KINGDOM OF THAILAND
MINISTRY OF AGRICULTURE AND COOPERATIVES
ROYAL IRRIGATION DEPARTMENT

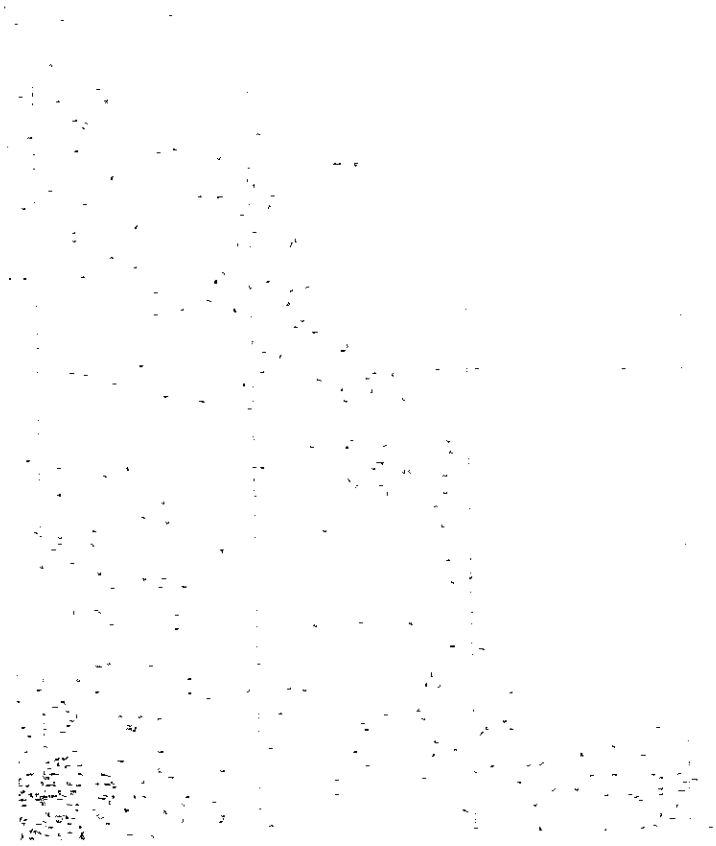
PRE-FEASIBILITY STUDY ON THE UPPER PASAK MEDIUM SCALE IRRIGATION PROJECT

FINAL REPORT
ANNEX VOL.1

I. GEOLOGY
II. HYDROLOGY
III. DAM AND RESERVOIR
IV. RESERVOIR OPERATION

MARCH 1982

JAPAN INTERNATIONAL COOPERATION AGENCY



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1.1 GENERAL GEOLOGY

As indicated in the geological map (Fig. 1.1) and the stratigraphical table (Table 1.1), the baserock within the Upper Pasak Medium Scale Irrigation Project area is composed essentially of Paleozoic Permian, Mesozoic Triassic and Cenozoic Tertiary sedimentary rock covered by Quarternary diluvial and alluvial deposit. Strata of sedimentary rock formed during different geological periods are mutually unconformable in structure. Igneous rock appears sporadically within the Permian formation as stock.

On the left bank of the Pasak River within the dam site area, a 20 - 30 km strip of Nam Duk formation of the Paleozic Middle Permian period extends north to south, with Khorat Group formation of the Mesozoic Triassic period distributed in higher mountainous sectors. However, said formations have no direct bearing on the dam site itself. The Nam Duk formation consists primarily of interbedded shale and sandstone, exhibiting folding along a north to south axis.

At the base of the mountainous area on either bank of the Pasak River, Pha Nok Khao formation composed mainly of Lower - Middle Permian limestone extends about 20 km north to south in a 500 - 700 m wide belt, within which zone a single quarry is currently in operation. A formation of identical structure is located approximately 15 km south of Phetchabun (said formation lies outside the project area and is not indicated on the geological map).

The geological map indicates Tertiary formation only in the vicinity of 1 km downstream from the Khlong Chaliang Lab Dam site. However, exploratory drilling at Huai Yai Dam site reveals that Tertiary formation is widely distributed about 7 - 10 m below Quaternary deposits in level sections of the project area. The results of said test drilling strongly suggest that Tertiary formation is generally present beneath Quaternary deposits in the area.

Intrusions of igneous rock (granite, diorite and gabbroic diorite) in the form of small stock are found within Paleozoic strata. This type of formation is particularly evident within the catchment area of the Huai Yai.

Nam Duk formation in the vicinity of the dam site exhibits extensive and extremely pronounced folding. The axis of folding is primarily north to south, and the formation appears to be interrupted at its western extremity by a fault running north to south.

1.2 GEOLOGICAL INVESTIGATIONS

1.2.1 Previous Investigations

Previous investigations for the Upper Pasak Medium Scale Irrigation Project were carried out by RID between 1980 and 1981. These investigations, including drillings, hand augers and test pits, were performed at four dam sites.

Drillings performed at each dam site are as follows.

Dam Site	Area	No. of Holes
Huai Saduang Yai	Right Abutment	2
	Left Abutment	2
	River Bed	1
	(Sub-total)	(5)
Huai Khon Kaen	Right Abutment	1
	Saddle	3
	Left Abutment	1
	River Bed	2
	(Sub-total)	(7)
Huai Yai	Right Abutment	24
	Left Abutment	6
	River Bed	1
	Spillway	3
	Outlet	3
	(Sub-total)	(37)
Khlong Chaliang Lab	Right Abutment	2
	Left Abutment	1
	River Bed	1
	(Sub-total)	(4)
	Grand Total	53

1.2.2 Geological Investigation in Pre-Feasibility Study

Geological investigations for the project in Pre-Feasibility Study were carried out by the Study team between Sep. 15 and Oct. 14, 1981.

The field investigations carried out at this study stage are as follows.

(a) Collection and review on the general geology of the project area and vicinity,

(b) Collection and review of the existing data obtained by the previous investigations, including drilling core logs, records of permeability test and R.Q.D.,

(c) Collection and review of the results of the investigations on the borrow areas by RID,

(d) Geological investigation at each dam site and reconnaissance at each reservoir area,

(e) Investigation on the vicinity of the borrow area, and

(f) Examination of drilling cores at the storehouse in Pa Daeng Project Office.

1.3 GEOLOGY OF RESPECTIVE DAM SITES AND RESERVOIR AREAS

1.3.1 Huai Saduang Yai Dam

(1) Geology of Reservoir Area

The geological structure of the area to be inundated by the Huai Saduang Yai Dam consists of interbedded sandstone and shale belonging to the Nam Duk Formation of the Paleozoic middle Permian period, with sandstone as the predominant component. Said sandstone is hard, gray to brown gray in color, with a grain size ranging from fine to intermediate. In contrast, the shale is dark gray to black in color and relatively softer than the sandstone, exhibiting a tendency to strip readily from the bedding plane. Preliminary investigation indicates that the strata is striking N3°E to N22°E and dipping to the west at 30° - 50°.

There might exist the identical strata dominated by folding on a north to south axis in the area.

The river meanders in a southeastern direction, with terrace deposits of 400 m maximum width distributed along both banks. Based on findings from test drilling at the dam site, stratal thickness is approximately 5 m, comprised of interbedded clayey sand of reddish brown color and weathered gravel. Terrace deposits along the base of mountainous portions are covered by talus consisting of clayey soil intermixed with rock fragments. The thickness of the overlaying talus cover varys from location to location.

In the area covered by terrace deposits mentioned above, portions in which fine grain materials and talus are distributed, are under consideration as borrow areas for embankment material.

(2) Geology of Dam Site

The slope at the dam site is 25° - 26° on the right bank and 20° or less on the left bank, respectively. The gorge at the site is relatively symmetric and the site is blessed with favourable topographic condition for construction of fill dam. However, a saddle exists on the southern side of the left bank abutment, the ramifications of which requires further investigation.

Base rock at the dam site consists of interbedded sandstone and shale of the Nam Duk formation of the middle Permian period. The predominant component of the abuttal formations on either side of the river is sandstone, while shale is preponderant in the vicinity of the riverbed. This situation clearly shows the difference in resistivity to erosion between the two materials.

Terrace deposits extend over about 90 m from the river on the left bank of the Huai Saduang Yai, and about 140 m on the right bank. Stratal thickness is approximately 7 m.

The strike of baserock is N3°E - N22°E and dip is 34° - 50°W. On the left bank, dip is in the direction of the slope.

Rock of the left bank abutment and the riverbed exhibits weathering of 7 - 8 m, and 10 - 14 m, respectively. The right bank abutment comprises a highly weathered zone with a depth of 22 m.

According to the permeability test, Lugeon value of 20 or more which shows relatively high permeability, is observed to a depth of 16.5 m on the left bank, 13.5 m on the riverbed and 19.0 m on the right bank. However, since said permeability is the result of cracks in the rock structure, it would be improved by grouting.

On the basis of drilling cores, existence of zones of rock fracture and/or clay deposits which suggest fault presence is not found.

Joints are most developed at 9 m or below in DH-3, having a gentle slop of 30° - 35°, and apertures are filled with clay and/or quartz stringer.

1.3.2 Huai Khon Kaen Dam

(1) Geology of Reservoir Area

The area to be inundated by the Huai Khon Kaen Dam consists of hilly terrain dissected by the Huai Khon Kaen River and circumscribed by rolling foothills. The downstream portion of the area is relatively open in topographical character, while the upstream portion of the river has a long and narrow topography.

The altitude of the riverbed along the dam axis is 172 m, and hilly sections of the area consist of ranges of 300 - 500 m in height.

The Huai Khon Kaen meanders in a southwestern direction. Although the normal river width is 20 - 25 m, during flooding in 1978 the water level of river rose to its terrace top achieving a width in excess of 150 m.

River meandering is mainly due to the difference in resistance to erosion of the harder sandstone formations and softer shale formations which dominate the geology of the area. This fact shows the relationship between river bending and geological structure.

The structure of a sharp ridge running north to south through the area is dominated by hard sandstone constituting an anticlinal formation.

The geological composition of the reservoir area consists of shale belonging to the Num Duk formation of the Paleozoic Permian period interbedded with sandstone. Said sandstone is gray - dark gray in color, with grain size ranging from fine to intermediate. Interspersed fragments of mudstone are seen within sandstone strata. External appearance indicates sandstone formations which are massive in texture and also formations where bedding is clearly evident, when interbedded with shale.

Shale in the area is black - black gray in color and exhibits developed bedding. In highly weathered zones, it shows a propensity for exfoliation. Although said shale displays greater tendency to exfoliate from bedding than the sandstone, it is strong in structure and features low permeability.

The overall geological structure of the area is dominated by a north-south folding axis. Stratal strike is N15°W - N30°E, dipping about 60° - 80° to west or east.

The topography of the inundation area in characterized by gentle sloping. Since tectonic lines or noticeable faulting, coupled with the presence of firmly structured base rock, are not found, collapsible geological formations are non-existent in the area. Furthermore, limestone deposits, a source of potential cavitation, are not in evidence.

(2) Geology of Dam Site

At the proposed dam site, there exist two humps, caused by erosion along the course of the current river and the old river course.

The geologic structure of the dam site consists of base rock formed from interbedded hard sandstone and shale of the Permian Period Nam Duk Formation. In and around the riverbed with a 150 m wide stretch, the base rock is covered by terrace deposits with 6.5 - 9.5 m thick consisting of gravel strata.

The structure of said base rock and the composition of the covering layer is discussed in detail hereunder.

Base rock strike is N10° - 15°W, dipping about 70° - 80°E. In highly weathered zones of the left bank abutment, riverbed and flat area on the right bank, the depth of weathering is 8 - 12 m in maximum. The depth of weathering along the right bank is only 3 - 6 m. As base rock conditions are generally good at the site, a large amount of excavation works would not be required for construction of fill dam, assuming to be 2 - 9.5 m in depth.

The depth of groundwater level in the vicinity of the river bed ranges from 0 - 7.2 m. Along hill ridges, the depth is 14 - 30 m. Groundwater distribution is accordingly estimated to be in generally normal conformity with topographical profile. Faulting and zones of fractured rock are not found, and the results of permeability indicates a normal permeability pattern that the permeability below 22 m depth gradually decrease from values of 14 Lugeon to 6 Lugeon. Therefore, no complications for dam construction can be found at the site.

Although permeability test results show 50 Lugeon value at the depth of 16.5 m on the left bank, the value under the above depth drops to 5 Lugeon or less. On the river bed, values of 20 - 50 Lugeon are achieved at the surface portion of 4 - 5 m in depth, but deeper portion more than 5 m in depth has low permeability of 5 Lugeon or less.

In the central portion of the dam site, values of 20 - 50 Lugeon obtained at 6 - 10 m in depth from the surface stratum of both valley and ridge sections. At deeper levels, the permeability decreases to 10 - 5 Lugeon. In DH-7 on the right bank, zones of high permeability of 20 Lugeon or more are recorded at the depth of 14.5 - 17.5 m and 20.5 - 22.0 m. However, this high permeability is caused by partial variations in degree of weathering of the rock constituting ridge sections of the area, not due to the fault or fractured rock zone. Grouting in the course of dam construction would adequately relieve the above situations.

1.3.3 Huai Yai Dam

(1) Geology of Reservoir Area

The reservoir area consists of hilly terrain of 200 - 250 m elevation. The Huai Yai, like other rivers in the vicinity, meanders considerably, and as a result, terrace deposits are distributed along both banks.

The geology of the area is comprised interbedded sandy shale and slightly metamorphic sandstone belonging to the middle Permian Nam Duk formation. On the left bank an intrusion of gabbroic diorite running in a north-southern direction is found in the vicinity of EL 226 m. The exact extent of said intrusion is unclear at present.

In terms of geologic structure, the strike of bedding is generally north to south (N7°W - N15°E), with a 70° - 80°E dip at the downstream portion and 60° - 65°W dip at the upstream. This suggests the possibility of a dominant folding structure throughout the area. The distribution of intrusive rock appears to be conformable with the sedimentary rock structure. Judging from visual inspection of outcrops, such intrusions are generally massive in texture and would appear to useful for appropriate riprap material. However, further investigation is necessary to confirm this assessment.

On the basis of aerial photograph, a linearment is in evidence running in the direction of N20°W - S20°E through the saddle located on the right bank approximately 800 m upstream from the debouchment of the river. In the upper area, the strike of bedding changes to a east-west configuration. From the above, it is suspected that a zone of fractured rock maight be existed along the linearment. Special attention to this point should be given in the coming geological survey of the area.

Existence of rock failure is not apparent within the area. Sloping therein is gentle, and no loose formations of sedimentary materials in the surface stratum, which would be a source of structural collapse at the time of inundation, are encountered in the area.

(2) Geology of Dam Site

Investigation results at the original dam site located at the debouchment of the river, where drilling was intensively undertaken, are presented hereinunder.

The originally proposed dam has a long crest length of about 2 km and then, the geological conposition of rock along the dam axis exhibits considerable variation. On the southern side of DH-8 near the left bank of the river, interbedded sandstone and sandy shale belonging to Nam Duk formation of the Permian period

are founded. On the other hand, the dam foundation in the vicinity of the right bank consists of Tertiary silty mudstone covered in an unconformable manner by an unconsolidated Quaternary diluvium - recent gravel layer. Consequently, the original dam must be constructed on the heterogeneous foundation, comprising Paleozoic, Tertiary, and Quaternary diluvial formations. Such a geological condition is disadvantageous for dam construction in due consideration of non-uniform subsidence leading to deformation of the structure.

The Middle Permian Nam Duk formation distributed on the left bank consists of yellow gray - dark gray, fine grained sandstone and shale - sandy shale with an interbedded configuration. (Sandstone is predominant with a 5 m bed of sandstone for every 1 m of shale layer.) However, in DH-5 - DH-8, shale is the dominant component. Sporadically, as in DH-1 and DH-5, a thin bed (2 - 4 m) of tuffaceous shale exists. Although rock structure is generally hard, there are some differences between the strength of sandstone, shale, and tuffaceous shale formations. A highly weathered zone reaches to 5 - 7 m in depth, and moderate weathered zone to 10 - 15 m in depth.

On the basis of drilling core inspection, no conspicous fault exists. Permeability of the rock structure shows values of 20 Lugeon or more at the depth of 10 - 17 m from the surface stratum. This situation is due to the existence of joint apertures caused by weathering.

The geological structure of the flat area of the original dam site comprises Tertiary (Chaliang Lab formation) mudstone. Said mudstone layer is covered by unconformable Quaternary deposit. The thickness of Quaternary deposits varies from 8 to 15 m and the boundary between the mudstone and Quaternary formations is irregular. The base of the Tertiary bedding is confirmed to a maximum depth of 36 m. Based on the results of drilling, the flat area mainly consists of mudstone, excepting the northern

area of DH-22, where argillaceous sandstone is predominant. However, the precise nature of bedding and geological structure can not be clarified only by use of the drilling results.

Although drilling cores are retrieved as the bar, they are collapsed by submerging in water. This fact indicates that core materials have a low degree of consolidation. Judging from the consolidative nature of the said rock structure, it appears to be sedimentary rock formed during the latter Tertiary - initial Quaternary period. In DH-12 and DH-15, N values are obtained near the bottom of the drilling hole. N values at the upper portion of the layer (7 - 9 m in depth) are N = 20 - 30, indicating fluctuation caused by the effects of weathering, while values below that level shows more than 50, revealing a good state of compaction.

Regarding the permeability of the Tertiary layer (Chaliang Lab formation), out of 37 holes, 5 test holes (DH-9 - DH-13) drilled in the vicinity of the river indicate particularly high values of 4×10^{-4} - 10^{-3} cm/sec at the depth of 2 - 6 m from the Tertiary surface stratum. However, most drilling holes show the low permeability with the range of 10^{-5} - 10^{-6} cm/sec.

Quaternary deposits are composed of sandy clay, clayey sand, silty sand, silty gravel and loose block of rock. The loose block of rock is located at the base of the Quaternary deposit layer and is distributed in the vicinity of the right bank of the Huai Yai (DH-7 - DH-9) with thickness of 4 - 7 m. As thickness of the loose block of rock increases nearby the river, it appears to be of sedimentary deposit caused by flooding. The present riverbed of the Huai Yai consists of an approximately 3 m layer of gravel sediment on this loose block of rock. At the upper portion and northern side of said loose block of rock, sandy clay can be mainly found. At the northward of DH-12, clayey sand is predominant. In DH-30 - DH-31, the gravel is deposited with 3 - 4 m of thickness. Although the permeability of surface strata is

small, the lower portion of the Quaternary deposit formation shows high permeability. In particular, large values of 10^{-3} cm/sec - 2 - 4 x 10^{-4} cm/sec are achieved for the loose gravel and clayey sand in DH-6 to DH-12. In DH-17 - DH-20 located at the northern part, clayey sand is distributed with approximately 5 m thick layer and features high permeability of around 10^{-3} cm/sec. At further northern part, in DH-23 - DH-24 and DH-30 - DH-31, values of approximately 10^{-3} cm/sec are obtained for deposits of silty sand and loose block of rocks.

Permeability in the dam site is generally high to the depth of 12 - 14 m. The groundwater level is recorded to be 10 - 16 m in depth in the hilly area on the left bank of the river and 0.3 - 5 m in the flat area, indicating normal distribution in conformity with topographical profile.

The proposed shifted dam site is located about 450 m upstream from the original dam site. The shifted site has narrow gorge with about 100 m wide, and is topographically more advantageous for construction of fill dam.

In terms of geological composition, the dam site has the base rock consisting of interbedded sandstone and shale and/or gabbroic diorite, belonging to the Nam Duk formation of the Permian period. Base rock is covered by an approximately 6 m thick layer of silt and/or sandy gravel. Outcrops of rock are partly existed on the left bank. The slope is more than 25° and the topsoil layer is relatively thin. On the right bank, the slope is generally about 15° with a thick top soil layer partly. However, based on the fact that a large number of loose sandstone boulders are visible on the upper portion of slopes, the base rock is assumed to be found at the shallow portion.

From the factors described above, the sifted site is more advantageous than the original site in terms of topographical and geological conditions. Nevertheless, prior to the next study, the following points should be further investigated.

a) A topographical survey is required to be conducted for for reservoir area of the proposed dam. In particular, the elevations of saddles on both sides of the river should be confirmed.

b) A geological survey is required to be implemented using the new topographical maps. The emphasis of said survey should be put on the confirmation of geological conditions at the dam site and reservoir area including the precise distribution of gabbroic diorite within the dam site area and riprap material in the vicinity of a site. Also, the fractured zones of rock along the linearment running NW20° - SE20° from the saddle on the left bank upstream from the site should be investigated whether exist or not.

