AND UNDER CONSTRUCTION MEDIUM SCALE PROJECTS IN THE STUDY AREA

Description	Huai Pho	Rong Nam Sap	Puttha Utthayan	Nong Chang Yai	Sa-Saming	Huai Tamkhae	Huai Ling Chon	Huai Sa Back
1) Location								
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Yasothon	Yasothon
- Amphoe	Amnat Charoen	Amnat Charoen	Amnat Charoen	Muang Sam Sip	Muang Ubon	Trakan Phut Phon	Leong Nok Tha	Loeng Nok Tha
2) River								
- Basin	Sebai	Sebai	Sebai	Sebok	Sebok	Sebok	Sebai	Sebai
- River	Huai Pho	Rong Nam Sap	Huai Pla Daek	Nong Chang Yai	Sa-saming	Huai Thamkhae	Huai Ling Chon	Huai Sa Back
- Watershed (sq.km)	17	1.7	62	62	2	52	51	49
3) Reservoir Capacity (MCM)	5.39	0.42	15.34	7.68	1.01	16.25	17.5	26.8
4) Irrigable Area (ha)	720	67	2,560	1,200	120	1,680	2,400	1,920
5) Dam								
- Dam Type	Earth	Earth	Earth	Earth	Earth	Zone	Earth	Earth
- Height (m)	6.0	5.0	13.5	5.5	4.0	18.5	13.5	19.0
- Length (m)	510	780	1,300	640	250	1,826	2,050	1,932
6) Intake (cms)	1.213	0.052	2.477	5.78	0.081	8.70	2.0	6.15
7) Canal (Channel)	2	1	2	2	1	2	2	2
(km)	17.9	1.7	21.3	15.9	1.2	18.0	48	41.6
							120	100
8) Construction Team	1953-1956	1952-1956	1957-*1 1963	1953-1954	1953-1953	1984-1986	1987-1990	1986-1990
9) Agency	RID	RID	RID	RID	RID	RID	RID	RID

Note: *1 ... rehabilitated in 1985 - 1987

TABLE F-4 : MAJOR EXISTING SSWR PROJECTS IN THE STUDY AREA

Changwat	Amphoe	RID Project*1 Number of Project	RID Project*1 Reservoir Capacity (MCM)	RID Project*1 Irrigable Area (Rai)	Other Agencies Project*2 Number of Project	Other Agencies Project*2 Reservoir Capacity (MCM)	Other Agencies Project*2 Irrigable Area (Rai)
Yasothon	Muang Yasothon	1	--	500	4	0.043	2,500
	Kham Khuan Kaeo	10	4.446	3,300	5	0.076	3,492
	Kut Chum	11	3.633	2,560	4	0.008	1,400
	Loeng Nok Tha	29	9.427	8,110	5	0.025	1,215
	Pa Tiu	8	1.455	1,150	2	--	150
	Sai Nam	1	0.068	20	--	--	--
	Sub-total	60	19.029	15,640	20	0.182	8,757
Ubon Ratchathani	Muang Ubon Ratchathani	5	4.264	1,930	3	0.032	150
	Amnat Charoen	15	2.365	3,720	35	0.792	4,605
	Saenang Khanikhon	5	0.171	1,750	3	0.009	--
	Hua Ta Phan	3	1.095	1,300	3	4.332	2,800
	Khuang Nai	--	--	--	1	--	850
	Kut Kaopun	1	0.090	810	2	0.678	600
	Muang Sam Sip	4	1.761	1,000	10	0.428	740
	Phana	4	0.355	1,200	1	--	900
	Tam Sum	2	0.550	270	--	--	--
	Si Muang Mai	5	0.944	800	--	--	--
	Trakan Phut Phon	15	5.706	6,200	2	0.120	4,600
	Sub-total	59	19.198	19,080	60	6.391	15,245
	Total	119	38.227	34,720	80	6.543	24,002

Note: a) SSWR ... Small Scale Water Resources (reservoir and weir)
b) *1 ..... Water Resources in Thailand (RID)
(completed to the end of 1987 and under construction in 1988)
c) *2 ..... ARDO and DLD projects (completed to the end of 1987)

TABLE F-5 : EXISTING WATER RESOURCES DEVELOPMENT PROJECTS

Basin	Area (sq.km)	Annual Rainfall (mm)	Annual Run-off (mm)	Reservoir Capacity (Unit)	MSIP	SSIP	O-SSWR	Total	Rate of Utilization (%)
				(Nos.)	5	76	41	122	
Sebai	3,950	1,482	413	(MCM)	65.45	23.58	4.88	93.91	5.8
				(Nos.)	3	37	38	78	
Sebok	3,730	1,694	716	(MCM)	24.94	12.10	1.61	38.65	1.4
				(Nos.)	-	6	1	7	
Tung Lung	860	1,691	737	(MCM)	-	2.54	0.06	2.60	0.4
				(Nos.)	8	119	80	207	
Total	8,540	1,596	578	(MCM)	90.39	38.22	6.55	135.16	2.7

Basin	Area (sq.km)	Gross Paddy (ha)	Net Paddy (ha)	Irrigable Area (Unit)	MSIP	SSIP	O-SSWR	Total	Rate of Irrigation (%)
				(Nos.)	5	76	41	122	
Sebai	3,950	260,400	178,800	(ha)	7,667	3,326	2,287	13,280	7.4
				(Nos.)	3	37	38	78	
Sebok	3,730	234,300	149,600	(ha)	3,000	2,037	1,275	6,312	4.2
				(Nos.)	-	6	1	7	
Tung Lung	860	52,700	17,600	(ha)	-	192	288	480	2.7
				(Nos.)	8	119	80	207	
Total	8,540	547,400	346,000	(ha)	10,667	5,555	3,850	20,072	5.8

Notes: a) ... MSIP : Medium scale irrigation projects under RID (completed and under construction as of the end of 1987).
SSIP : Small scale irrigation projects under RID (completed to the end of 1987).
O-SSWR: Small scale water resources under ARDO and DLD (completed to the end of 1987).
b) ... Annual Rainfall and Run-off: Average annual rainfall and run-off for 11 years from 1976 to 1988.
c) ... Rate of utilization: Reservoir capacity/annual run-off.
d) ... Rate of irrigation : Irrigable area/Net paddy field.

TABLE F-6 : DEVELOPMENT PLAN FOR RID WATER RESOURCES PROJECTS

(1989 to 1991)

Project Scale	Region	Number of Project / Project Name	Reservoir Capacity (MCM)	Beneficial Area (ha)	Remarks
Large Scale	Eastern	Nong Pla Lai	151.2	3,500	
	ditto	Map Ta Put	--	--	
	Southern	Bang Nara Development Basin	--	(9,900)	
	Sub-total	3	151.2	3,500	
Medium Scale	Northern	6	65.53	11,040	
	North-east	15	138.87	27,950	
	Region 4	(6)	(47.55)	(15,210)	
	Region 5	(4)	(15.12)	(4,150)	Huai Phong/Huai Ban/Huai Yang (Patue)/Huai Si Tho
	Region 6	(5)	(76.20)	(8,590)	
	Central & Eastern	6	173.40	28,850	
	Southern	8	69.20	32,060	
	Sub-total	35	447.00	99,900	
Small Scale	Northern	72	--	25,130	
	North-east	305	--	13,190	
	Region 4	(96)	--	(3,030)	
	Region 5	(105)	--	(2,720)	
	Region 6	(104)	--	(7,440)	
	Central & Eastern	51	--	9,370	
	Southern	43	--	5,650	
	Sub-total	471	--	53,340	
Total	Total	509	598.20	156,740	

Notes: a) Large and Medium scale projects shown in above mean new projects being implemented from 1989 to 1991 Thai fesical year.

b) Small scale projects shown in above mean new projects being implemented in 1989 Thai fesical year.

c) Data source: RID Planning Div., Nov. 1988.

TABLE F-7 : POTENTIAL SURFACE WATER RESOURCES

Description	Sebai	Sebok	Tung Lung	Total
1) Watershed (sq.km)	3,950	3,730	860	8,540
2) Run-off				
a) Annual rainfall (mm)	1,482	1,694	1,691	1,596 1/
b) Annual run-off (mm)	413	716	737	578 1/
(MCM)	1,631	2,671	634	4,936
3) Existing Project				
a) Watershed (sq.km)	2,169.2	1,344.4	178.4	3,692
MSIP	180.7	116.0	-	296.7
SSWP	1,988.6	1,228.4	178.4	3,395.4
b) Reservoir Capacity (MCM)	94.0	38.6	2.6	135.2
MSIP	65.5	24.9	-	90.4
SSWP	28.5	13.7	2.6	44.8
4) Available Water Resources for Future Development				
a) Watershed (sq.km)	1,780.7	2,385.6	681.6	4,848
b) Run-off (MCM)	735	1,708	502	2,945

Note: 1/ ... Annual average

TABLE F-8 : MAJOR EXISTING SMALL SCALE PROJECTS

Description \ Basin	Sebai	Sebok	Huai Tung Lung	Total
(1) Storage Project				
a) No	34	10	2	46
b) Watershed (km^2)	325.0	97.0	7.1	429.1
c) Storage capasity (MCM)	11.63	9.19	0.53	21.35
d) Irrigated area (ha)	1,512	1,409	96	1,617
e) Average watershed (km^2/one project)	9.6	9.7	3.6	9.3
f) Av. 1/ storage per watershed (MCM/km^2)	0.04	0.09	0.07	0.05
G) Av. rate of watershed/ irrigated area	21	7	7	26.5
(2) River Diversion Project				
a) No	13	11	2	26
b) Watershed (km^2)	439.6	472.4	55.3	967.3
c) Irrigated area (ha)	802	835	32	1,669
d) Average watershed (km^2/one project)	33.8	42.9	27.7	37.2
e) Av. rate of watershed/ irrigated area	54.8	56.6	172.8	58.0

Note : 1/ Av.: Average

Source: RID (constructed the end of 1987)

TABLE F-9 : REHABILITATION PLAN FOR EXISTING MEDIUM SCALE PROJECTS

Project	Irrigable Area (ha)	Rehabilitation		
		Dam	Main Canal	On-farm
1. Huai Pho	720	-	17.9 km Enlargement	880 ha
2. Ron Nam Sap	67	-	1.7 km Lining	70 ha in 1990 by RID
3. Phuttha Utthayan	2,560	Constructed in 1987	Constructed in 1985-86	-
4. Nong Chong Yai	1,200	-	Completed in 1982-1987	1,200 ha
5. Sa Saming	120	-	-	-
6. Huai Thamkhae	1,680	-	-	1,680 ha in 1989 by RID
Sub-total	6,347		2 projects	4 projects 3,930 ha
7. Tung Ma Hew	1,260	Dike-9 km Pumping Station-6 units	9.9 km	1,260 ha
Total	7,607			5,090 ha

TABLE F-10 : POTENTIAL PROJECT SITES FOR MEDIUM SCALE PROJECTS

Basin	Changwat	Code No.	Project	Watershed Area (sq.m)	Reservoir Capacity (MCM)	Remarks
Sebai (BA)	Yasothon	BA-1	Huai Phong	45.2	13.9	Pre-study by RID
	Ubon R.	BA-2	Huai Ban	14.5	2.1	Pre-study by RID
	Yasothon	BA-4	Huai Pong Pode	8.7	3.4	
	ditto	BA-5	Lam Se	22.4	9.7	
	ditto	BA-6	Huai Yang	25.0	4.6	Pre-study by RID
	ditto	BA-8	Huai San	13.7	8.9	
	Ubon R.	BA-9	Huai Hin Lat	17.5	8.0	
	Sub-total		7 projects	147.0	50.6	
Sebok (BO)	Ubon R.	BO-2	Huai Si Tho	28.2	8.0	Pre-study by RID
	ditto	BO-3	Huai Phra Lao	23.0	6.2	Pre-study by RID
	ditto	BO-6	Huai Kum Bi	16.4	1.1	
	ditto	BO-8	Huai Saen Si	25.0	1.7	
	ditto	BO-9	Huai Na Pho	26.4	0.3	
	ditto	BO-10	Huai Khu Lu	44.7	6.3	
	ditto	BO-11	Huai Khum Kham	36.8	22.0	
	ditto	BO-12	Huai Thi	38.4	3.3	
	ditto	BO-13	Huai Kham Phak Wan	13.5	10.6	
	ditto	BO-14	Huai Tham	17.0	5.0	
	ditto	BO-15	Huai Phai Ban	21.2	4.8	
	ditto	BO-17	Huai Yang	14.6	6.3	
	ditto	BO-18	Huai Na Khai	31.3	18.3	
	ditto	BO-19	Huai Ba Hang	51.3	3.1	
	Sub-total		14 projects	387.8	97.0	
Tung Lung (TL)	Ubon R.	TL-1	Huai Tung Lung	40.3	7.8	
	ditto	TL-2	Huai Khut	18.8	1.2	
	ditto	TL-3	Huai Ngu Luamg	11.4	2.9	
	ditto	TL-5	Huai Chalung	35.7	6.7	
	ditto	TL-6	Huai Soob	18.5	8.2	
	Sub-total		5 projects	124.7	26.8	
	Total		26 projects	659.5	174.4	

Note: Ubon R.: Ubon Ratchathani

TABLE F-11 : SUMMARY OF NEW DEVELOPMENT PROJECTS

Description \ Basin	Sebai	Sekok	Huai T.L. 1/	Total
1) Total area (km^2)	3,950	3,730	860	8,540
2) Paddy field (ha) (Net)	178,800	149,600	17,600	346,000
3) Existing Project				
3-1) Medium scale project	5	3	-	8
a) Catchment area (km^2)	180.7	116.0	-	296.7
b) Irrigation area (ha)	7,667	3,000	-	10,667
3-2) Small scale project	117	75	7	119
a) Watershed (km^2)	1,988.6	1,228.4	178.4	3,395.4
b) Irrigation area (ha)	5,613	3,312	480	9,405
4) New Development Project				
4-1) Storage Scheme				
a) Medium scale project	7	14	5	26
- Catchment area (km^2)	147.0	387.8	124.7	659.5
- Storage capacity (MCM)	50.6	97.0	26.8	174.4
- Irrigable area (ha)	7,000	14,460	4,550	26,010
b) Small scale project	24	46	17	87
- Catchment area (km^2)	238	458	178	869
- Storage capacity (MCM)	9.5	18.3	6.9	34.5
- Irrigable area (ha)	1,190	2,290	870	4,350
4-2) Run-off River Scheme				
a) River pumping project	21	17	3	41
- Catchment area (km^2)	1,039	853	124	2,016
- Irrigable area (ha)	2,080	1,700	250	4,030
b) River Diversion Project	11	21	8	40
- Catchment area (km^2)	357	687.2	259.3	1,303.5
- Irrigable area (ha)	710	1,370	520	2,600
4-3) Project Related to Pak Mun Project				
- Irrigable area (ha)	1,800	3,600	-	5,400
4-4) Total Irrigable Area	12,780	23,420	6,190	42,390

Note: 1/ Huai Tung Lung.

TABLE F-12 ; PRESENT CONDITIONS OF PETENTIAL PROJECT SITES (1/7)

Description \ Project	Huai Phong (BA-1)	Huai Ban (BA-2)	Huai Pong Pode (BA-4)	Lam Se (BA-5)
(1) Location				
- Changwat	Yasothon	Ubon Ratchathani	Yasothon	Yasothon
- Amphoe	Loeng Nok Tha	Senang Khanikhom	Kut Chum	Loeng Nok Tha
- Tambon	Som Pho	Senang Khanikhom	Kut Chum	Kut Chiang Mee
- Muban	Sri Kaeo	Nong Kha	Na Mon	Kut Kae Don
(2) Annual Rainfall (mm)	1,372	1,657	1,372	1,372
(3) River				
- Basin	Sebai	Sebai	Sebai	Sebai
- Watershed (km^2)	45.2	14.5	8.7	22.4
- River	Huai Phong	Huai Ban	Huai Pong Pode	Huai Lam Se
- Annual Runoff (MCM)	18.15	9.38	3.49	8.99
(4) Topography				
- EL at riverbed	EL 176.5	EL 162.5	EL 176.93	EL 167.11
- Slope	Comparative steep	Rather steep	Rather flat	Comparative flat
- Vegitation	Well	Well	Well but cassava	Well but paddy field
(5) Geology and Material				
- Geology	Shallow base rock (fresh sandstone appear)	Shallow base rock (fresh sandstone)	Shallow base rock (fresh sandstone)	Comparative deep base rock (3-5m)
- Impervious Embankment Material	Available but rather far	Available but rather far	Available but rather far/Wider area covered with finesand	Available
(6) Reservoir Area				
- Land use	Cassava, Woods	Woods, Paddy	Mostly cassava, few paddy	Mostly paddy
- Existing Facility	---	Small reservoir at upstream	---	---
- Village	---	---	---	---
(7) Soil and Agriculture in Beneficial Area				
- Existing Arable Land(ha)	2,000	350	450	1,300
- Soil Classification	Fine sandy loam	Fine sandy loam and fine sand	Fine sandy and sandy loam	Fine sandy loam and loam
- Land Use	Paddy, Cassava	Paddy	Paddy Cassava	Paddy Cassava
- Average Agriculture Production (kg/rai)	268 2,273	243	374 1,833	271 1,233
(8) Irrigation Facility	No facility	No facility	No facility	No facility
(9) Social Condition				
- Electricity	No electricity	Electricity	No electricity (Ban Nong Kao)	Electricity
- Average House Hold (person/family)	6.7	3.0	5.7	5.6
- Average Land Holding (rai/family)	29.9	19.5	20.8	26.0
- % of farmer household (farmer H.H/total H.H)	99.0	97.7	82.4	98.6
- Income level (%)				
#below 6,000 ฿/y-HH	---	62.6	---	---
#6,000-10,000	---	21.8	---	---
(10) Farmer's needs	Irrigation water Strong request	Irrigation water Strong request	Irrigation water Expect	Irrigation water Expect

TABLE F-12 ; PRESENT CONDITIONS OF PETENTIAL PROJECT SITES (2/7)

Description \ Project	Huai Yang (BA-6)	Huai Sun (BA-8)	Huai Hin Lat (BA-9)
(1) Location			
- Changwat	Yasothon	Yasothon	Ubon Ratchathani
- Amphoe	Pa Tiu	Loeng Nok Tha	Amnat Charoen
- Tambon	Kok Na Ko	Bung Ka	Kuem Yai
- Muban	Nong Chum	Kok Charoen	Don Rai
(2) Annual Rainfall (mm)	1,372	1,657	1,458
(3) River			
- Basin	Sebai	Sebai	Sebai
- Watershed (km^2)	25.0	13.7	17.5
- River	Huai Yang	Huai San	Huai Hin Lat
- Annual Runoff (MCM)	10.04	8.86	8.19
(4) Topography			
- EL at riverbed	EL 142.0	EL 163.5	EL 156.47
- Slope	Rather flat	Rather flat	Rather flat
- Vegitation	Well	Well	Well
(5) Geology and Material			
- Geology	Shallow base rock (weathered sandstone)	Shallow base rock (weathered rock appear)	Shallow base rock/rock appear
- Impervious Embankment Material	Available	Available	
(6) Reservoir Area			
- Land use	Reserve forest area forest cassave	Paddy, Cassava	Mostly forest, few paddy
- Existing Facility	Small reservoir at upstream	Small reservoir at upstream	---
- Village	---	---	---
(7) Soil and Agriculture in Beneficial Area			
- Existing Arable Land(ha)	1,000	1,200	1,600
- Soil Classification	Fine sandy loom	Fine sandy loom and loom	Fine sand
- Land Use	Paddy, Cassava	Paddy, Cassava	Paddy, Cassava
- Average Agriculture Production (kg/rai)	149 2,667	264 1,856	263 1,400
(8) Irrigation Facility	No facility	No facility	No facility
(9) Social Condition			
- Electricity	Electricity	Electricity	Electricity
- Average House Hold (person/family)	5.6	5.5	6.3
- Average Land Holding (rai/family)	17.8	25.1	20.3
- % of farmer household (farmer H.H/total H.H)	94.1	96.8	98.1
- Income level (%)			
#below 6,000 ฿/y-HH	---	---	47.7
#6,000-10,000	---	---	32.0
(10) Farmer's needs	Irrigation water Strong request	Irrigation water	Irrigation water Expect reservoir construction

TABLE F-12 ; PRESENT CONDITIONS OF PETENTIAL PROJECT SITES (3/7)

Description \ Project	Huai Si Tho (BO-2)	Huai Phra Lao (BO-3)	Huai Kum Bi (BO-6)	Huai Saen Si (BO-8)
(1) Location				
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	Amnat Charoen	Phana	Phana	Kut Khao Pun
- Tambon	Srang Nok Tha	Na Wa	Na Wa	Na Pin
- Muban	Kham Ma Khong	Noan Ngam	Nong Saeng	Tu Yai
(2) Annual Rainfall (mm)	1,458	1,458	1,591	1,591
(3) River				
- Basin	Sebok	Sebok	Sebok	Sebok
- Watershed (km^2)	28.2	23.0	16.4	25.0
- River	Huai Si Tho	Huai Phra Lao	Huai Kam Bi	Huai Saen
- Annual Runoff (MCM)	13.2	10.76	10.09	15.38
(4) Topography				
- EL at riverbed	EL 164.7	EL 158.5	EL 151.99	EL 134.41
- Slope	Comparative steep	Comparative flat	Comparative flat	Comparative flat
- Vegitation	Well (forest area)	Well	Well	Well
(5) Geology and Material				
- Geology	Covered with fresh rock (sand-stone)	Shallow base rock	Shallow base rock (rock appear)	Covered with terrace deposit
- Impervious Embankment Material	Rather difficult	Available	Available	Few materials
(6) Reservoir Area	Reserve forest area	Forest, some upland crop	Almost paddy	Mostly paddy
- Existing Facility	—	---	SSIP at upstream	---
- Village	—	---	---	---
(7) Soil and Agriculture in Beneficial Area				
- Existing Arable Land(ha)	1,200	1,000	700	1,000
- Soil Classification	Fine sandy loom	Fine sandy and sandy loom	Loom	Fine sand and loom
- Land Use	Paddy, Cassava	Paddy, Cassava	Paddy	Paddy
- Average Agriculture Production (kg/rai)	172 1,000	252 1,604	252	271
(8) Irrigation Facility	No facility	No facility	No facility	No facility
(9) Social Condition				
- Electricity	Electricity	Electricity	Electricity	No electricity
- Average House Hold (person/family)	3.7	6.4	6.4	6.2
- Average Land Holding (rai/family)	23.9	21.4	21.4	12.6
- % of farmer household (farmer H.H/total H.H)	94.2	93.5	93.5	93.3
- Income level (%)				
#below 6,000 ฿/y-HH	47.7	54.8	54.8	54.9
#6,000-10,000	32.0	27.8	27.8	31.2
(10) Farmer's needs	Irrigation water Strong request	Irrigation water Expect	Irrigation water refuse to submerging of paddy	Irrigation water

TABLE F-12 ; PRESENT CONDITIONS OF PETENTIAL PROJECT SITES (4/7)

Description \ Project	Huai Na Pho (BO-9)	Huai Khu Lu (BO-10)	Huai Khum Kham (BO-11)	Huai Thi (BO-12)
(1) Location				
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	Kut Khao Pun	Trakan Phutphon	Trakan Phutphon	Trakan Phutphon
- Tambon	Noan Sawang	Kasem	Khon Sai	Khon Sai
- Muban	Nong Wa	Bung Saeng	Na Kham	Huai Tee Tai
(2) Annual Rainfall (mm)	1,591	1,775	1,775	1,775
(3) River				
- Basin	Sebok	Sebok	Sebok	Sebok
- Watershed (km^2)	26.4	44.7	36.8	38.4
- River	Huai Na Pho	Huai Khu Lu	Huai Khum Kham	Huai Thi
- Annual Runoff (MCM)	16.25	35.05	28.86	30.11
(4) Topography				
- EL at riverbed	EL 151.76	EL 151.26	EL 146.5	EL 160.35
- Slope	Comparative flat	Comparative flat	Comparative steep	Comparative steep
- Vegitation	Well	Almost paddy field	Well	Well
(5) Geology and Material				
- Geology	Shallow base rock but not appear	Shallow base rock but not appear	Shallow base rock (rock appear)	Shallow base rock (rock appear)
- Impervious Embankment Material	Available	Available	Rather difficult	Available
(6) Reservoir Area				
- Land use	Almost paddy, few forest	Almost paddy	Almost forest area	Mostly forest(reserve forest)
- Existing Facility	—	—	Small weir by farmers	—
- Village	—	Village	—	—
(7) Soil and Agriculture in Beneficial Area				
- Existing Arable Land(ha)	1,000	1,400	2,200	500
- Soil Classification	Clay loam and loam	Fine sandy loam	Fine sandy loam	Fine sandy loam
- Land Use	Paddy, Cassava	Paddy, Cassava	Paddy, Cassava	Paddy
- Average Agriculture Production (kg/rai)	251 3,000	207 3,000	297 2,585	297
(8) Irrigation Facility	No facility	No facility	No facility	No facility
(9) Social Condition				
- Electricity	No electricity	No electricity (Ban Dan Muang)	Electricity	Electricity
- Average House Hold (person/family)	4.4	6.1	6.2	6.2
- Average Land Holding (rai/family)	27.6	20.8	18.5	18.5
- % of farmer household (farmer H.H/total H.H)	97.7	97.8	96.5	96.5
- Income level (%)				
#below 6,000 ฿/y-HH	70.0	54.9	54.9	54.9
#6,000-10,000	19.0	31.2	31.2	31.2
(10) Farmer's needs	Irrigation water Worry about land loss of paddy	Irrigation water Worry about land loss of paddy	Irrigation water Requested since 3 years ago	Irrigation water

TABLE F-12 ; PRESENT CONDITIONS OF PETENTIAL PROJECT SITES (5/7)

Description \ Project	Huai Kham Phak Wan (BO-13)	Huai Tham (BO-14)	Huai Phai Ban (BO-15)	Huai Yang (BO-17)
(1) Location				
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	Trakan Phutphon	Trakan Phutphon	Trakan Phutphon	Trakan Phutphon
- Tambon	Kra Diean	Kok Chan	Kok Chan	Trakan
- Muban	Chat	Kok Nai	Na Tan	Don Mu
(2) Annual Rainfall (mm)	1,775	1,775	1,775	1,732
(3) River				
- Basin	Sebok	Sebok	Sebok	Sebok
- Watershed (km^2)	13.5	17.0	21.2	14.6
- River	Huai Khamen	Huai Tham	Huai Phai Ban	Huai Yang
- Annual Runoff (MCM)	10.59	13.33	16.62	10.74
(4) Topography				
- EL at riverbed	EL 132.3	EL 130.24	EL 129.18	EL 120.98
- Slope	Comparative flat	Comparative flat	Comparative flat	Comparative flat
- Vegitation	Well	Well	Well	Well
(5) Geology and Material				
- Geology	Rather deep base rock covered with terrace deposite	Shallow base rock (rock appear)	Shallow base rock	Shallow base rock but not appear
- Impervious Embankment Material	Rather difficult	Rather difficult	Rather difficult	Available
(6) Reservoir Area				
- Land use	Woods, some paddy land	Forest, Paddy	Forest, Paddy	Mostly forest/fee paddy
- Existing Facility	---	---	---	---
- Village	---	---	---	---
(7) Soil and Agriculture in Beneficial Area				
- Existing Arable Land(ha)	1,300	1,300	1,400	1,000
- Soil Classification	Fine sandy loam and loam	Fine sandy loam and loam	Fine sandy loam and loam	Fine sandy loam
- Land Use	Paddy	Paddy	Paddy	Paddy
- Average Agriculture Production (kg/rai)	206	208	208	183
(8) Irrigation Facility	No facility	No facility	No facility	No facility
(9) Social Condition				
- Electricity	Electricity	Electricity	Electricity	Electricity
- Average House Hold (person/family)	6.2	5.6	5.6	5.7
- Average Land Holding (rai/family)	26.6	25.1	25.1	21.4
- % of farmer household (farmer H.H/total H.H)	99.1	97.6	97.6	91.1
- Income level (%)				
#below 6,000 ฿/y-HH	54.9	54.9	54.9	54.9
#6,000-10,000	31.2	31.2	31.2	31.2
(10) Farmer's needs	Irrigation water	Irrigation water	Irrigation water	Irrigation water *Worry about loss of paddy land*

TABLE F-12 ; PRESENT CONDITIONS OF PETENTIAL PROJECT SITES (6/7)

Project / Description	Huai Na Khai (BO-18)	Huai Ba Hung (BO-19)	Huai Tung Lung (TL-1)
(1) Location			
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	King Amphoe Tan Sum	King Amphoe Tan Sum	Trakan Phutphon
- Tambon	Chik Tueng	Chik Tueng	Noan Kung
- Muban	Kham Nam Taeng	Chick Tueng	Ta Luang
(2) Annual Rainfall (mm)	1,558	1,558	1,775
(3) River			
- Basin	Sebok	Sebok	Tung Lung
- Watershed (km^2)	31.3	51.3	40.3
- River	Huai Na Khai	Huai Ba Hung	Huai Tung Lung
- Annual Runoff (MCM)	19.41	31.81	31.60
(4) Topography			
- EL at riverbed	EL 123.5	EL 122.05	EL 153.26
- Slope	Comparative flat	Comparative flat	Comparative flat
- Vegitation	Well	Well	Well
(5) Geology and Material			
- Geology	Shallow base rock/ apperance of rock	Shallow base rock (about 2 m depth)	Shallow base rock/ apperance of rock
- Impervious Embankment Material	Difficult obtain	Available/Lateritic gravelly clay	Difficult obtain
(6) Reservoir Area			
- Land use	Forest area	Mostly paddy field	Paddy field, Forest
- Existing Facility	Small weir of SSIP	Small village ponds	----
- Village	----	----	----
(7) Soil and Agriculture in Beneficial Area			
- Existing Arable Land(ha)	2,400	400	1,300
- Soil Classification	Fine sandy loam and loam	Fine sand	Silty loam
- Land Use	Paddy	Paddy	Paddy
- Average Agriculture Production (kg/rai)	175	175	153
(8) Irrigation Facility	No facility	No facility	No facility
(9) Social Condition			
- Electricity	No electricity	No electricity	No electricity
- Average House Hold (person/family)	5.8	5.8	6.2
- Average Land Holding (rai/family)	21.4	25.4	18.5
- % of farmer household (farmer H.H/total H.H)	91.3	91.3	95.6
- Income level in %			
# below 6,000 (฿/F.)	62.3	62.3	54.9
# 6,000-10,000	27.1	27.1	31.2
(10) Farmer's needs	Irrigation water	Irrigation water	Irrigation water

TABLE F-12 ; PRESENT CONDITIONS OF PETENTIAL PROJECT SITES (7/7)

Description \ Project	Huai Khut (TL-2)	Huai Ngu Luam (TL-3)	Huai Chalung (TL-5)	Huai Soob (TL-6)
(1) Location				
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	Trakan Phutphon	Sri Muang Mai	Sri Muang Mai	Sri Muang Mai
- Tambon	Noan Kung	Song Yang	Na Kham	Kham Lai
- Muban	Ta Luang	Pong	Pang Kung Yai	Na Huai Daeng
(2) Annual Rainfall (mm)	1,558	1,558	1,558	1,558
(3) River				
- Basin	Tung Lung	Tung Lung	Tung Lung	Tung Lung
- Watershed (km^2)	18.8	11.4	35.7	18.5
- River	Huai Khut	Huai Ngu Luam	Huai Chalung	Huai Sup
- Annual Runoff (MCM)	11.66	7.07	22.14	11.47
(4) Topography				
- EL at riverbed	EL 161.71	EL 172.48	EL 160.31	EL 153.78
- Slope	Comparative flat	Comparative flat	Comparative steep	Comparative flat
- Vegitation	Well	Well	Well	Well
(5) Geology and Material				
- Geology	Shallow base rock/ Apperance of rock	Shallow base rock	Very shallow base rock (appearing rock)	Very shallow base rock (rock appear)
- Embankment Material	Difficult obtain	Difficult obtain	Difficult obtain	Difficult obtain
(6) Reservoir Area				
- Land Use	Mostly forest	Mostly forest	Paddy field 30-50%, Woods	Forest, some paddy field
- Existing Facility	—	—	—	—
- Village	—	—	—	—
(7) Soil and Agriculture in Beneficial Area				
- Existing Arable Land(ha)	500	380	800	1,700
- Soil Classification	Silty loam	Loam and silty loam	Loam and fine sand loam	Loam and fine sand loam
- Land Use	Paddy	Paddy, Cassava	Paddy	Paddy
- Average Agriculture Production (kg/rai)	153	212	220	219
(8) Irrigation Facility	No facility	No facility	No facility	No facility
(9) Social Condition				
- Electricity	Electricity	Electricity	Electricity	No electricity
- Average House Hold (person/family)	6.1	6.1	5.4	5.9
- Average Land Holding (rai/family)	34.3	21.8	19.8	28.3
- % of farmer household (farmer H.H/total H.H)	95.9	94.8	92.1	94.4
- Income levelin %				
#below 6,000 (฿/F.)	54.9	67.4	67.4	67.4
#6,000-10,000	31.2	23.2	23.2	23.2
(10) Farmer's needs	Irrigation water	Irrigation water	Irrigation water	Irrigation water

TABLE F-13 : MAJOR FEATURES OF 26 MEDIUM SCALE IRRIGATION PROJECTS (1/4)

Description	Huai Phong (BA-1)	Huai Ban (BA-2)	Huai Pong Pode (BA-4)	Lam Se (BA-5)	Huai Yang (BA-6)	Huai Sun (BA-8)	Huai Hin Lat (BA-9)	Huai Si Tho (BO-2)
1) Location								
- Changwat	Yasothon	Ubon Ratchathani	Yasothon	Yasothon	Yasothon	Yasothon	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	Loeng Nok Tha	Senang Knikhom	Kut Chum	Loeng Nok Tha	Pa Tiu	Loeng Nok Tha	Amnat Charoen	Amnat Charoen
2) River								
- Basin	Sebai	Sebai	Sebai	Sebai	Sebai	Sebai	Sebai	Sebok
- Watershed Area (sq.km)	45.2	14.5	8.7	22.4	25.0	13.7	17.5	28.2
3) Reservoir								
- Total Storage Capacity (MCM)	14.50	2.35	3.5	10.00	4.85	9.10	8.26	8.40
- Dead Storage Capacity (MCM)	0.62	0.24	0.1	0.34	0.28	0.21	0.26	0.44
- Effect. Storage Capacity (MCM)	13.88	2.11	3.4	9.66	4.57	8.89	8.00	7.96
- High Water Level (m)	184.5	170.7	189.0	179.3	150.6	177.6	172.6	177.0
- Normal Water Level (m)	183.5	170.0	188.2	178.5	149.6	177.0	172.0	176.0
- Low Water Level (m)	176.3	166.2	181.0	171.4	144.0	168.4	164.8	168.5
4) Dam								
- Crest EL (m)	186.0	172.0	190.5	180.8	152.0	179.1	174.1	178.5
- Width of Dam Crest (m)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
- Length of Dam (m)	500	960	570	1,380	950	1,490	1,260	455
- Height of Dam (m)	13.0	12.0	13.6	13.7	12.2	15.6	17.6	15.5
- Embankment Volume ('000 cu.m)	112.0	157.3	151.9	239.1	257.0	441.6	338.1	251.7
- Design Flood (cu.m/s)	214	120	41	68	177	29	36	86
5) Distribution System								
- Irrigable Area (ha)	2,070	400	460	940	830	1,200	1,100	1,190
- Main Canal (km)	25.7	3.4	5.7	16.3	13.2	13.1	17.4	10.5

TABLE F-13 : MAJOR FEATURES OF 26 MEDIUM SCALE IRRIGATION PROJECTS (2/4)

Description	Huai Phra Lao (BO-3)	Huai Kum Bi (BO-6)	Huai Saen Si (BO-8)	Huai Na Pho (BO-9)	Huai Khu Lu (BO-10)	Huai Khum Kham (BO-11)	Huai Thi (BO-12)	Huai Kham Phak Wan (BO-13)
1) Location								
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	Non Ngam	Phana	Kut Khao Pun	Kut Khao Pun	Trakan Phutphon	Trakan Phutphon	Trakan Phutphon	Trakan Phutphon
2) River								
- Basin	Sebok	Sebok	Sebok	Sebok	Sebok	Sebok	Sebok	Sebok
- Watershed Area (sq.km)	23.0	16.4	25.0	26.4	44.7	36.8	38.4	13.5
3) Reservoir								
- Total Storage Capacity (MCM)	6.55	1.4	1.9	0.7	7.0	22.50	3.8	10.80
- Dead Storage Capacity (MCM)	0.35	0.3	0.2	0.4	0.7	0.55	0.6	0.20
- Effect. Storage Capacity (MCM)	6.20	1.1	1.7	0.3	6.3	21.95	3.3	10.60
- High Water Level (m)	172.9	160.5	140.5	160.0	160.3	163.5	171.5	145.1
- Normal Water Level (m)	172.0	159.5	139.5	158.8	159.3	162.5	170.3	144.5
- Low Water Level (m)	165.4	157.1	136.2	156.1	154.0	152.2	166.6	136.5
4) Dam								
- Crest EL (m)	174.4	162.0	142.0	161.5	161.8	165.0	173.0	146.6
- Width of Dam Crest (m)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
- Length of Dam (m)	1,530	820	800	870	870	1,160	700	1,410
- Height of Dam (m)	15.9	10.0	7.6	9.8	10.5	18.5	12.7	14.3
- Embankment Volume ('000 cu.m)	309.6	94.9	93.5	86.5	123.4	333.8	71.9	432.3
- Design Flood (cu.m/s)	79	192	349	344	247	107	349	25
5) Distribution System								
- Irrigable Area (ha)	1,100	200	310	50	1,130	3,400	590	1,340
- Main Canal (km)	20.7	5.2	5.0	1.2	9.5	37.6	5.9	13.7

TABLE F-13 : MAJOR FEATURES OF 26 MEDIUM SCALE IRRIGATION PROJECTS (3/4)

Description	Huai Tham (BO-14)	Huai Phai Ban (BO-15)	Huai Yang (BO-17)	Huai Na Khai (BO-18)	Huai Ba Hung (BO-19)	Huai Tung Lung (TL-1)	Huai Khut (TL-2)	Huai Ngu Luam (TL-3)
1) Location								
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	Trakan Phutphon	Trakan Phutphon	Trakan Phutphon	Tan Sum	TanSum	Trakan Phutphon	Trakan Phutphon	Sri Muang Mai
2) River								
- Basin	Sebok	Sebok	Sebok	Sebok	Sebok	Tung Lung	Tung Lung	Tung Lung
- Watershed Area (sq.km)	17.0	21.2	14.6	31.3	51.3	40.3	18.8	11.4
3) Reservoir								
- Total Storage Capacity (MCM)	5.3	5.1	6.47	18.78	3.9	8.44	1.5	3.1
- Dead Storage Capacity (MCM)	0.3	0.3	0.22	0.47	0.8	0.60	0.3	0.2
- Effect. Storage Capacity (MCM)	5.0	4.8	6.25	18.31	3.1	7.84	1.2	2.9
- High Water Level (m)	140.5	141.0	130.7	137.7	130.5	166.1	170.0	182.7
- Normal Water Level (m)	139.8	140.0	130.0	137.0	129.3	165.0	169.0	182.0
- Low Water Level (m)	133.5	135.0	124.0	130.0	127.0	159.2	166.5	176.5
4) Dam								
- Crest EL (m)	142.0	142.5	132.2	139.2	132.0	167.6	171.5	184.2
- Width of Dam Crest (m)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
- Length of Dam (m)	1,100	1,300	1,350	2,150	720	1,970	250	1,350
- Height of Dam (m)	11.8	13.3	12.2	15.7	10.0	14.3	9.8	11.7
- Embankment Volume ('000 cu.m)	191.7	175.1	288.5	449.0	67.1	283.4	26.4	162.2
- Design Flood (cu.m/s)	116	158	50	65	303	215	134	82
5) Distribution System								
- Irrigable Area (ha)	900	860	830	2,000	560	1,460	220	520
- Main Canal (km)	9.4	11.3	9.9	26.4	7.1	21.0	3.0	2.7

TABLE F-13 : MAJOR FEATURES OF 26 MEDIUM SCALE IRRIGATION PROJECTS (4/4)

Description	Huai Chalung (TL-5)	Huai Soob (TL-6)
1) Location		
- Changwat	Ubon Ratchathani	Ubon Ratchathani
- Amphoe	Sri Muang Mai	Sri Muang Mai
2) River		
- Basin	Tung Lung	Tung Lung
- Watershed Area (sq.km)	35.7	18.5
3) Reservoir		
- Total Storage Capacity (MCM)	7.23	8.50
- Dead Storage Capacity (MCM)	0.54	0.28
- Effect. Storage Capacity (MCM)	6.69	8.22
- High Water Level (m)	171.1	170.0
- Normal Water Level (m)	170.0	169.0
- Low Water Level (m)	163.9	160.2
4) Dam		
- Crest EL (m)	172.6	171.5
- Width of Dam Crest (m)	6.0	6.0
- Length of Dam (m)	480	1,570
- Height of Dam (m)	12.3	17.7
- Embankment Volume ('000 cu.m)	77.0	304.0
- Design Flood (cu.m/s)	214	71
5) Distribution System		
- Irrigable Area (ha)	1,250	1,100
- Main Canal (km)	19.1	20.3

TABLE F-14 : DIMENSION OF PROPOSED RESERVOIRS

Description / Project		BA-5 (Lam Se)	BO-11 (Huai Khum Kham)	BO-13 (Huai Kham Phak Wan)	BO-18 (Huai Na Khai)	TL-6 (Huai Soob)	Remark
(1) Catchment Area	(km^2)	22.4	36.8	13.5	31.3	18.5	
(2) Av. Annual Rainfall	(mm)	1,641	1,714	1,714	1,670	1,670	Term; 1968-1987
(3) Av. Annual Runoff	(MCM)	13.5	23.3	8.6	20.1	11.9	
(4) Total Storage	(MCM)	8.84	20.03	8.39	18.78	7.87	
(5) Dead Storage	(MCM)	0.34	0.55	0.20	2.67	0.28	
(6) Sediment Volume	(MCM)	0.34	0.55	0.20	0.47	0.28	
(7) Effective Storage	(MCM)	8.50	19.48	8.19	16.11	7.59	
(8) H.W.L.	(MSL)	179.0	163.1	144.5	137.9	162.6	
(9) N.W.L.	(MSL)	178.0	162.0	143.5	137.0	161.5	
(10) L.W.L.	(MSL)	171.4	152.2	136.5	132.3	153.0	Intake W.L.
(11) Sediment EL	(MSL)	171.4	152.2	136.5	130.0	153.0	
(12) Water Surface Area at N.W.L.	(ha)	278.8	453.7	237.7	559.6	190.8	

Notes: (a) Reservoir capacities were estimated based on the reservoir area maps scaled 1:10,000 for BA-5, BO-11, BO-13 and BO-18, and scaled 1:4,000 for TL-6, which were prepared by RID.

(b) Sediment volume = 150 (m^3/km^2/year) x Catchment Area (km^2) x 100 (years).

TABLE F-15 : LIST OF QUARRY AND BORROW SITES FOR RIPRAP, SAND AND GRAVEL

Material	Site	Distance from A. Muang Ubon Ratchathani (km)	Remarks
(Rock)	- A. Muang Buri Ram, C. Buri Ram	190	Lime-stone G = 2.73
	- A. Kantharalak, C. Si Sa Ket	70	Lime-stone G = 2.76
	- C. Udon Thani	310	Lime-stone
	- C. Nakhon Phanom	240	Sand-stone
	- C. Nakhon Ratchasima	290	Lime-stone
	- C. Surin	150	Lime-stone
	- A. Non Khun, C. Ubon Ratchathani	30	Lime-stone, but not so good
	- A. Khammarat, C. Ubon Ratchathani	100	Sand-stone, but not so good
(Sand)	- A. Muang Ubon Ratchathani, C. Ubon R.	10	From Mun River
(Gravel)	- A. Muang Nakhon Phanom, C. Nakhon Phanom	240	From Mae Klong
	- A. Muang Mukdahan, C. Mukdahan	150	From Mae Klong

Note: A: Amphoe
C: Changwat

TABLE F-16 SUMMARY OF SOIL TEST (1/3)

Sample No.	Depth (m)	Unified Soil Classification	Dispersive Clay Identification Test I (Class)	II (%)	III (Ratio)	IV (Grade)	V (Zone)	Grain Size Analysis Graval mm ~4.76 (%)	Sand mm ~0.074 (%)	Silt mm ~0.005 (%)	Clay mm 0.005~ (%)	Max. Particle Size (mm)	Atterbery Limits Liquid Limit (%)	Plastic Limit (%)	PI (%)	Shrinkage Limit (%)
(Lam Se Project)																
TPA-1	0.0~0.8	SM						-	68	14	18	4.76		Non-Plastic		
"	0.8~3.2	CL	ND1	14	6	1	B	-	50	26	24	2.38	26.6	17.8	8.8	
TPA-2	0.0~1.6	SM						2	56	24	20	9.52		Non-Plastic		
"	1.6~4.0	CL	D1	80	1	4	A	-	24	36	40	2.38	24.5	14.7	9.8	
TPA-3	0.0~3.0	CL	ND1	19	4	1	B	-	46	30	24	4.76	25.9	14.8	11.1	
TPA-5	0.0~1.5		ND1	26	4	1	-									
"	1.5~4.5		D2	95	2	4	A									
TPA-6	0.0~1.8	SM						-	58	18	24	4.76		Non-Plastic		
TPA-8	0.0~3.5	CL	ND1	11	11	1	-	-	48	22	30	4.76	31.2	16.4	14.8	
(Huai Khum Kham Project)																
TPA-1	0.0~3.0	CL	ND1	3.2	6	1	B	30	20	26	24	38.1	39.6	22.6	17.0	
TPA-3	0.0~1.7	SM						1	59	28	12	19.1		Non-Plastic		
"	1.7~4.0	CL	ND1	21	6	1	-	5	11	48	36	38.1	38.3	22.3	16.0	
TPA-4	0.0~2.4	GC	ND1	9.5	9	1	B	48	26	14	12	19.1	32.3	18.5	13.8	
TPA-5	0.0~3.0	GC	ND1	1	8	1	-	46	18	19	17	19.1	38.6	23.3	15.3	
TPA-9	0.0~1.1	CL						1	43	30	26	19.1	24.8	15.4	9.4	
"	1.1~2.0	GC	ND1	21	4	1	B	41	27	19	13	38.1	28.5	18.9	9.6	
TPA-11	0.0~1.5	GC	ND1	24	5	1	-	62	18	10	10	38.1	37.0	21.5	15.5	
"	1.5~3.5	CL	ND1	38	6	1	-	4	26	38	32	38.1	35.4	21.3	14.1	
(Huai Kham Phak Wan Project)																
TPA-1	0.0~1.0	SC	ND1	24	5	1	B	30	37	15	18	38.1	32.2	20.2	12.0	
"	1.0~2.1	SC	ND1	21	7	1	-	25	27	28	20	38.1	35.3	22.7	12.6	
TPA-2	0.0~1.0	GC	ND1	4	14	1	-	44	30	14	12	19.1	47.0	26.7	20.3	
"	1.0~2.5	GC	ND1	10	7	1	-	34	18	24	24	38.1	42.5	24.5	18.0	
TPA-3	0.0~1.2	GC	ND1	3.3	11	1	B	50	25	14	11	38.1	35.1	21.4	13.7	
"	1.2~3.0	CL	ND1	11	11	1	B	6	20	30	44	38.1	44.1	23.6	20.5	
TPB-1	0.0~2.0	GC						53	20	16	11	76.2	34.0	20.7	13.3	
TPB-2	0.0~0.9	GC	ND1	9.5	5	1	B	58	20	12	10	38.1	35.2	21.4	13.8	
"	0.9~2.2	GC	ND1	22	6	1	-	40	26	19	15	76.2	36.5	23.2	13.3	
TPB-3	0.0~0.7	GM						40	40	10	10	38.1		Non-Plastic		
(Huai Na Khai Project)																
TPA-2	1.0~3.0	CL	ND1	17	7	1	-	18	22	32	28	19.1	37.7	24.0	13.7	
TPA-3	0.0~0.8	CL						1	35	25	39	9.52	27.6	18.3	9.3	
"	0.8~2.5	ML	ND2	19	10	1	B	3	18	53	26	19.1	44.4	28.0	16.4	
TPA-5	0.0~0.5	SM						-	52	20	28	9.52		Non-Plastic		
"	0.5~2.0	SM	ND1	22	7	1	B	30	22	28	20	76.2		Non-Plastic		
TPA-8	0.0~3.5	ML	ND1	21	5	1	B	5	25	56	14	19.1		Non-Plastic		
TPA-9	0.0~1.4	GC						60	18	13	9	38.1	40.0	23.5	16.5	
"	1.4~3.0	ML						39	8	33	20	76.2	38.7	26.1	12.6	
TPA-11	1.1~2.5	CL	ND1	17	7	1	B	5	25	44	26	19.1	26.1	18.5	7.6	
(Huai Soob Project)																
TPA-3	0.0~1.4	SM						0.5	72.5	15	12	9.52		Non-Plastic		
"	1.4~3.0	GC	ND1	17	7	1	B	49	28	12	11	76.2	29.6	18.9	10.7	
TPA-4	0.0~1.0	SM						-	58	22	20	2.38		Non-Plastic		
"	1.0~2.0	CL	ND1	17	6	1	B	1	45	29	25	19.1	27.5	17.6	9.9	
"	2.0~3.0	GC						44	24	16	16	38.1	39.8	22.1	17.7	
TPA-5	0.0~2.0	SM						-	66	22	12	2.38		Non-Plastic		
"	2.0~4.0	SC	ND1	5.7	5	1	-	-	54	28	22	2.38	31.0	18.2	12.8	
TPB-2	0.0~1.1	CL	ND1	21	6	1	-	-	48	28	24	4.76	29.2	18.4	10.8	
"	1.1~3.5	GC	ND1	12	9	1	B	42	26	16	16	38.1	34.3	21.8	12.5	
TPB-4	0.0~3.2	SM~SC	ND1	30	4	1	-	-	54	27	19	4.76	20.3	15.2	5.1	
TPB-5	0.0~1.6	SM						-	66	23	11	2.38		Non-Plastic		
"	1.6~2.3	SM	ND1	14	5	1	B	-	60	23	17	2.38		Non-Plastic		
"	2.3~3.0	SC	ND2	8.2	6	1	-	12	63	10	15	19.1	44.5	23.6	20.9	

TABLE F-16 SUMMARY OF SOIL TEST (2/3)