1.3.4 Khlong Chaliang Lab Dam

(1) Geology of Reservoir Area

The area to be inundated by the proposed dam is long and narrow in configuration, being circumscribed by foothills. Sloping on the left and right banks is dissymmetrical in nature, that of the left bank being 30° or more and that of the right bank consisting of a gradual grade of 25° or less. There scarcely exist the cultivated land in the reservoir area, almost consisting of forest.

Due to the existence of no outcrops, the precise geology of surface strata remains unclear. Based on visual inspection of the site, as well as the results of drilling test, the geological structure at the left bank consists of interbedded sandstone and shale of the Nam Duk formation, and that of the right bank mainly

comprises gray-green, fine grained sandstone. The strike of strata is N30°W - N50°W, dipping 40 - 60°NE. No unstable formations which would cause to collapse slopes in the area, are encountered.

The long and narrow configuration of terrace deposits along the riverbed indicates that sufficient quantities of embankment materials are not available in the upstream area from the dam site.

(2) Geology of Dam Site

The proposed dam site is situated at the narrow neck where the river debouches from the mountains, and is topographically V-shaped. The slope of the right bank is about 25° and that of the left bank is 30° or more.

The geological structure of the site consists of sandstone and shale belonging to Nam Duk formation of the middle Permian period. Based on the results of drilling, interbedded gray sandstone and dark gray shale is distributed in DH-1 on the left bank. Said formation exhibits heavy weathering to 6.0 m in depth and is slightly argillized. Such argillization suggests that there might exist the fault in the site. The riverbed portion of DH-2 consists of a 5 - 6 m layer of river sedimentation deposits, with the surface stratum consisting of an approximately 2 m thick bed of clayey sand - silty sand, below which lies approximately 4 m thick of gravel bed. The gravel is composed of stones with 3 - 10 cm in diameter. A base rock of hard shale - sandstone is distributed below the gravel bed (at a depth below 6.0 m).

In DH-3 and DH-4 on the right bank, weathering is observed to 3 - 4.5 m in depth and geological formations exhibit considerable deterioration. Below said zone of weathering, however, base rock suitable for fill dam foundation can be found.

The groundwater level at both abutments is recorded to be 12 m in depth, and said level continues to the riverbed showing distribution in conformity with topography.

Test drilling indicates to be high permeability for the base rock. At the left bank, riverbed and right bank, zones of 20 Lugeon or more are registered to a depth of 15.0 m, 9.0 m and 10.5 m, respectively. These high degrees of permeability are due to cracks in the rock structure caused by weathering.

1.4 DAM EMBANKMENT MATERIALS

The preliminary investigation for embankment materials are carried out by hand auger borings and test pittings at each dam site and its surroundings. The locations of the borrow areas surveyed at four dam sites are shown in Fig. 1.4 to 1.11 and the volumes of borrow materials are roughly estimated as summarized in Table 1.2.

As shown in Table 1.2, the borrow materials mainly comprise various fine soils, such as silty sand, clayey sand, sandy clay, silty clay, etc. The percentage of these fine soils for the total volume is estimated as follows.

Dam Site	Total Volume	Fine Soils	Percentage
Huai Saduang Yai	533,000 m^3	340,000 m^3	64 %
Huai Khon Kaen	1,175,250	907,250	77
Huai Yai	3,278,850	3,274,630	99
Khlong Chaliang Lab	366,000	305,000	83

These fine materials are much suitable for the impervious zone. Needless to say, however, the laboratory tests are required for the precise qualitative analysis.

From the above, it can be said that fine materials for the impervious zone are sufficient and readily obtainable around the proposed dam sites, but coarse materials, essencial for zoned type of earthfill dam, are insufficient in the vicinity of each site. Such coarse materials might be scattered hillside and foot of hill, and exist in deep soil layers. More detailed investigations together with the laboratory tests are required to assure the volume and quality of the borrow materials for the next study.

The rip-rap materials for protection of the upstream slope are proposed to be obtained from the limestone quarry site being located at Tham Kao Phra about 15 km southwest of the Lom Sak Municipality at the present study. However, this quarry site is far from each dam site. Further investigations should be made at the next stage to quarry out rip-rap materials in the vicinity of the dam site.

Table 1.1 Stratigraphical Table

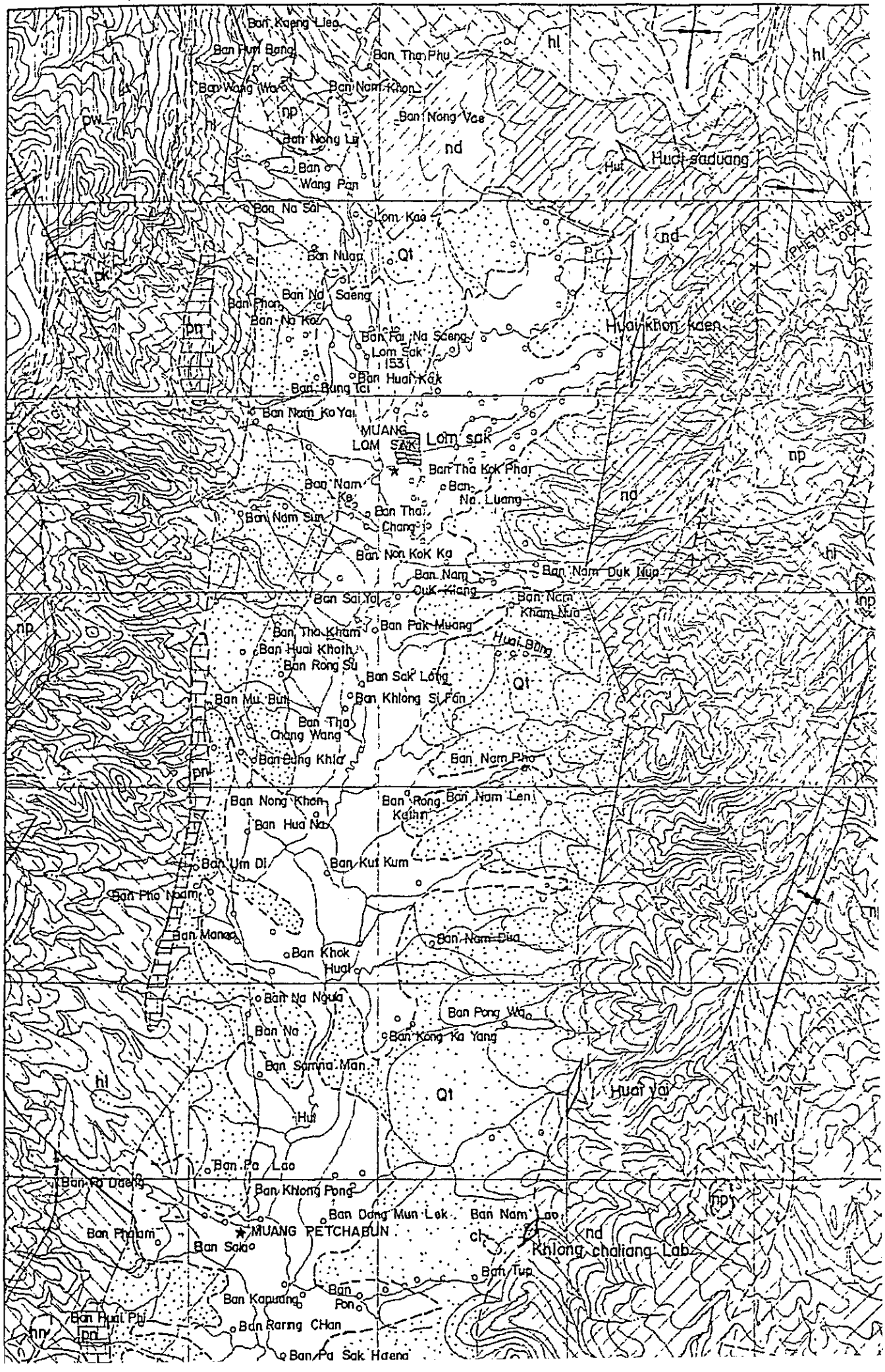
Age	Group	Formation	Symbol	Geological Aspect
Quaternary			Qa	Alluvial deposit
			Qt	Terrace gravel, talus, delluvial deposit
Tertiary		Chaliang Lab	Cl	Shale, yellowish gray Calcareous mudstone
Lower-Middle Jurassic	Khorat	Phra Wihan	Pw	Sandstone with shale
Lower Jurassic		Phu Kradung	Pk	Shale Sandstone
Upper Triassic		Nam Phong	np	Sandstone Conglomerate Shale
Permo Triassic		Huai Hin Lat	ht	Tuff Agglomerate
Middle Permian		Nam Duk	nd	Shale Sandstone Limestone
Lower-Middle Permian		Pha Nok Khao	pn	Limestone Chart Shale
Igneous Rocks			G	Granite diorite, gabbroic diorite

Table 1.2 Volume of Borrow Materials

(Unit: m^3)

Dam Site	Borrow Area	Soil Classification							Total
		GC	GM	SP	SM	SC	ML	CL	
Huai Saduang Yai	A	131,000	5,000	-	15,000	90,000	-	105,000	346,000
	B	57,000	-	-	-	40,000	-	90,000	187,000
	Total	188,000	5,000	-	15,000	130,000	-	195,000	533,000
Huai Khon Kaen	A	88,000	-	-	-	5,000	-	232,000	325,000
	B	180,000	-	-	17,750	94,500	-	558,000	850,250
	Total	268,000	-	-	17,750	99,500	-	790,000	1,175,250
Huai Yai	A	-	-	4,220	2,530	-	313,820	900,440	1,221,010
	B	-	-	-	-	-	126,050	524,950	651,000
	C	-	-	-	-	-	1,310	150,410	151,720
	D	-	-	-	-	-	11,860	727,260	739,120
	E	-	-	-	-	-	-	516,000	516,000
	Total	-	-	4,220	2,530	-	453,040	2,819,060	3,278,850
Khlong Chaliang Lab	A	61,000	-	-	7,000	41,500	-	256,500	366,000

Note: GC - Clayey gravel, GM - Silty gravel, SP - Poorly graded, gravelly sand, SM - Silty sand
SC - Clayey sand, ML - Inorganic site and very fine sand, CL - Sandy clay, Silty clay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Lom Kao
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LOM SAK
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Hut
Ban Pa Lao
Ban Ka Daeng
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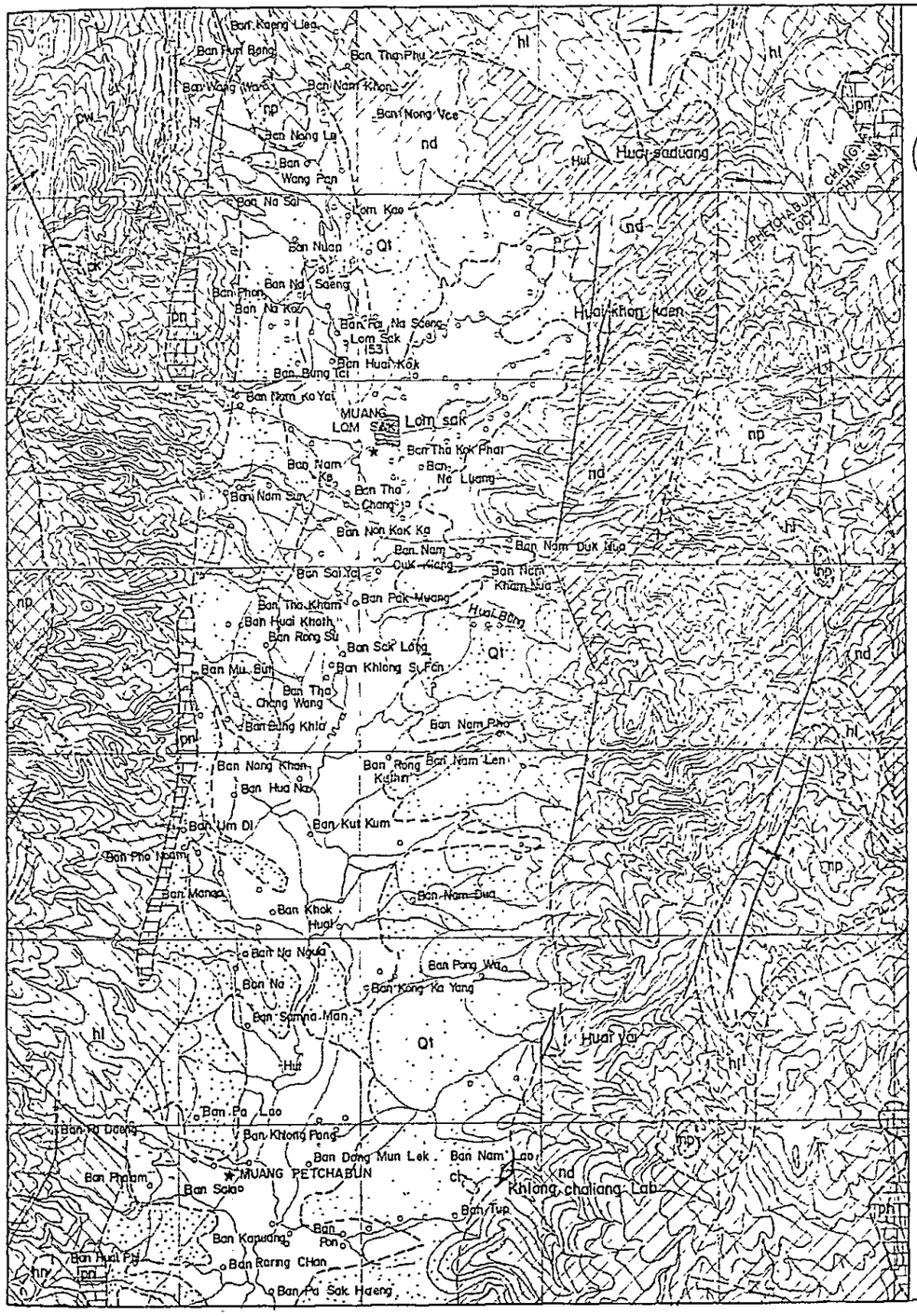

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		FORMATION	GROUP	AGE
Qa	Alluvial deposit			QUATERNARY
Qt	Terrace gravel, talus, colluvial deposit			
	UNCONFORMITY			
cl	Shale : yellowish gsay, calcareous. mudstone white, calcareous welbedded	CHALIANG LAB		TERTIARY
	UNCONFORMITY			
pw	Sand stone white pink arthogusrizitic cross bedded massive pebble layering on the upper bed, with some reddish brown and gray shale	PHAR WIHAN	KHORAT	LOWER MIDDLE JURASSIC
Pk	Shale browr, reddish brown, purplish red, micaceous siltstone, sandstone brown ,grav, micaceous small scale cross bedded,with some lime-noduled conglomerate.	PHU KRADUNG	KHORAT	LOWER JURASSIC
np	Sandstone; reddish brown. brown, cross-bedded. conglomerate; pebples of quartz, quartzite chart red siltstone. up to 10 cm in diameter shale siltstone brown, reddish brown.	NAM PHONG	KHORAT	UPPER TRIASSIC
ht	Tutt agglo merate rhyclite			PERMO TRIASSIC
	UNCONFORMITY			
nd	Shale; gray to black sandstone, yellowish brown fine-grained; limestone, lense and bedded highly disturbant.	NAM DUK		MIDDLE PERMIAN
pn	Limestone, gray massive to thick bedded chert, black noduled or thin bedded. with thn bedded, gray shale	PHA NOK KHAO		LOWER - MIDDLE PERMIAN
	IGNEOUS ROCKS			
G	Granite, diorite gabbroic diorite			

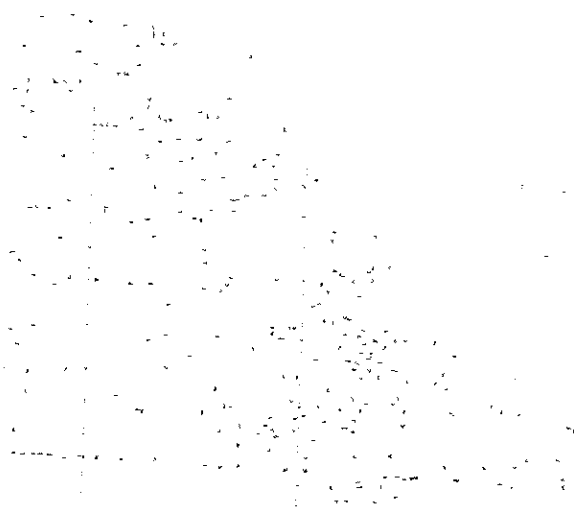
SYMBOLS

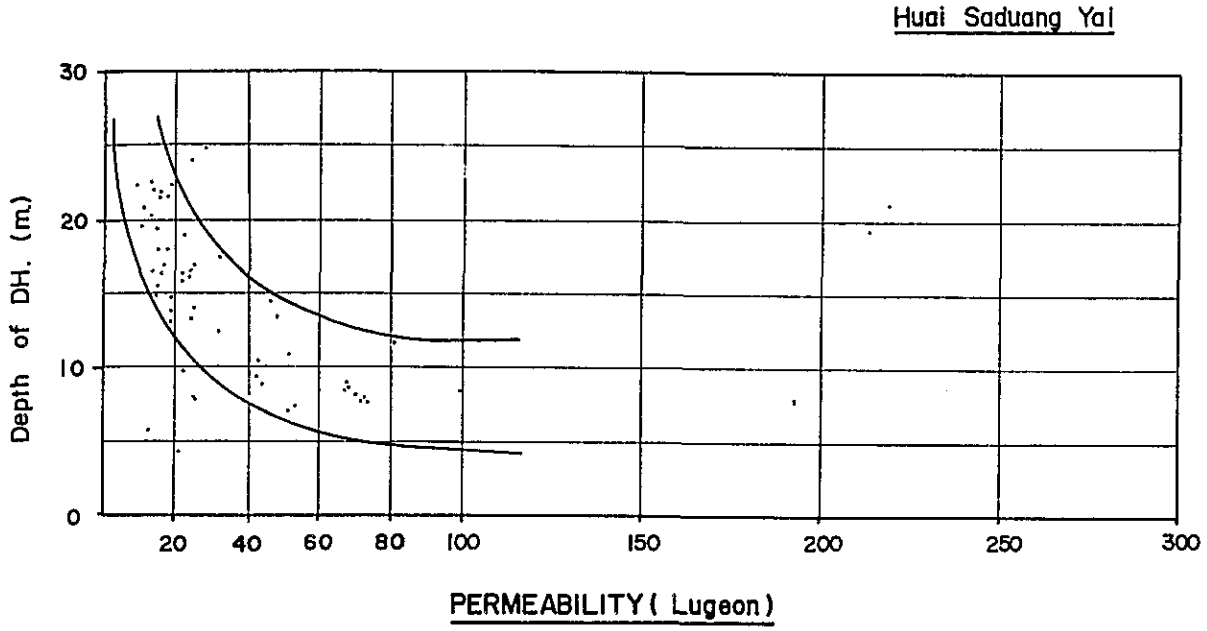
- Boundary
- Anticline, with plunging direction
- Syncline with plunging direction
- Fault