Sample No.	Depth (m)	Specific Gravity (Gs)	Field Moisture Content (%)	Compaction Test: Opt Moisture Content (%)	Compaction Test: Max Dry Density (g/cm³)	Initial Condition of Specimen: D-Value (%)	Moisture Content (%)	Dry Density (g/cm³)	Void Ratio	Degree of Saturation (%)	Direct Shear Test: C (t/m²)	Direct Shear Test: φ (°)	Permeability Test: Coefficient of Permeability (cm/sec)
(Lam Se Project)													
TPA-1	0.0~0.8	2.64	1.2										
"	0.8~3.2	2.64		13.7	1.798	94.8	16.0	1.704	0.549	76.9	1.6	29	4.7×10^{-8}
TPA-2	0.0~1.6	2.68	2.0										
"	1.6~4.0	2.67	7.4										
TPA-3	0.0~3.0	2.79	4.5										
TPA-5	0.0~1.5												
"	1.5~4.5												
TPA-6	0.0~1.8	2.65		11.0	1.910	95.0	13.4	1.814	0.461	77.0	2.2	33	6.9×10^{-6}
TPA-8	0.0~3.5	2.72		14.0	1.805	94.8	16.2	1.712	0.586	74.8	1.8	23	2.2×10^{-8}
(Huai Khum Kham Project)													
TPA-1	0.0~3.0	2.75	10.3										
TPA-3	0.0~1.7	2.63	4.6										
"	1.7~4.0	2.72	8.2										
TPA-4	0.0~2.4	2.80		14.8	1.820	94.9	16.9	1.728	0.620	76.3	1.7	30	2.2×10^{-6}
TPA-5	0.0~3.0	2.87		18.2	1.710	94.8	20.4	1.621	0.770	76.0	2.0	29	7.7×10^{-8}
TPA-9	0.0~1.1	2.67	6.0										
"	1.1~2.0	2.78	7.8										
TPA-11	0.0~1.5	2.85		13.5	1.910	95.1	15.3	1.817	0.568	76.8	2.5	25	2.4×10^{-6}
"	1.5~3.5	2.84		15.2	1.780	94.9	17.3	1.689	0.681	72.1	2.6	21.5	1.5×10^{-7}
(Huai Kham Phak Wan Project)													
TPA-1	0.0~1.0	2.86		13.5	1.948	95.0	15.6	1.850	0.546	81.7	1.8	31.5	3.4×10^{-6}
"	1.0~2.1	2.75	8.9										
TPA-2	0.0~1.0	2.86	7.1										
"	1.0~2.5	2.75	8.9										
TPA-3	0.0~1.2	2.83		14.2	1.892	95.0	16.2	1.797	0.575	79.7	1.4	34.0	5.3×10^{-8}
"	1.2~3.0	2.77	9.2										
TPB-1	0.0~2.0	2.66	3.7										
TPB-2	0.0~0.9	2.78		16.2	1.793	95.1	18.1	1.705	0.630	79.9	1.6	29	4.5×10^{-6}
"	0.9~2.2	2.71	7.3										
TPB-3	0.0~0.7	2.77		11.0	2.015	94.7	13.3	1.909	0.451	81.7	1.4	35.5	1.3×10^{-7}
(Huai Na Khai Project)													
TPA-2	1.0~3.0	2.70		15.0	1.775	95.0	17.0	1.687	0.600	76.5	1.6	29	3.0×10^{-6}
TPA-3	0.0~0.8	2.76	8.6										
"	0.8~2.5	2.81	17.8										
TPA-5	0.0~0.5	2.73	10.8										
"	0.5~2.0	2.72	14.3										
TPA-8	0.0~3.5	2.76	5.4										
TPA-9	0.0~1.4	2.67		14.2	1.800	95.1	16.1	1.712	0.559	76.9	1.3	30.5	3.5×10^{-8}
"	1.4~3.0	2.68		17.5	1.660	94.8	19.8	1.573	0.704	75.4	1.2	32	1.8×10^{-7}
TPA-11	1.1~2.5	2.76		13.0	1.825	95.1	14.9	1.736	0.590	69.7	1.2	32.5	7.1×10^{-8}
(Huai Soob Project)													
TPA-3	0.0~1.4	2.76		11.7	1.780	95.4	13.3	1.698	0.625	58.7	0.3	35	6.6×10^{-5}
"	1.4~3.0	2.75		15.0	1.823	94.7	17.3	1.726	0.593	80.2	1.6	3.0	4.1×10^{-8}
TPA-4	0.0~1.0	2.75	1.4										
"	1.0~2.0	2.76		14.6	1.806	94.7	17.0	1.711	0.613	76.5	2.0	26	2.9×10^{-8}
"	2.0~3.0	2.78	3.9										
TPA-5	0.0~2.0	2.68	2.9										
"	2.0~4.0	2.75	5.5										
TPB-2	0.0~1.1	2.75	7.6										
"	1.1~3.5	2.85	5.9										
TPB-4	0.0~3.2	2.73		11.4	1.932	94.8	13.7	1.831	0.491	76.2	1.8	30	3.4×10^{-8}
TPB-5	0.0~1.6	2.72	0.7										
"	1.6~2.3	2.76	4.2										
"	2.3~3.0	2.76	4.3										

TABLE F-16 : SUMMARY OF SOIL TEST (3/3)

(Note)

Dispersive Clay Identification Test

I: Pinhole Test Classification Test

D1 - D2: Dispersive Clay
ND4 - ND3: Transition Clay
ND2 - ND1: Non-dispersive Clay

II: Dispersion Ratio Test

Degree of dispersion 0-33%: Non-dispersion
Degree of dispersion 34-67%: Moderately dispersion
Degree of dispersion 68-100%: High dispersion

III: Dilution Turbidity Ratio

Ratio $\leq$ 3: Highly dispersive

IV: Crumb Test Classification

Grade 1: Non-dispersive
Grade 2: Primarily-dispersive
Grade 3: Moderately-dispersive
Grade 4: Highly-dispersive

V: Saturation Extract

Zone A: Dispersive Zone
Zone B: Non-dispersive Zone
Zone C: Intermediate Zone

TABLE F-17 : SUMMARY OF SOIL TEST BY GROUP

Unified Soil Classification	Sample No.	Sample Depth (m)	Specific Gravity (Gs)	Optimum Moisture Content (%)	Optimum Dry Density (g/cm³)	Condition of D = 95% Moisture Content (%)	Condition of D = 95% Dry Density (g/cm²)	Condition of D = 95% Void Ratio	Direct Shear Test C (t/m²)	Direct Shear Test φ (°)	K (cm/sec)	Remarks
CL ~ ML	TPA- 1	0.8 ~ 3.2	2.64	13.7	1,798	18.2	1,708	0.546	1.6	29	4.7×10^{-6}	Lam Se
	TPA- 8	0.0 ~ 3.5	2.72	14.0	1,805	18.0	1,715	0.586	1.8	23	2.2×10^{-8}	"
	TPA-11	1.5 ~ 3.5	2.84	15.2	1,780	19.1	1,691	0.679	2.6	21.5	1.5×10^{-7}	Khum Kham
	TPA- 2	1.0 ~ 3.0	2.70	15.0	1,735	20.0	1,686	0.601	1.6	29	3.0×10^{-6}	Na Khai
	TPA- 9	1.4 ~ 3.0	2.68	17.5	1,660	22.8	1,577	0.699	1.2	32	1.8×10^{-7}	"
	TPA-11	1.1 ~ 2.5	2.76	13.0	1,825	17.0	1,734	0.592	1.2	32.5	7.1×10^{-8}	"
	TPA- 4	1.0 ~ 2.0	2.76	14.6	1,806	17.8	1,716	0.608	2.0	26	2.9×10^{-6}	Soob
(Average)			2.73	14.7	1,778	19.0	1,690	0.616	1.7	27.6	7.6×10^{-8}	
GC	TPA- 4	0.0 ~ 2.4	2.80	14.8	1,820	18.3	1,729	0.619	1.7	30	2.2×10^{-8}	Khum Kham
	TPA- 5	0.0 ~ 3.0	2.87	18.2	1,710	22.2	1,625	0.766	2.0	29	7.7×10^{-8}	"
	TPA-11	0.0 ~ 1.5	2.85	13.5	1,910	17.5	1,815	0.570	2.5	25	2.4×10^{-8}	"
	TPA- 3	0.0 ~ 1.2	2.83	14.2	1,892	16.8	1,797	0.575	1.4	34	5.3×10^{-8}	Kham Phak Wan
	TPB- 2	0.0 ~ 0.9	2.78	16.2	1,793	20.0	1,703	0.632	1.6	29	4.5×10^{-8}	"
	TPA- 9	0.0 ~ 1.4	2.67	14.2	1,800	19.5	1,710	0.561	1.3	30.5	3.5×10^{-8}	Na Khai
	TPA- 3	1.4 ~ 3.0	2.75	15.0	1,823	17.8	1,732	0.588	1.6	30	4.1×10^{-8}	Soob
(Average)			2.79	15.2	1,821	18.9	1,730	0.616	1.7	29.6	4.2×10^{-8}	
SC ~ SM	TPA- 6	0.0 ~ 1.8	2.65	11.0	1,910	14.6	1,815	0.460	2.2	33	6.9×10^{-6}	Lam Se
	TPA- 1	0.0 ~ 1.0	2.86	13.5	1,948	16.2	1,851	0.545	1.8	31.5	3.4×10^{-6}	Kham Phak Wan
	TPA- 3	0.0 ~ 1.4	2.76	11.7	1,780	16.7	1,691	0.632	0.3	35	6.6×10^{-6}	Soob
	TPB- 4	0.0 ~ 3.2	2.73	11.4	1,932	14.0	1,835	0.488	1.8	30	3.4×10^{-8}	"
(Average)			2.75	11.9	1,893	15.2	1,798	0.531	1.5	32.3	1.7×10^{-6}	
GM	TPB- 3	0.0 ~ 0.7	2.77	11.0	2,015	14.3	1,914	0.477	1.4	35.5	1.3×10^{-7}	Kham Phak Wan

TABLE F-18 : CHARACTERISTIC OF EACH TYPE DAM

Description	Plan A; Earth Fill Type Dam	Plan B; Concrete Facing Type Dam	Plan C; Asphalt Facing Type Dam	Plan D; Asphalt Core Type Dam
1) Application	1) In case that embankment materials especially core material can be obtained from nearby the site, this type dam shall be applicable with the most economical cost.	1) In case that obtaining of embankment materials especially core material is difficult and/or impossible at nearby the site and/or with reasonable hauling distance.	1) Some as plan B.	1) Same as Plan B.
2) Seepage control	2) Core zone (clayey soil) prevents seepage from reservoir.	2) Water-tight is made by concrete slab provided at the up-stream surface of dam.	2) Water-tight is made by asphalt pavement provided at the up-stream surface of dam.	2) Water-tight is made by asphalt core provided at the center of dam.
3) Dam section	3) Taking into account of pore-pressure caused by seepage water, the dam section is designed in the slope of about 1:3.0 at up-stream and 1:2.5 at down-stream commonly. It qives a large section than the Plan B and C.	3) The up-stream of dam can be designed with the most steep slope among the four plans (about 1:1.50) because of no-seepage water inside of dam-body.	3) From the same reason as Plan B, the up-stream slope will be sharp, however, more than 1:1.7 slope shall be adopted taking into account of safety of construction.	3) The up-stream slope shall be same gentle as plan A affected by pore-pressure.
4) Capability against deformation of dam-body and foundation	4) Flexible capability for deformation caused by loads of dam self weight, storage water and/or earthquake is the best among the four plans.	4) -Since the cement concrete is too weak in tension stress, fexible capability for deformation of foundation is quite small. Therefore, this type dam shall be applied in small or non-earthquake area. -And in order to place the concrete slab on rigidity foundation, the up-stream section of dam shall be zoned with transition and/or rock materials.	4) -Fexible capability for deformation is rather large, so that it can be adopted in earthquake area, under the condition that the asphalt pavement is provided on stiffness foundation. -Namely the up-stream section of dam shall be zoned with transition and/or rock materials as some as Plan B.	4) Since core zone is protected by outer-shells, this type dam is stronger than the facing type dam in such outer loads as earthquake, temperature, flowing log, etc.
5) Availability of onstruction	5) -It is the most prevailing type dam, and there are a lot of construction example. -Construction period is relied on weather conditions partecularly rainfall	5) -Construction of inclined concrete, slab is not so difficult compared with Plan C and D because of non utilization of special equipment. -Design and erection of joint structure shall be made with due consideration and attention. -A number of this type' dams including Khao Laem Dam in Thailand have been constructed except in such earthquake area as Japan. -By development of construction method and modernizstion of construction equipment, settlement of embankment becomes to small recently.	5) -Mobilization of special equipment such as inclined finisher and winch portal, and due experience of construction are required in construction of this type dam. -There are comparative number of construction example.	5) -In construction of asphalt core, special construction equipment such as asphalt finisher and experience especially for quality control are also required by rather lower level than plan C. -Dam construction period is restricted by construction of asphalt core.
6) Construction Cost	6) If materials are available, this type dam will be constructed with the most economical cost among the plans.	6) This type dam will be 2nd of low cost.	6) construction cost of this type dam is the costliest among the plans.	6) Construction cost of this type dam will be intermediate between it of Plan B and Plan C.
7) Maintenance	7) When there are some trouble in the core zone, rehabilitation and repair of it is quite difficult.	7) Maintenance and rehabilitation of concrete slab is easy because of surfacing type of water tight.	7) Same as Plan B.	7) Rehabilitation of core zone is difficult due to inter-sell.

TABLE F-19 : CONSTRUCTION COST FOR EACH TYPE DAM

Description	Unit	Unit Price (฿)	Plan A Qu.	Plan A Amount (฿)	Plan B Qu.	Plan B Amount (฿)	Plan C Qu.	Plan C Amount (฿)	Plan D Qu.	Plan D Amount (฿)	Remarks
1) Embankment											
- Core zone	m^3	110	160.0	17,600	-	-	-	-	-	-	
- Random zone	"	75	863.9	64,792	506.0	37,950	506.0	37,950	959.2	71,940	
- Transition & Rock	"	210	51.6	10,836	327.1	68,691	341.9	71,799	51.6	10,836	
- Riprap	"	240	31.6	7,584	-	-	-	-	31.6	7,584	
- Sand & Gravel	"	250	20.1	5,025	3.7	925	3.7	925	64.3	16,075	
2) Concrete											
- Facing concrete	m^3	3,200	-	-	11.90	38,080	-	-	-	-	
- Base concrete	"	1,800	-	-	2.00	3,600	3.03	5,453	4.7	8,460	
3) Asphalt											
- Facing asphalt	m^3	6,000	-	-	-	-	11.3	67,800	-	-	
- Asphalt core	"	4,000	-	-	-	-	-	-	12.0	48,000	
4) Other's											
- Laterite pavement	m^3_2	15	1.8	27	1.8	27	1.8	27	1.8	27	
- Sodding	m^2	10	40.4	404	40.4	404	40.4	404	40.4	404	
Total			1,127.2	106,268	850.7	149,670	865.9	184,358	1,123.4	163,326	
Unit Price (฿/m^3)				94		176		213		145	

Note: a) Plan A ... Earth fill type dam
Plan B ... Concrete facing type dam
Plan C ... Asphalt facing type dam
Plan D ... Asphalt core type dam
b) Qu ..... Quantity

TABLE F-20 : ASSUMED DESIGN VALUES OF EMBANKMENT MATERIALS

Project	Zone	rt (t/m³)	rsat (t/m³)	C (t/m²)	ϕ (°)	Remarks
Lam Se	Zone I	2.05	2.12	1.0	21	Impervious zone, D≧98 %
	Zone II	2.02	2.08	1.0	21	Impervious zone, D≧95 %
Huai Khum Kham	Zone I	2.08	2.14	1.0	23	Impervious zone, D≧98 %
	Zone II	2.04	2.10	1.0	23	Impervious zone, D≧95 %
Huai Kham	Zone I	2.07	2.13	1.0	21	Impervious zone, D≧98 %
Phak Wan	Zone II	2.03	2.09	1.0	21	Impervious zone, D≧95 %
Huai Na Khai	Zone I	2.07	2.13	1.0	21	Impervious zone, D≧98 %
	Zone II	2.03	2.09	1.0	21	Impervious zone, D≧95 %
Huai Soob	Zone I	2.09	2.15	1.0	23	Impervious zone, D≧98 %
	Zone II	2.05	2.11	1.0	23	Impervious zone, D≧95 %
Random Zone	Zone III	2.19	2.20	1.0	28	D≧95%, based on GM material
Riprap/Rock Fill		2.10	2.30	-	40	Refered to the previous design data
Drain		2.10	2.20	-	35	Refered to the previous design data

TABLE F-21 : FEATURES OF EXISTING AND UNDER-CONSTRUCTION DAMS

Description \ Project	Huai Pho	Rong Nam Sap	Phuttha Utthayan	Nong Chang Yai	Sa-Saming	Huai Thamkhai	Huai Ling Chon	Huai Sa Back
1) Location								
- Changwat	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Ubon Ratchathani	Yasothon	Yasothon
- Amphoe	Amnat Charoen	Amnat Charoen	Amnat Charoen	Muang Sam Sip	Muang Ubon	Trakan Phut Phon	Loeng Nok Tha	Loeng Nok Tha
2) River								
- Basin	Sebai	Sebai	Sebai	Sebok	Sebok	Sebok	Sebai	Sebai
- River	Huai Pho	Rong Nam Sap	Huai Pla Daek	Nong Chang Yai	Sa Saming	Huai Thamkhai	Huai Ling Chon	Huai Sa Back
- Watershed (Knf)	17.2	1.75	62.0	62.0	2.00	52.5	52.0	49.0
3) Reservoir								
- Cap. at NWL (MCM)	5.392	0.423	15.339	7.681	1.011	14.500	17.500	26.800
- Cap. at LWL (MCM)	0.050	0.085	0.782	0.500	0.304	0.950	0.400	0.600
- H.W.L.	---	---	---	---	---	139.00	176.45	177.25
- N.W.L.	202.00	203.00	166.00	128.462	12.00	137.50	175.00	176.00
- L.W.L.	195.00	201.00	160.00	126.662	8.00	132.50	168.00	167.00
- Intake EL	195.00	201.00	160.00	126.662	8.00	132.50	168.00	167.00
- Av. Inflow (MCM/Y)	7.626	0.755	27.861	26.589	1.099	21.396	22.895	19.986
- Sedi. Yield (mm/Y)	---	---	---	---	---	0.20	---	0.20
- Sediment V. (MCM)	---	---	---	---	---	1.093	---	0.669
4) Dam						(100Y)		(50Y)
- Type of Dam	Earth	Earth	Earth	Earth	Earth	Earth	Earth	Earth
- Dam Crest EL (m)	203.50	204.00	167.50	129.462	13.00	140.50	178.50	179.50
- Width of Dam (m)	6.00	5.00	6.00	4.00	4.00	7.00	8.00	8.00
- Length of Dam(m)	510	780	1,385	640	250	1,826	2,000	1,932
- Height of Dam(m)	11.6	5.0	13.5	4.5	7.0	18.5	13.5	19.00
- Free-board (m)	---	---	---	---	---	1.50	2.05	2.25
- Slope of Dam								
Up-stream	1:3.0	1:3.0	1:3.0	1:3.0	1:3.0	1:3.0	1:2.5	1:2.5-3.0
Down-stream	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5	1:2.0	1:2.0-2.5
5) Spill-way								
(Service Spill-way)								
- Design Flood (cms)	---		---	---		118.8	---	323.4
- Probability (year)	---		---	---		100	---	100
- Speci. Yield (cms/km^3)	---		---	---		2.26	---	6.60
- Design Discharge (cms)	18.0		69.0	40.0		70.0	129.0	100.0
- Type of Spill-way	Side Cha.		Side Cha.	Side Cha.		Glory Ho.	Side Cha.	Side Cha.
- Length of Weir (m)	55.0		43.0	40.0		d=3.10	101.0	40.0
(Emergency Spill-way)	---		---	---			---	---
- Design Flood (cms)						---		
- Probability (year)						---		
- Design Discharge (cms)						110.0		

Note : Sedi. = Sediment, Side Cha. = Side Channel
Cap. = Capacity, Y = Year

TABLE F-22 : MAJOR FEATURES OF PROPOSED DAMS

Description \ Project	BA-5 (Lam Se)	BO-11 (Huai Khum Kham)	BO-13 (Huai Kham Phak Wan)	BO-18 (Huai Na Khai)	TL-6 (Huai Soob)	Remark
(1) Dam-body						
- Dam Type	Earth Fill	ditto	ditto	ditto	ditto	
- Crest EL (MSL)	181.0	165.0	146.5	140.0	164.5	
- Crest Length (m)	1,680	1,150	1,320	2,750	1,630	
- Crest Width (m)	6.0	6.0	6.0	6.0	6.0	
- Height (m)	16.0	20.5	14.5	17.5	19.5	
- Slope Up-stream	1:3.0	1:3.0	1:3.0	1:3.0	1:3.0	
Down-stream	1:2.5	1:2.5	1:2.5	1:2.5	1:2.5	
- Volume ('000 m^3)	331	355	401	600	391	
(2) Foundation Treatment						
- Lowest Trench EL (MSL)	165.0	144.5	132.0	122.5	145.0	
- Treatment Method	Earth Blanket	Grounting	Grounting	Grounting	Grounting	
- Max Length of Depth (m)	140.0	12.0	12.0	15.0	13.0	
(3) Spill-way						
- Design Flood (cum/s)	222	239	157	316	239	1/100 years
- Design Discharge(cum/s)	67	104	56	78	134	
- Spill-way Type	Duck Bill Type	ditto	ditto	ditto	ditto	OG Curve
- Crest EL (MSL)	178.0	162.0	143.5	137.0	161.5	
- Crest Length (m)	40.0	50.0	30.0	50.0	60.0	
- Width of Canal (m)	7.0	9.0	7.0	8.0	10.0	
- Structure Length (m)	175	432	219	248	208	
- Total Length (m)	465	702	419	678	645	
(4) Outlet						
a) Left Outlet	1	1	1	1	1	
- Design Discharge(cum/s)	0.90	2.29	1.52	3.36	0.61	
- Diameter of Conduit(m)	0.80	1.20	1.10	1.50	0.70	
- Structure Length (m)	97.5	116.8	97.8		98.0	
b) Right Outlet	1	1	Non	Non	1	
- Design Discharge(cum/s)	0.86	1.87	-	-	0.86	
- Diameter of Conduit(m)	0.80	1.10	-	-	0.80	
- Structure Length (m)	97.5	104.3	-	-	95.5	

TABLE F-23 ; ENVIRONMENT EFFECT PARAMETER (1/2)

(A) Dam and Reservoir Project

(1) Physical Resources

- Surface water hydrology: possible changes in hydrological regime by comparing the typical hydrographs for normal, drought and flood year conditions and mass water balance, both for before and after project conditions.
- Surface water quality: effect of storage on physical, biological and dissolved mineral constituents parameters, for both the reservoir and river downstream.
- Groundwater: quality and quantity of groundwater, both in reservoir vicinity and river downstream.
- Soils: soil erosion in the watershed as well as the irrigation aspects.
- Geology and seismology: adequacy of foundation conditions for structural stability and anticipated earthquake hazards in the region.
- Sediments and erosion: sedimentation in the reservoir.
- Climate: possible changes in microclimate in the project vicinity.

(2) Ecological Resources

- Fisheries: loss in existing riverline fisheries and expected new fishery situation in the reservoir and in the altered river.
- Aquatic biology: expected new ecology in the reservoir and on the affected downstream riverline zone.
- Wildlife: impact of project on wildlife in watershed area and in downstream, and new wildlife to be created by the project.
- Forests: impact of project in inundating forest reserves especially from the aspects in soil and water conservation.
- Reservoir ecology: anticipated environment in the new reservoir.

(3) Human Use Values

- Water supply: availability of water for downstream communities for both domestic and rural water supply.
- Aquaculture: potentials for improved downstream aquaculture resulting from low flow augmentation, and brackish water fishery in downstream area.
- Navigation: effect of low flow augmentation caused by supply of river maintenance water, especially during dry period.

TABLE F-23 ; ENVIRONMENT EFFECT PARAMETER (2/2)

(4) Quality of Live Values

- Socio-economics: welfare of affected rural population.
- Resettlement: problems involved in the resettlement plan of the population to be inundated.
- Public health: anticipated health/sanitation problems especially for altering hazards of water-oriented diseases in the region.
- Nutrition: probable effects on nutrition pattern due to the altered fishery production.
- Recreation: recreation and aesthetic values of the new reservoir systems.

(B) Irrigation Project

Irrigation aspects also need to be evaluated in terms of the following:

- Crop and food production: estimated impact on types and amounts of crops to be produced, and the resulting increase in food production.
- Institutional requirement: plans for reorientation and training of the farmers to make the adjustment to irrigated farming including plans for extension services, farmers' cooperatives, and service center for furnishing training, credit, ready purchase of farm inputs, ready marketing, etc.
- Irrigation distribution: plans for distribution and use of the irrigation water.
- Soil fertility: loss of soil fertility caused by continuous irrigation.
- Return-flow: effect of return-flow on river water salinity.
- Agro-industries: potentials for agro-industrial development in the irrigation areas.
- Agricultural chemicals: effects of runoff from farming areas containing residues of fertilizers and toxic chemicals on stream ecology and effects of toxic chemicals on terrestrial wildlife.

TABLE F-24 : REQUIRED TOPO-SURVEY WORKS

Item	Unit	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob	Total
(Dam and Reservoir)							
a) Topo-survey (S = 1/1,000)	ha	60	120	200	230	130	740
- Borrow area		60	90	150	150	100	
- Dam-site (additional)		-	30	50	80	30	
b) Longitudinal leveling	km	1.0	1.1	0.7	2.6	1.9	7.3
- Dam axis (additional)		-	-	-	1.6	0.8	
- Spill-way, Outlet		1.0	1.1	0.7	1.0	1.1	
c) Cross leveling	km	3.1	2.8	2.2	4.0	2.8	14.9
- Dam axis		2.1	1.7	1.5	3.0	1.7	
- Spillway, Outlet		1.0	1.1	0.7	1.0	1.1	
(Shifted Road)							
a) Route survey	km	6.0	3.5	-	-	1.0	10.5
b) Site plan survey	ha	12	7			3	22

TABLE F-25 : REQUIRED SOIL AND GEOLOGICAL SURVEY WORKS

Item	Unit	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob	Total
(1) Geological Investigation							
(Dam and Reservoir)							
a) Seismic exploration	km	2.1	2.0	1.9	3.6	2.4	12.4
b) Boring investigation ϕ66 m/m							
- Drilling with coring	m	240	210	220	350	250	1,270
- Permiability test	test	50	40	50	90	60	290
- Standard penetration test	time	50	40	50	90	60	290
(Shifted Road)							
a) Boring investigation							
- Drilling with coring	m	120	70	-	-	20	210
b) Auger boring	m	700	400	-	-	150	1,250
(2) Soil Investigation							
a) Test pit	place	20	20	30	30	20	120
b) Auger boring	m	40	40	60	60	40	240
c) Laboratory test							
- Physical property test 1/	sample	20	20	30	30	20	120
- Mechanical soil test 2/	"	10	10	15	15	10	60

Notes: 1/ Gradation analysis, Atterbery limit, Specific gravity, Moisture content, Dispersive identification.
2/ Compaction, Rermeability, Triaxial shear (UU & CU), Consolidation.

TABLE F-26 : RESERVOIR OPERATION CASE STUDY (1/3)

Item \ Month	4	5	6	7	8	9	10	11	12	1	2	3	Total
(Inflow)													
- Rainfall (mm)	76.0	171.2	94.2	94.2	235.4	292.6	254.8	93.7	8.1	0.0	1.1	13.5	37.0	1,371.8
- Run-off Co. 1/ (%)	18.6	31.0	33.2	25.0	25.0	31.6 (92.6mm)	25.0	20.9	9.8	0	8.8	10.5	13.6	
1) Case A													
- R. from Ca. 2/ ($1000m^3$)	4.3	16.2	16.8	18.0	28.3	19.5	6.0	0.2	0	0	0.4	1.5	111.2
- R. in pond 3/ ($1000m^3$)	2.6	5.8	6.4	8.0	9.9	8.7	3.2	0.3	0	0	0.5	1.3	46.7
Total ($1000m^3$)	6.9	22.0	23.2	26.0	38.2	28.2	9.2	0.5	0	0	0.9	2.8	157.9
2) Case B													
- R. from Ca. ($1000m^3$)	4.5	16.8	17.3	18.6	29.3	20.1	6.2	0.3	0	0	0.4	1.6	115.1
- R. in pond ($1000m^3$)	1.8	4.1	4.5	5.6	7.0	6.1	2.2	0.2	0	0	0.3	0.9	32.7
Total ($1000m^3$)	6.3	20.9	21.8	24.2	36.3	26.2	8.4	0.5	0	0	0.7	2.5	147.8
3) Case C													
- R. from Ca. ($1000m^3$)	4.6	17.1	17.7	20.5	29.9	20.6	6.3	0.3	0	0	0.5	1.6	119.1
- R. in pond ($1000m^3$)	1.3	2.9	3.2	4.0	5.0	4.3	1.6	0.1	0	0	0.2	0.6	23.2
Total ($1000m^3$)	5.9	20.0	20.9	24.5	34.9	24.9	7.9	0.4	0	0	0.7	2.2	142.3

Notes: 1/ Runoff Coefficiency.
2/ Runoff from the catchment area (or beneficial area).
3/ Rain water in the pond.

TABLE F-26 : RESERVOIR OPERATION CASE STUDY (2/3)

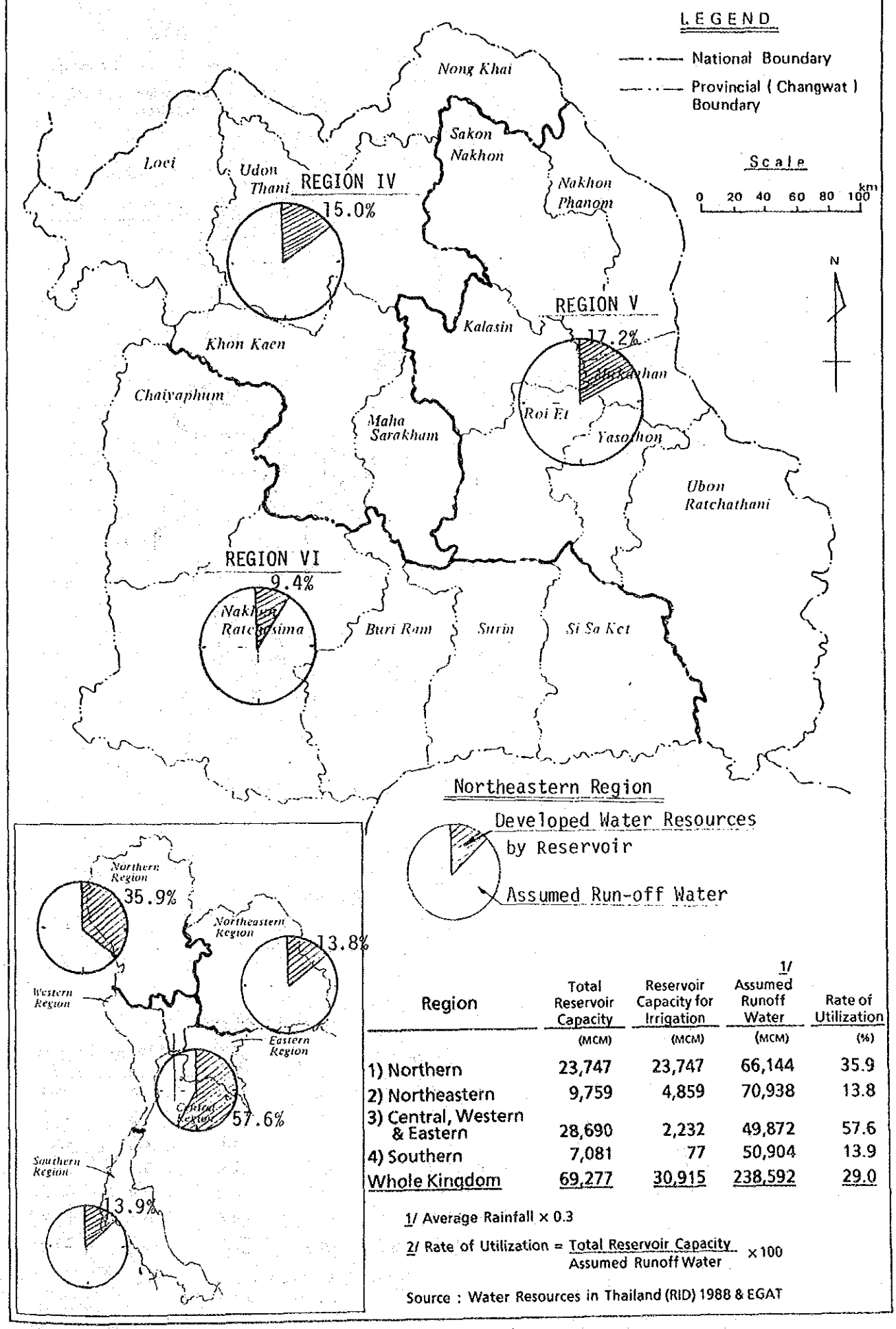
Item \ Month	4	5	6	7	8	9	10	11	12	1	2	3	Total
(Outflow)													
- Pan-evapo. 1/ (mm)	210.8	184.0	161.9	163.9	151.7	129.1	164.1	173.1	173.0	174.9	174.3	216.1	2,076.9
- 0.7 Pan-evapo. 2/ (mm)	147.6	128.8	113.3	114.7	106.2	90.4	114.9	121.1	121.1	122.4	122.0	151.3	1,453.8
- Field Water Re. 3/ (mm)	-	-	54.3	58.9	76.5	23.3	156.2	0	-	-	-	-	369.2
1) Case A													
- 100% D.W. 4/ ($1000m^3$)	-	-	18.5	20.0	26.0	7.9	53.1	0	-	-	-	-	125.5
- Evapo. W. 5/ ($1000m^3$)	5.0	4.4	3.9	3.9	3.6	3.1	3.9	4.1	4.1	4.2	4.1	5.1	49.4
- Perco. W. 6/ ($1000m^3$)	2.0	2.1	2.0	2.1	2.1	2.0	2.1	2.0	2.1	2.1	1.9	2.1	24.6
Total (100% D.W.)	7.0	6.5	24.4	26.0	31.7	13.0	59.1	6.1	6.2	6.3	6.0	7.2	199.5
Total (75% D.W.)	7.0	6.5	19.8	21.0	25.2	11.0	45.8	6.1	6.2	6.3	6.0	7.2	168.1
2) Case B													
- 100% D.W. ($1000m^3$)	-	-	19.1	20.7	26.9	8.2	54.9	0	-	-	-	-	129.8
- Evapo. W. ($1000m^3$)	3.5	3.1	2.7	2.7	2.5	2.2	2.7	2.9	2.9	2.9	2.9	3.6	34.6
- Perco. W. ($1000m^3$)	1.4	1.5	1.4	1.5	1.5	1.4	1.5	1.4	1.5	1.5	1.3	1.4	17.3
Total (100% D.W.)	4.9	4.6	23.2	24.9	30.9	11.8	59.1	4.3	4.4	4.4	4.2	5.0	181.7
Total (75% D.W.)	4.9	4.6	18.4	19.7	24.2	9.8	45.4	4.3	4.4	4.4	4.2	5.0	149.3

Notes: 1/ Pan-evaporation
2/ 70% of Pan-evaporation
3/ Field water requirement
4/ 100% of Diversion water requirement
5/ Evaporated water
6/ Percorated water

TABLE F-26 : RESERVOIR OPERATION CASE STUDY (3/3)

Item \ Month	4	5	6	7	8	9	10	11	12	1	2	3	Total
3) Case C													
- 100% D.W. ($1000m^3$)	-	-	19.5	21.1	27.5	8.4	56.1	0	-	-	-	-	
- Evapo. W. ($1000m^3$)	2.5	2.2	1.9	1.9	1.8	1.5	2.0	2.1	2.1	2.1	2.1	2.6	
- Perco. W. ($1000m^3$)	1.0	1.1	1.0	1.1	1.1	1.0	1.1	1.0	1.1	1.1	1.0	1.1	
Total (100% D.W.)	3.5	3.3	22.4	24.1	30.4	10.9	59.2	3.1	3.2	3.2	3.1	3.7	170.1
Total (75% D.W.)	3.5	3.3	17.5	18.8	23.5	8.8	45.2	3.1	3.2	3.2	3.1	3.7	136.9
Total (60% D.W.)	3.5	3.3	14.6	15.7	19.4	7.5	36.8	3.1	3.2	3.2	3.1	3.7	117.1
(Reservoir Operation)													
1) Case A (75% D.W.)													
- Storage ($1000m^3$)	0.0	15.5	18.9	23.9	36.9	54.1	17.5	11.9	5.7	0.0	0.0	0.0	
- Spill ($1000m^3$)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2) Case B (75% D.W.)													
- Storage ($1000m^3$)	1.4	17.7	21.1	25.6	37.7	45.0	8.0	4.2	0.0	0.0	0.0	0.0	
- Spill ($1000m^3$)	0.0	0.0	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	
3) Case C (60% D.W.)													
- Storage ($1000m^3$)	2.4	19.1	25.4	34.0	34.0	34.0	5.1	7.4	0.0	0.0	0.0	0.0	
- Spill ($1000m^3$)	0.0	0.0	0.0	0.2	15.5	17.4	0.0	0.0	0.0	0.0	0.0	0.0	

FIGURE F-1 DEVELOPED SURFACE WATER RESOURCES



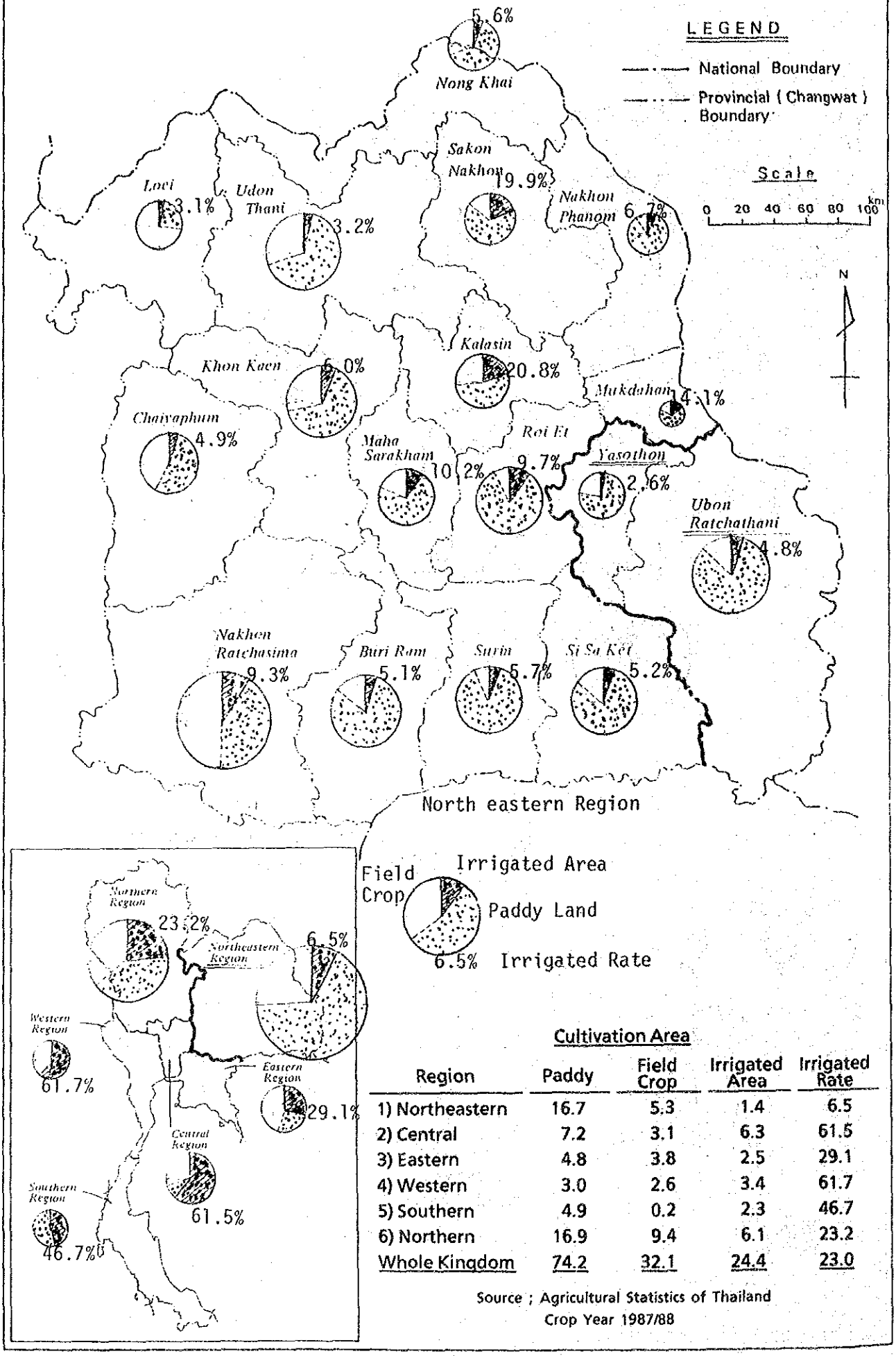
Region	Total Reservoir Capacity (MCM)	Reservoir Capacity for Irrigation (MCM)	1/ Assumed Runoff Water (MCM)	Rate of Utilization (%)
1) Northern	23,747	23,747	66,144	35.9
2) Northeastern	9,759	4,859	70,938	13.8
3) Central, Western & Eastern	28,690	2,232	49,872	57.6
4) Southern	7,081	77	50,904	13.9
Whole Kingdom	69,277	30,915	238,592	29.0

1/ Average Rainfall x 0.3

2/ Rate of Utilization = $\frac{\text{Total Reservoir Capacity}}{\text{Assumed Runoff Water}} \times 100$

Source : Water Resources in Thailand (RID) 1988 & EGAT

FIGURE F-2 CULTIVATION AREA ~ IRRIGATED AREA



Cultivation Area

Region	Paddy	Field Crop	Irrigated Area	Irrigated Rate
1) Northeastern	16.7	5.3	1.4	6.5
2) Central	7.2	3.1	6.3	61.5
3) Eastern	4.8	3.8	2.5	29.1
4) Western	3.0	2.6	3.4	61.7
5) Southern	4.9	0.2	2.3	46.7
6) Northern	16.9	9.4	6.1	23.2
Whole Kingdom	74.2	32.1	24.4	23.0

Source ; Agricultural Statistics of Thailand
Crop Year 1987/88

FIGURE F-3 RATE OF IRRIGATED AREA ~ PADDY YIELD

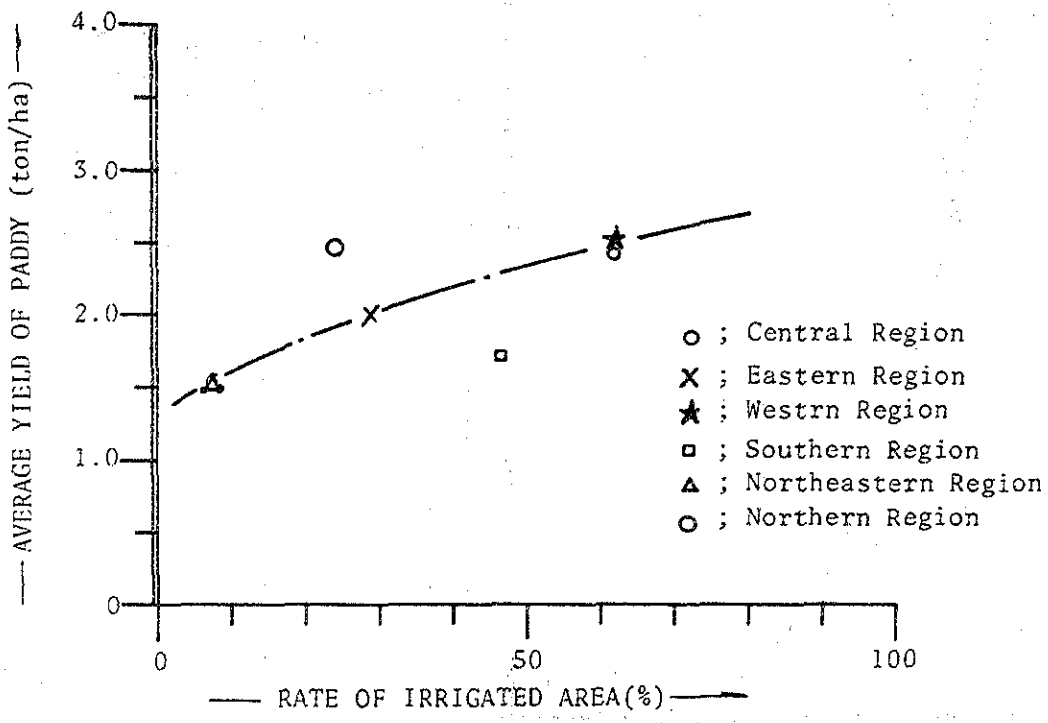
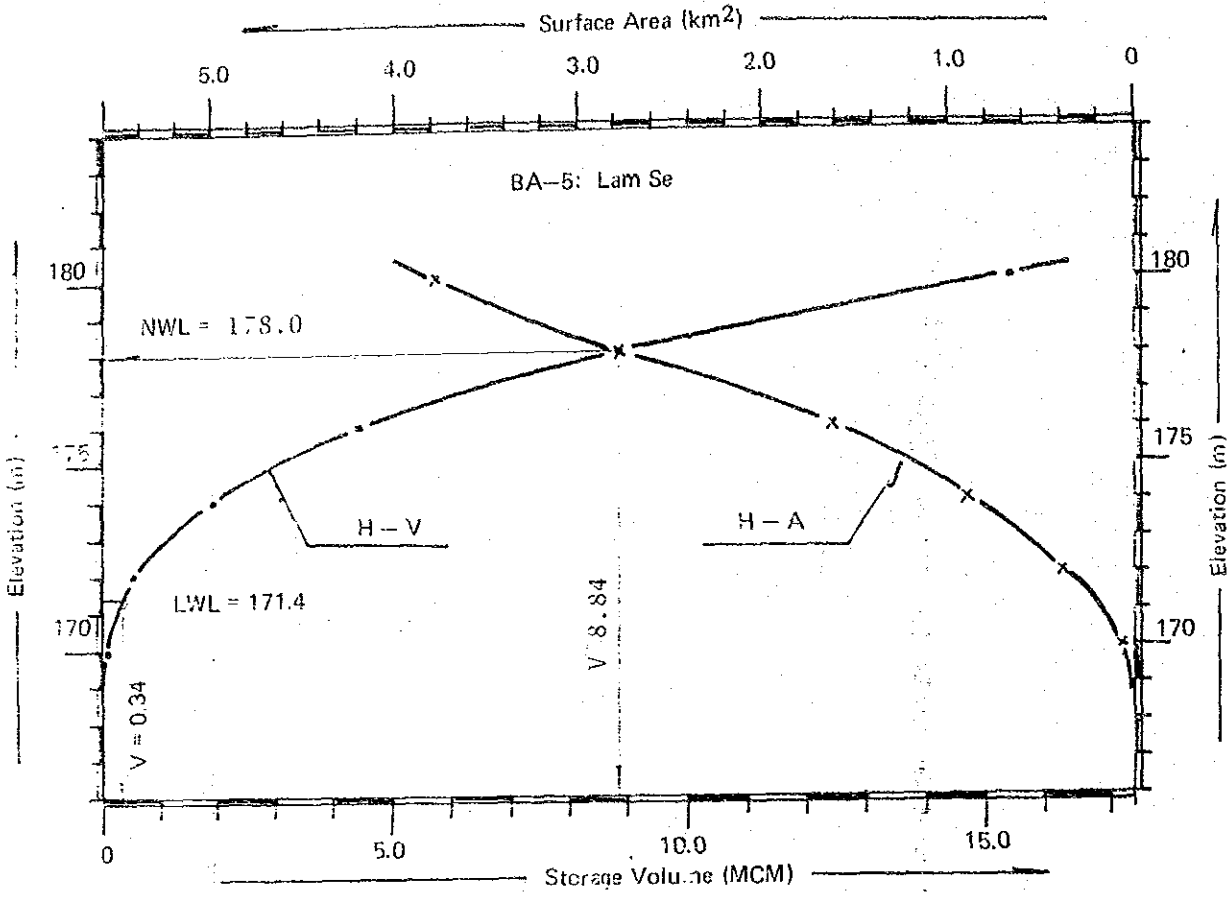
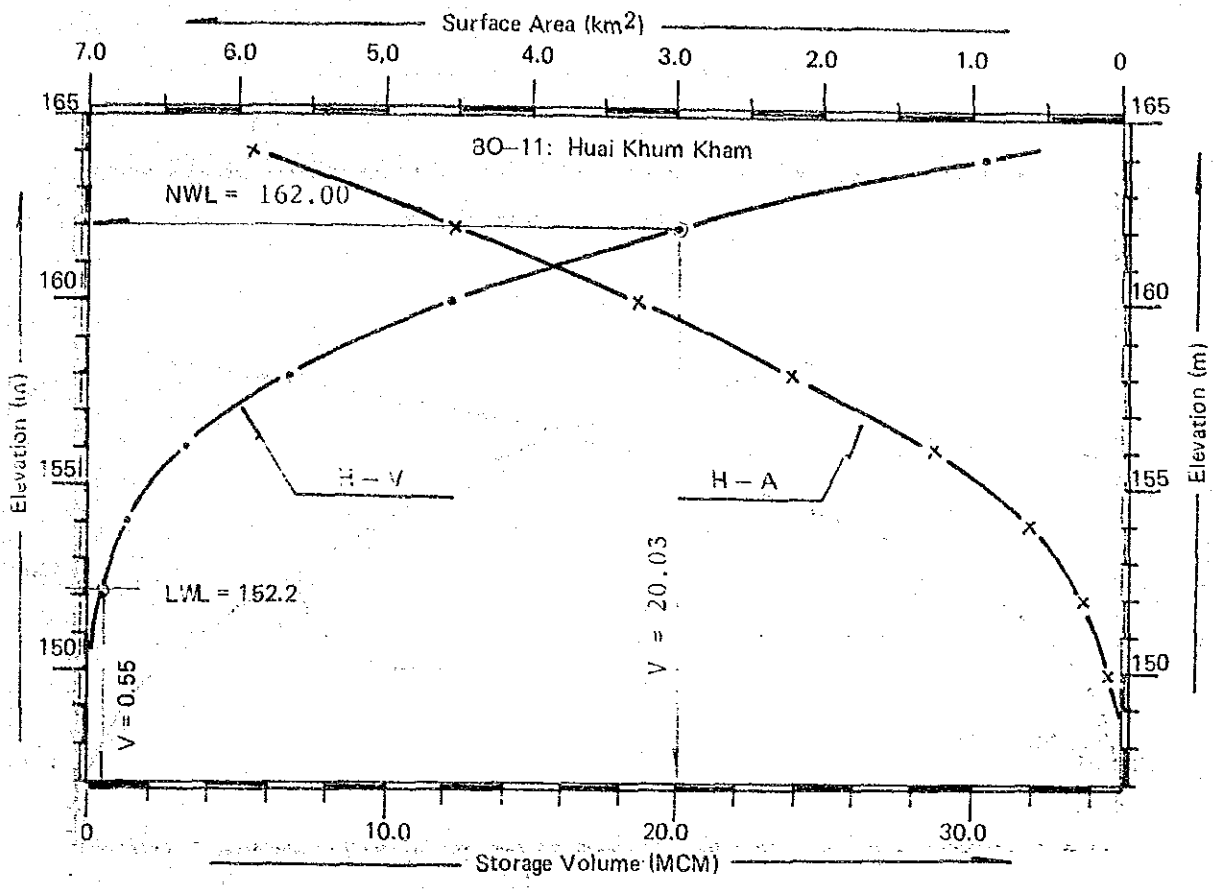


FIGURE F-4 : RESERVOIR AREA ~ CAPACITY CURVE (1/5)



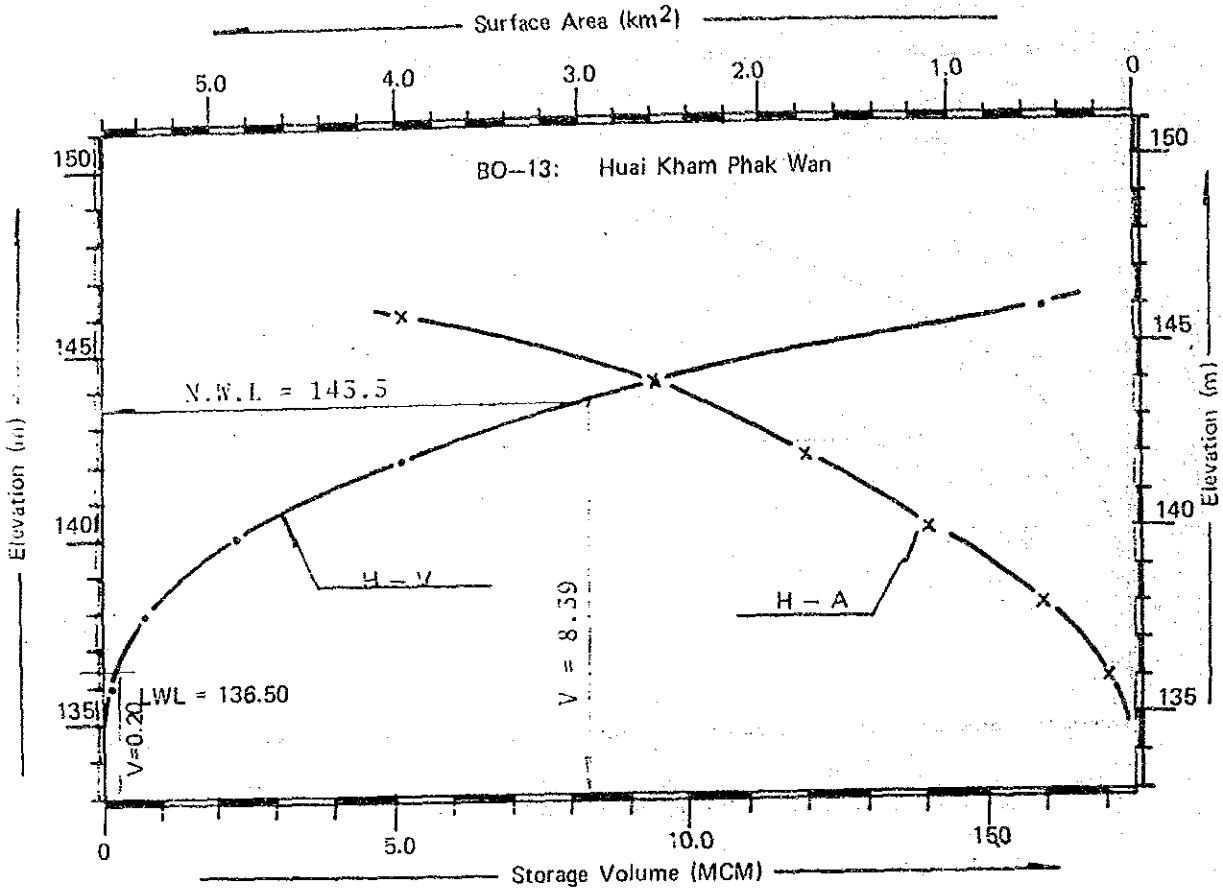
PROJECT ; BA-5, Lam Se						
EL (m)	Distance (m)	Area ('000m²)	Av.Area ('000m²)	Volume ('000m³)	Acc.Volume ('000m³)	Remarks
167						
170	3.0	83.5	41.75	125.25	125.25	
172	2.0	391.0	237.25	474.5	599.75	
174	2.0	917.5	654.25	1,308.5	1,908.25	
176	2.0	1,613.5	1,265.50	2,531.0	4,439.25	
178	2.0	2,788.0	2,200.75	4,401.5	8,840.75	
180	2.0	3,773.0	3,280.50	6,561.0	15,401.75	