Fig. 1.1 GEOLOGICAL MAP

5 0 5 10 km

SCALE 1 : 250,000





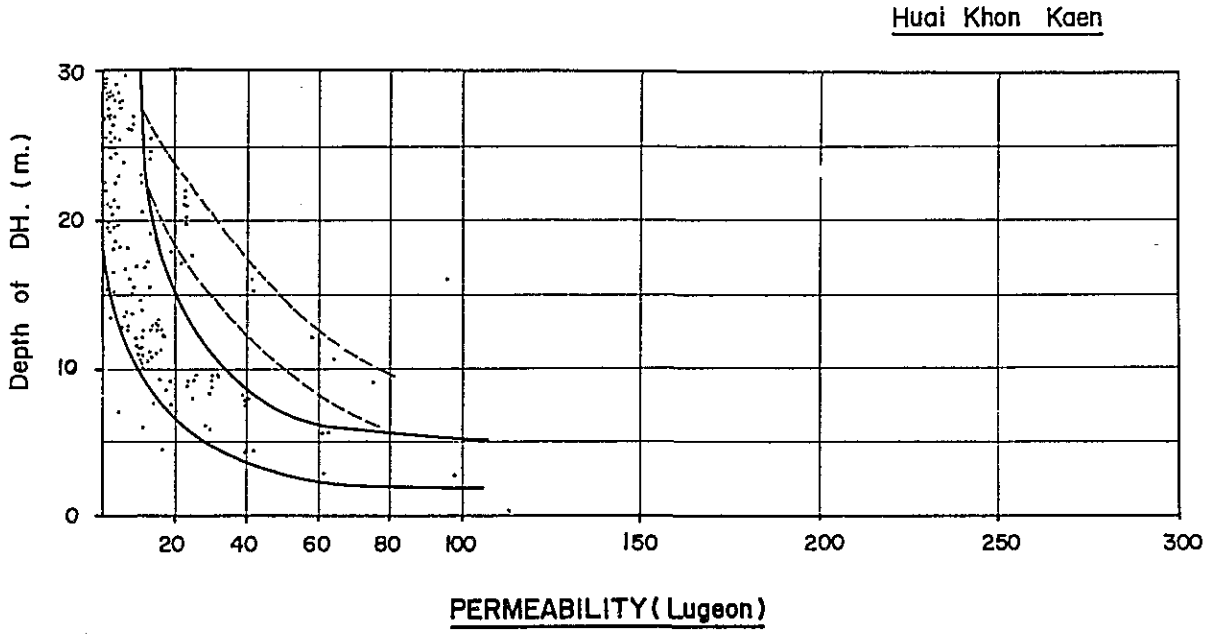
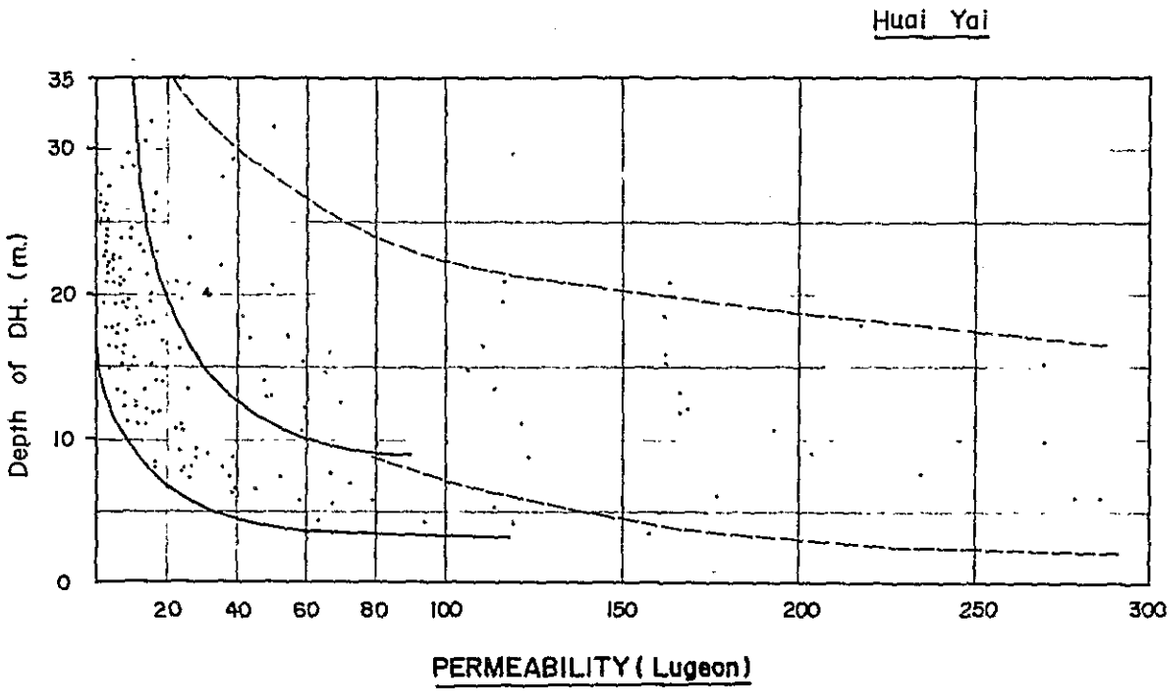


Fig. 1.2.(1) DISTRIBUTION CHART OF LUGEON VALUE



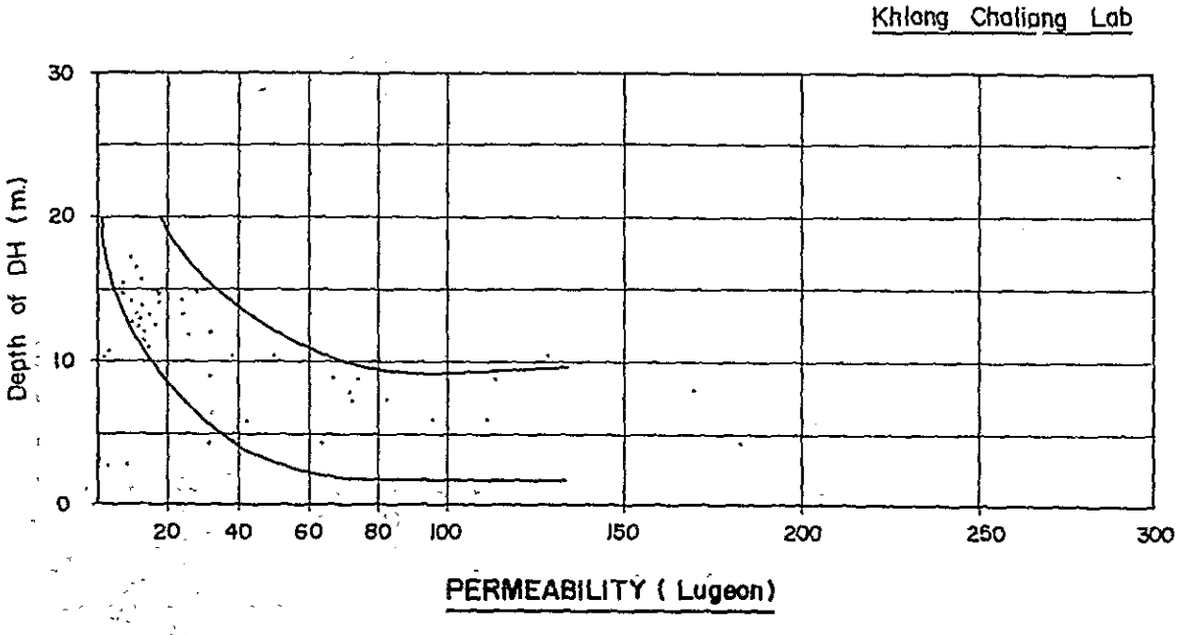
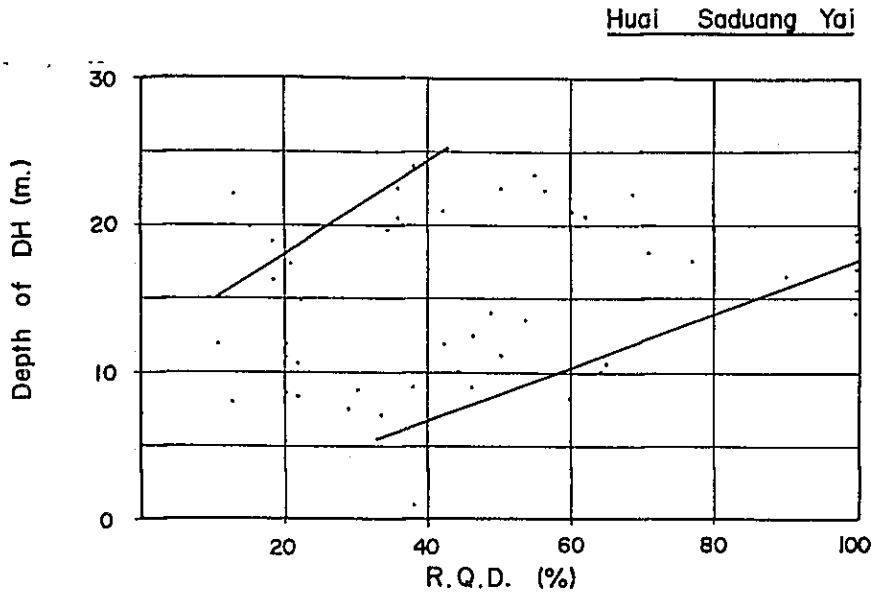
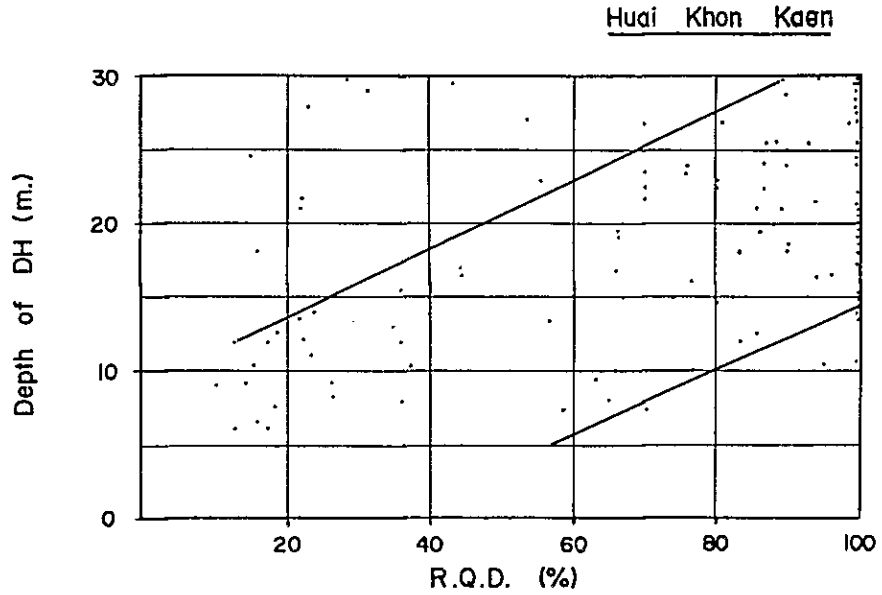