FIGURE F-4 : RESERVOIR AREA ~ CAPACITY CURVE (2/5)



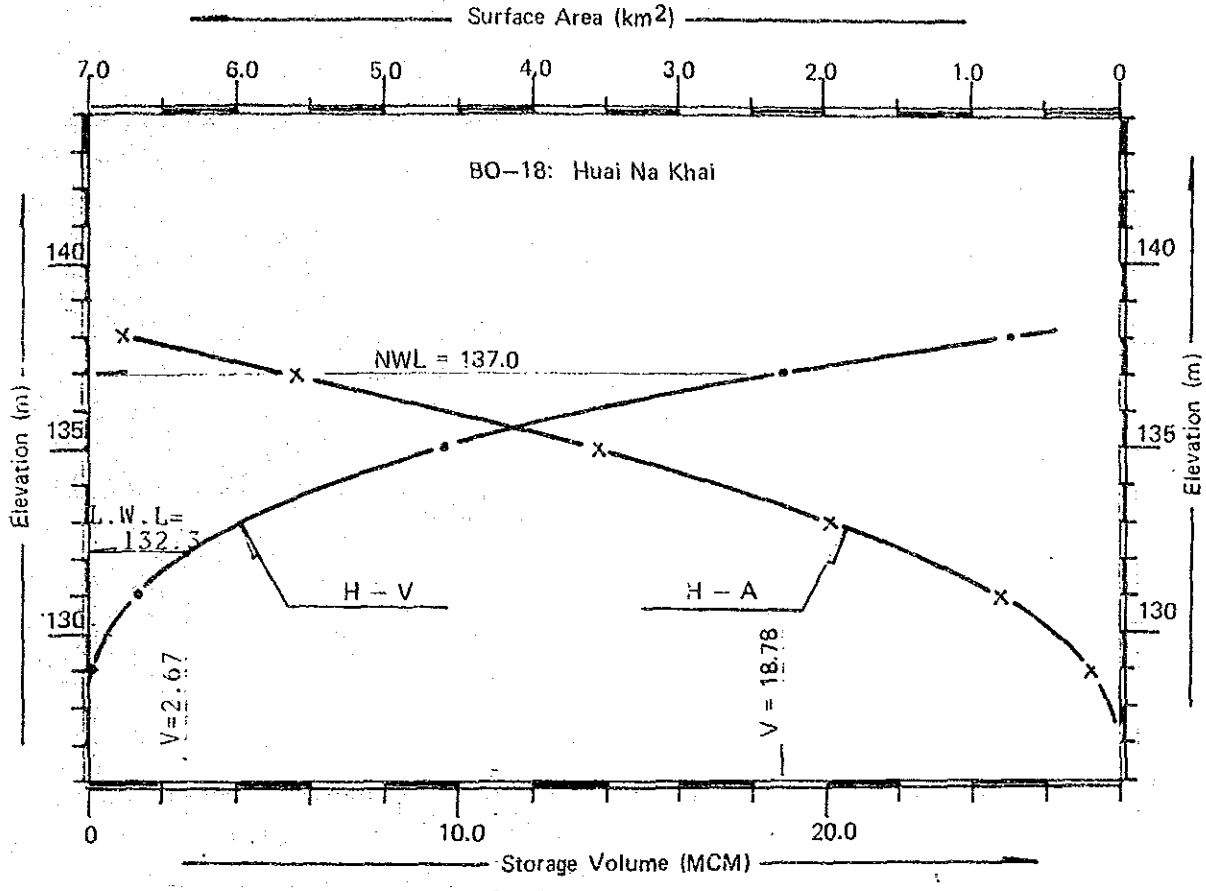
PROJECT ; BO-11, Huai Khum Kham						
EL (m)	Distance (m)	Area ('000m^2)	Av.Area ('000m^2)	Volume ('000m^3)	Acc.Volume ('000m^3)	Remarks
148						
150	2.0	90.0	45.0	90.0	90.0	
152	2.0	257.5	173.75	347.5	437.5	
154	2.0	623.0	440.25	880.5	1,318.0	
156	2.0	1,265.0	944.0	1,888.0	3,206.0	
158	2.0	2,223.0	1,744.0	3,488.0	6,694.0	
160	2.0	3,287.0	2,755.0	5,510.0	12,204.0	
162	2.0	4,537.0	3,912.0	7,824.0	20,028.0	
164	2.0	5,921.5	5,229.25	10,458.5	30,486.5	

FIGURE F-4 : RESERVOIR AREA ~ CAPACITY CURVE (3/5)



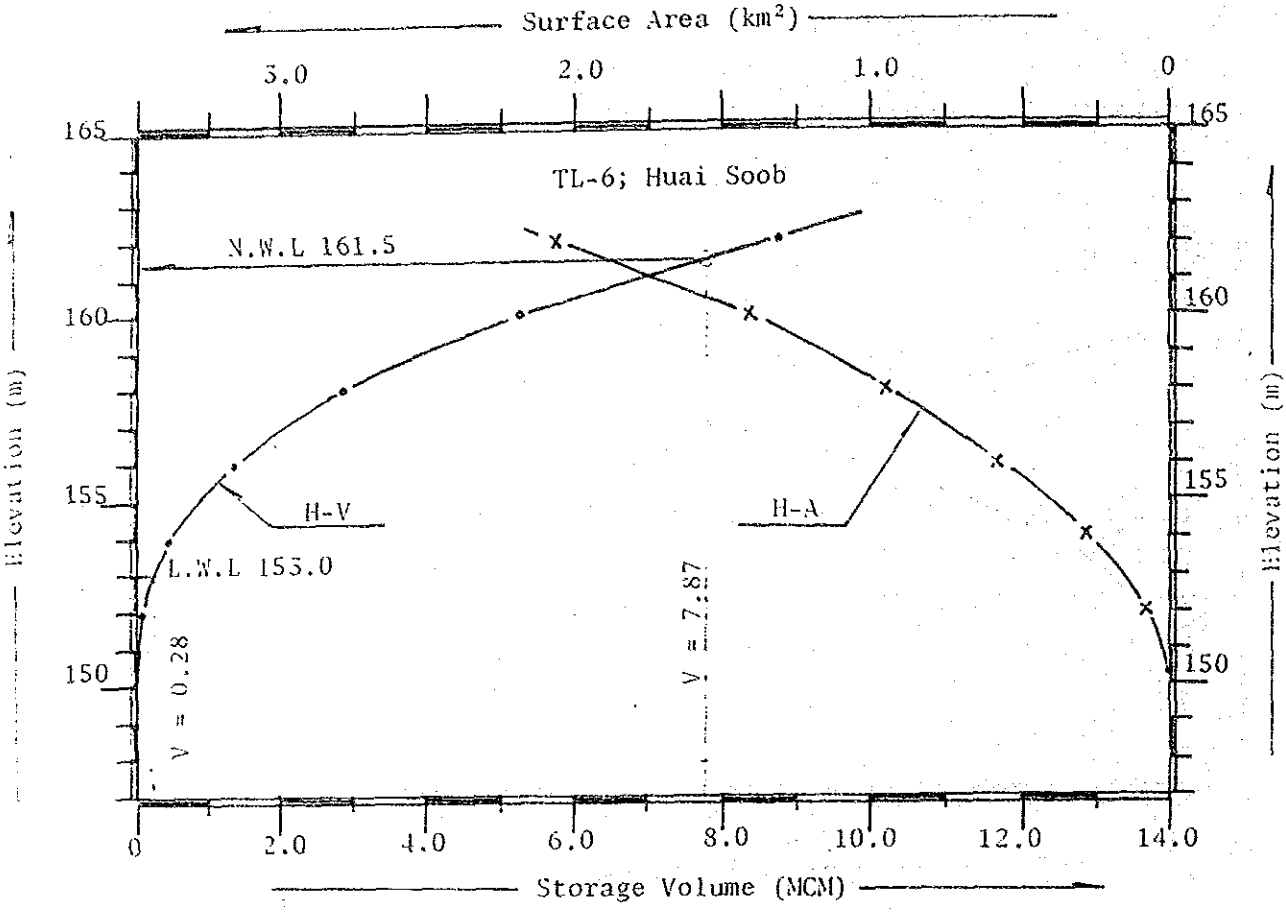
PROJECT ; BO-13, Huai Kham Phak Wan						
EL (m)	Distance (m)	Area ('000m^2)	Av.Area ('000m^2)	Volume ('000m^3)	Acc.Volume ('000m^3)	Remarks
134						
135	1.0	46.4	23.2	23.2	23.2	
136	2.0	144.3	95.35	95.4	118.6	
138	2.0	482	313.15	626.3	744.9	
140	2.0	1,070	776.0	1,552.0	2,296.9	
142	2.0	1,763	1,416.5	2,833.0	5,129.9	
144	2.0	2,581	2,172.0	4,344.0	9,473.9	
146	2.0	3,952.5	3,266.8	6,533.5	16,007.4	

FIGURE F-4 : RESERVOIR AREA ~ CAPACITY CURVE (4/5)



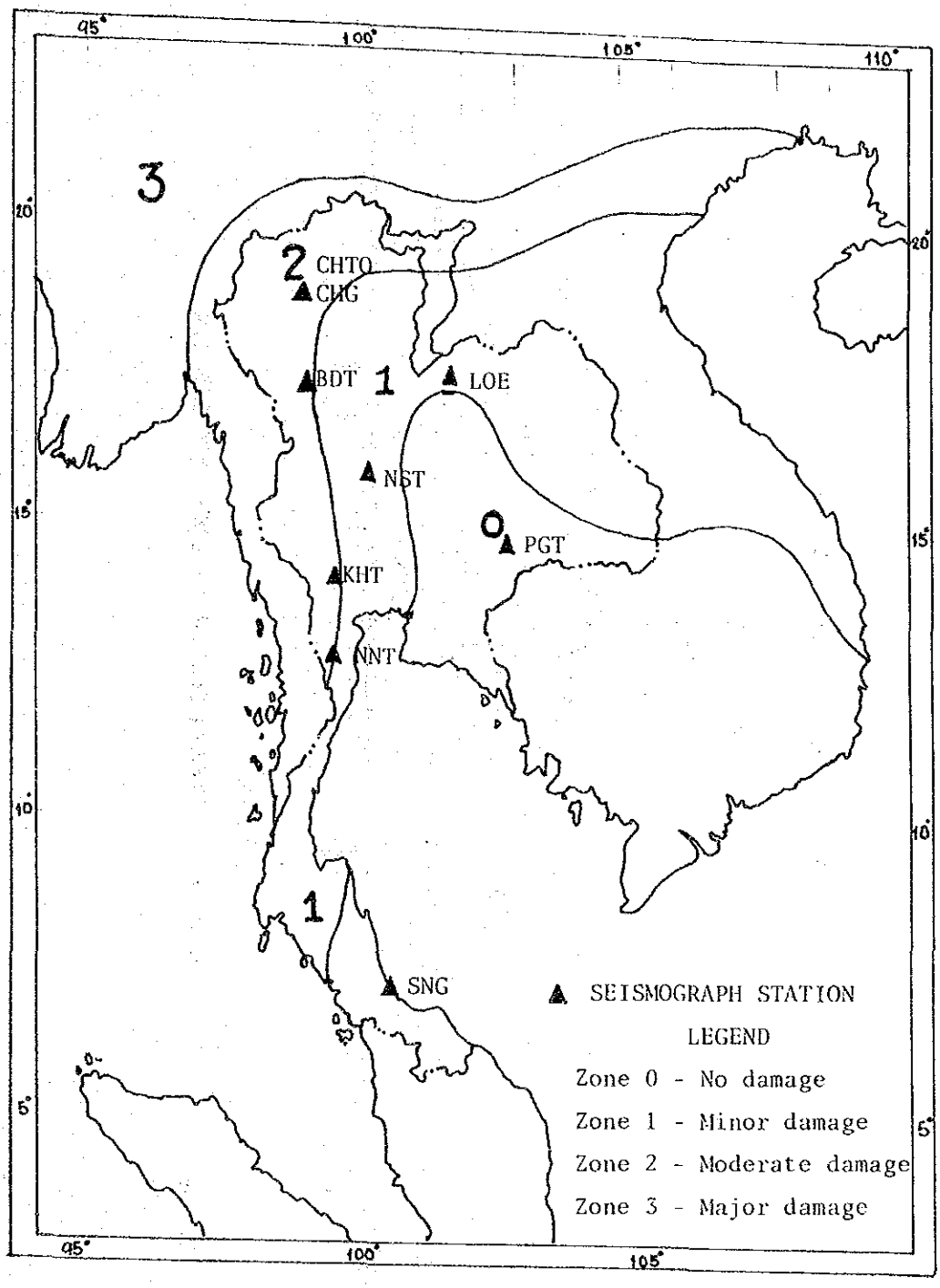
PROJECT ; BO-18, Huai Na Khai						
EL (m)	Distance (m)	Area ('000m²)	Av.Area ('000m²)	Volume ('000m³)	Acc.Volume ('000m³)	Remarks
127						
129	2.0	216	108	216	216	
131	2.0	830	523	1,046	1,262	
133	2.0	1,993	1,411.5	2,823	4,085	
135	2.0	3,552	2,772.5	5,545	9,630	
137	2.0	5,596	4,574	9,148	18,778	
138	1.0	6,768	6,182	6,182	24,960	

FIGURE F-4 : RESERVOIR AREA ~ CAPACITY CURVE (5/5)



PROJECT ;TL-6,Huai Soob						
EL (m)	Distance (m)	Area ('000m²)	Av.Area ('000m²)	Volume ('000m³)	Acc.Volume ('000m³)	Remarks
148						
150	2.0	7.2	3.6	7.2	7.2	
152	2.0	90.3	48.75	97.5	104.7	
154	2.0	285.0	187.65	375.3	480.0	
156	2.0	585.0	435.10	870.2	1,350.2	
158	2.0	955.0	770.10	1,540.2	2,890.4	
160	2.0	1,411.0	1,183.45	2,366.9	5,257.3	
162	2.0	2,073.0	1,742.45	3,484.9	8,742.2	

FIGURE F-5 A SEISMIC ZONING MAP FOR THAILAND AND NEIGHBORING REGIONS



(Source)

" 1st Workshop on Earthquake Engineering and Hazard Mitigation "/organized by Southeast Asia Association of Seismology and Earthquake Engineering (SEASEE) National Earthquake Committee of Thailand/Nov. 1986.

PLAN A: EARTH FILL TYPE DAM

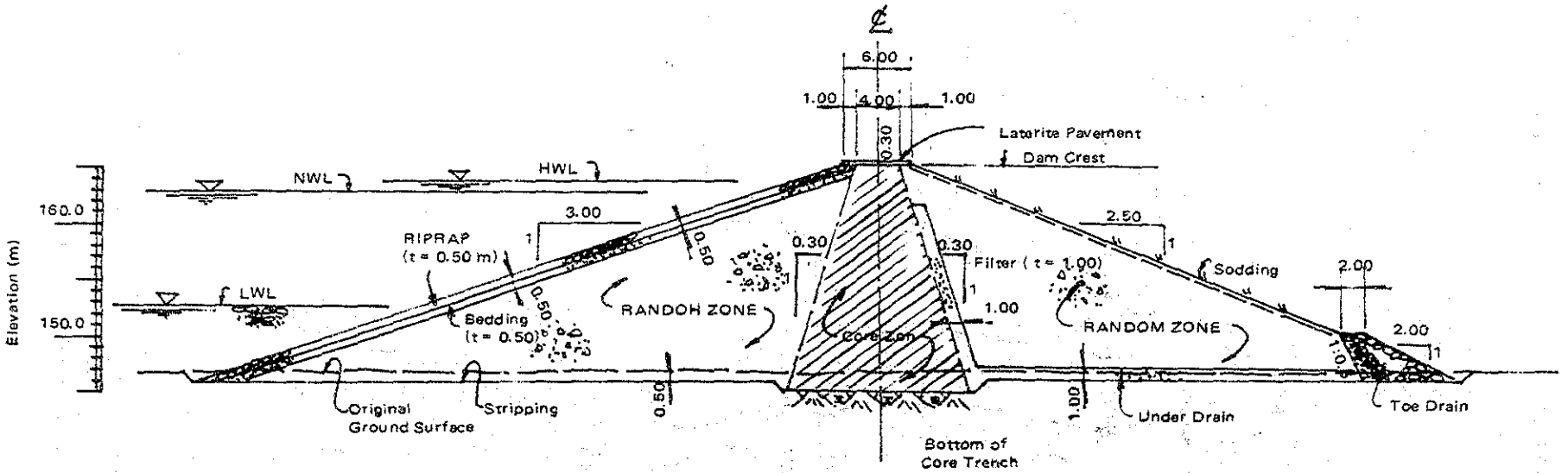


FIGURE F-6 TYPICAL SECTION OF EACH TYPE DAM (1/4)

PLAN B: CONCRETE FACING TYPE DAM

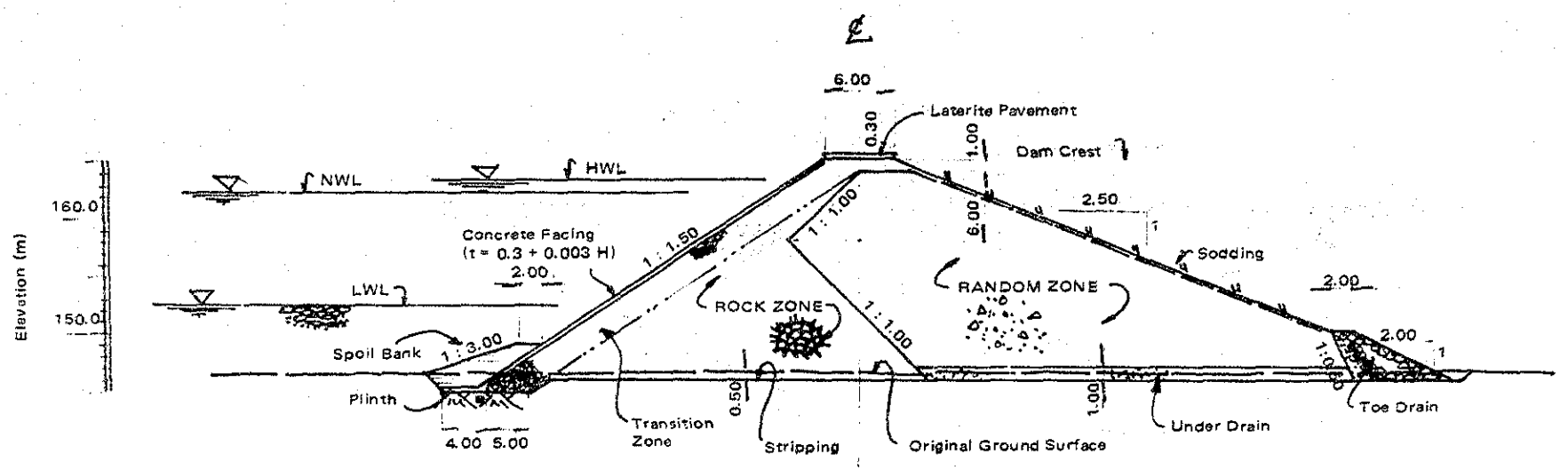


FIGURE F-6 TYPICAL SECTION OF EACH TYPE DAM (2/4)

PLAN C: ASPHALT FACING TYPE DAM

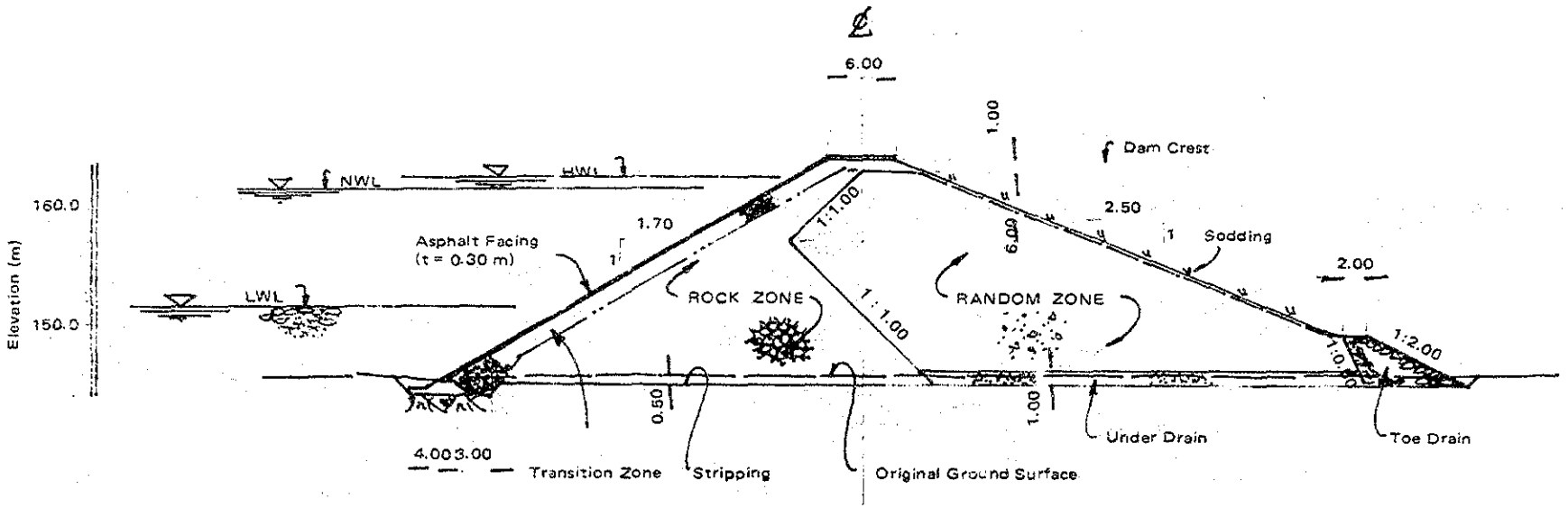


FIGURE F-6 TYPICAL SECTION OF EACH TYPE DAM (3/4)

PLAN D: ASPHALT CORE TYPE DAM

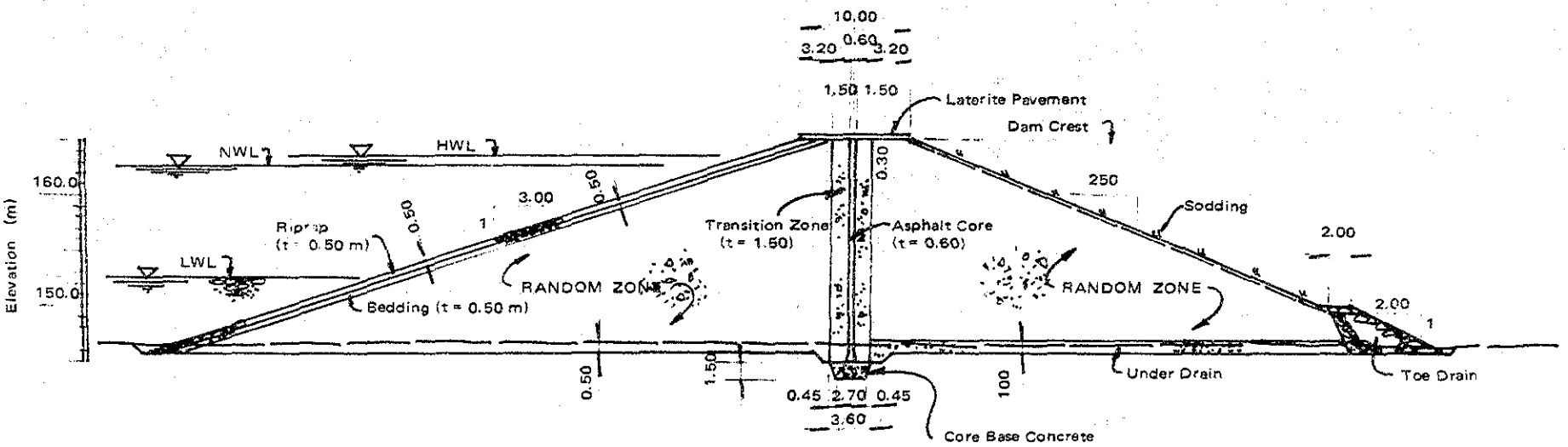


FIGURE F-6 TYPICAL SECTION OF EACH TYPE DAM (4/4)

FIGURE F-7 RELATIONSHIP BETWEEN WIDTH AND HEIGHT OF EARTH DAMS
(IN THE REGION V, RID)

(July, 1989)

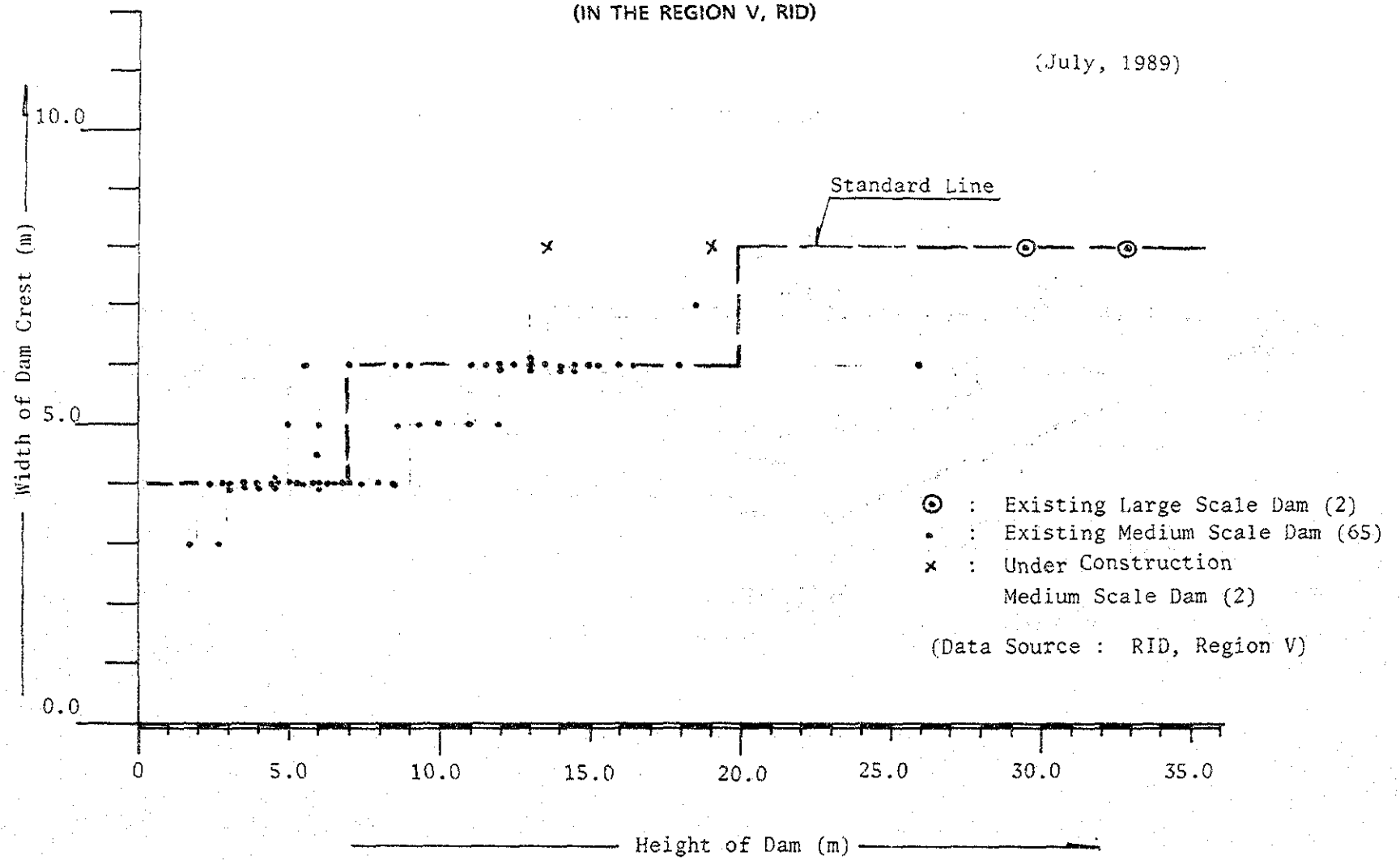


FIGURE F-8 : STABILITY ANALYSIS OF DAM (1/10)

Lam Se Dam (Up-stream)

Case	;	Nomal Water Level
Water Level	;	178.00 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.232

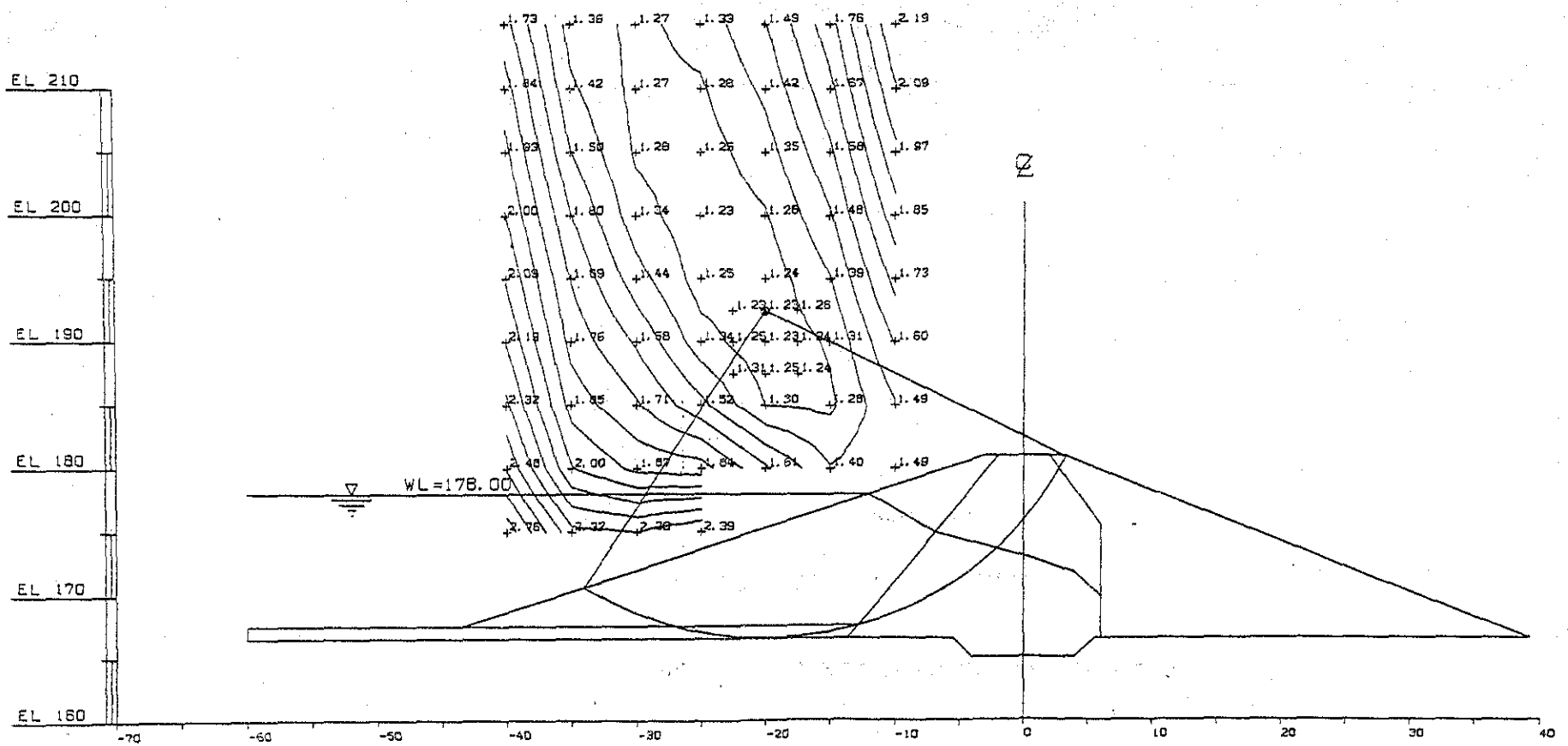


FIGURE F-8 : STABILITY ANALYSIS OF DAM (2/10)

Lam Se Dam (Down-stream)

Case	;	Nomal Water Level
Water Level	;	178.00 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.239

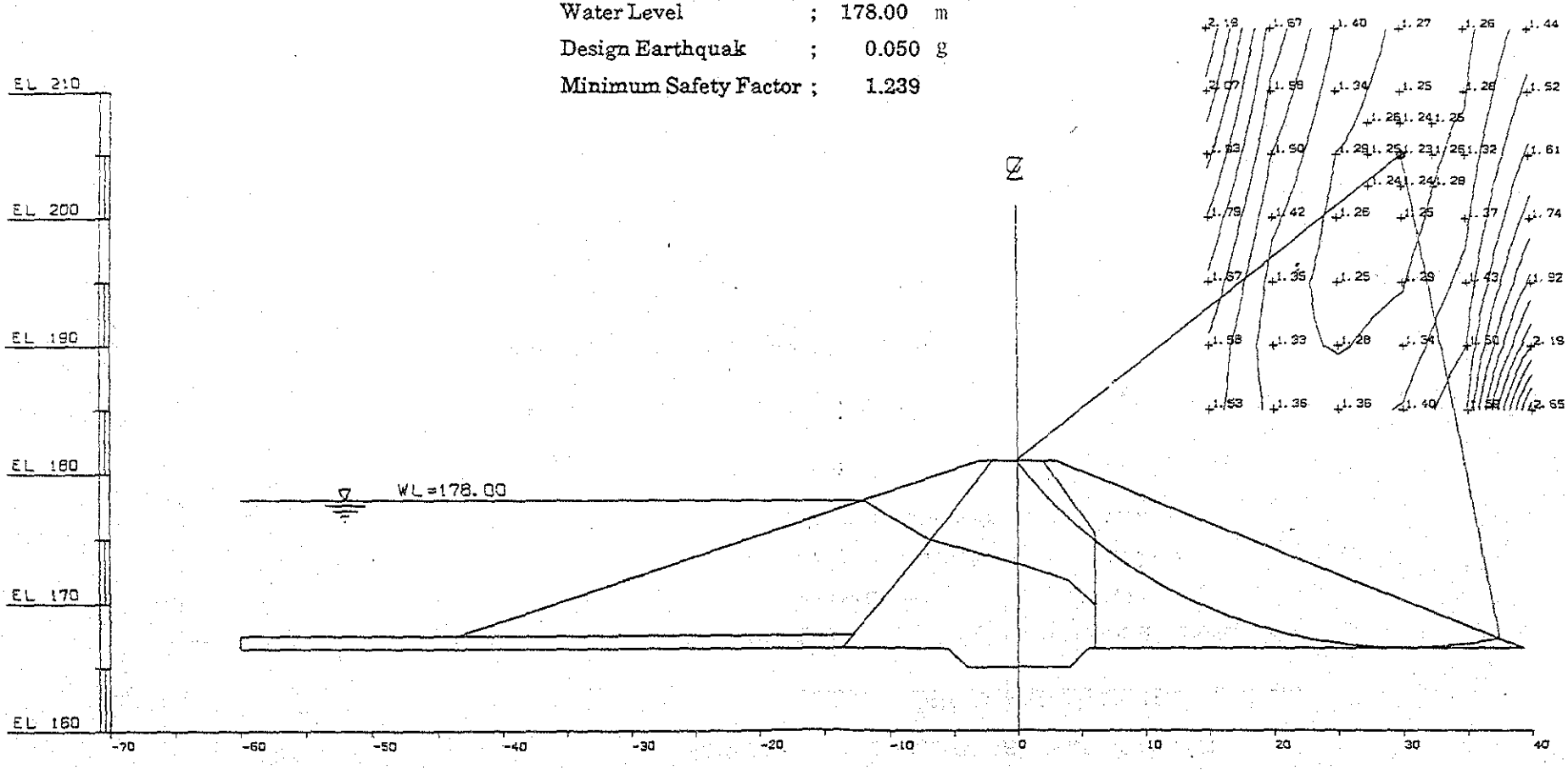


FIGURE F-8 : STABILITY ANALYSIS OF DAM (3/10)

Huai Khum Kham Dam (Up-stream)

Case	;	Nomal Water Level
Water Level	;	162.00 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.213

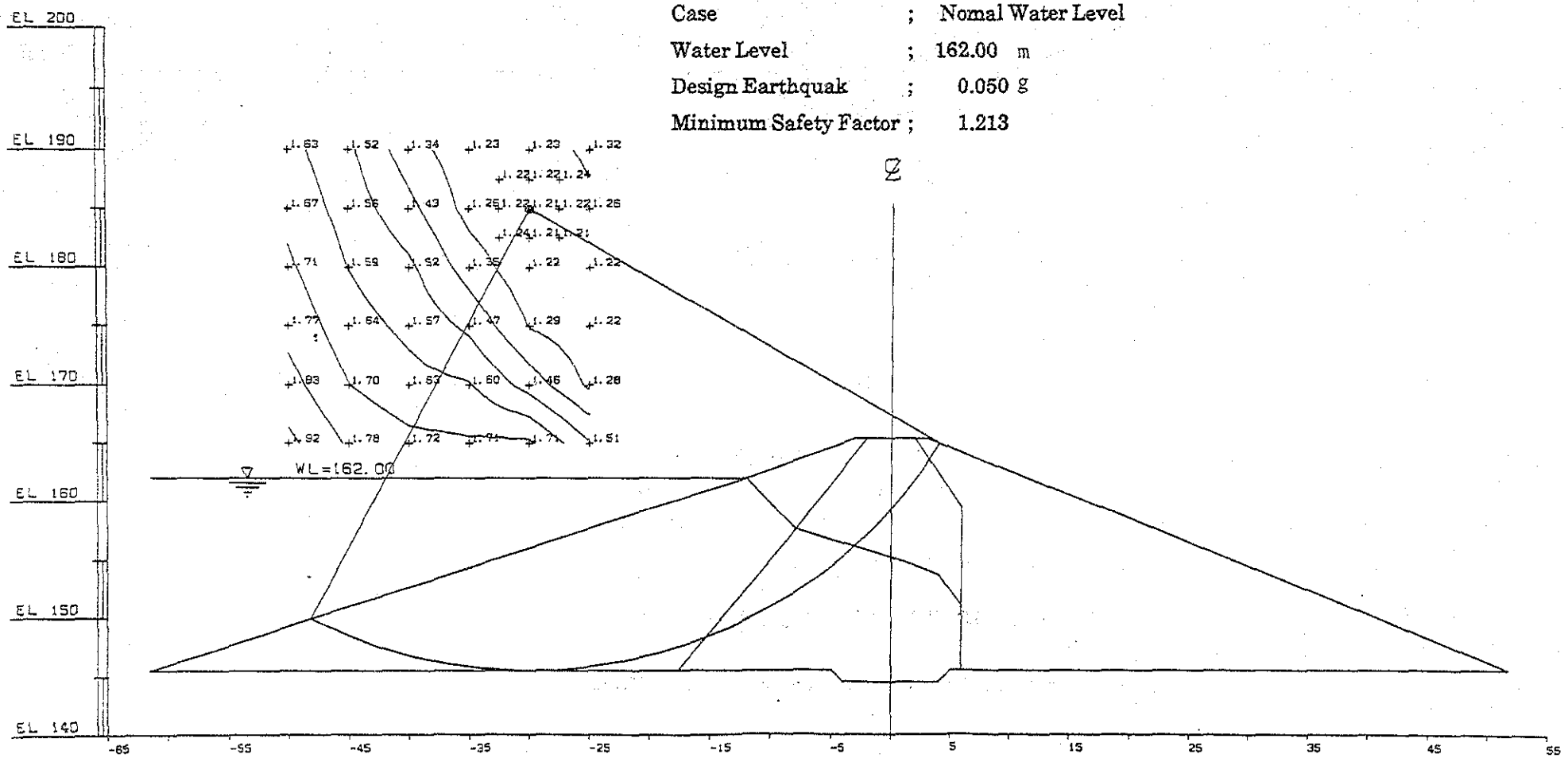


FIGURE F-8 : STABILITY ANALYSIS OF DAM (4/10)

Huai Khum Kham Dam (Down-stream)

Case	;	Nomal Water Level
Water Level	;	162.00 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.442

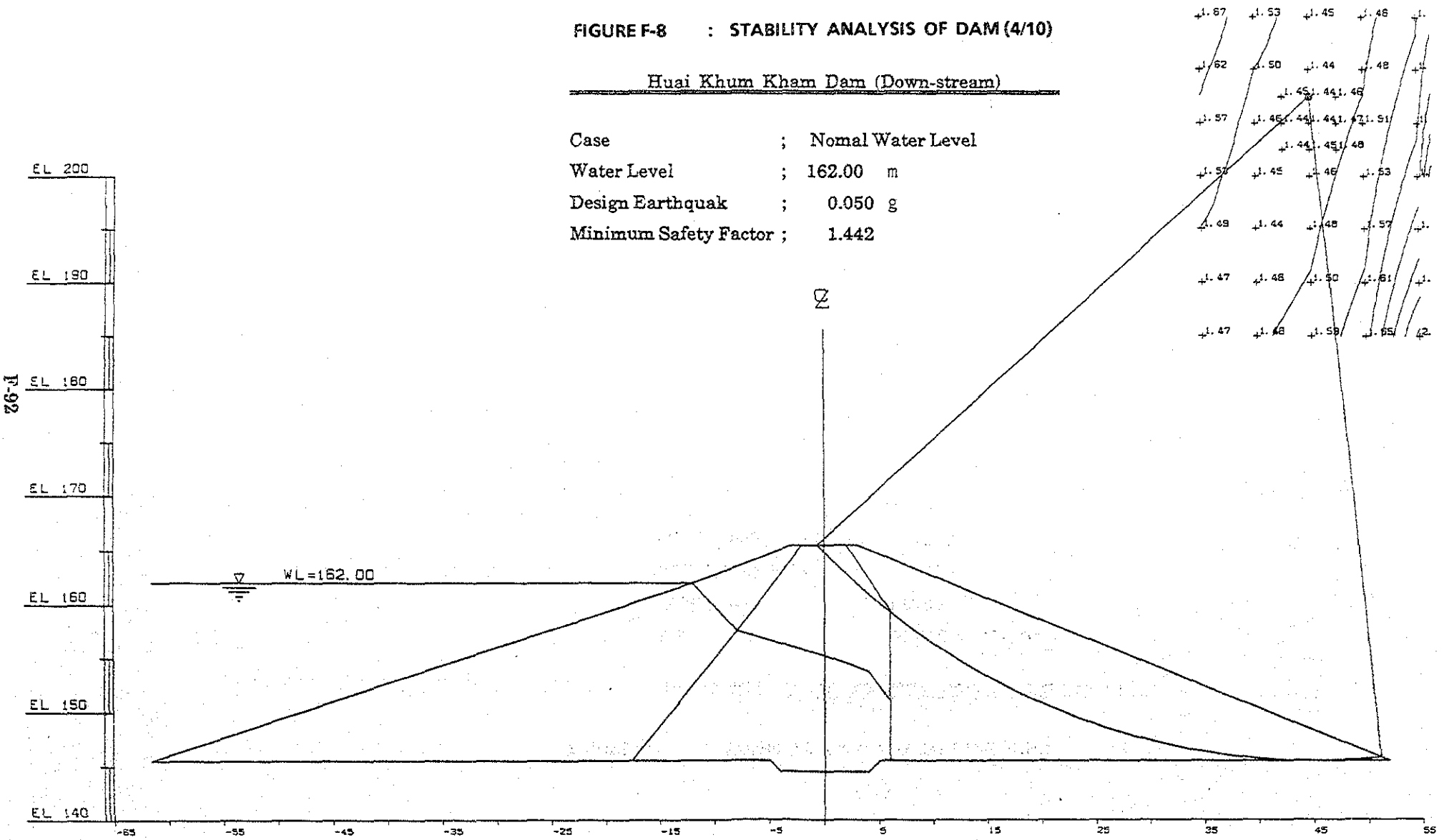


FIGURE F-8 : STABILITY ANALYSIS OF DAM (5/10)

Huai Kham Phak Wan Dam (Up-stream)

Case	;	Nomal Water Level
Water Level	;	143.50 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.340

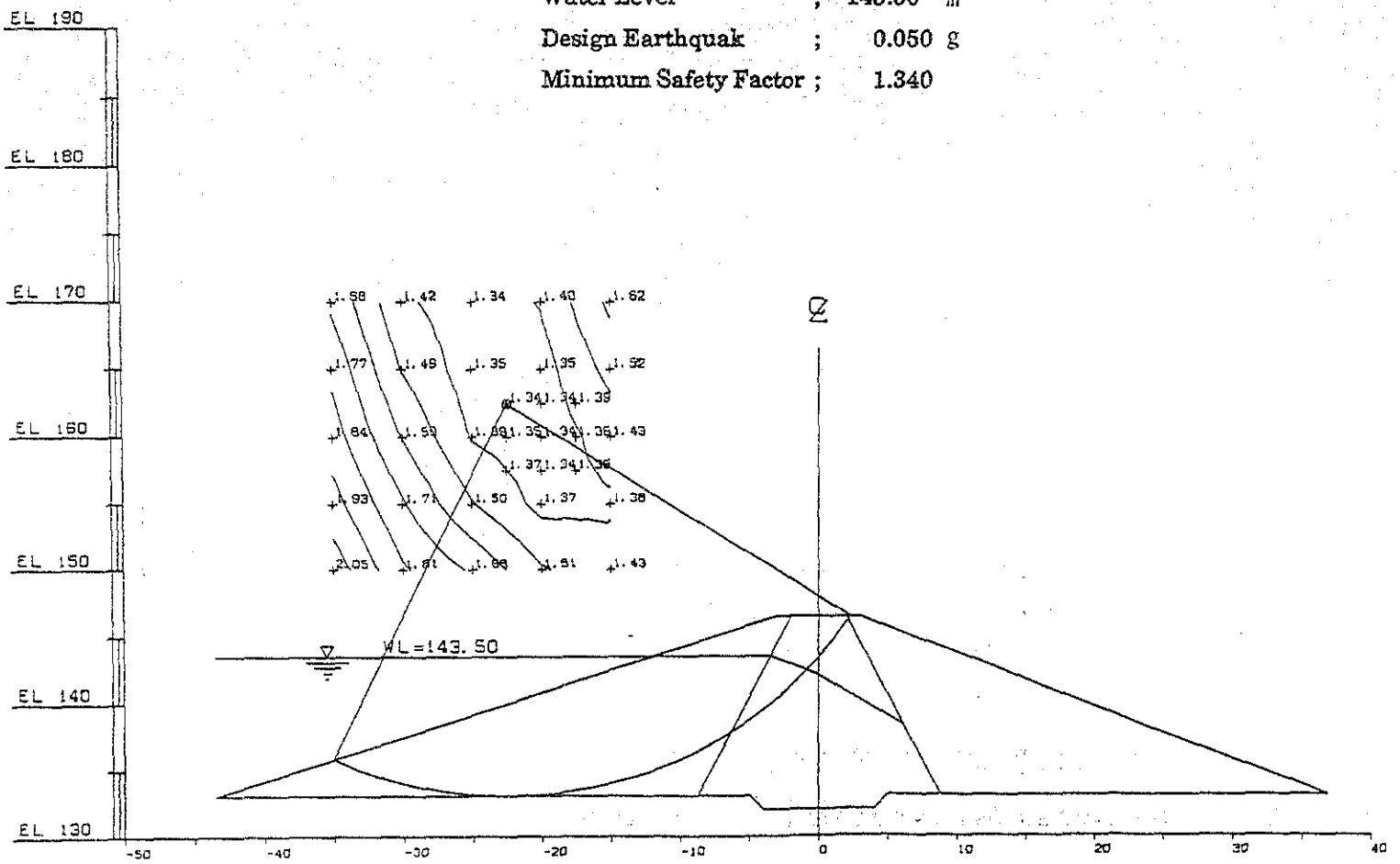


FIGURE F-8 : STABILITY ANALYSIS OF DAM (6/10)

Huai Na Khai Dam (Up-stream)

Case	;	Nomal Water Level
Water Level	;	137.00 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.281

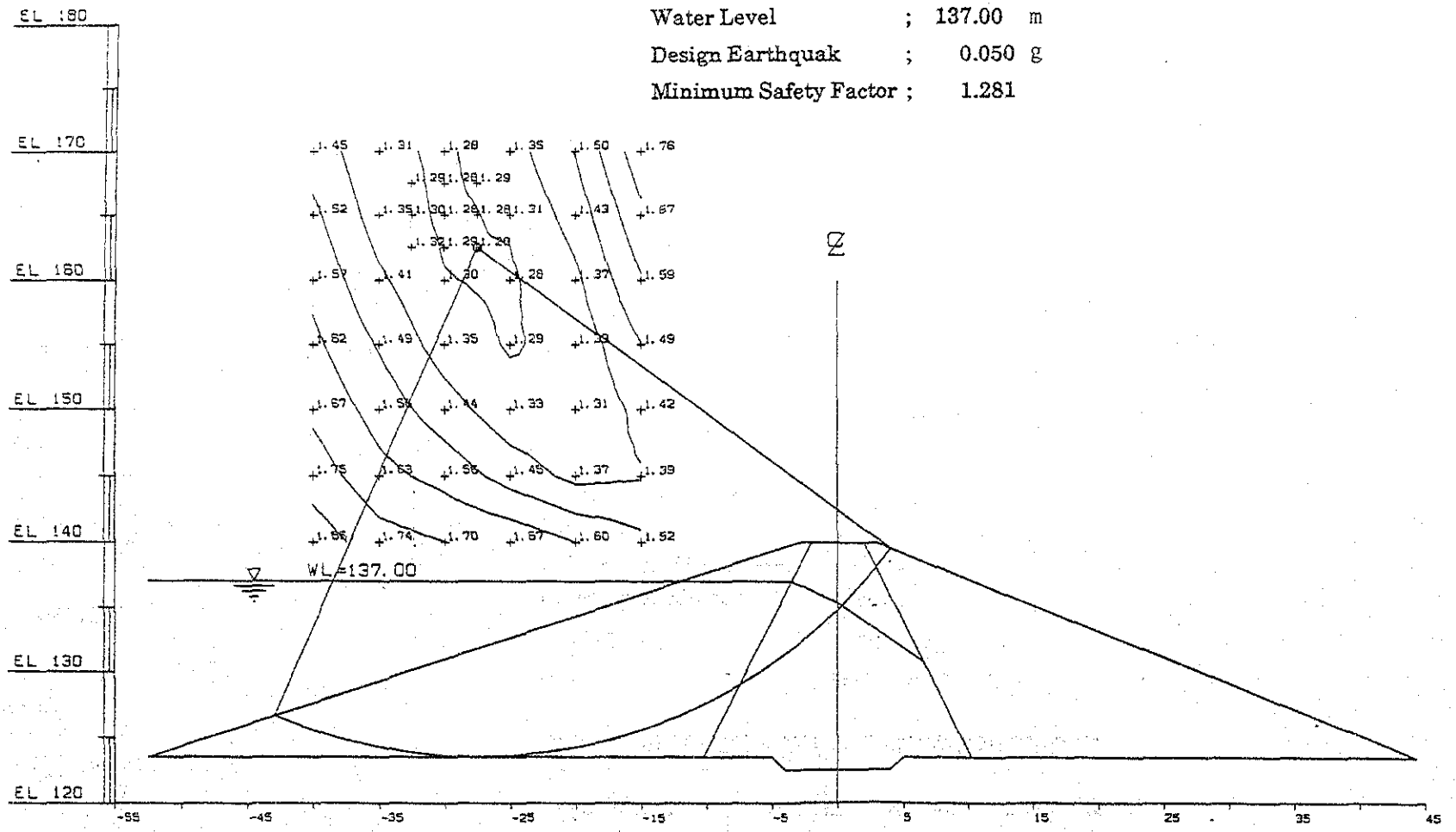


FIGURE F-8 : STABILITY ANALYSIS OF DAM (7/10)