Fig. 1.2 (2) DISTRIBUTION CHART OF LUGEON VALUE





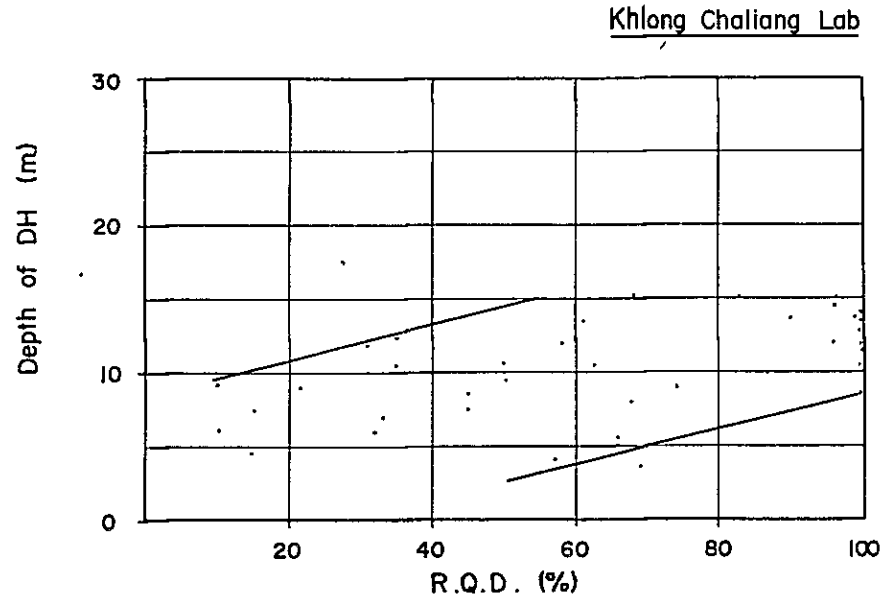


Fig. 1.3 DISTRIBUTION CHART OF R.Q.D

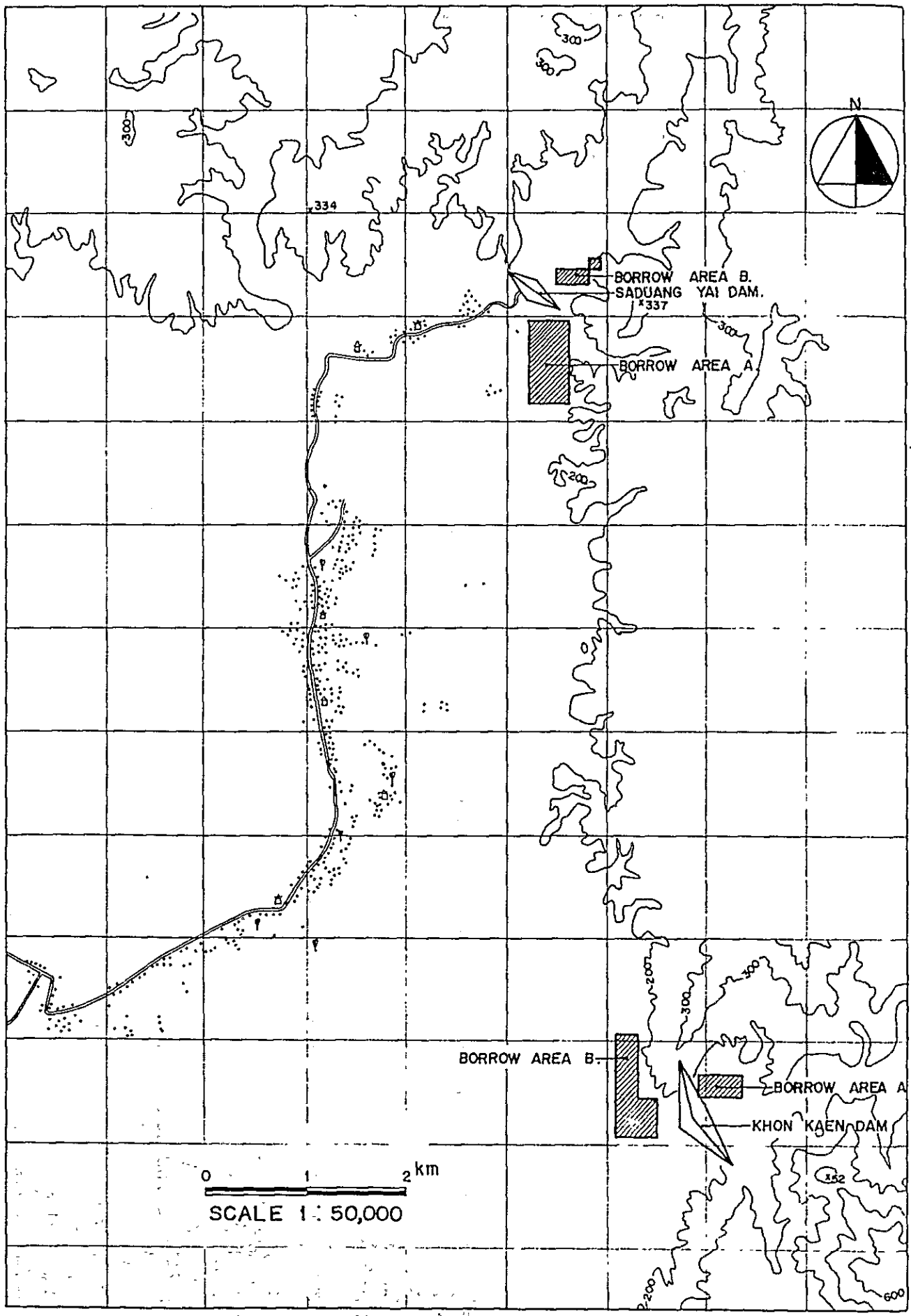


Fig. 1.4 LOCATION MAP OF BORROW AREA OF HUAI SADUANG YAI DAM AND HUAI KHON KAEN DAM

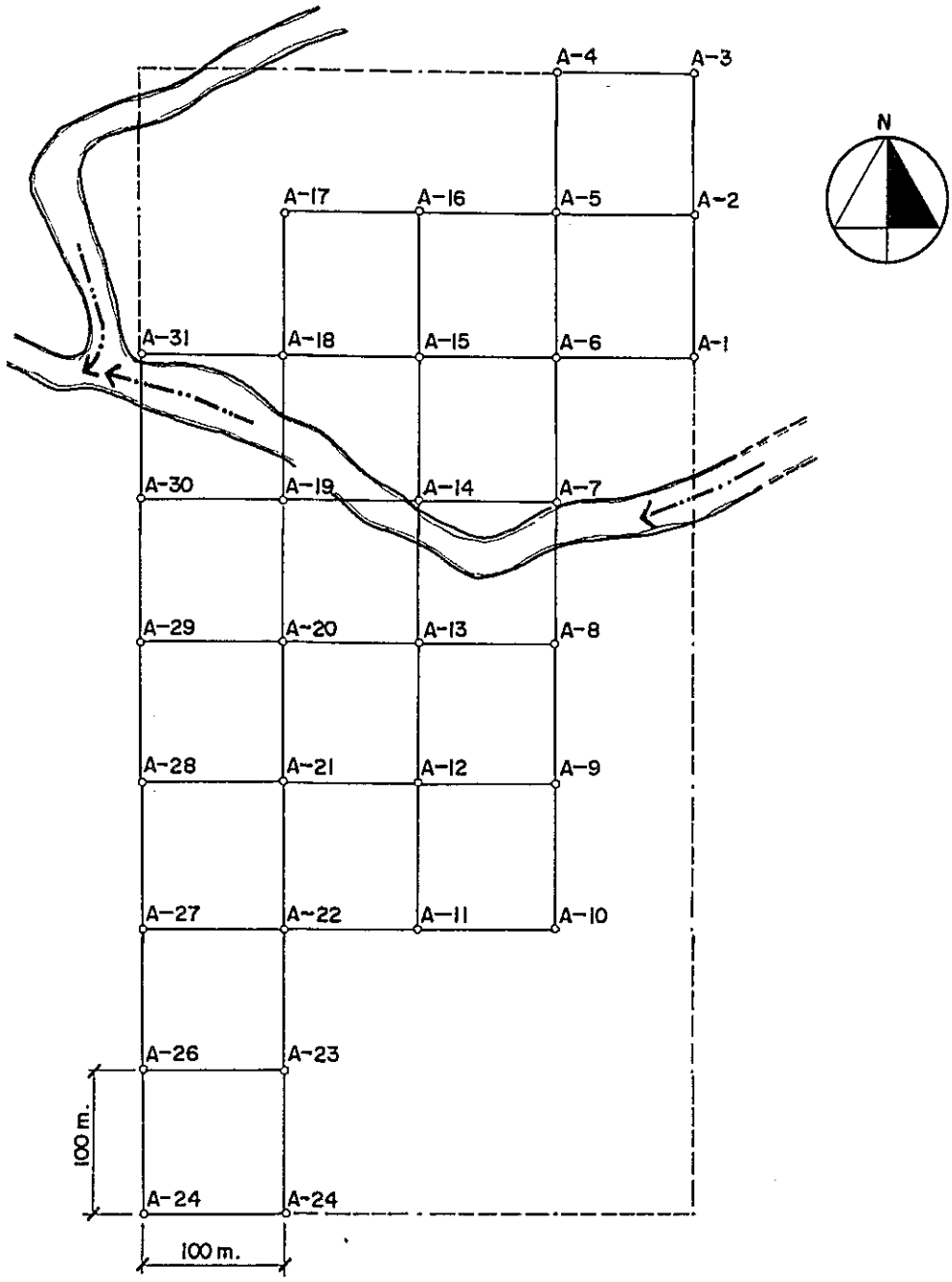


Fig. 1.5 SKETCH MAP OF BORROW AREA (A) OF HUAI SADUANG YAI DAM

0 100 200 300m

SCALE 1 : 5,000

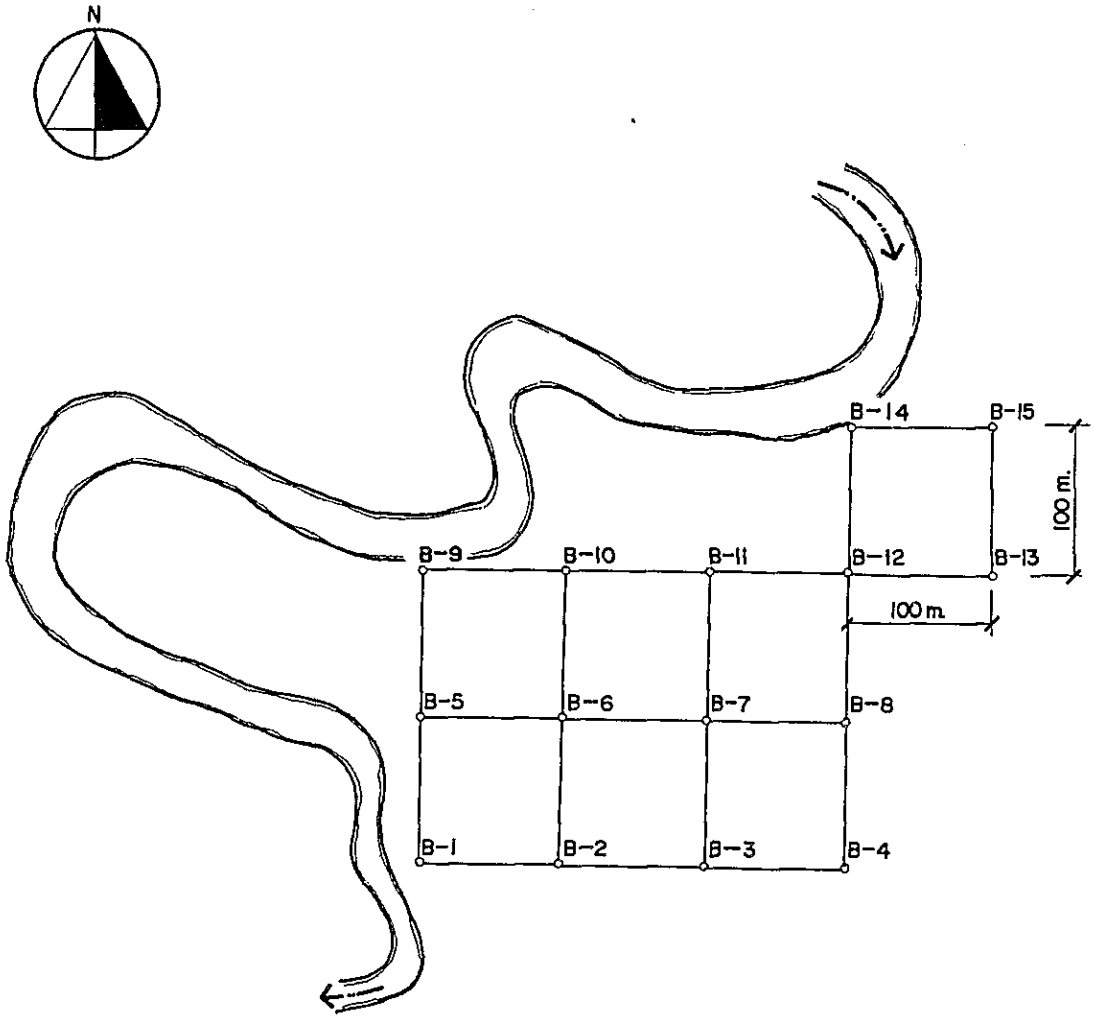


Fig. 1.6 SKETCH MAP OF BORROW AREA (B) OF HUAI SADUANG YAI DAM

0 100 200 300 m

SCALE 1 : 5,000

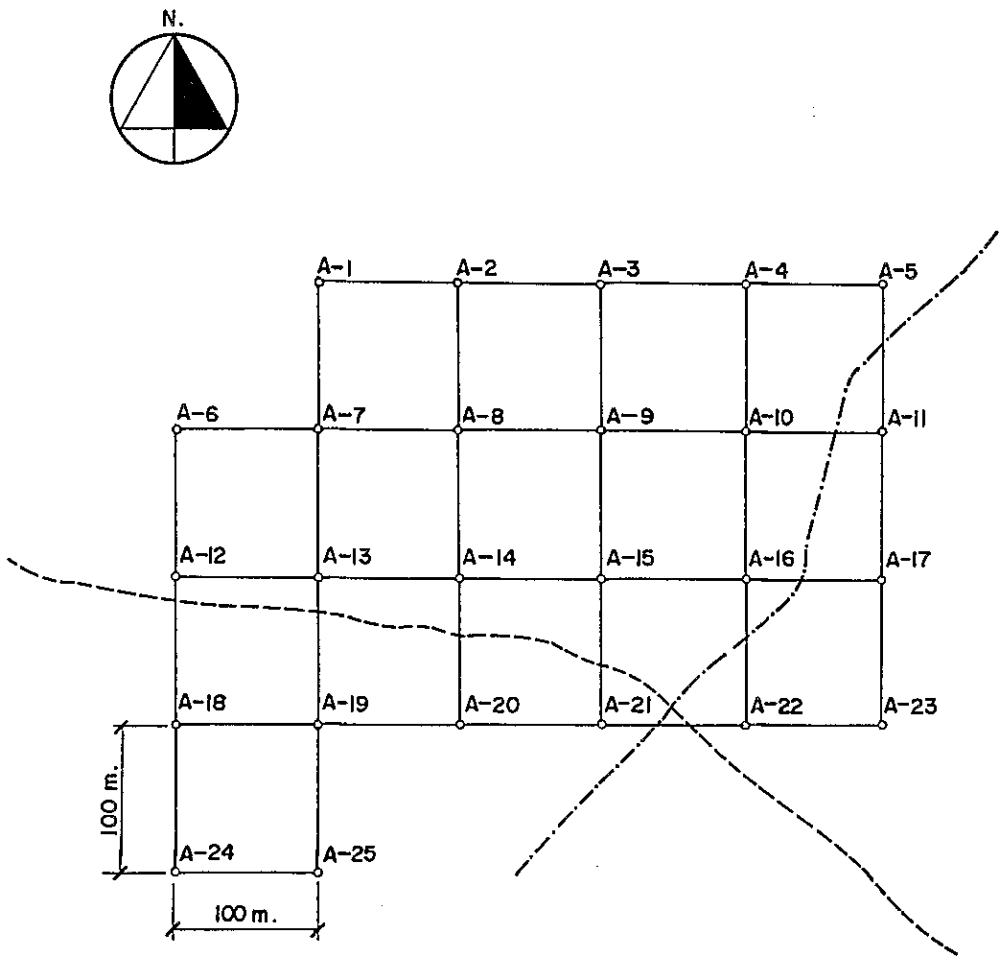


Fig. 1.7 SKETCH MAP OF BORROW AREA (A) OF HUAI KHON KAEN DAM

0 100 200 300 m

SCALE 1 : 5,000

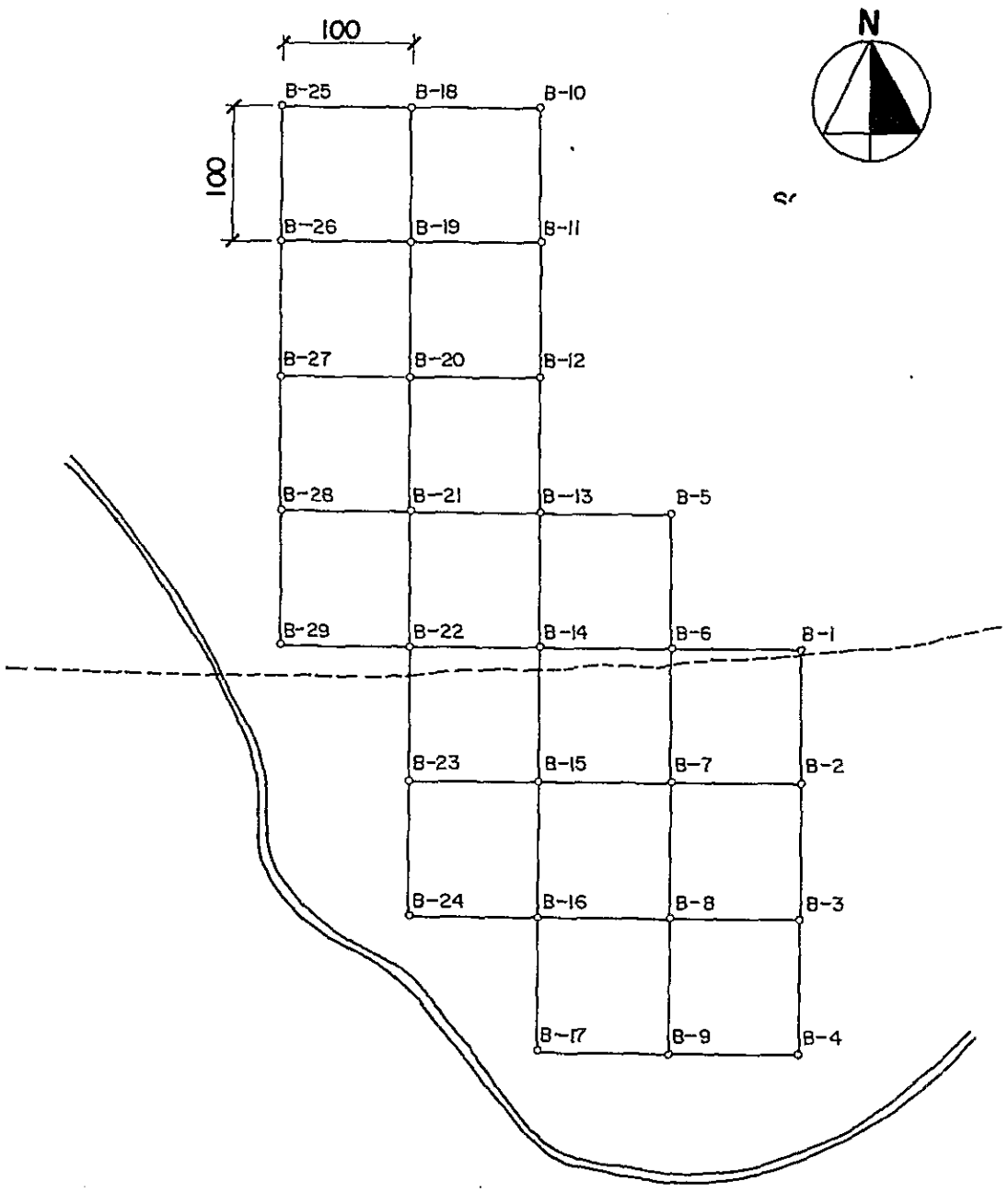


Fig. 1.8 SKETCH MAP OF BORROW AREA (B) OF HUAI KHON KAEN DAM

0 150 300 450 m

SCALE 1 : 7,500

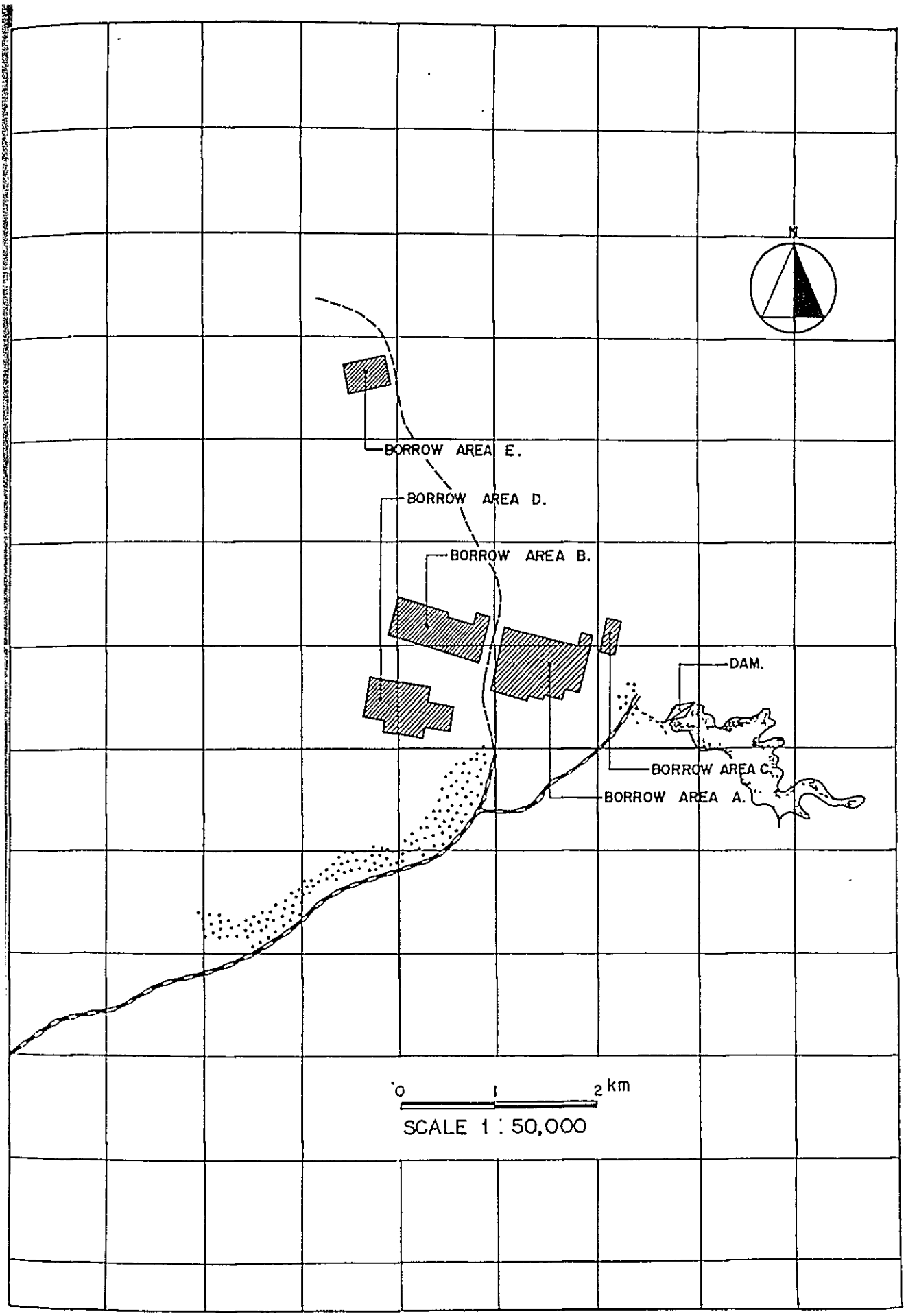


Fig. 1.9 LOCATION MAP OF BORROW AREA OF HUAI YAI DAM

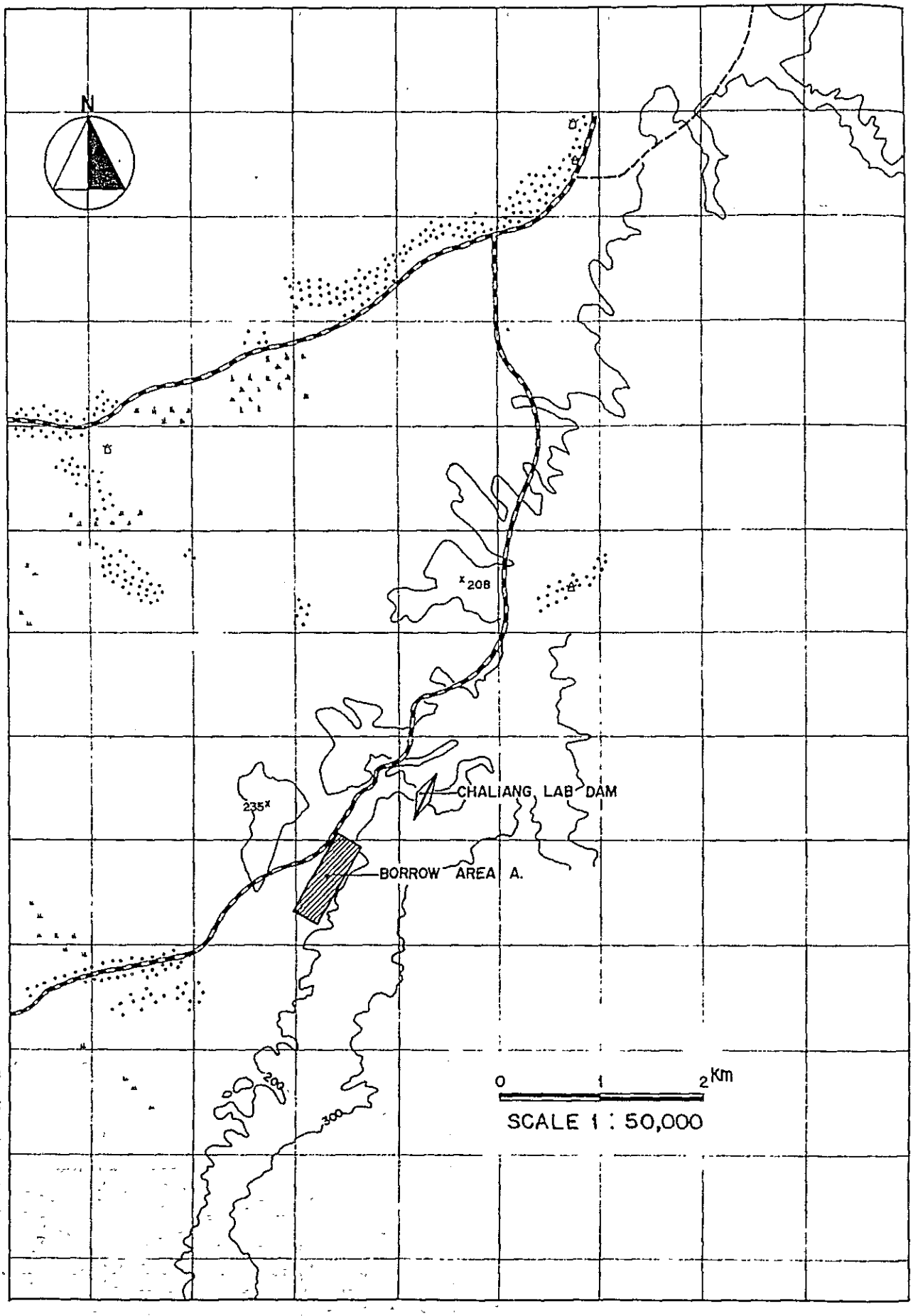


Fig. 1.10 LOCATION MAP OF BORROW AREA OF KHLONG CHALIANG LAB DAM

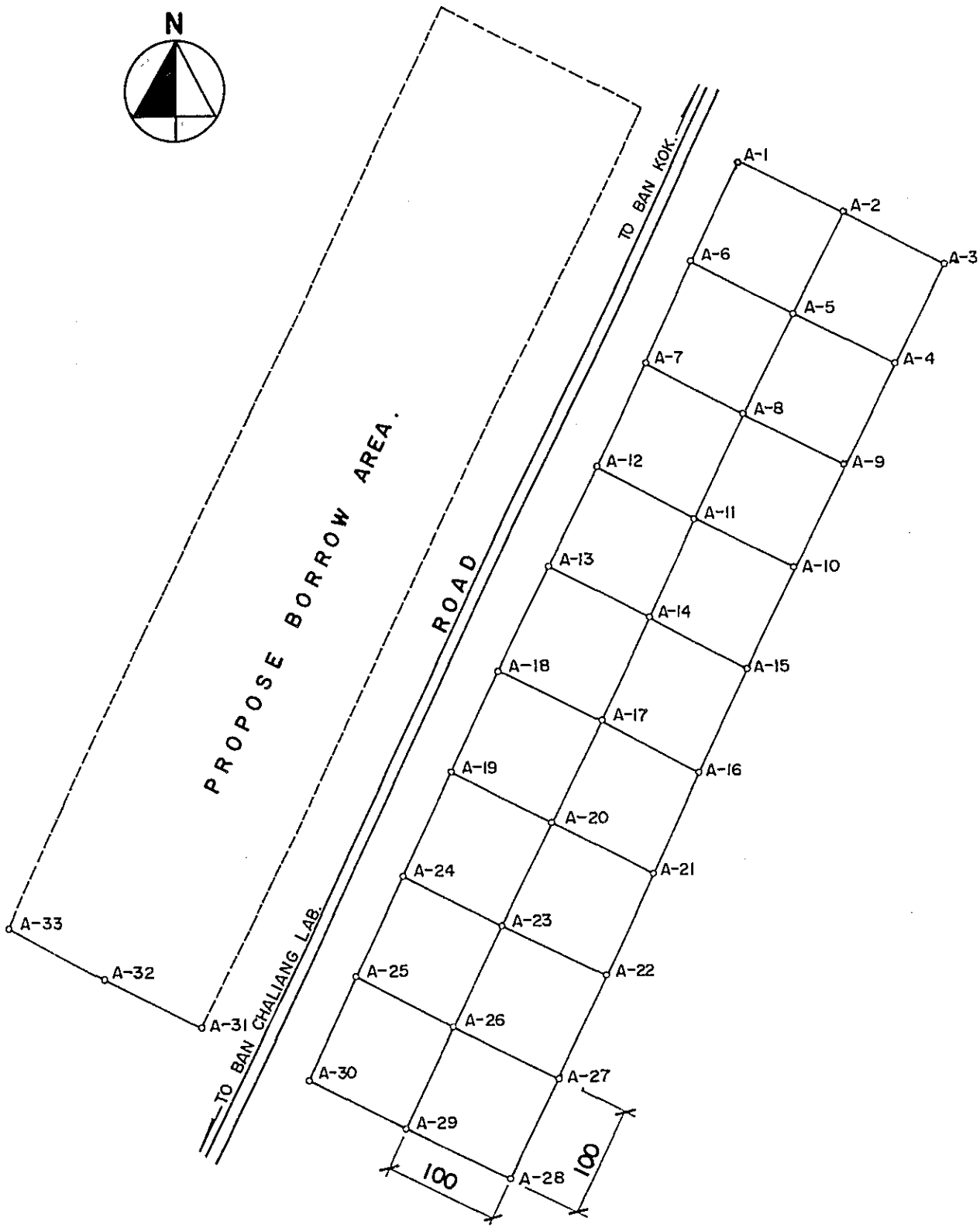


Fig. 1.11 SKETCH MAP OF BORROW AREA (A) OF KHLONG CHALIANG LAB DAM

0 100 200 300m

SCALE 1 : 5,000

ANNEX II

HYDROLOGY

ANNEX II HYDROLOGY

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2.1 DATA AVAILABLE

2.1.1 Rainfall Data

Rainfall stations in upper Pasak Valley are located at Ban Sila, Kaeng Sida, Lom Sak and Phetchabun, as shown in Fig. 2.1. Ban Sila and Kaeng Sida rainfall stations are operated by NEA, and Lom San and Phetchabun stations are managed by RID. The location and observation period of each station are summarized as shown below.