Huai Kham Phak Wan Dam (Down-stream)

Case	;	Nomal Water Level
Water Level	;	143.50 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.579

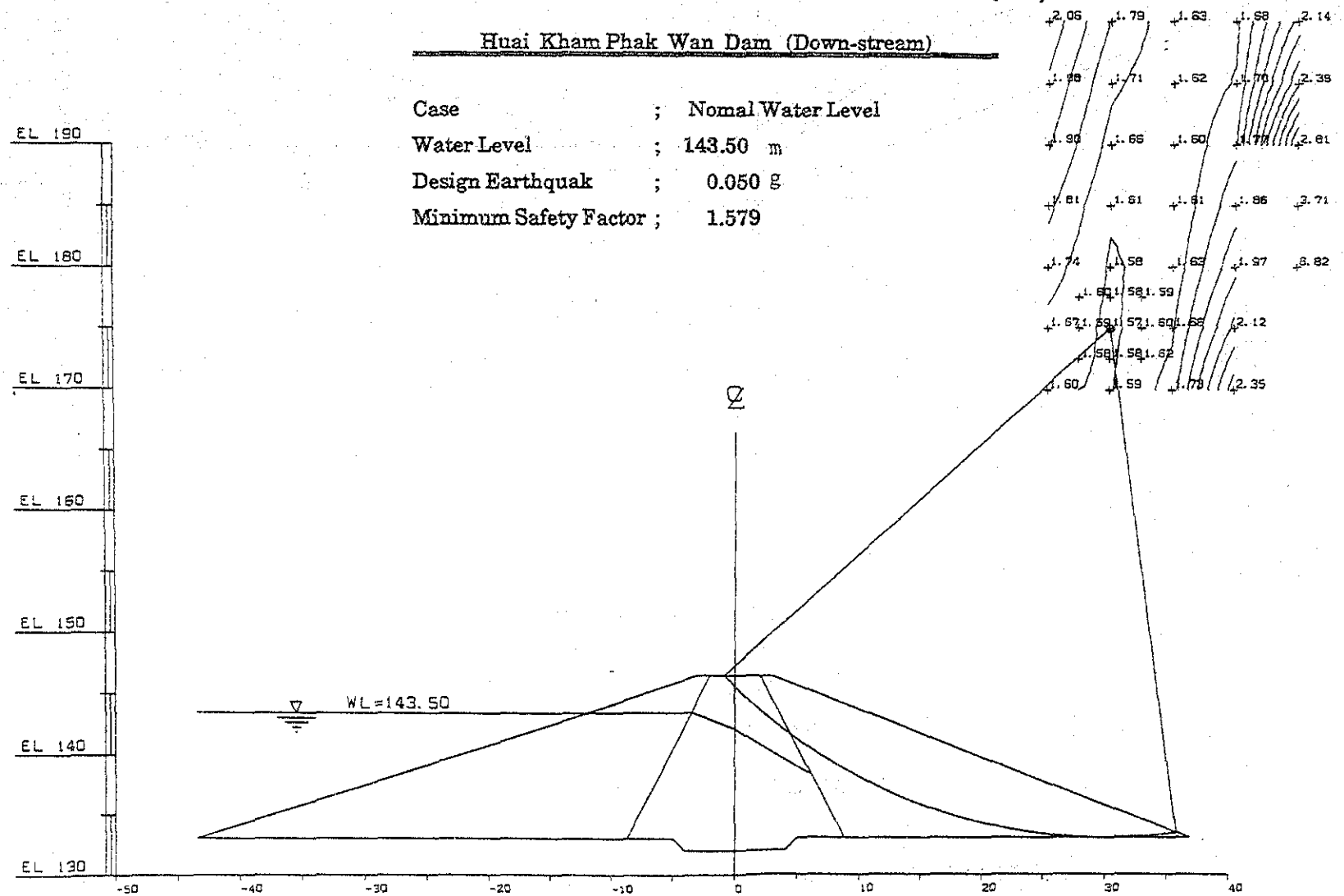


FIGURE F-8 : STABILITY ANALYSIS OF DAM (8/10)

Huai Na Khai Dam (Down-stream)

Case	;	Nomal Water Level
Water Level	;	137.00 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.517

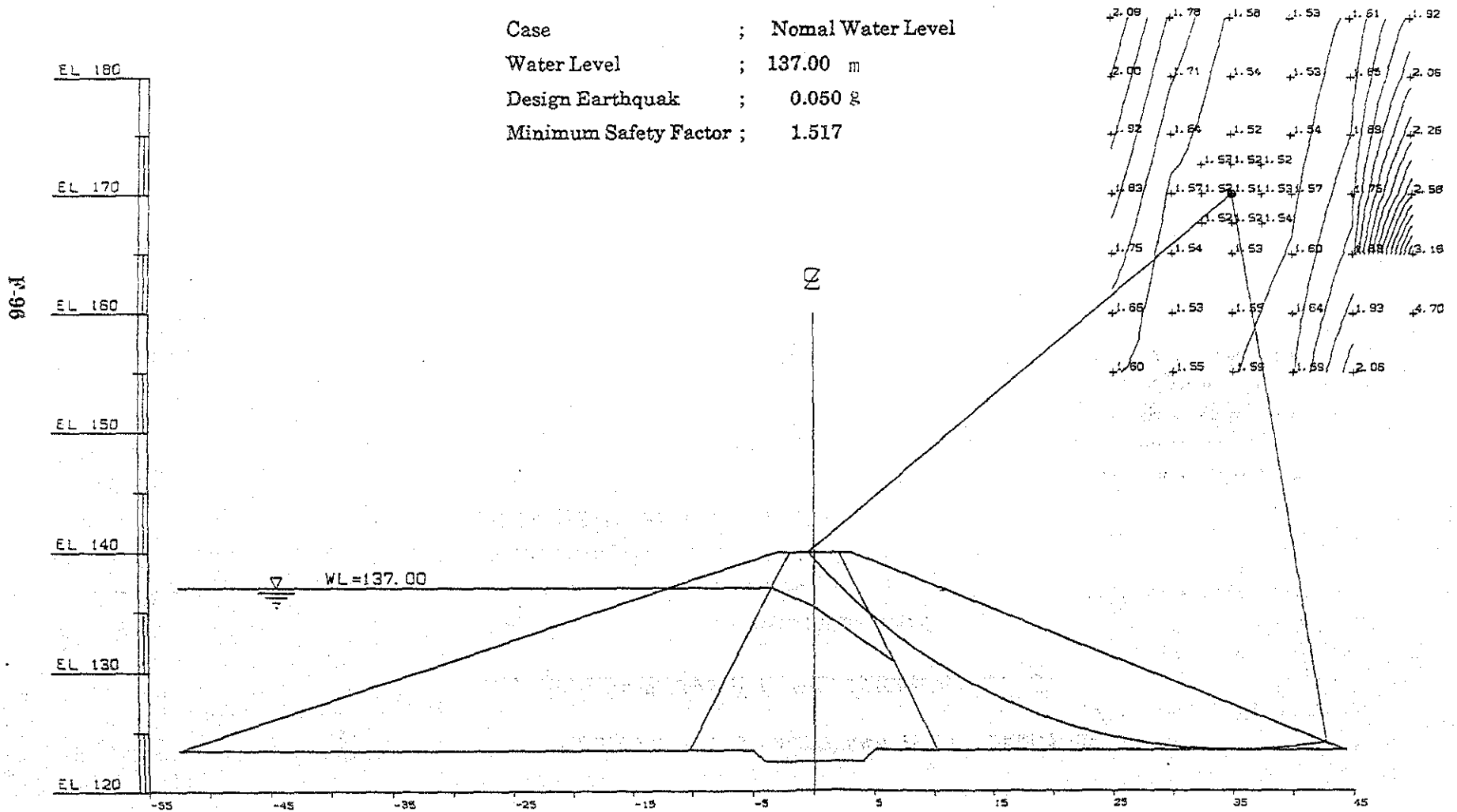


FIGURE F-8 : STABILITY ANALYSIS OF DAM (9/10)

Fuai Soob Dam (Up-stream)

Case	;	Nomal Water Level
Water Level	;	161.50 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.258

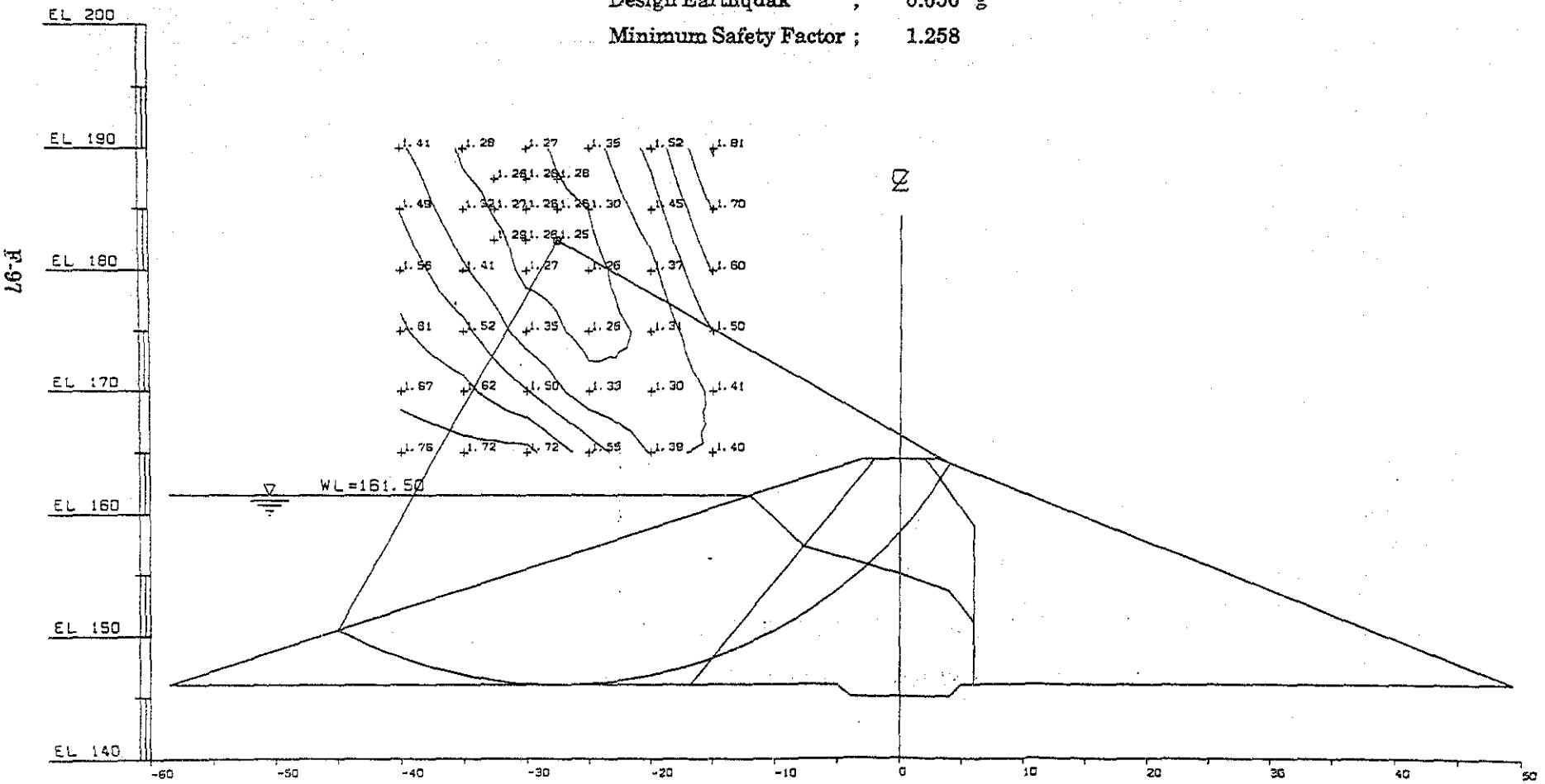


FIGURE F-8 : STABILITY ANALYSIS OF DAM (10/10)

Fuai Soob Dam (Down-stream)

Case	;	Nomal Water Level
Water Level	;	161.50 m
Design Earthquak	;	0.050 g
Minimum Safety Factor	;	1.489

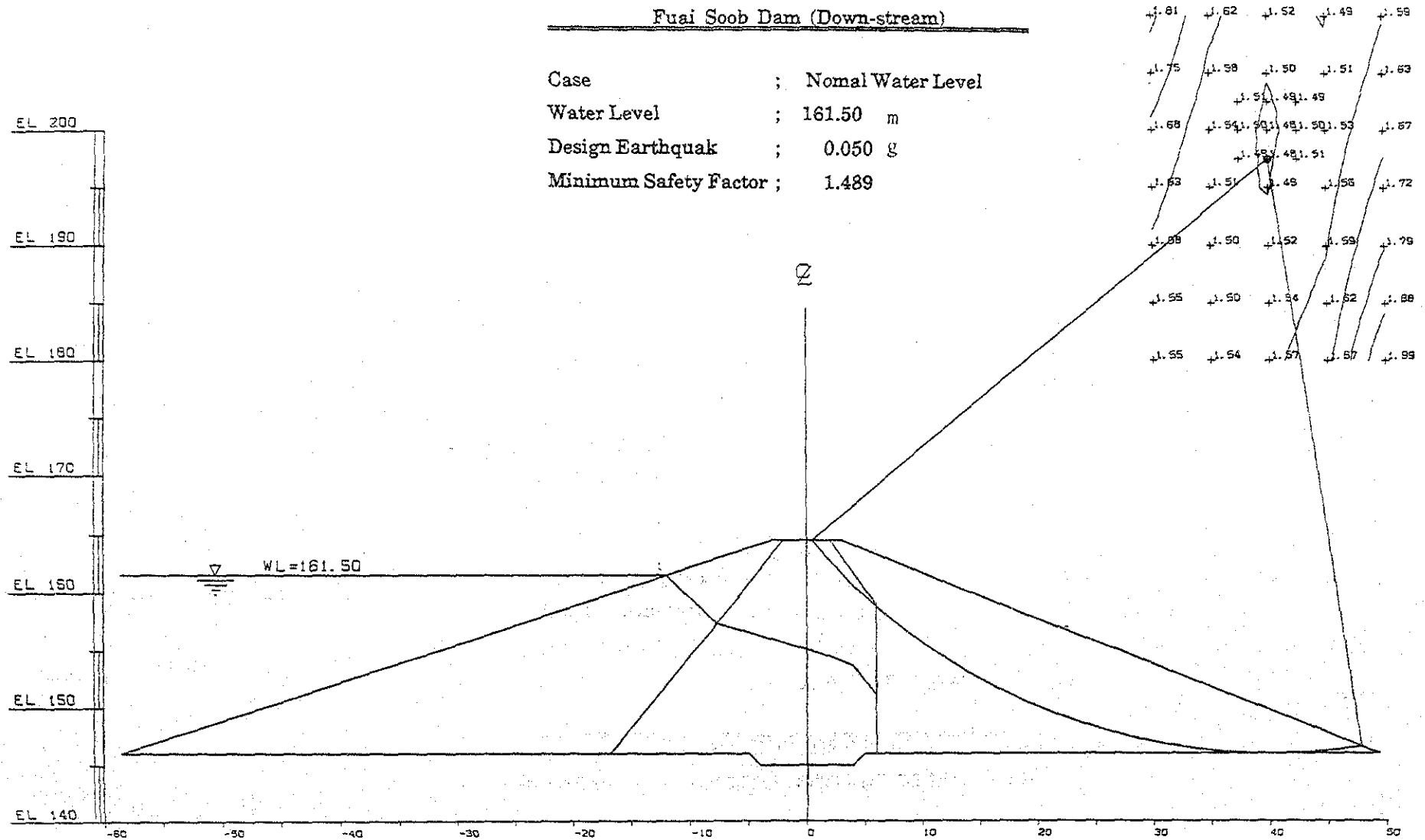


FIGURE F-9 INFLOW - OUTFLOW HYDROGRAPHY

(TL-6 HUAI SOOB)

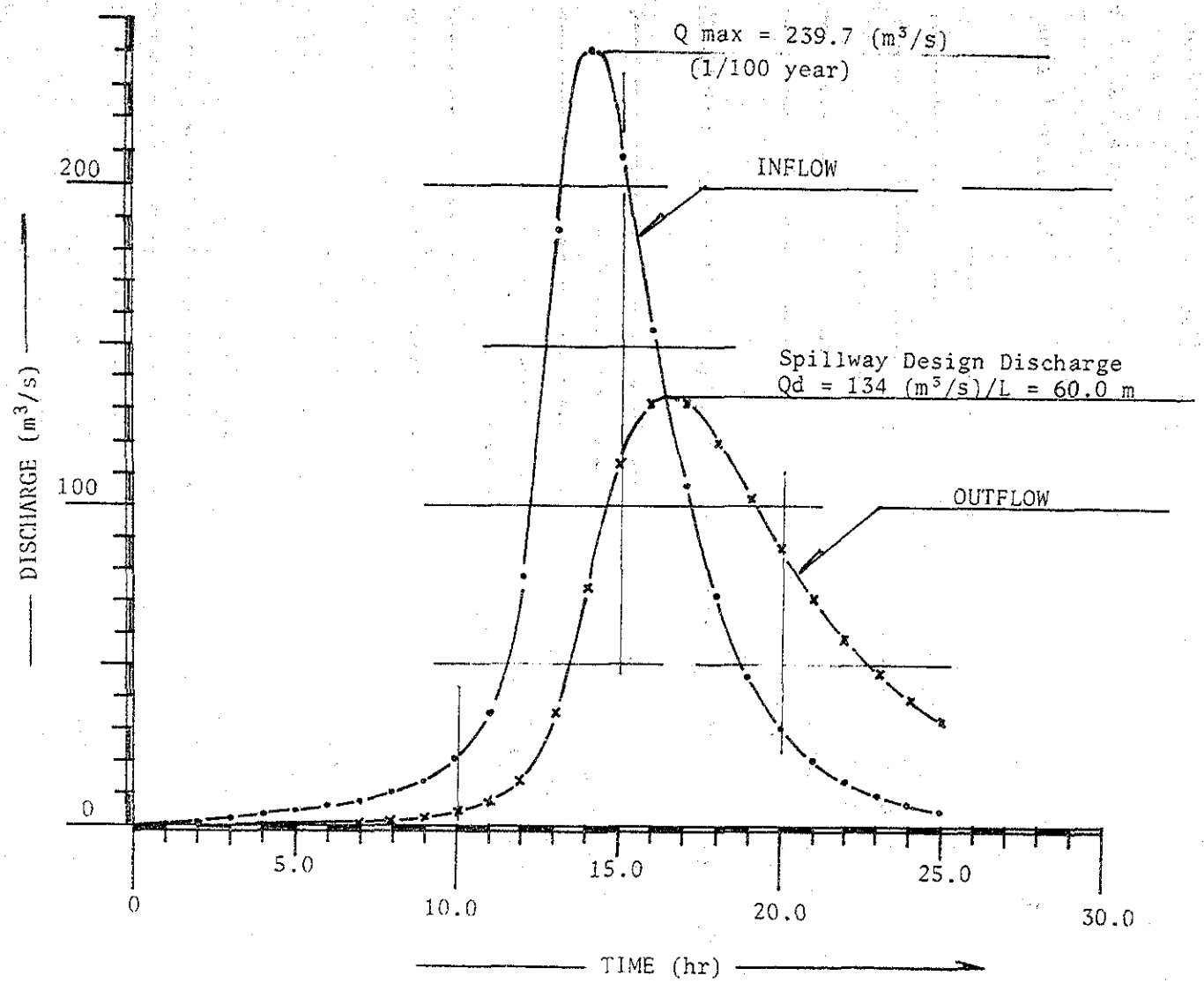
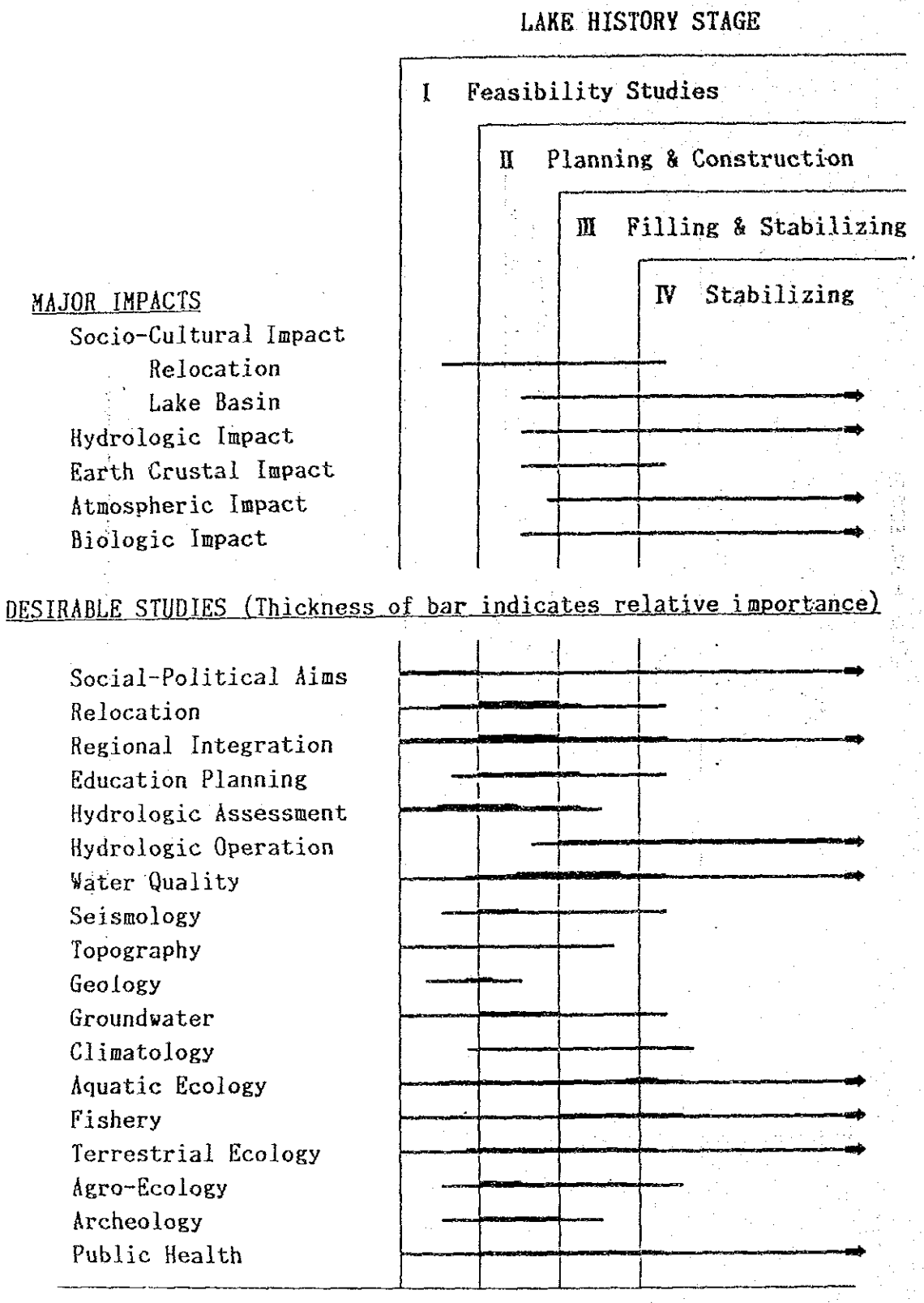