Name of Station	Location		Observation Period
	Latitude	Longitude	
Ban Sila	17°01'	101°19'	1963, Apr. - 1978, Dec.
Kaeng Sida	16°54'	101°20'	1963, Feb. - 1978, Dec.
Lom Sak	16°47'	101°15'	1952, Apr. - 1978, Mar.
Phetchabun	16°25'	101°09'	1952, Apr. - 1978, Mar.

As illustrated in Fig. 2.1, four rainfall stations are located at relatively lowlying plain of the Pasak river. No rainfall data are available in the mountainous ranges of watersheds. These rainfall stations have monthly or daily rainfall records. But, no hourly rainfall data are available in and around projects areas.

Monthly rainfall records of each station are given in Table 2.1. Daily rainfall records of Lom Sak and Phetchabun stations are attached in Data Book.

2.1.2 Meteorological Data

As meteorological data other than rainfall, Phetchabun meteorological station is applied for the study, which station is located at the Phetchabun Municipality, in latitude 16°26' north and longitude 101°09'E. This station provides meteorological data, i.e. temperature, relative humidity, dew point, evaporation, cloudiness, wind velocity, sunshine duration, and so on. These data are obtained from Meteorological Department and summarized in Table 2.2.

2.1.3 Runoff Data

No runoff data are available at all in the tributaries relevant to the projects. But, in the mainstream of the Pasak, there exist two water gauging sites; one is located at Kaeng Sida covering the drainage area of 836 km^2 and operated by NEA, and the other is located at the diversion weir of Pasak Left Bank Irrigation Project, which covers the drainage area of 1,007 km^2 and is operated by RID. These water gauging sites are illustrated in Fig. 2.1.

Annual runoff records of the two gauging sites are given in Table 2.3.

2.2 WATER RESOURCES

2.2.1 Water Sources

Four proposed projects would depend their water resources on the tributaries of the Pasak which is one of the major tributaries of the Chao Phraya. The water sources and the characteristics of the drainage areas are as follows.

Huai Saduang Yai

The Huai Saduang Yai, a small tributary of the Pasak river, originates in the Mt. Phykok, Pnu and Bukpaen of about 700 m or so in altitude, and drifts down about 30 km from east to west to join the main reach of the Pasak river at about 1.5 km upstream from the confluence of the Pasak river in the vicinity of the Fung Dorn village.

The total watershed of this tributary extends over about 96 km^2 at the proposed dam site which is located at about 1.5 km upstream from the confluence of the mainstream of the Pasak river. The river channel totals about 28.5 km stretching from its origin to dam site. The river-bed gradient is relatively steep in the vicinity of the proposed dam site. No water gauging station has been installed so far in the watershed. No data are available on runoff at all.

Huai Khon Kaen

The Huai Khon Kaen, the largest tributary among the four selected water sources, originates in the ranges of Mt. Huai Koh, Huai Hi, Pu Mok, Pu Nam Rin, Pa Lob, etc., 900 m above MSL, locating in due east of the Lom Sak municipality. It meanders about 72 km westward to join the mainstream of the Pasak river at the left bank, at about 24 km downstream from the Upper Pasak diversion weir.

The watershed of the tributary is located at due south of the Huai Saduang Yai watershed, extending to about 322 km^2 at the proposed dam site which is proposed at about 19.5 km upstream from the confluence of the Pasak river. The river channel totals about 53 km stretching out from its origin to the proposed dam site. The river-bed gradient is relatively steep in the vicinity of the proposed dam site. The watershed is relatively better reserved even though sporadic land reclamation has been recently made by farmers for shifting farming in the hillside. No water gauging station has been installed so far in the watershed and no data are available on runoff at the dam site.

Huai Yai

The Huai Yai originates in the ranges of Mt. Hingumn, Ponthong, Suiroi, Saliang Tatard, etc. of about 1,200 m in altitude and drifts down about 47 km from northeast to southwestward joining many small rivulets, and debounches into the main reach of the Pasak river in the vicinity of the Phetchabun municipality.

The watershed of the tributary is located at due east of the Phetchabun municipality, extend over about 78 km^2 at the dam site which is proposed at about 25 km upstream from the confluence of the Pasak river. The river channel totals about 47 km stretching from its origin to the confluence of the Pasak river. The river-bed gradient is rather steep in the vicinity of the proposed dam site. Water and soils in the watershed are likely to be relatively better reserved.

Khlong Chaliang Lab

The Khlong Chaliang Lab originates in the ranges of Mt. None Yang, Huai Rong, None Sra, Ta Boh, etc. of about 1,300 m in altitude and meanders about 54 km from southeast to northwest joining many small rivulets and debouches into flat fan. Then, it splits into many distributaries developed across the fan.

The watershed of this tributary is located in due south of the Huai Yai watershed, extending to about 77 km^2 at the dam site which would be proposed at about 27.5 km upstream from the confluence with the Pasak river. The river channel of about 54 km stretches out its origin to the said confluence; about 26 km from its origin to the proposed dam site. The river-bed gradient is rather steep in the vicinity of the proposed dam site.

The water sources and the drainage areas of respective projects are as tabulated below.

Name of Project	Water Source	Drainage Area
Huai Saduang Yai Project	Huai Saduang Yai	96 km^2
Huai Khon Kaen Project	Huai Khon Kaen	322 km^2
Huai Yai Project	Huai Yai	78 km^2
Khlong Chaliang Lab Project	Khlong Chaliang Lab	77 km^2

The watershed of each tributary is illustrated in Fig. 2.2.

2.2.2 Characteristics of Rainfall in the Project Area

There exist four rainfall stations, namely Ban Sila, Kaeng Sida, Lom Sak and Phetchabun, as mentioned before. Among four rainfall records, Lom Sak rainfall records would be applied for the rainfall analysis in the Huai Saduang Yai and the Huai Khon Kaen watersheds, since no rainfall records have been obtained in these watersheds. For a similar reason, Phetchabun rainfall records would be applied in the Huai Yai and the Khlong Chaliang Lab watershed as tabulated below.

Project	Applied Rainfall Station
Huai Saduang Yai Project	Lom Sak Station
Huai Khon Kaen Project	"
Huai Yai Project	Phetchabun Station
Khlong Chaliang Lab Project	"

These applied rainfall data surely bring about conservative results for water resources development and irrigation planning since the basin rainfall in the hilly watershed is generally greater than that in the lowlying plain.

(1) Probable Annual Rainfall

To obtain probable rainfall in both drought year and pluvious year, two theoretical methods, i.e. Gumbel and Iwai, are applied and then, the results are cross-checked by the Thomas platting. The estimated annual rainfalls of respective recurrences are as follows.

Non-Excess Probability (Drought Year)

Recurrences (%)	Probable Annual Rainfall at Lom Sak	Probable Annual Rainfall at Phetchabun
10	787	868
20	885	938
50	1,040	1,040

Excess Probability (Pluvious Year)

Recurrences (%)	Probable Annual Rainfall at Lom Sak	Probable Annual Rainfall at Phetchabun
10	1,494	1,388
20	1,340	1,276

Calculation results of respective methods are given in Table 2.5.

(2) Rainfall Distribution

Monthly rainfall distributions of droughty years are estimated from "Rainfall and Evaporation Analysis of Thailand" issued by The Asian Institute of Technology (AIT), as given in Table 2.6. The distribution pattern of each probability is cross-checked by Gumbel and Iwai methods based on the rainfall records for 26 years. Comparing these two distributions, there is almost no difference as illustrated in Fig. 2.3.

Monthly rainfall distributions of pluvious years are estimated by Gumbel and Iwai methods. Monthly distributions of respective probabilities are given in Table 2.7 and Fig. 2.3.

Probable monthly rainfalls are estimated based on the probable annual rainfall and rainfall distribution, and the results are shown in Table 2.8. About 90% of the annual rainfall concentrates in rainy season from May to October, and in September monthly rainfall indicates a peak to be 20%.

2.2.3 Assessment of Endowed Water Resources

Monthly runoffs of respective tributaries are estimated based on the monthly rainfalls since no runoff data are available in tributaries. The estimates are made as follows.

(a) Estimate monthly runoff coefficients

(b) Calculate monthly runoff by multiplying monthly rainfalls by monthly runoff coefficient

(c) Calculate annual runoffs and annual runoff coefficients

(d) Cross-check by annual runoff coefficient and average yield of runoff of the Pasak at Kaeng Sida and the weir site of the Pasak Left Bank Irrigation Project

(e) Cross-check by use of the runoff yield map prepared by RID

The details for the above are explained hereinafter.

(1) Monthly Runoff Coefficient

Monthly runoff coefficient in this analysis is defined as the following equation:

$$Cm = \frac{Rfm}{Rnm}$$

where, Cm : Monthly runoff coefficient
Rfm: Monthly runoff
Rnm: Monthly rainfall

Monthly runoff coefficients are estimated by applying "Estimate of Runoff Coefficient Chart" authorized by RID. This chart has been made based on the observations of runoffs and rainfalls in various kinds of terrain conditions in Thailand, as shown in Fig. 2.4. In this chart there are five types of terrain conditions. In selecting the type, B type is chosen in due consideration of the terrain conditions of the respective watersheds.

(2) Monthly Runoff

Monthly runoffs at respective dam sites are estimated based on the monthly rainfalls and monthly runoff coefficients. Monthly rainfall record of Lom Sak rainfall station is applied to Huai Saduang Yai and Huai Khon Kaen areas, and that of Phetchabun rainfall station is applied to Huai Yai and Khlong Chaliang Lab areas.

Respective monthly runoffs are calculated by multiplying monthly rainfalls by runoff coefficients, and the results are given in Table 2.9 for each probability.

(3) Annual Runoff and Annual Runoff Coefficient

Annual runoffs at respective dam sites are calculated by summing up monthly runoffs and are summarized in Table 2.10. Annual runoff coefficients and average yield of runoff are tabulated as follows.

Probability	Huai Saduang Yai & Huai Khon Kaen		Huai Yai & Khlong Chaliang Lab	
	Runoff Coefficient (%)	Average Yield of Runoff (ℓ/s/km^2)	Runoff Coefficient (%)	Average Yield of Runoff (ℓ/s/km^2)
Non-Excess				
10%	23.3	5.8	26.3	7.2
20%	24.9	7.0	26.1	7.8
50%	26.0	8.6	26.3	8.7
Excess				
10%	30.7	14.5	28.4	12.5
20%	29.1	12.3	27.7	11.2

As shown in the above table in an ordinary year (probability: 50%), runoff coefficient and average yield of runoff are about 26.2% and 8.7 ℓ/s/km^2.

(4) Cross-Check by Observed Annual Runoff

There exist two stream gauging stations in the Pasak river. One is Kaen Sida and the other is Pasak Left Bank Weir. Annual runoff coefficients at the two gauging stations are calculated based on the rainfalls of Ban Sila station and Kaeng Sida station, applying the following Thiessen weight.

Gauging Station	Rainfall Station	Thiessen Weight
Kaeng Sida	Ban Sila	100 (%)
Pasak Left Bank Weir	Ban Sila	75
	Kaeng Sida	25

Calculation results are given in Table 2.11. Annual runoff coefficients at Kaeng Sida gauging station vary from 9% to 25% and the average is 20%. While, annual runoff coefficients at Pasak Left Bank Weir vary from 13% to 36% and the average is 27%.

Annual average yield of runoff at Kaeng Sida station vary from 3.9 ℓ/s/km^2 to 11.0 ℓ/s/km^2 and the average is 7.7 ℓ/s/km^2. While, annual average yield of runoff at Pasak Left Bank Weir vary from 4.8 ℓ/s/km^2 to 17.4 ℓ/s/km^2 and the average is 9.8 ℓ/s/km^2 as shown in Table 2.11.

Estimated runoff coefficients (26.2%) is in this range between 20% and 27% and estimated average yield of runoff (8.7 ℓ/s/km^2) is also in this range between 7.7 ℓ/s/km^2 and 9.7 ℓ/s/km^2.

(5) Cross-Check by "Average Yield of Runoff Map"

"Average Yield of Runoff Map" is developed by RID as shown in Fig. 2.5. According to this map, average yield of runoff of four watersheds is in range between 10 ℓ/s/km^2 and 5 ℓ/s/km^2. Estimated average yield of runoff (8.7 ℓ/s/km^2) is in this range.

2.3 FLOOD

2.3.1 Probable Maximum Daily Rainfall

Annual maximum daily rainfall data picked out from Lom Sak and Phetchabun stations are applied to the estimate of probable daily rainfalls, which are made by Gumbel, Iwai and Thomas-plotting method. Calculation results are given in Table 2.12 and are summarized as follows.

Return Period (year)	Probable Daily Rainfall	
	Lom Sak St.	Phetchabun St.
500	275 mm	197 mm
100	218	164
50	196	150
30	182	140
10	146	116

2.3.2 Rainfall Intensity

Rainfall Intensity within a certain time is estimated by the following empirical formula.

$$It = \frac{R_{24}}{24} \left(\frac{24}{t}\right)^n$$

where, It : Rainfall intensity (mm/hour)

R_{24}: Daily rainfall (mm/day)

t : Rainfall duration (hour)

n : Coefficient (n = 0.815)

Coefficient (n) is estimated to be 0.815 by "Intensity-Duration Curve of Maximum Daily Rainfall" prepared by the Meteorological Department, illustrated in Fig. 2.6. Estimated intensity of 100-year return period are given in Table 2.13 with derived intensity from "Intensity-Duration Curve".

2.3.3 Flood in 100-Year Return Period

Synthesis hydrograph method by Snyder is adopted to estimate the flood. The Synder method is as follows.

(a) Estimate concentration time

(b) Estimate peak discharge of unit hydrograph

(c) Estimate runoff duration of unit hydrograph

(d) Estimate hourly rainfall distribution

(e) Estimate base flow of flood

(f) Estimate the flood

The details for the above are explained hereinafter.

(1) Concentration Time

Concentration time is determined by the condition of watersheds. Synder explains it as follows.

$$Tp = 0.75\ Ct(L \cdot Lc)^{0.3}$$

where, Tp : Concentration time (hour)
L : River length from origin (km)
Lc : River length from the center of watershed (km)
Ct : Snyder's coefficient (Ct = 1.8)

Unit time of rainfall in unit hydrograph is explained by following formula.

$$Tr = Tp/5.5$$

where, Tr : Unit time (hour)

(2) Peak Discharge of Unit Hydrograph

Peak discharge for 1.0 mm of excess rainfall is expressed as follows.

$$q_p = 0.275\ Cp \cdot A/Tp$$

where, q_p : Peak discharge (m^3/sec)
A : Drainage area (km^2)
Cp : Snyder's coefficient (Cp = 0.56)

(3) Runoff Duration of Unit Hydrograph

Runoff duration is expressed as follows.

$$Tb = 2 \cdot A/3.6 \cdot q_p$$

where, Tb : Runoff duration (hour)

Calculation results, i.e. concentration time (Tp), unit time of rainfall (Tr), peak discharge (q_p) and runoff duration (Tb) of unit hydrograph, are shown in Table 2.14. Based on the above results, unit hydrographs at respective dam sites are illustrated in Fig. 2.7 and are tabulated in Table 2.15.

(4) Hourly Rainfall Distribution

Hourly rainfall distributions are estimated as a central concentrated pattern, shown in Fig. 2.8. Hourly rainfalls are calculated in Table 2.16, based on the rainfall intensity formula abovementioned.

Effective rainfall for runoff is calculated by multiplying rainfall by runoff coefficient. Runoff coefficients are calculated by the following formula, and shown in Fig. 2.9.

$$C = 3.6 \times 10^{-2} R^{1.5}, \quad R \leqq 100 \text{ mm}$$

$$C = [(R-64)/R] \times 100, \quad R > 100 \text{ mm}$$

where, C : Accumulated runoff coefficient (%)

R : Accumulated rainfall (mm)

Calculation results are given in Table 2.17.

(5) Base Flow in Flood

Floods in the upper Pasak Valley happen generally in August and September. Base flow is considered to be the average discharge in these two months for the safety side. Specific discharges in these months are calculated, based on the estimated runoffs in the previous section.

Specific discharges for respective probabilities are plotted in Fig. 2.10. Probable base flow at each dam site is given in Table 2.18.

(6) Flood in 100-Year Return Period

Hydrograph of the flood is made by the unit hydrograph, effective rainfall and base flow, and the result is illustrated in Fig. 2.11. Peak discharges and specific discharges of respective probabilities are summarized as follows.

Area	Huai Saduang Yai	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
Peak Discharge (m^3/s)	268.4	697.4	168.4	149.9
Specific Discharge ($m^3/s/km^2$)	2.8	2.2	2.2	1.9

2.3.4 Flood in 500-Year Return Period

Rational formula as presented below is applied for estimate of the peak discharge.

$$Q = \frac{1}{3.6} \cdot C \cdot I \cdot A$$

where, Q : Peak discharge (m^3/sec)

C : Coefficient of runoff

I : Rainfall intensity within flood concentration time (mm/hr)

A : Drainage area (km^2)

In the above formula, flood concentration time and rainfall intensity are calculated by the same method of the estimate of the flood in 100-year return period and summarized as follows.

	Huai Saduang Yai	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
Daily rainfall (mm/day)	275	275	197	197
Concentration Time (hour)	9	12	7	8
Rainfall Intensity (mm/hour)	25.5	20.2	22.4	20.1

Coefficients of runoff is variable according to magnitude of flooding, rainfall intensity and concentration time. In this case the coefficient is assumed at 1.1 times as that of the flood in 100-year return period. Peak runoff coefficients of the floods in 100-year return period are mentioned in Table 2.19.

Calculation results are given in Table 2.20 and summarized as follows.

	Huai Saduang Yai	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
Area (km^2)	96	322	78	77
Peak Discharge (m^3/s)	354	940	218	193
Specific Discharge ($m^3/s/km^2$)	3.7	2.9	2.8	2.5

2.3.5 Cross-Check by Design Discharge of Existing Projects

The estimated specific discharges are cross-checked by those of the existing dams constructed in Thailand as tabulated below.

Project	Drainage Area (km^2)	Specific Discharge Return Period 100-Year ($m^3/s/km^2$)	500-Year ($m^3/s/km^2$)	Location
		-- Existing Projects --		
Me Kuang	565	2.6	4.1	Chiang Mai
Huay Me Moh	296	2.7	-	Lampang
Lam Nam Oon	1,100	1.3	1.6	Sakon Nakhon
Padaeng	81	2.0	2.6	Phetchabun
		-- Proposed Projects --		
Huai Saduang Yai	96	2.8	3.7	Lom Sak
Huai Khon Kaen	322	2.2	2.9	Lom Sak
Huai Yai	78	2.2	2.8	Phetchabun
Khlong Chaliang Lab	77	1.9	2.5	Phetchabun

Specific peak discharge is generally variable, depending on the shape of watershed and topo-condition, rainfall intensity and so on. But, estimated specific discharges are almost in the range of those of existing projects.

2.3.6 Flood Control

Flood control effects of respective dams are estimated, though the dams are proposed mainly for irrigation purpose. Calculation process in as follows.

$$S_t = S_{t-1} + Q_{tave} \cdot t - O_t \cdot t$$

$$O_t = C \cdot B \cdot (H_{t-1})^{3/2}$$

where, S_t : Dam storage at time (t)
S_{t-1} : Dam storage at time (t-1)
Q_{tave}: $(Q_t + Q_{t-1})/2$
Q_t : Inflow discharge at time (t)
Q_{t-1} : Inflow discharge at time (t-1)
t : Unit time
O_t : Out-spill discharge at time (t-1)

C : Over-flow coefficient (C = 1.84)

B : Crest length of spillway

H_{t-1} : Over-flow depth of time (t-1)

Dimensions of spillways and mass curves of respective dams are mentioned in Annex III. Floods of 10-year, 30-year and 50-year return period are applied to the calculations abovementioned. Inflow discharge of each probability is estimated by the Snyder's method, as well as the flood of 100-year return period, and hydrographs are illustrated in Fig. 2.12. Computed results are given in Table 2.21 and summarized as tabulated below.

Dam	Return Period (year)	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Outflow/Inflow (%)
Huai Saduang Yai	10	139	131	94.3
	30	202	192	95.4
	50	226	217	95.9
Huai Khon Kaen	10	370	367	99.2
	30	534	531	99.6
	50	598	596	99.8
Huai Yai	10	84	76	91.0
	30	126	114	91.1
	50	144	131	91.1
Khlong Chaliang Lab	10	75	75	99.7
	30	113	112	99.7
	50	129	128	99.7

Flood control effects of Huai Khon Kaen and Khlong Chaliang Lab dam are negligible small, indicating 0.2 - 0.8% decrease of peak discharge. While, the effects of Huai Saduang Yai and Huai Yai dam are comparatively bigger than the above two dams, but only 4.1 - 9.0% of peak inflows would be mitigated and cut-off discharges are to be 7.6 - 12.7 m^3/sec.

Table 2.1.(1) Monthly Rainfall Record of Ban Sila Rainfall Station

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1963	-	-	-	128.2	64.1	174.5	242.4	280.6	139.9	112.7	2.2	10.2	-
1964	0.0	0.0	20.3	59.5	189.1	122.0	154.0	225.0	341.0	220.0	4.0	1.3	1,336.2
1965	0.0	59.0	26.0	60.0	248.0	256.0	44.0	275.0	290.0	120.0	72.0	0.0	1,450.0
1966	18.5	12.3	5.4	5.0	301.9	205.1	175.8	461.7	134.0	88.3	12.0	68.7	1,488.7
1967	7.0	31.0	1.2	116.1	90.7	132.6	129.9	247.0	474.1	21.6	9.0	0.0	1,260.2
1968	0.0	0.0	28.0	181.0	245.8	239.8	161.7	125.1	180.7	17.0	0.0	0.0	1,179.1
1969	33.0	0.0	36.3	59.2	94.2	164.5	148.0	158.3	310.0	74.0	0.0	0.0	1,077.5
1970	0.0	12.7	72.0	45.2	133.7	274.2	128.3	396.1	228.0	65.4	2.0	3.2	1,360.8
1971	0.0	0.0	28.0	74.0	161.1	199.1	128.1	136.0	116.0	140.1	25.0	0.0	1,007.4
1972	0.0	0.0	41.0	62.0	91.3	153.1	96.4	236.9	175.7	109.2	22.0	32.5	1,020.1
1973	0.0	0.0	80.5	20.5	133.8	170.0	140.1	156.0	188.6	4.0	0.0	0.0	893.5
1974	1.5	32.3	69.2	76.2	248.5	79.7	182.9	335.8	245.5	39.0	0.0	0.0	1,310.6
1975	38.8	13.0	45.2	34.0	188.8	88.0	197.8	354.6	141.0	93.9	10.0	0.0	1,205.1
1976	0.0	77.5	23.3	100.5	161.1	194.3	317.1	296.6	293.1	88.1	10.5	0.0	1,562.1
1977	0.0	0.0	36.3	36.9	105.8	122.8	103.4	247.8	353.1	28.3	0.0	13.3	1,047.7
1978	0.0	17.5	5.0	45.8	195.0	174.0	262.5	321.4	462.6	53.8	1.1	0.0	1,538.7
Average													1,249.2

Table 2.1.(2) Monthly Rainfall Record of Kaeng Sida Rainfall Station

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1963	-	2.61	53.6	56.2	66.8	151.0	195.8	128.1	207.6	231.4	27.8	3.7	-
1964	5.5	2.8	20.6	60.2	176.2	64.4	206.2	257.7	317.1	218.9	4.5	2.8	1,366.9
1965	0.0	18.0	22.9	115.7	235.8	144.6	154.7	218.4	174.3	57.6	24.2	0.0	1,166.2
1966	11.9	14.7	11.5	11.9	197.2	95.0	136.8	255.1	215.8	69.2	16.0	41.4	1,076.5
1967	2.5	0.8	12.8	102.3	51.7	84.1	221.2	133.1	396.5	37.9	6.4	0.0	1,049.3
1968	0.0	10.4	20.8	154.6	246.9	255.4	161.5	88.1	131.0	37.0	19.2	0.0	1,124.9
1969	36.5	1.1	106.8	38.9	111.7	118.1	169.1	152.6	230.6	73.2	29.0	0.0	1,067.6
1970	0.0	6.0	63.6	99.9	110.6	160.6	71.5	285.0	211.5	109.6	32.8	3.6	1,154.7
1971	0.0	2.6	1.6	15.9	168.0	123.1	-	219.0	121.1	156.1	1.8	4.2	-
1972	0.0	26.6	43.9	116.5	74.9	174.1	118.5	185.8	244.9	80.8	22.5	12.1	1,100.6
1973	0.0	0.0	73.3	27.9	155.0	124.7	186.5	111.3	176.0	18.5	2.7	0.0	875.9
1974	10.9	10.2	20.4	71.0	226.7	137.5	106.9	168.3	131.3	86.1	26.1	0.0	995.4
1975	44.7	16.3	49.1	6.5	192.9	155.7	157.2	327.9	248.0	76.2	28.0	0.0	1,302.5
1976	0.0	79.0	24.3	35.3	188.7	167.3	245.9	314.4	201.3	113.4	8.8	0.0	1,378.4
1977	2.0	0.0	6.7	92.5	98.1	121.6	87.5	197.0	336.4	78.0	0.0	10.7	1,030.5
1978	3.9	34.4	6.2	35.8	200.9	138.2	325.6	217.5	401.8	48.7	0.0	0.0	1,413.0
Average													1,150.2

Table 2.1.(3)-(1) Monthly Rainfall Record of Lom Sak Rainfall Station

(Unit: mm)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1977	66.7	134.8	70.0	127.4	126.9	180.6	43.9	2.6	43.9	2.5	28.0	7.4	834.7
1976	46.6	194.1	135.3	215.3	229.5	183.9	126.5	7.0	0.0	0.4	0.0	57.6	1,196.2
1975	1.9	101.2	124.9	159.9	187.0	178.1	110.8	54.8	0.0	0.0	77.0	4.8	1,000.4
1974	74.8	184.4	137.8	132.1	180.8	101.6	87.3	40.1	0.0	51.9	51.7	39.3	1,081.8
1973	64.1	135.6	136.4	141.8	96.6	138.2	10.1	8.4	0.0	1.0	2.5	57.3	792.0
1972	57.5	81.3	161.4	80.5	211.2	170.8	83.8	16.5	6.7	0.0	0.9	55.2	925.8
1971	6.6	169.5	167.0	108.5	217.5	148.2	84.6	0.3	3.0	0.0	31.6	41.7	978.5
1970	35.1	100.3	245.3	40.5	245.4	184.2	92.9	2.8	18.2	0.4	25.7	43.0	1,041.8
1969	50.3	130.1	69.2	91.2	96.5	296.8	55.7	17.7	0.0	0.3	1.0	126.0	934.8
1968	115.0	300.5	163.4	177.9	115.5	73.2	70.0	0.4	0.0	28.3	3.6	100.4	1,148.2
1967	100.4	68.7	86.2	115.6	114.4	0.0	0.0	0.0	0.0	0.0	0.0	34.7	520.0
1966	22.1	131.7	64.0	49.8	104.2	52.9	82.2	15.9	26.0	0.5	0.0	3.0	552.3
1965	0.0	165.8	173.9	66.8	244.4	193.0	-	0.0	0.0	0.0	0.0	7.6	-
1964	82.7	313.5	98.9	159.8	184.0	244.1	194.4	7.3	0.0	0.0	32.0	16.7	1,333.4
1963	57.0	59.4	268.7	220.6	202.1	212.5	198.8	43.3	21.2	0.0	0.0	0.0	1,283.6
1962	87.0	95.5	122.2	191.5	150.2	371.3	64.6	0.0	0.0	0.0	11.8	133.0	1,227.1
1961	91.2	177.9	155.7	219.0	158.2	327.4	120.1	0.0	3.8	0.0	0.0	1.1	1,254.4

(to be continued)

Table 2.1.(3)-(2) Monthly Rainfall Record of Lom Sak Rainfall Station

(Unit: mm)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1960	14.4	269.4	156.0	84.9	269.6	182.5	81.8	0.0	0.0	0.0	23.8	64.4	1,146.8
1959	87.7	105.6	96.1	197.2	176.2	483.2	0.0	0.0	0.0	2.9	9.8	43.3	1,202.0
1958	76.4	63.1	192.7	164.1	305.6	235.3	100.0	0.0	0.0	0.0	10.3	43.4	1,190.9
1957	78.1	125.9	245.8	263.6	223.8	431.7	81.1	0.0	0.0	31.1	3.5	0.0	1,484.6
1956	171.9	235.0	101.0	200.3	230.7	310.9	75.6	0.0	0.0	0.0	20.3	186.1	1,531.8
1955	151.8	113.2	478.6	89.0	325.9	244.1	14.9	0.0	0.0	0.0	65.6	63.5	1,546.6
1954	3.8	98.8	211.1	126.8	181.1	450.1	83.8	3.6	115.0	0.0	12.3	30.4	1,213.3
1953	105.8	203.0	211.5	166.7	136.2	272.8	51.8	45.9	0.0	0.0	0.0	80.7	1,274.4
1952	36.1	89.4	147.1	177.4	183.6	300.2	124.9	2.0	0.0	28.5	67.7	16.8	1,173.7
Average													1,114.8

Table 2.1.(4)-(1) Monthly Rainfall Record of Phetchabun Rainfall Station

(Unit: mm)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1977	36.6	160.8	108.8	133.1	167.0	189.0	90.4	0.3	17.3	0.0	2.3	38.0	943.6
1976	37.4	230.7	110.3	236.6	300.1	309.0	173.9	16.9	0.0	0.2	0.0	3.2	1,418.3
1975	0.1	152.0	87.9	118.9	213.3	187.2	107.7	6.4	0.0	0.0	17.2	36.3	927.0
1974	57.9	79.2	76.7	136.8	157.0	108.7	135.3	11.5	0.0	58.7	43.7	116.2	981.7
1973	37.7	127.9	139.7	155.8	154.0	331.5	34.1	0.2	0.0	0.3	28.7	2.6	1,012.5
1972	63.3	60.0	228.3	165.5	192.4	115.1	109.4	22.6	3.3	0.0	6.1	65.0	1,031.0
1971	108.2	210.3	65.8	117.0	180.5	123.0	27.7	2.4	2.7	0.0	30.2	18.3	886.1
1970	80.6	142.8	274.1	213.4	252.3	231.8	50.3	3.0	13.0	0.9	24.7	12.3	1,299.2
1969	58.5	92.0	145.0	123.6	165.6	280.7	179.6	0.8	0.0	0.0	0.2	60.1	1,106.1
1968	113.0	182.3	134.1	215.4	55.9	178.9	62.1	17.8	0.0	66.9	0.0	24.7	1,051.1
1967	185.0	199.9	74.4	151.9	149.0	226.5	17.1	16.4	0.0	0.0	10.2	18.3	1,048.7
1966	45.1	214.4	82.6	268.7	260.3	117.7	106.7	26.9	10.4	0.5	5.1	0.3	1,138.7
1965	67.9	83.9	226.6	99.3	255.4	234.4	37.4	19.5	3.4	9.4	13.2	14.0	1,064.4
1964	47.9	284.4	157.0	200.3	282.5	367.3	123.4	12.0	2.0	0.0	25.8	86.2	1,588.8
1963	142.4	142.6	159.5	290.9	343.0	276.9	257.7	63.5	19.1	0.7	0.2	12.9	1,709.4
1962	124.6	124.3	61.7	190.6	248.4	276.3	54.0	23.1	2.1	0.0	7.4	40.8	1,153.3
1961	62.5	197.6	177.5	251.8	243.1	152.9	67.0	0.0	0.0	6.6	0.0	21.0	1,180.0

(to be continued)

Table 2.1.(4)-(2) Monthly Rainfall Record of Phetchabun Rainfall Station

(Unit: mm)

Year	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total
1960	9.0	130.4	63.7	134.9	187.3	105.5	109.3	8.6	0.0	8.1	23.0	28.4	808.2
1959	83.0	239.8	109.3	220.4	108.2	442.3	34.4	23.4	0.0	3.0	0.3	42.7	1,306.8
1958	36.4	86.3	156.3	255.7	186.7	209.3	55.4	0.0	0.0	0.0	33.1	78.3	1,097.5
1957	74.1	91.6	144.2	96.2	215.1	227.7	112.1	0.0	0.0	102.9	23.6	43.7	1,131.2
1956	38.8	152.7	141.5	219.7	154.5	291.5	52.5	2.5	0.0	0.0	12.9	125.3	1,191.9
1955	67.1	85.4	113.0	78.6	127.5	288.8	15.1	0.0	0.0	0.0	37.1	2.8	815.4
1954	25.0	217.3	143.2	64.5	348.9	324.1	81.8	17.6	0.0	0.0	10.4	48.4	1,281.2
1953	93.4	96.5	175.9	173.1	77.0	161.3	114.2	24.1	0.0	0.7	0.0	39.2	955.4
1952	18.2	192.3	237.2	77.0	172.1	128.4	70.0	2.0	0.0	21.1	77.2	30.9	1,026.4
Average													1,121.3

Table 2.2 Meteorological Data

Station PHETCHABUN
Index Station 48 379
Latitude 16°26' N.
Longitude 101°09' E.

Elevation of station above MSL. 117.93 meters
Height of varometer above MSL. 119.24 meters
Height of thermometer above ground 1.40 meters
Height of wind vane above ground 11.43 meters
Height of raingauge 1.25 meters

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Pressure (+1,000 or 900 mbs.) (1953 - 1975)													
Mean	13.50	11.46	09.78	08.09	06.44	05.55	05.91	05.75	07.09	10.28	12.83	13.76	09.19
Ext. Max.	28.84	24.57	23.31	19.05	15.87	13.07	18.90	14.80	15.87	19.07	22.84	24.92	28.84
Ext. Min.	03.70	01.54	99.79	97.85	97.78	95.94	94.37	96.53	94.10	93.89	03.37	02.99	93.89
Mean daily range	5.63	6.01	6.08	5.76	4.97	4.13	3.96	4.08	4.57	4.94	4.78	5.15	5.01
Temperature (°C) (1951 - 1975)													
Mean	24.7	27.3	28.2	30.9	29.8	28.7	28.0	27.5	27.4	27.4	26.1	24.5	27.6
Mean Max.	32.0	34.2	36.2	37.3	35.2	33.0	32.0	31.5	31.8	32.4	31.9	31.3	33.2
Mean Min.	14.7	17.9	21.0	23.2	24.0	23.8	23.4	23.4	23.3	22.0	18.8	15.5	21.0
Ext. Max.	38.9	39.1	40.6	43.0	42.4	40.0	36.5	36.7	36.3	36.5	36.4	36.0	43.0
Ext. Min.	2.0	9.5	11.0	13.5	20.7	21.4	20.6	21.0	18.3	15.4	7.5	5.1	2.0
Relative Humidity (%) (1951 - 1975)													
Mean	62.0	60.0	60.0	62.0	72.0	78.0	81.0	83.0	84.0	78.0	71.0	64.0	71.0
Mean Max.	91.0	88.7	87.5	87.0	91.7	94.2	95.3	96.2	96.7	95.3	92.8	92.3	92.4
Mean Min.	41.6	39.7	40.3	42.5	55.1	64.3	67.5	70.3	70.1	61.7	52.4	44.3	54.2
Ext. Min.	16.0	17.0	19.0	21.0	29.0	40.0	46.0	46.0	41.0	35.0	19.0	17.0	16.0
Dew Point (°C) (1951 - 1975)													
Mean	16.0	17.8	20.2	22.0	23.8	24.3	24.2	24.2	24.3	23.0	20.0	16.6	21.4
Evaporation (mm) (1957 - 1975)													
Mean-Piché	92.4	95.9	117.5	115.7	82.3	58.1	49.7	42.3	36.7	51.0	66.2	82.1	889.9
Cloudiness (0 - 8) (1951 - 1975)													
Mean	3.0	3.2	3.4	4.0	5.9	6.9	7.1	7.3	6.9	5.2	3.9	3.0	5.0
Wind (Knots) (1951 - 1975)													
Prevailing Wind	N	S	S	S	S	S	S	S	S	N	N	N	-
Mean Wind Speed	3.6	3.5	4.1	4.6	4.2	4.4	4.4	4.2	3.2	3.7	4.1	4.1	-
Max. Wind Speed	18N,NW	30SW	50N	46N	45S,W	22S	24S	22S	20S	25NE	20N	18N	-
Sunshine Duration (1976-1981)													
Mean	8.00	7.44	7.99	7.92	6.62	4.98	4.28	3.45	4.22	6.89	8.54	8.24	6.54
Number of Days with (1951 - 1975)													
Haze	17.4	21.6	23.1	13.8	1.2	0.7	0.1	0.3	0.6	3.6	7.0	11.5	100.9
Fog	10.6	8.6	5.2	2.9	0.8	0.6	0.8	1.2	2.3	6.6	8.1	8.7	56.4
Hail	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Thunderstorm	0.5	1.4	5.6	11.4	13.4	6.9	5.6	5.9	7.8	6.4	1.3	0.1	66.3
Squall	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 2.3 Observed Annual Runoff

(Unit: $10^3 m^3$)

Year	Annual Runoff at Kaeng Sida	Annual Runoff at Pasak Left Bank
1964	254,478	-
65	271,282	-
66	246,871	-
67	123,477	-
68	141,535	-
69	210,338	-
70	275,462	-
71	191,026	302,756
72	182,917	226,486
73	117,040	152,551
74	104,082	158,580
75	200,724	420,232
76	273,456	552,138
77	215,270	356,820
78	-	928,203
79	-	261,399
80	-	357,544

Table 2.4 Observed Monthly Runoff

(Pasak Left Bank Weir Site)

(Unit: 10^3m^3)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1970	-	-	-	-	489	7,737	30,482	182,779	115,928	29,990	9,708	0
1971	1,639	1,410	0	465	596	21,085	32,334	37,239	116,203	76,055	9,994	5,736
1972	2,751	294	550	3,461	252	18,421	11,675	36,565	53,606	85,629	9,021	4,262
1973	7,772	1,327	2,838	534	3,757	15,287	22,066	15,226	53,767	22,090	6,446	1,441
1974	1,324	459	0	687	10,638	953	1,842	56,708	51,138	25,464	9,367	0
1975	1,430	112	0	0	0	22,254	29,554	128,120	168,702	61,788	8,272	0
1976	5,688	3,656	0	0	9,196	18,188	11,253	144,028	211,632	124,241	24,258	0
1977	0	0	0	3,343	5,287	5,711	5,219	26,928	297,406	12,925	0	0
1978	0	0	0	0	0	0	64,821	339,453	414,459	109,471	0	0
1979	3,330	1,942	0	0	0	67,961	12,791	138,053	24,858	8,830	3,634	0
1980	0	0	0	0	0	68,220	30,542	63,213	162,463	33,107	0	0
1981	0	0	0	0	0	13,686	84,129	158,849	-	-	-	-

Table 2.5 Probable Annual Rainfall

(Unit: mm/year)

	Gumbel	Iwai	Thomas	Average Rainfall
Lom Sak				
1. Non-Excess Probability				
10%	796	763	803	787
20%	880	860	914	885
50%	905	1,080	1,137	1,040
2. Excess Probability				
10%	1,516	1,528	1,438	1,494
20%	1,341	1,356	1,322	1,340
Phetchabun				
1. Non-Excess Probability				
10%	858	883	863	868
20%	927	946	942	938
50%	948	1,091	1,093	1,044
2. Excess Probability				
10%	1,453	1,399	1,312	1,388
20%	1,308	1,280	1,239	1,276

Table 2.6 Monthly Rainfall Distribution of Droughty Year

(By AIT)

(Unit: %)