FIGURE F-10 TIMING RECOMMENDABLE FOR ENVIRONMENTAL ACTIVITIES



Type of Pattern

A - Steep mountainous area, no paddy field

B - Rather steep area, openforest

C - Rolling area, open forest, corns paddy fields

D - Gentle slope area, many paddy fields

E - Flat area, many paddy feild

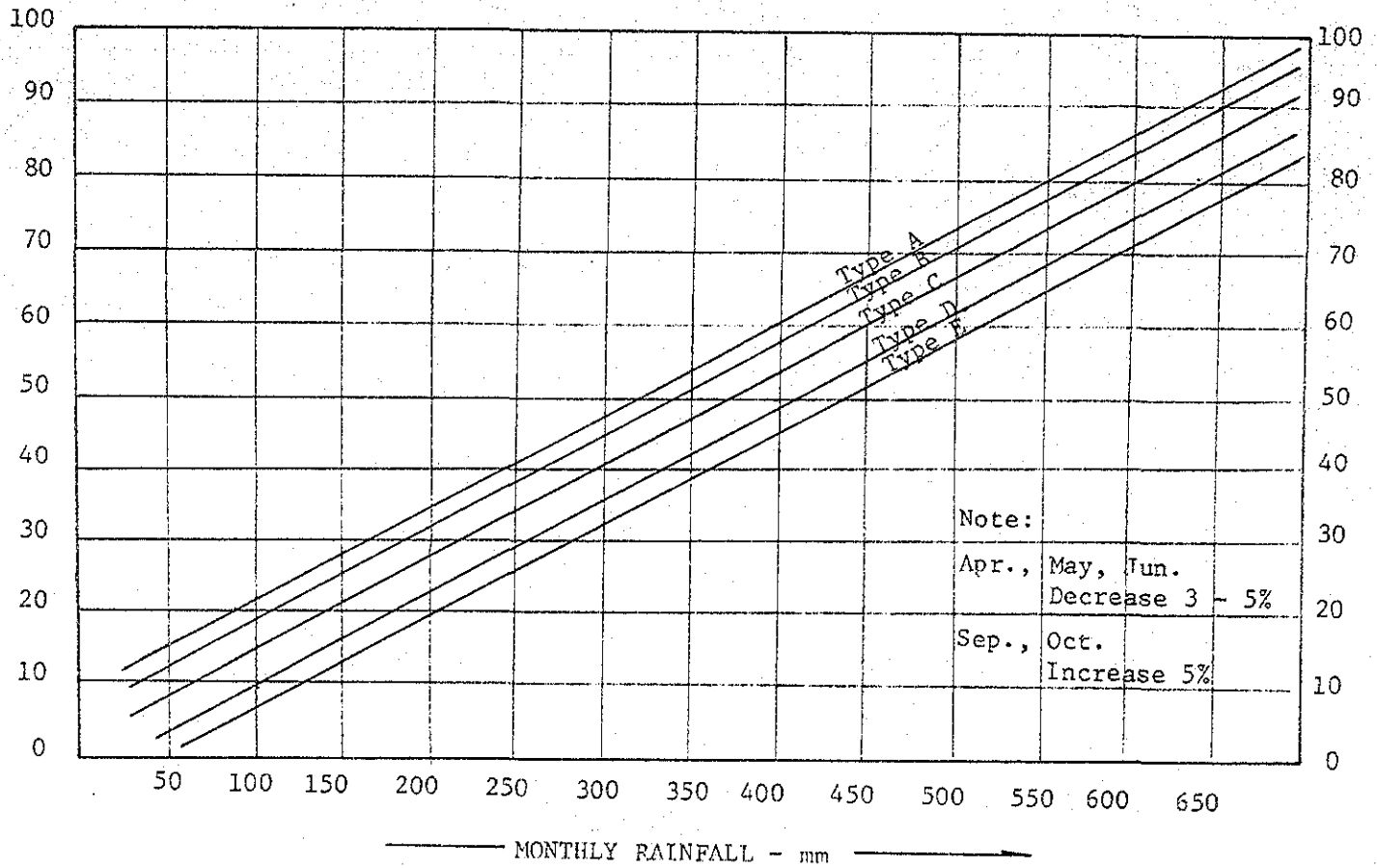
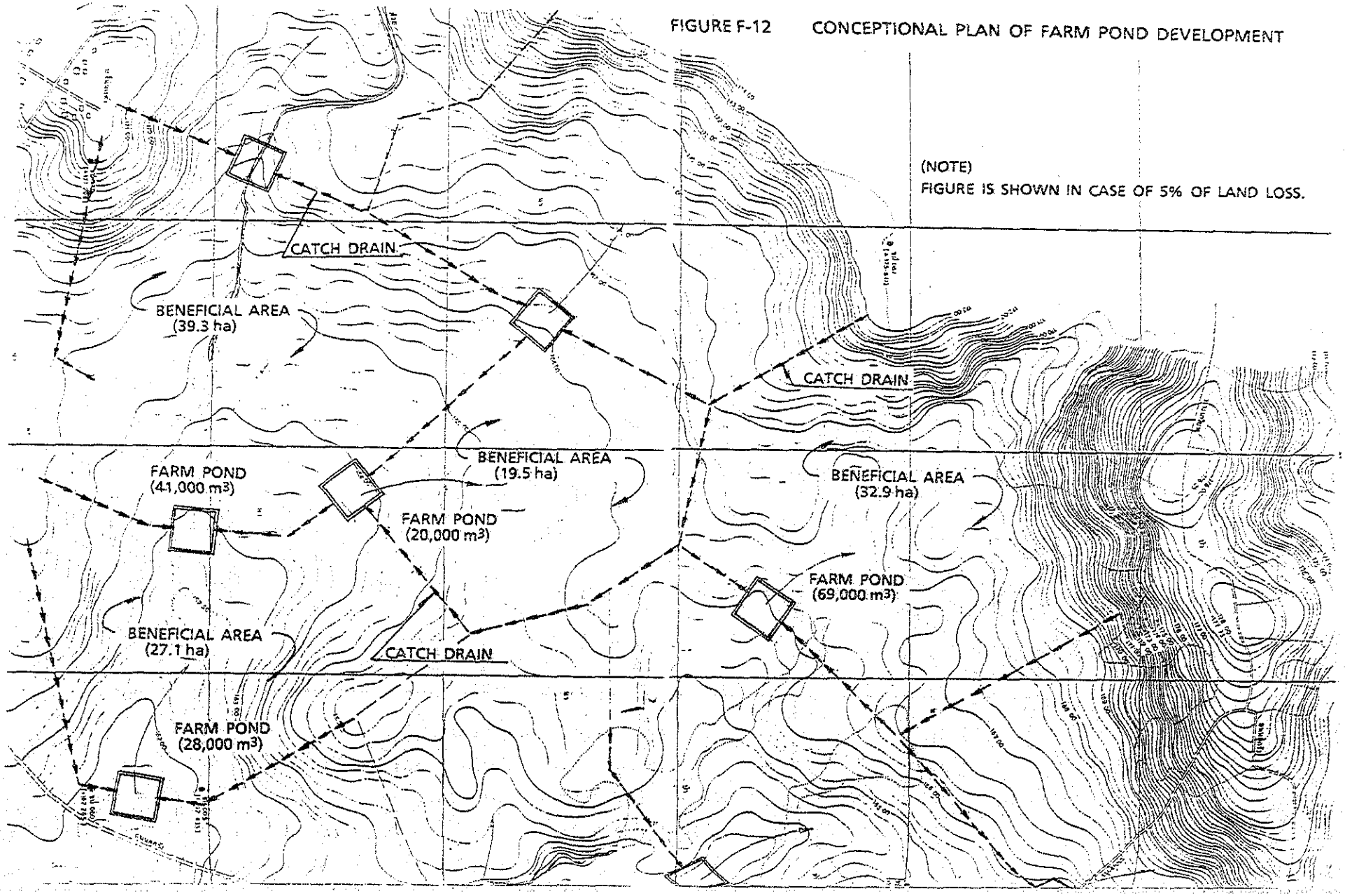


FIGURE F-11 ESTIMATE OF RUNOFF COEFFICIENT
(DEVELOPED BY RID)

FIGURE F-12 CONCEPTIONAL PLAN OF FARM POND DEVELOPMENT



APPENDIX G. CANAL SYSTEM

APPENDIX G. CANAL SYSTEM

G-1. Irrigation Canal

G-1-1. Main and Lateral Canal

(1) Canal Alignment

The layout of the canal system is made based on the topographic maps with scale of 1:10,000. The alignment of canals is planned to enable the paddy field to be irrigated by gravity, running in parallel with contour lines as far as it can be so that the number of appurtenant structures like drops and the quantity of earth work are reduced to a certain extent. Main and lateral canals are designed to be trapezoid channels with concrete lining having a conveyance capacity of 1.60 l/sec/ha (0.26 l/sec/rai). Canals will be constructed to command a project area down to a terminal irrigation block of 16 ha (100 rai).

(2) Design of Irrigation Canal

Irrigation canal with a bottom width of more than 0.5 m is designed with concrete lining taking into consideration that the soil in the service area consists of pervious sandy materials.

Canal standard cross section is designed as shown in Drawings F-50.

(3) Related Structures of Canals

The following related structures of canals are planned:

- Head regulators are provided to divert irrigation water from the main to lateral canal or from the lateral to sub-lateral. Distributors are also installed as measuring devices at the head of the structure to keep accurate water diversion.
- Farm turnouts are placed at the head of service units and designed by a pipe barrel of 400 mm in diameter with a steel slide gate as measuring devices.
- Check structures are provided at the downstream of the head regulator and turnout, and used to control diversion water and

maintain a certain water level of canal. The check structures are designed with overflow weir of duckbill type.

- Check/drop structures are designed at the place where dissipation of surplus energy is required due to different elevation of canal water level. One check/drop structure is employed for 1.00 m different elevation and the structure is provided with manually operated slide gate.

- Siphons are provided at places where canals cross the existing streams to release the flood from streams into the river. Precast concrete pipe is used for siphons with a discharge of less than 3.0 cu.m/sec and the cast-in-place concrete, for a discharge of more than 3.0 cu.m/sec. The flow in the siphon is designed at high velocity in order to avoid clogging of siltation in the pipe.

- Crossing structures are provided to deliver the canal water under free flow conditions at the crossing points of canal and road. The crossing structure is designed with the precast concrete pipe for discharge of less than 2.0 cu.m/sec, and the cast-in-place concrete for discharge of more than 2.0 cu.m/sec.

- Cross drain structures are provided to release the side-slope flow. Precast concrete pipes of 1.0 m diameter with doable barrels are used.

- Tail regulators are provided at the end of canal to discharge water to the drain.

(4) Selection of Roughness Coefficient

a) Standard Coefficient of Roughness

Careful consideration is required in determing the coefficient on various influencing factors such as surface roughness, vegetation , bends, cross-sectional area, velocity, hydraulic mean depth, sediment, scoure, suspended materials and so on. In canals constructed with the same materials, the coefficient of roughness tends to become larger in the case of extremely slow flow or small hydraulic mean depth. It must also be considered that friction, scoure, etc. are affedted by the flow in the canal, and the smoothness of the internal section of the canal decreases gradually due to growth of aqatic plants.

Table G-3 presents the stadard coefficient of roughness for excavated or dredged canals, for lining, retaining walls, tunnels, culverts, siphons and aqueducts, and for natural flow canals, which is

recomendable for designing canals of the Sebai-Sebok irrigation project.

b) Effects of Bends, Sedimentation and Vegetation on Coefficient of Roughness

The following factorts have an effect on the coefficient of roughness.

- Canal bends : The coefficient of roughness (n) increases when a canal meanders because such meandering produces losses and sand deposits in the canal. In the case of low velocity, increase of n may be neglected. In general, n increases by about 0.002 as an allowance for canal bend losses when the canal has curves, and n in a natural meandering channel increases by 30%.

- Sedimentation : n is affected by sand deposits in a canal and increases significantly in the case of non-uniform sediments such as sandbars and sand ripples.

- Vegetation : n increases with growth of weeds in a canal.

(5) Major Features of Canals

The layout of the canal networks is shown in the Drawings F-41 ~ F-45 and irrigation diagram is shown in Drawings F-56 ~ F-57. The summary of the major features of the canal is as follows:

Description		Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob	Total
A. Main Canal							
- Irrigable Area	(ha)	1,100	2,600	950	2,100	920	7,670
- Total Length	(km)	19.33	44.25	12.20	26.77	28.21	130.76
- Maximum Discharge	(cu.m/sec)	0.90	2.29	1.52	3.37	0.86	
B. Lateral Canal							
- No. of Lateral	(No.)	7	13	6	11	7	44
- Total Length	(km)	11.42	27.72	12.91	21.14	12.37	85.56

* Canal type and length is shown in Table G-1.

G-1-2. On-farm Canals

On-farm facilities will be implemented as a ditch and dike project under the control of Operation and Maintenance Division of RID.

G-2. Drainage Canal

There exist a number of small channels connected to the main rivers, which will be used as main drainage canals with some improvement works. The design capacity of drainage canals inside the service area is estimated at 5.8 l/sec/ha (0.9 l/sec/rai) for Lam Se, 6.5 l/sec/ha (1.0 l/sec/rai) for Huai Khum Kham, Huai Kham Phak Wan and Huai Na Khai and 6.7 l/sec/ha (1.1 l/sc/rai) for Huai Soob. The standard cross section of drainage canal is designed as in Drawings F-50.

The summary of the major features of the drainage canal is as follows:

Description	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob	Total
- Maximum Drainage Area (ha)	161	320	193	-	243	
- Maximum Discharge (cu.m/sec)	0.93	2.08	1.25	-	1.63	
- Total Length (km)	3.79	3.42	1.01	-	2.28	10.50

G-3. Village Pond

Each Muban in the project area will be provided with one village pond with a capacity of about 16,000 CM. The pond shall be surrounded 4 sides by earth dike in order to prevent the pond from inflow of undesired water. Typical layout of a village pond is shown in Drawing F-50. Number and type of village pond are as follows ;

Type	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob	Total
Type 1	2	1			1	4
Type 2	1	3	1	1	-	6
Type 3	2	7	4	9	4	26
Total	5	12	5	10	5	36

TABLE G-1 : CANAL TYPE AND LENGTH

Unit: km

Name of Project	Canal Type										Total
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	
1. Lam Se											
- Right Main Canal	-	-	-	-	-	4.21	-	1.62	0.81	3.47	10.11
- Left Main Canal	-	-	-	-	-	2.69	3.78	-	0.90	1.85	9.22
- Latheral Canal	-	-	-	-	-	-	-	-	-	11.42	11.42
2. Huai Khum Kham											
- Right Main Canal	-	-	5.56	4.02	1.69	-	1.26	-	4.67	2.79	19.99
- Left Main Canal	-	9.04	-	1.81	4.90	2.29	-	2.55	1.38	2.29	24.26
- Lateral Canal	-	-	-	-	-	-	-	-	-	27.72	27.72
3. Huai Kham Phak Wan											
- Left Main Canal	-	-	-	3.98	-	4.51	-	-	-	3.71	12.20
- Lateral Canal	-	-	-	-	-	-	-	-	0.69	12.22	12.91
4. Huai Na Khai											
- Conveyance Main Canal	6.30	-	-	-	-	-	-	-	-	-	6.30
- Right Main Canal	-	-	-	-	-	1.06	0.37	1.83	1.36	2.10	6.72
- Left Main Canal	-	2.18	-	-	-	3.42	-	5.50	-	2.65	13.75
- Lateral Canal	-	-	-	-	-	-	-	-	2.08	19.06	21.14
5. Huai Soob											
- Right Main Canal	-	-	-	-	-	4.34	4.32	2.55	-	5.20	16.41
- Left Main Canal	-	-	-	-	-	-	-	6.22	-	5.58	11.80
- Lateral Canal	-	-	-	-	-	-	-	-	-	12.37	12.37

TABLE G-2 : NUMBER OF RELATED STRUCTURE

Name of Structure	Name of Project				
	Lam Se	Huai Khum Kham	Huai Kham Phak Wan	Huai Na Khai	Huai Soob
- Head Regulator	7	15	5	16	7
- Check Structure	9	14	4	13	9
- Check/Drop Structure	3	99	34	81	47
- Siphon	4	12	-	4	6
- Spillway	20	17	5	20	19
- Crossing Structure	31	38	9	16	14
- Crossing Drain Structure	20	57	5	9	32
- Tail Regulator	9	17	7	17	9

TABLE G-3 : COEFFICIENTS OF ROUGHNESS N (1/3)

Materials and conditions of canals	Coefficient of roughness		
	Minimum value	Standard value	Maximum value
Earth canals, uniform and straight			
1) No weeds (immediately after completion of the canal)	0.016	0.018	0.020
2) No weeds (after the canal has been exposed to weather)	0.018	0.022	0.025
3) Sand (no weeds)	0.022	0.025	0.030
4) No weeds except some short grasses	0.022	0.027	0.033
Earth canals, non-uniform and bent			
1) No vegetation coverage	0.023	0.025	0.030
2) Some weeds	0.025	0.030	0.033
3) Weeds and aquatic plants are growing densely	0.030	0.035	0.040
4) Earth bottom and rubble at both sides	0.028	0.030	0.035
5) Earth bottom and weedy sides	0.025	0.035	0.040
6) Cobblestones on the bottom and no weeds at either side	0.030	0.040	0.050
Drag line excavation and dredging			
1) No vegetation coverage	0.025	0.028	0.033
2) Some shrubs on shore	0.030	0.050	0.060
Rock excavation			
1) Smooth and uniform	0.025	0.035	0.040
2) Irregular	0.035	0.040	0.050

TABLE G-3 : COEFFICIENTS OF ROUGHNESS N (2/3)

2) Lining, retaining walls, tunnels, culverts, siphons, and aqueducts

Materials and conditions of canals	Coefficient of roughness		
	Minimum value	Standard value	Maximum value
Concrete (cast-in-place flume, culvert, etc.)	0.012	0.015	0.016
Concrete (shotcrete)	0.016	0.019	0.023
Concrete (with precast flume, pipe, etc.)	0.012	0.014	0.016
Concrete (reinforced concrete pipe)	0.011	0.013	0.014
Concrete block masonry	0.014	0.016	0.017
Cement (mortar)	0.011	0.013	0.015
Asbestos cement pipe	0.011	0.013	0.014
Steel (locked bar or welded)	0.010	0.012	0.014
Steel (revet)	0.013	0.016	0.017
Smooth steel surface (not painted)	0.011	0.012	0.014
Smooth steel surface and pipe (painted)	0.012	0.013	0.017
Corrugated surface (steel sheet)	0.021	0.025	0.030
Cast iron (not painted)	0.011	0.014	0.016
Cast iron sheet and pipe (painted)	0.010	0.013	0.014
Chloride vinyl pipe		0.012	
Reinforced plastic		0.012	
Ceramic pipe	0.011	0.014	0.017
Earth lining		0.025	
Asphalt (smooth surface)		0.014	
Asphalt (rough stone)		0.017	
Masonry (rough stone wet masonry)	0.017	0.025	0.030
Masonry (rough stone dry masonry)	0.023	0.032	0.035
Wood (wooden gutter)	0.010	0.012	0.014
Wood (lined in thin layer, treated with creosote)	0.015	0.017	0.020
Rock tunnel with no lining on overall cross-sectional area	0.030	0.035	0.040
Rock tunnel with no lining except concrete placed on the bottom	0.020	0.025	0.030
Vegetation coverage (turfing)	0.030	0.040	0.050

Source; "Design Manual for Canal, Land Improvement Project" edited by Ministry of Agriculture, Forest and Fisheries, Japan

TABLE G-3 : COEFFICIENTS OF ROUGHNESS N (3/3)

Materials and conditions of canals	Coefficient of roughness		
	Minimum value	Standard value	Maximum value
Small canals on flat land			
1) Not weedy, straight. Neither cracks nor crevices are seen when water reaches the high water level	0.025	0.030	0.033
2) Weedy and stony. Neither cracks nor crevices are seen when water reaches the high water level	0.030	0.035	0.040
3) Not weedy but meandering. Some crevices and shallows are seen	0.033	0.040	0.045
4) Some weeds and stones. Meandering. Some abysses and shallows are seen	0.035	0.045	0.050
5) Meandering. Some crevices and shallows are seen. Water level is low. The changes in gradients and cross-sections are few.	0.040	0.048	0.055
The same as 4). Somewhat stony	0.045	0.050	0.060
7) Weeds and deep crevices are seen along moderate flow areas.	0.050	0.070	0.080
8) Area where weeds grow densely, deep crevices are seen, or trees are present.	0.075	0.100	0.115
Canals in mountainous areas. No plants in canals. River banks are usually steep. The trees and shrubs along river banks are flooded when water reaches the high water level			
1) Cobblestones and gravel on river beds	0.030	0.040	0.050
2) Large cobblestones on river beds	0.040	0.050	0.070
Large canals			
1) Constant cross sections without large cobblestones or shrubs	0.025		0.060
2) Rough and irregular cross sections	0.035		0.100

APPENDIX H. PROJECT IMPLEMENTATION AND PROJECT COST

APPENDIX H. PROJECT IMPLEMENTATION AND PROJECT COST

H-1. Project Organization

H-1-1. Executing Agency

Major works of the project are to construct storage dams, main and lateral irrigation canals, drainage canals and on-farm facilities. The contract basis implementation is recommended for construction of the project. RID is responsible for overall planning, programming and execution of irrigation and major flood protection projects in the country and shall be an executing agency for the implementation of the project with the assistance and cooperation of other government agencies concerned in their respective field.

H-1-2. Project Office

The project is a package comprised of five sub-projects including Lam Se, Huai Khum Kham, Huai Kham Phak Wan, Huai Na Khai and Huai Soob projects. Therefore, Sebai-Sebok Package Project Office which has responsibilities for promoting the project and organizing, coordinating and directing sub-projects will be set up for smooth execution of the project. Each project office under the package project office will be established at each project site for securing smooth execution of the works during the construction stage. The organization chart is shown in Figure H-1.

The project office will consist of the administrative division and the engineering division. The administrative division will consist of administrative, accounting and land acquisition sections responsible for budgeting, accounting personnel matters, negotiation of land acquisition and other miscellaneous matters. The engineering division will consist of dam construction, canal construction, on-farm construction and laboratory section responsible for supervision of construction works and various testing of soil and concrete from the viewpoints of quality control.

H-2. Construction Method and Schedule

H-2-1. Implementation Mode

The major work composed of dam and canal systems in the five sub-projects will be carried out under the control of RID. Since the project-work includes five dams and a number of canal systems of medium scale, the major work will be implemented under a loan from an international financing agency with the following procedure.

The detail design and construction supervision of the major work will be carried out by consultants employed by RID under the engineering service loan.. The construction of the major work will be executed on contract or force account basis under the construction loan.

However, it is recommendable that the major work would be carried out on a contract basis for the following reasons:

- Since the major work includes dam and canal systems on a medium scale, construction on contract basis will be done smoothly and on time as compared with force account basis.
- When construction works are carried out on force account basis, the procurement of construction equipment should be made prior to the commencement of construction and will require a period of about one and half years, taking into consideration the preparation of tender documents, execution of tendering and contracting, manufacturing of equipment and transportation of equipment to the site.

  In case construction is done on contract basis, construction could be commenced immediately after tendering of the major work for the contractor and save a period of about one year.

H-2-2. Construction Method

(1) Dam Works

a) Workable Days

Earth works especially dam embankment works are mostly affected by rainfall. Thereby, estimation of monthly mean workable days in the construction period will be required by using the daily rainfall records of recent ten years in the vicinity of each dam site at the time of detail design stage. Assumed workable days of each work are as follows;

Description	Assumed Workable Days Month	
	West Season (May to Oct.)	Dry Season (Nov. to Apr.)
- Common Works	21	25
- Dam embankment of impervious zone	16	25

b) Sequence of Construction Works

Dam will be constructed in two sections of right and left abutments due to wide river-bed. Normally dams are constructed will be in the following sequence (refer to Figure H-3) ;

No. of Sequence	Working Contents
(1)	Excavation of right core trench upto pre-excavation line.
(2)	Grouting of right abutment and construction of right outlet.
(3)	Excavation of over-burden of 1.0 m in the right abutment.
(4)	Backfilling of core trench in the right abutment and shifting the river diversion.
(5)	Embankment of right section and excavation of left core trench upto pre-excavation line.
(6)	Grouting of left abutment and construction of left outlet.
(7)	Excavation of over-burden of 1.0 m in the left abutment.
(8)	Backfilling of core trench in the left abutment.
(9)	Embankment of left section.
(10)	Closing the river diversion and embankment of river diversion section during dry season.

(2) Canal Works

Construction of canals together with on-farm facilities will be made in parallel with dam construction. It is economical to supply the concrete aggregates from the existing borrow areas. The fuel energy will be useful for the canal system construction as compared with electricity. The embankment materials shall be compacted sufficiently with the careful control of moisture content, since the field moisture will be in dry side from the optimum moisture in the same state as the dam materials.

H-2-3. Construction schedule

Construction schedule of each five project is shown in Table H-2 (1/5) ~(5/5).

H-3. Project Cost

The construction of the major works of dams and canals will be carried out by the contractor under the supervision of RID with assistance of the consultants. The following condition and methodology of cost estimate are applied.

H-3-1. Unit Rate for Major Works

The unit costs of major works are adopted from the current unit costs of RID as of July 1989 on the contract basis and shown in Table H-22. The foreign and local currency portions for the basis rate are estimated, based on the prevailing percentage in the international fund agency, as follows:

Description	Percentage	
	F/C	L/C
Cement	60	40
Reinforcement	70	30
Fuel and Oil	80	20
Timber	20	80
Explosive	80	20
Depreciation for Equipment	70	30
Repair for Equipment	80	20
Labour	0	100

H-3-2. Composition of Project Cost

(1) Construction Cost

The construction cost of the major works to be executed by RID is estimated based on the quantities calculated from the preliminary design and the unit costs. The costs of overhead, profit and taxes are adopted from the current percentage of RID, as follows:

Description	Rate (%)
1. Overhead	5.5% of material and wage costs
2. Profit	6.5% of material and wage costs
3. Taxes	3.4% of (material and wage costs + 1. + 2.)

Note: Material and wage cost is over 100 million Baht.

The construction cost of major works is calculated as shown in Tables H-10 ~ H-14.

(2) Construction Cost of On-farm and Village Pond

The construction cost of on-farm canals is estimated at Baht 8,125/ha (Baht 1,300/rai). The construction costs of village pond are estimated based on the quantities calculated and the unit costs. The construction cost of on-farm facilities is calculated as shown in Tables H-10 ~ H-14.

(3) O & M Equipment

The cost of O & M equipment for five projects of 7,670 ha is estimated as shown in Table H-16 and allocated among five projects based on the proportion of respective service area.

(4) Right of Way

The right of way will be required for the agricultural land in the reservoir area and along the canal alignment of the service area. The unit costs of right of way are as follows ;

Name of Projects	Right of Way Cost	
	Baht/ha	Baht/rai
Lam Se	43,750	7,000
Huai Khum Kham	31,250	5,000
Huai Kham Phak Wan	25,000	4,000
Huai Na Khai	25,000	4,000
Huai Soob	25,000	4,000

The cost of right of way is shown in Table H-17.

(5) Survey and Investigation

The survey and investigation works consist of preparation of map, geological investigation and construction material survey for the detail design of the major works. The costs of survey and investigation works are estimated as shown in Table H-18.

(6) Detail Design and Supervision

The cost of consulting services for the detail design and construction supervision of the major works is estimated as shown in Table H-19. The cost has also been allocated among the five projects by ratio of the service areas.

(7) Administration

The administration cost consists of allowance, salary for temporary personnel, cost for transportation and miscellaneous costs. It is estimated at 3 percent of the construction cost of the major works.

(8) Base Cost

The base cost is the sum of the costs of the above listed items (1) to (7).

(9) Physical Contingencies

The physical contingency is estimated at 10 percent of the base cost.

(10) Price Contingency

The price escalation is estimated at 1 percent per annum for the foreign currency portion and 4 percent per annum for the local currency portion.

The project cost based on the above estimation is summarized in Table H-1 and H-3.