	Lom Sak			Phetchabun		
	Non-excess Probability			Non-excess Probability		
	50%	20%	10%	50%	20%	10%
Jan.	0.4	0.05	0.0	0.5	0.1	0.0
Feb.	0.7	0.2	0.1	1.1	0.7	0.4
Mar.	3.5	2.1	1.5	2.8	1.8	1.3
Apr.	5.3	4.2	3.4	5.1	4.0	3.3
May	14.8	15.2	15.9	13.3	13.1	12.7
Jun.	15.8	17.1	18.1	11.9	11.9	11.4
Jul.	12.9	13.5	13.8	16.5	17.7	18.8
Aug.	19.9	24.0	26.0	17.6	18.2	17.6
Sep.	20.4	19.0	17.7	22.7	25.3	27.7
Oct.	5.8	4.5	3.5	7.5	6.7	6.5
Nov.	0.3	0.1	0.0	0.8	0.5	0.3
Dec.	0.2	0.05	0.0	0.2	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

Table 2.7 Monthly Rainfall Distribution of Pluvious Year

(Unit: %)

	Lom Sak		Phetchabun	
	Excess Probability		Non-excess Probability	
	20%	10%	20%	10%
Jan.	0.60	0.80	1.25	1.75
Feb.	2.10	2.85	1.90	2.50
Mar.	5.10	5.95	4.20	4.75
Apr.	6.50	6.80	6.60	7.05
May	12.85	12.45	13.10	12.70
Jun.	14.30	13.85	11.95	11.65
Jul.	12.20	11.35	14.40	13.75
Aug.	15.75	14.70	16.95	16.10
Sep.	21.05	20.85	19.40	18.65
Oct.	7.85	8.05	8.50	8.90
Nov.	1.15	1.60	1.40	1.75
Dec.	0.55	0.75	0.35	0.45
Total	100.00	100.00	100.00	100.00

Table 2.8 Annual Rainfall Distribution for Each Probability

(Unit: mm)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Lom Sak													
1. Non-Excess Probability (Droughty Year)													
10%	0.0	1.0	12.0	27.0	125.0	142.0	109.0	204.0	139.0	28.0	0.0	0.0	787
20%	0.5	2.9	19.0	37.0	135.0	151.0	119.0	212.0	168.0	40.0	1.0	0.5	885
50%	4.0	7.0	36.0	55.0	153.0	164.0	134.0	207.0	212.0	60.0	3.0	2.0	1,040
2. Excess Probability (Pluvious Year)													
10%	12.0	43.0	89.0	102.0	186.0	207.0	169.0	220.0	311.0	120.0	24.0	11.0	1,494
20%	8.0	28.0	68.0	87.0	172.0	192.0	164.0	211.0	282.0	105.0	15.0	8.0	1,340
Phetchabun													
1. Non-Excess Probability (Droughty Year)													
10%	0.0	3.0	11.0	29.0	110.0	99.0	163.0	153.0	241.0	56.0	3.0	0.0	868
20%	1.0	6.0	17.0	37.0	123.0	112.0	166.0	171.0	237.0	63.0	5.0	0.0	938
50%	5.0	12.0	29.0	53.0	139.0	124.0	172.0	184.0	237.0	78.0	9.0	2.0	1,044
2. Excess Probability (Pluvious Year)													
10%	24.0	35.0	66.0	98.0	176.0	162.0	191.0	224.0	259.0	123.0	24.0	6.0	1,388
20%	16.0	24.0	54.0	84.0	167.0	153.0	184.0	216.0	247.0	109.0	18.0	4.0	1,276

Table 2.9.(1) Monthly Runoff at Each Damsite

(Non-Excess Probability 10%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3) Huai Saduang Yai (96 km^2)	Runoff (m^3) Huai Khon Kaen (322 km^2)
Jan.	0	0.0	0	0
Feb.	1	5.7	5,472	18,354
Mar.	12	7.2	82,944	278,208
Apr.	27	5.1	132,192	443,394
May	125	17.8	2,136,000	7,164,500
Jun.	142	20.0	2,726,400	9,144,800
Jul.	109	19.8	2,071,872	6,949,404
Aug.	204	32.1	6,286,464	21,085,848
Sep.	139	28.7	3,829,728	12,845,546
Oct.	28	14.2	381,696	1,280,272
Nov.	0	0.0	0	0
Dec.	0	0.0	0	0
Total	787	-	17,652,768	59,210,326

Annual runoff (184 mm)

Annual runoff coefficient (23.3%)

Average unit runoff (5.8 ℓ/s/km^2)

Table 2.9.(2) Monthly Runoff at Each Damsite

(Non-Excess Probability 20%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3)	
			Huai Saduang Yai (96 km^2)	Huai Khon Kaen (322 km^2)
Jan.	0.5	5.6	2,688	9,016
Feb.	2.0	6.0	11,520	38,640
Mar.	19.0	8.1	147,744	495,558
Apr.	37.0	10.1	358,752	1,203,314
May	135.0	22.1	2,864,160	9,606,870
Jun.	151.0	24.2	3,508,032	11,766,524
Jul.	119.0	21.0	2,399,040	8,046,780
Aug.	212.0	33.2	6,756,864	22,663,648
Sep.	168.0	28.9	4,660,992	15,633,744
Oct.	40.0	11.4	437,760	1,468,320
Nov.	1.0	5.8	5,568	18,676
Dec.	0.5	5.6	2,688	9,016
Total	885.0	-	21,155,808	70,960,106

Annual runoff (220 mm)

Annual runoff coefficient (24.9%)

Average unit runoff (7.0 $\ell/s/km^2$)

Table 2.9.(3) Monthly Runoff at Each Damsite

(Non-Excess Probability 50%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3) Huai Saduang Yai ($96\ km^2$)	Runoff (m^3) Huai Khon Kaen ($322\ km^2$)
Jan.	4	6.1	23,424	78,568
Feb.	7	6.5	43,680	146,510
Mar.	36	10.3	355,968	1,193,976
Apr.	55	18.8	464,640	1,558,480
May	153	21.5	3,157,920	10,592,190
Jun.	164	22.9	3,605,376	12,093,032
Jul.	134	23.0	2,958,720	9,924,040
Aug.	207	32.5	6,458,400	21,662,550
Sep.	212	38.1	7,754,112	26,008,584
Oct.	60	18.4	1,059,840	3,554,880
Nov.	3	6.0	17,280	57,960
Dec.	2	5.9	11,328	37,996
Total	1,040	-	25,910,688	86,908,766

Annual runoff (270 mm)

Annual runoff coefficient (26.0%)

Average unit runoff (8.6 $\ell/s/km^2$)

Table 2.9.(4) Monthly Runoff at Each Damsite

(Excess Probability 10%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3) Huai Saduang Yai (96 km^2)	Runoff (m^3) Huai Khon Kaen (322 km^2)
Jan.	12	7.2	82,944	278,208
Feb.	43	11.2	462,336	1,550,752
Mar.	89	17.2	1,469,568	4,929,176
Apr.	102	14.9	1,459,008	4,893,756
May	186	25.8	4,606,848	15,452,136
Jun.	207	28.5	5,663,520	18,996,390
Jul.	169	27.6	4,477,824	15,019,368
Aug.	220	34.2	7,223,040	24,227,280
Sep.	311	51.0	15,226,560	51,072,420
Oct.	120	26.2	3,018,240	10,123,680
Nov.	24	8.7	200,448	672,336
Dec.	11	7.0	73,920	247,940
Total	1,494	-	43,964,256	147,463,442

Annual runoff (458 mm)

Annual runoff coefficient (30.7%)

Average unit runoff (14.5 $\ell/s/km^2$)

Total 2.9.(5) Monthly Runoff at Each Damsite

(Excess Probability 20%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3) Huai Saduang Yai (96 km^2)	Runoff (m^3) Huai Khon Kaen (322 km^2)
Jan.	8	6.7	51,456	172,592
Feb.	28	9.2	247,296	829,472
Mar.	68	14.4	940,032	3,153,024
Apr.	87	12.9	1,077,408	3,613,806
May	172	23.9	3,946,368	13,236,776
Jun.	192	26.5	4,884,480	16,383,360
Jul.	164	26.9	4,235,136	14,205,352
Aug.	211	33.0	6,684,480	22,420,860
Sep.	282	47.2	12,777,984	42,859,488
Oct.	105	24.2	2,439,360	8,182,020
Nov.	15	7.6	109,440	367,080
Dec.	8	6.7	51,456	172,592
Total	1,340	-	37,444,896	125,596,422

Annual runoff (390 mm)

Annual runoff coefficient (29.1%)

Average unit runoff (12.3 ℓ/s/km^2)

Table 2.9.(6) Monthly Runoff at Each Damsite

(Non-Excess Probability 10%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3)	
			Huai Yai (78 km^2)	Khlong Chaliang Lab (77 km^2)
Jan.	0	0.0	0	0
Feb.	3	6.0	14,040	13,860
Mar.	11	7.0	60,060	59,290
Apr.	29	5.4	122,148	120,582
May	110	15.9	1,364,220	1,346,730
Jun.	99	14.4	1,111,968	1,097,712
Jul.	163	26.8	3,407,352	3,363,668
Aug.	153	25.5	3,043,170	3,004,155
Sep.	241	41.9	7,876,362	7,775,383
Oct.	56	17.9	781,872	771,848
Nov.	3	6.0	14,040	13,860
Dec.	0	0.0	0	0
Total	868	-	17,795,232	17,567,088

Annual runoff (228 mm)

Annual runoff coefficient (26.3%)

Average unit runoff (7.2 $\ell/s/km^2$)

Table 2.9.(7) Monthly Runoff at Each Damsite

(Non-Excess Probability 20%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3)	
			Huai Yai (78 km^2)	Khlong Chaliang Lab (77 km^2)
Jan.	1	5.8	4,524	4,466
Feb.	6	6.5	30,420	30,030
Mar.	17	7.9	104,754	103,411
Apr.	37	10.1	291,486	287,749
May	123	20.7	1,985,958	1,960,497
Jun.	112	19.4	1,694,784	1,673,056
Jul.	166	27.2	3,521,856	3,476,704
Aug.	171	27.8	3,707,964	3,660,426
Sep.	237	38.2	7,061,652	6,971,118
Oct.	63	14.5	712,530	703,395
Nov.	5	6.3	24,570	24,255
Dec.	0	0.0	0	0
Total	938	-	19,140,498	18,895,107

Annual runoff (245 mm)

Annual runoff coefficient (26.1%)

Average unit runoff (7.8 $\ell/s/km^2$)

Table 2.9.(8) Monthly Runoff at Each Damsite

(Non-Excess Probability 50%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3) Huai Yai (78 km^2)	Runoff (m^3) Khlong Chaliang Lab (77 km^2)
Jan.	5	6.3	24,570	24,255
Feb.	12	7.2	67,392	66,528
Mar.	29	9.4	212,628	209,902
Apr.	53	8.5	351,390	346,885
May	139	19.7	2,135,874	2,108,491
Jun.	124	17.7	1,711,944	1,689,996
Jul.	172	27.9	3,743,064	3,695,076
Aug.	184	29.5	4,233,840	4,179,560
Sep.	237	41.4	7,653,204	7,555,086
Oct.	78	20.7	1,259,388	1,243,242
Nov.	9	6.8	47,736	47,124
Dec.	2	5.9	9,204	9,086
Total	1,044	-	21,450,234	21,175,231

Annual runoff (275 mm)

Annual runoff coefficient (26.3%)

Average unit runoff (8.7 $\ell/s/km^2$)

Table 2.9.(9) Monthly Runoff at Each Damsite

(Excess Probability 10%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3) Huai Yai (78 km^2)	Runoff (m^3) Khlong Chaliang Lab (77 km^2)
Jan.	24	8.7	162,864	160,776
Feb.	35	10.2	278,460	274,890
Mar.	66	14.2	731,016	721,644
Apr.	98	14.3	1,093,092	1,079,078
May	176	24.4	3,349,632	3,306,688
Jun.	162	22.6	2,855,736	2,819,124
Jul.	191	30.4	4,528,992	4,470,928
Aug.	224	34.7	6,062,784	5,985,056
Sep.	259	44.2	8,929,284	8,814,006
Oct.	123	26.6	2,552,004	2,519,286
Nov.	24	8.7	162,864	160,776
Dec.	6	6.4	29,952	29,568
Total		-	30,736,680	30,342,620

Annual runoff (394.1 mm)

Annual runoff coefficient (28.4%)

Average unit runoff (12.5 $\ell/s/km^2$)

Table 2.9.(10) Monthly Runoff at Each Damsite

(Excess Probability 20%)

Month	Rainfall (mm)	Runoff Coefficient (%)	Runoff (m^3)	
			Huai Yai (78 km^2)	Khlong Chaliang Lab (77 km^2)
Jan.	16	7.7	96,096	94,864
Feb.	24	8.7	162,864	160,776
Mar.	54	12.6	530,712	523,908
Apr.	84	12.5	819,000	808,500
May	167	23.3	3,035,058	2,996,147
Jun.	153	21.5	2,565,810	2,532,915
Jul.	184	29.4	4,219,488	4,165,392
Aug.	216	33.7	5,677,776	5,604,984
Sep.	247	42.7	8,226,582	8,121,113
Oct.	109	24.8	2,108,496	2,081,464
Nov.	18	8.0	112,320	110,880
Dec.	4	6.1	19,032	18,788
Total	1,276	-	27,573,234	27,219,731

Annual runoff (353.5 mm)

Annual runoff coefficient (27.7%)

Average unit runoff (11.2 $\ell/s/km^2$)

Table 2.10 Summary of Annual Runoff

Drainage Area (km^2)		Huai Saduang Yai 96	Huai Khon Kaen 322	Huai Yai 78	Khlong Chaliang Lab 77
Non-Excess Probability 10%	Rainfall (mm)	787	787	868	868
	Runoff (10^3m^3)	17,653	59,210	11,795	11,567
	Ave. Yield R. ($\ell/s/km^2$)	5.8	5.8	7.2	7.2
	R.O. Co. (%)	23.3	23.3	26.3	26.3
Non-Excess Probability 20%	Rainfall (mm)	885	885	938	938
	Runoff (10^3m^3)	21,156	70,960	19,140	18,895
	Ave. Yield R. ($\ell/s/km^2$)	7.0	7.0	7.8	7.8
	R.O. Co. (%)	24.9	24.9	26.1	26.1
Non-Excess Probability 50%	Rainfall (mm)	1,040	1,040	1,044	1,044
	Runoff (10^3m^3)	25,911	86,909	21,450	21,175
	Ave. Yield R. ($\ell/s/km^2$)	8.6	8.6	8.7	8.7
	R.O. Co. (%)	26.0	26.0	26.3	26.3
Excess Probability 10%	Rainfall (mm)	1,494	1,494	1,388	1,388
	Runoff (10^3m^3)	43,964	147,463	30,737	30,343
	Ave. Yield R. ($\ell/s/km^2$)	14.5	14.5	12.5	12.5
	R.O. Co. (%)	30.7	30.7	28.4	28.4
Excess Probability 20%	Rainfall (mm)	1,340	1,340	1,276	1,276
	Runoff (10^3m^3)	37,445	125,596	27,573	27,219
	Ave. Yield R. ($\ell/s/km^2$)	12.3	12.3	11.2	11.2
	R.O. Co. (%)	29.1	29.1	27.7	27.7

Note: R.O. Co. means Runoff Coefficient

Ave. Yield R. means Average Yield of Runoff

Table 2.11 Observed Annual Runoff

1) At Kaeng Sida (1964 - 1977) D.A = 836 km^2

Year	Annual Runoff (mm)	Annual Rainfall (mm) At Ban Sila	-	Adopted Rainfall (mm)	Runoff Coefficient	Average Yield of Runoff (ℓ/s/km^2)
1964	304.4	1,336.2	-	1,336.2	0.23	9.7
65	324.5	1,450.0	-	1,450.0	0.22	10.3
66	295.3	1,488.7	-	1,488.7	0.20	9.4
67	147.7	1,260.2	-	1,260.2	0.12	4.7
68	169.3	1,179.1	-	1,179.1	0.14	5.4
69	251.6	1,077.5	-	1,077.5	0.23	8.0
70	329.5	1,360.8	-	1,360.8	0.24	10.4
71	228.5	1,007.4	-	1,007.4	0.23	7.2
72	218.8	1,020.1	-	1,020.1	0.21	6.9
73	140.0	893.5	-	893.5	0.16	4.4
74	124.5	1,310.6	-	1,310.6	0.09	3.9
75	240.1	1,205.1	-	1,205.1	0.20	7.6
76	347.1	1,562.1	-	1,562.1	0.22	11.0
77	257.5	1,047.7	-	1,047.7	0.25	8.2
Average	241.3	1,228.5	-	1,228.5	0.20	7.7

2) At Pasak Left Bank Weir (1971 - 1977) D.A = 1,007 km^2

Year	Annual Runoff (mm)	Annual Rainfall (mm) At Ban Sila	At Kaeng Sida	Adopted/1 Rainfall (mm)	Runoff Coefficient	Average Yield of Runoff (ℓ/s/km^2)
1971	300.7	1,007.4	-	1,007.4	0.30	9.5
72	224.9	1,020.1	1,100.6	1,040.2	0.22	7.1
73	151.3	893.5	875.9	889.1	0.17	4.8
74	157.5	1,310.6	995.4	1,231.8	0.13	5.0
75	417.3	1,205.1	1,302.5	1,229.5	0.34	13.2
76	548.2	1,562.1	1,378.4	1,516.2	0.36	17.4
77	354.3	1,047.7	1,030.5	1,043.4	0.34	11.2
Average	307.7	-	-	1,136.8	0.27	9.8

/1: Adopted rainfall is calculated by Thiessen Method.
Thiessen Weight

Ban Sila : Kaeng Side = 3 : 1

Table 2.12 Daily Rainfall of Each Probability

Return Period (years)	Station	Gumbel (mm/day)	Iwai (mm/day)	Thomas (mm/day)	Adopted Rainfall (mm/day)
10	Lom Sak	151.0	145.8	142.5	146
	Phetchabun	117.8	113.8	117.4	116
30	Lom Sak	187.9	179.4	178.6	182
	Phetchabun	143.2	134.5	142.7	140
50	Lom Sak	204.8	194.6	190.0	196
	Phetchabun	154.9	143.6	152.2	150
100	Lom Sak	227.6	215.2	210.0	218
	Phetchabun	170.5	155.7	166.5	164
500	Lom Sak	280.2	263.5	280.0	275
	Phetchabun	206.7	183.0	202.2	197

Table 2.13 Estimated Rainfall Intensity

(Return Period: 1/100 Yrs.)

Duration (hr)	Derived Intensity from I.D.C. (mm/hr)	Estimated Intensity from Formula: It (mm/hr)
1	82	82.6
2	46	47.0
3	32	33.8
4	25	26.7
5	21.5	22.3
6	18.3	19.2
7	16	16.9
8	15	15.2
9	14	13.8
10	13	12.7
11	12	11.7
12	11	10.9
13	10.5	10.2
14	9.8	9.6
15	9.3	9.1
16	8.8	8.6
17	8.3	8.2
18	7.9	7.8
19	7.6	7.5
20	7.2	7.2
21	7.0	6.9
22	6.6	6.7
23	6.3	6.4
24	6.2	6.2

Note: I.D.C. means Intensity-Duration Curve

$It = \frac{R_{24}}{24} \left(\frac{24}{t}\right)^{0.815}$

R_{24} = 148.8 mm/day

t means Duration of rainfall

Table 2.14 Dimension of Unit Hydrograph

Area	Huai Saduang Yai	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
Drainage Area: A (km^2)	96	322	78	77
River Length from Origin: L (km)	28.5	52.1	22.3	26.4
River Length from Center of Basin: LC (km)	17.1	28.7	12.5	16.2
Flood Concentration Time: tp (hr)	9	12	7	8
Unit Time of Rainfall: tr (hr)	(1.64) 1.5	(2.2) 2.0	(1.27) 1.5	(1.45) 1.5
Peak Discharge of Unit Hydrograph: q_p (m^3/s)	2.024	5.092	2.114	1.826
Runoff Duration: Tb (hr)	26.4	35.1	20.5	23.4

Table 2.15 Discharge of Unit Hydrograph

Huai Saduang Yai		Huai Khon Kaen		Huai Yai		Khlong Chaliang Lab	
Time	Discharge	Time	Discharge	Time	Discharge	Time	Discharge
(hour)	(cms)	(hour)	(cms)	(hour)	(cms)	(hour)	(cms)
1.5	0.34	2	0.85	1.5	0.46	1.5	0.34
3.0	0.67	4	1.70	3.0	0.90	3.0	0.68
4.5	1.01	6	2.55	4.5	1.38	4.5	1.03
6.0	1.35	8	3.39	6.0	1.83	6.0	1.37
7.5	1.69	10	4.24	7.5	2.03	7.5	1.71
9.0	2.02	12	5.09	9.0	1.80	9.0	1.71
10.5	1.85	14	4.65	10.5	1.50	10.5	1.53
12.0	1.68	16	4.21	12.0	1.33	12.0	1.35
13.5	1.50	18	3.77	13.5	1.10	13.5	1.17
15.0	1.33	20	3.33	15.0	0.87	15.0	1.00
16.5	1.15	22	2.88	16.5	0.64	16.5	0.82
18.0	0.98	24	2.45	18.0	0.40	18.0	0.64
19.5	0.80	26	2.01	19.5	0.17	19.0	0.46
21.0	0.63	28	1.57	21.0	0.00	21.0	0.28
22.5	0.45	30	1.12			22.5	0.11
24.0	0.28	32	0.68			24.0	0.00
25.5	0.10	34	0.24				
27.0	0.00	36	0.00				

Table 2.16.(1) Calculation of Hourly Rainfall of Lom Sak

(Return Period: 1/100)

t (hour)	It (mm/hour)	Rt (mm/t.hour)	R (mm/hour)
1	121.1	121.1	121.1
2	68.9	137.7	16.6
3	49.5	148.4	10.7
4	39.1	156.5	8.1
5	32.6	163.1	6.6
6	28.1	168.7	5.6
7	24.8	173.6	4.9
8	22.2	177.9	4.3
9	20.2	181.8	3.9
10	18.5	185.4	3.4
11	17.2	188.7	3.4
12	16.0	191.8	3.2
13	15.0	194.6	2.8
14	14.1	197.3	2.7
15	13.3	199.8	2.5
16	12.6	202.2	2.4
17	12.0	204.5	2.3
18	11.5	206.7	2.2
19	11.0	208.8	2.1
20	10.5	210.8	2.0
21	10.1	212.7	1.9
22	9.8	214.5	1.8
23	9.4	216.3	1.8
24	9.1	218.0	1.7

Note: $It = \frac{R_{24}}{24} \left(\frac{24}{t}\right)^{0.815}$

R_{24} = 218 mm/day

Rt = It x t

R = Rt - R(t - 1)

Table 2.16(2) Calculation of Hourly Rainfall of Phetchabun

(Return Period: 1/100)

t (hour)	It (mm/hour)	Rt (mm/t.hour)	R (mm/hour)
1	91.1	91.1	91.1
2	51.8	103.6	12.5
3	37.2	111.6	8.0
4	29.4	117.7	6.1
5	24.5	122.7	5.0
6	21.2	126.9	4.2
7	18.65	130.6	3.7
8	16.7	133.8	3.2
9	15.2	136.8	3.0
10	13.9	139.5	2.7
11	12.9	142.0	2.5
12	12.0	144.3	2.3
13	11.3	146.4	2.1
14	10.6	148.4	2.0
15	10.0	150.3	1.9
16	9.5	152.1	1.8
17	9.1	153.9	1.8
18	8.6	155.5	1.6
19	8.3	157.1	1.6
20	7.9	158.6	1.5
21	7.6	160.0	1.4
22	7.3	161.4	1.4
23	7.0	162.7	1.3
24	6.83	164.0	1.3

Note: $It = \frac{R_{24}}{24} \left(\frac{24}{t}\right)^{0.815}$

R_{24} = 164 mm/day

Rt = It x t

R = Rt - P(t-1)

Table 2.17 Effective Rainfall for Runoff

Huai Saduang Yai		Huai Khon Kaen		Huai Yai		Khlong Chaliang Lab	
Unit Time (hour)	Effective Rainfall (mm)	Unit Time (hour)	Effective Rainfall (mm)	Unit Time (hour)	Effective Rainfall (mm)	Unit Time (hour)	Effective Rainfall (mm)
1.5	0	2	0	1.5	0	1.5	0
3.0	0	4	0.1	3.0	0	3.0	0
4.5	0.1	6	0.1	4.5	0	4.5	0
6.0	0.1	8	0.5	6.0	0.1	6.0	0.1
7.5	0.3	10	1.4	7.5	0.2	7.5	0.2
9.0	0.7	12	97.9	9.0	0.3	9.0	0.3
10.5	1.9	14	24.7	10.5	0.9	10.5	0.9
12.0	98.1	16	9.9	12.0	57.8	12.0	57.8
13.5	20.6	18	6.6	13.5	15.8	13.5	15.8
15.0	9.7	20	5.1	15.0	7.0	15.0	7.0
16.5	6.0	22	4.2	16.5	4.6	16.5	4.6
18.0	4.9	24	3.5	18.0	3.6	18.0	3.6
19.0	4.1			19.0	3.1	19.0	3.1
21.0	3.2			21.0	2.3	21.0	2.3
22.5	2.9			22.5	2.3	22.5	2.3
24.0	2.6			24.0	2.0	24.0	2.0

Table 2.18 Probable Base Flow

Lom Sak Area			
Return Period (year)	Probable Specific Discharge ($l/s/km^2$)	Huai Saduang Yai (m^3/s)	Huai Khon Kaen (m^3/s)
10	44	4.2	14.1
30	54	5.2	17.4
50	58	5.6	18.7
100	64	6.1	20.6

Phetchabun Area			
Return Period (year)	Probable Specific Discharge ($l/s/km^2$)	Huai Yai (m^3/s)	Khlong Chaliang Lab (m^3/s)
10	41	3.2	3.2
30	47	3.7	3.6
50	50	3.9	3.9
100	54	4.2	4.2

Table 2.19 Runoff Coefficient of the Flood in 100-year Return Period

Area	Huai Saduang Yai	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
Daily Rainfall (mm/day)	218	218	164	164
Concentration Time (hour)	9	12	7	8
Rainfall Intensity (mm/hour)	20.2	16.0	18.7	16.7
Drainage Area (km^2)	96	322	78	77
Peak Direct Discharge (m^3/sec)	262.3	676.8	164.2	145.7
Runoff Coefficient (%)	47.5	47.2	40.5	40.8

Table 2.20 Peak Discharge of the Flood in 500-year Return Period

Area	Huai Saduang Yai	Huai Khon Kaen	Huai Yai	Khlong Chaliang Lab
Runoff Coefficient (%)	52	52	45	45
Daily Rainfall (mm/day)	275	275	197	197
Concentration Time (hour)	9	12	7	8
Rainfall Intensity (mm/hour)	25.5	20.2	22.4	20.1
Drainage Area (km^2)	96	322	78	77
Peak Discharge (m^3/sec)	354	940	218	193

Table 2.21 Flood Control Study

(1) Huai Saduang Yai Dam (Return Period 10 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
0.75	4.2	4.20	0.000	0.000	0.000	14631465	0.008	187.508
1.50	4.2	4.20	0.000	0.084	0.084	14642579	0.016	187.516
2.25	4.2	4.20	0.000	0.233	0.233	14653285	0.024	187.524
3.00	4.2	4.20	0.000	0.419	0.419	14663497	0.032	187.532
3.75	4.2	4.20	0.000	0.627	0.627	14673144	0.039	187.539
4.50	4.2	4.20	0.000	0.847	0.847	14682197	0.046	187.546
5.25	4.2	4.20	0.000	1.073	1.073	14690659	0.052	187.552
6.00	4.2	4.20	0.000	1.299	1.299	14698471	0.057	187.557
6.75	4.2	4.21	0.000	1.522	1.522	14705725	0.063	187.563
7.50	4.2	4.23	0.000	1.738	1.738	14712441	0.068	187.568
8.25	4.3	4.25	0.000	1.947	1.947	14718662	0.072	187.572
9.00	4.3	4.28	0.000	2.147	2.147	14724434	0.077	187.577
9.75	4.4	4.33	0.000	2.338	2.338	14729825	0.080	187.580
10.50	4.4	4.40	0.000	2.521	2.521	14734901	0.084	187.584
11.25	4.6	4.54	0.000	2.698	2.698	14739863	0.088	187.588
12.00	4.8	4.74	0.000	2.875	2.875	14744897	0.092	187.592
12.75	12.6	8.74	0.000	3.059	3.059	14760223	0.103	187.603
13.50	20.4	16.52	0.000	3.639	3.639	14795010	0.128	187.628
14.25	30.3	25.37	0.000	5.075	5.075	14849791	0.169	187.669
15.00	40.2	35.26	0.000	7.638	7.638	14924373	0.223	187.723
15.75	51.3	45.75	0.000	11.646	11.646	15016454	0.291	187.791
16.50	62.4	56.83	0.000	17.315	17.315	15123154	0.369	187.869
17.25	74.2	68.29	0.000	24.759	24.759	15240674	0.455	187.955
18.00	86.0	80.11	0.000	33.924	33.924	15365362	0.547	188.047
18.75	98.3	92.18	0.000	44.646	44.646	15493700	0.641	188.141
19.50	110.7	104.51	0.000	56.662	56.662	15622680	0.736	188.236
20.25	123.1	116.87	0.000	69.685	69.685	15750269	0.829	188.329
21.00	135.4	129.25	0.000	83.377	83.377	15874138	0.920	188.420
21.75	137.0	136.23	0.000	97.454	97.454	15978633	0.997	188.497
22.50	138.6	137.80	0.000	109.910	109.910	16054130	1.052	188.552
23.25	136.9	137.75	0.000	119.171	119.171	16104296	1.089	188.589
24.00	135.3	136.10	0.000	125.479	125.479	16132965	1.110	188.610
24.75	132.1	133.69	0.000	129.132	129.132	16145284	1.119	188.619
25.50	129.0	130.54	0.000	130.713	130.713	16144829	1.119	188.619
26.25	124.9	126.96	0.000	130.654	130.654	16134352	1.112	188.612
27.00	120.9	122.94	0.000	129.374	129.374	16117476	1.099	188.599
27.75	115.9	118.42	0.000	127.154	127.154	16093894	1.081	188.581
28.50	110.9	113.40	0.000	124.162	124.162	16064847	1.060	188.560
29.25	105.3	108.11	0.000	120.510	120.510	16031347	1.036	188.536
30.00	99.7	102.54	0.000	116.345	116.345	15994082	1.008	188.508
30.75	93.4	96.59	0.000	111.765	111.765	15953106	0.978	188.478
31.50	87.1	90.27	0.000	106.802	106.802	15908460	0.945	188.445
32.25	80.5	83.80	0.000	101.482	101.482	15360717	0.910	188.410
33.00	73.9	77.19	0.000	95.893	95.893	15810207	0.873	188.373
33.75	66.6	70.26	0.000	90.097	90.097	15756648	0.834	188.334
34.50	59.4	63.02	0.000	84.084	84.084	15699783	0.792	188.292
35.25	52.4	55.89	0.000	77.953	77.953	15640467	0.749	188.249
36.00	45.3	48.84	0.000	71.526	71.526	15579224	0.704	188.204
36.75	38.1	41.73	0.000	65.184	65.184	15515998	0.657	188.157
37.50	31.0	34.54	0.000	58.836	58.836	15450308	0.609	188.109
38.25	25.5	28.25	0.000	52.493	52.493	15384844	0.561	188.061
39.00	20.1	22.84	0.000	46.408	46.408	15321216	0.514	188.014
39.75	17.5	18.81	0.000	40.739	40.739	15262016	0.471	187.971
40.50	14.8	16.16	0.000	35.689	35.689	15209265	0.432	187.932
41.25	13.1	13.97	0.000	31.383	31.383	15162273	0.398	187.898
42.00	11.4	12.26	0.000	27.703	27.703	15120568	0.367	187.867
42.75	10.1	10.77	0.000	24.568	24.568	15083316	0.340	187.840
43.50	8.9	9.52	0.000	21.877	21.877	15049957	0.315	187.815
44.25	8.0	8.44	0.000	19.557	19.557	15019934	0.293	187.793
45.00	7.1	7.52	0.000	17.544	17.544	14992862	0.274	187.774
45.75	6.4	6.73	0.000	15.772	15.772	14968391	0.256	187.756
46.50	5.7	6.07	0.000	14.263	14.263	14946278	0.239	187.739
47.25	5.3	5.53	0.000	12.926	12.926	14926318	0.225	187.725
48.00	4.9	5.11	0.000	11.756	11.756	14908371	0.212	187.712
48.75	4.6	4.77	0.000	10.740	10.740	14892259	0.200	187.700
49.50	4.4	4.52	0.000	9.852	9.852	14877854	0.189	187.689
50.25	4.3	4.34	0.000	9.080	9.080	14865061	0.180	187.680
51.00	4.2	4.25	0.000	8.412	8.412	14853815	0.171	187.671
51.75	4.2	4.20	0.000	7.840	7.840	14843787	0.164	187.664
52.50	4.2	4.20	0.000	7.350	7.350	14835481	0.158	187.658

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest or S.S .

Table 2.21 Flood Control Study

(2) Huai Saduang Yai Dam (Return Period 30 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
0.75	5.2	5.20	0.000	0.000	0.000	14634165	0.010	187.510
1.50	5.2	5.20	0.000	0.115	0.115	14647893	0.020	187.520
2.25	5.2	5.20	0.000	0.321	0.321	14661066	0.030	187.530
3.00	5.2	5.20	0.000	0.575	0.575	14673554	0.039	187.539
3.75	5.2	5.20	0.000	0.357	0.357	14685280	0.048	187.548
4.50	5.2	5.20	0.000	1.154	1.154	14696204	0.056	187.556
5.25	5.2	5.20	0.000	1.456	1.456	14706312	0.063	187.563
6.00	5.2	5.20	0.000	1.756	1.756	14715611	0.070	187.570
6.75	5.2	5.21	0.000	2.043	2.043	14724145	0.076	187.576
7.50	5.2	5.23	0.000	2.326	2.326	14731968	0.082	187.582
8.25	5.3	5.26	0.000	2.596	2.596	14739159	0.087	187.587
9.00	5.3	5.31	0.000	2.850	2.850	14745801	0.092	187.592
9.75	5.5	5.39	0.000	3.092	3.092	14752016	0.097	187.597
10.50	5.6	5.51	0.000	3.324	3.324	14757921	0.101	187.601
11.25	5.9	5.74	0.000	3.550	3.550	14763631	0.105	187.605
12.00	6.2	6.06	0.000	3.781	3.781	14770030	0.110	187.610
12.75	13.6	12.44	0.000	4.028	4.028	14792733	0.127	187.627
13.50	31.0	24.82	0.000	4.977	4.977	14846327	0.166	187.666
14.25	46.0	38.43	0.000	7.466	7.466	14930078	0.227	187.727
15.00	60.9	53.42	0.000	11.975	11.975	15041974	0.310	187.810
15.75	77.4	69.12	0.000	17.014	17.014	15177264	0.409	187.909
16.50	93.8	85.60	0.000	28.860	28.860	15330453	0.521	188.021
17.25	111.2	102.53	0.000	41.546	41.546	15495096	0.642	188.142
18.00	128.6	119.91	0.000	56.796	56.796	15665499	0.767	188.267
18.75	146.6	137.59	0.000	74.174	74.174	15836731	0.893	188.393
19.50	164.6	155.57	0.000	93.126	93.126	16005341	1.016	188.516
20.25	182.5	173.51	0.000	113.141	113.141	16168343	1.136	188.636
21.00	200.4	191.41	0.000	133.688	133.688	16324191	1.250	188.750
21.75	200.9	200.65	0.000	154.374	154.374	16449125	1.342	188.842
22.50	201.5	201.22	0.000	171.659	171.659	16528946	1.401	188.901
23.25	198.1	199.81	0.000	183.018	183.018	16574285	1.434	188.934
24.00	194.7	196.41	0.000	189.577	189.577	16592731	1.448	188.948
24.75	189.3	192.03	0.000	192.267	192.267	16592083	1.447	188.947
25.50	184.0	186.67	0.000	192.173	192.173	16577217	1.436	188.936
26.25	177.6	180.81	0.000	190.004	190.004	16552383	1.418	188.918
27.00	171.3	174.45	0.000	186.399	186.399	16520109	1.394	188.894
27.75	163.6	167.42	0.000	181.743	181.743	16481430	1.366	188.866
28.50	155.9	159.74	0.000	176.226	176.226	16436910	1.333	188.833
29.25	147.6	151.75	0.000	169.942	169.942	16387734	1.297	188.797
30.00	139.3	143.45	0.000	163.096	163.096	16334743	1.256	188.756
30.75	130.0	134.67	0.000	155.810	155.810	16277654	1.216	188.716
31.50	120.8	125.39	0.000	148.094	148.094	16216359	1.171	188.671
32.25	111.1	115.93	0.000	139.955	139.955	16151502	1.124	188.624
33.00	101.5	106.29	0.000	131.513	131.513	16083408	1.074	188.574
33.75	91.1	96.26	0.000	122.837	122.837	16011655	1.021	188.521
34.50	80.6	85.85	0.000	113.916	113.916	15935872	0.966	188.466
35.25	70.7	75.67	0.000	104.738	104.738	15857378	0.909	188.409
36.00	60.7	65.72	0.000	95.506	95.506	15776947	0.849	188.349
36.75	50.3	55.51	0.000	86.346	86.346	15693697	0.788	188.288
37.50	39.8	45.06	0.000	77.196	77.196	15606920	0.724	188.224
38.25	32.3	36.09	0.000	68.028	68.028	15520677	0.661	188.161
39.00	24.9	28.61	0.000	59.307	59.307	15437781	0.600	188.100
39.75	21.6	23.22	0.000	51.310	51.310	15361943	0.544	188.044
40.50	18.3	19.93	0.000	44.339	44.339	15296049	0.496	187.996
41.25	16.2	17.23	0.000	38.565	38.565	15238439	0.454	187.954
42.00	14.0	15.10	0.000	33.741	33.741	15188112	0.417	187.917
42.75	12.5	13.27	0.000	29.707	29.707	15143722	0.384	187.884
43.50	11.0	11.72	0.000	26.293	26.293	15104380	0.355	187.855
44.25	9.8	10.38	0.000	23.336	23.336	15069269	0.330	187.830
45.00	8.7	9.25	0.000	20.889	20.889	15037839	0.307	187.807
45.75	7.9	8.28	0.000	18.735	18.735	15009587	0.286	187.786
46.50	7.1	7.47	0.000	16.867	16.867	14984221	0.267	187.767
47.25	6.5	6.81	0.000	15.246	15.246	14961439	0.250	187.750
48.00	6.0	6.29	0.000	13.838	13.838	14741049	0.235	187.735
48.75	5.7	5.87	0.000	12.617	12.617	14922036	0.222	187.722
49.50	5.4	5.56	0.000	11.556	11.556	14906849	0.210	187.710
50.25	5.3	5.36	0.000	10.644	10.644	14892375	0.200	187.700
51.00	5.2	5.25	0.000	9.858	9.858	14879939	0.191	187.691
51.75	5.2	5.20	0.000	9.190	9.190	14869164	0.183	187.683
52.50	5.2	5.20	0.000	8.625	8.625	14859918	0.176	187.676

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

Table 2.21 Flood Control Study

(3) Huai Saduang Yai Dam (Return Period 50 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
0.75	5.6	5.60	0.000	0.000	0.000	14635245	0.011	187.511
1.50	5.6	5.60	0.000	0.129	0.129	14650017	0.022	187.522
2.25	5.6	5.60	0.000	0.359	0.359	14664168	0.032	187.532
3.00	5.6	5.60	0.000	0.641	0.641	14677556	0.042	187.542
3.75	5.6	5.60	0.000	0.955	0.955	14690097	0.051	187.551
4.50	5.6	5.60	0.000	1.285	1.285	14701749	0.060	187.560
5.25	5.6	5.61	0.000	1.618	1.618	14712523	0.068	187.568
6.00	5.6	5.63	0.000	1.949	1.949	14722449	0.075	187.575
6.75	5.7	5.65	0.000	2.271	2.271	14731573	0.082	187.582
7.50	5.7	5.68	0.000	2.582	2.582	14739949	0.088	187.588
8.25	5.8	5.73	0.000	2.878	2.878	14747660	0.094	187.594
9.00	5.8	5.80	0.000	3.161	3.161	14754790	0.099	187.599
9.75	6.0	5.91	0.000	3.429	3.429	14761490	0.104	187.604
10.50	6.1	6.06	0.000	3.689	3.689	14767901	0.108	187.608
11.25	6.5	6.34	0.000	3.942	3.942	14774373	0.113	187.613
12.00	6.9	6.75	0.000	4.204	4.204	14781240	0.118	187.618
12.75	21.1	14.03	0.000	4.488	4.488	14807009	0.137	187.637
13.50	35.3	28.20	0.000	5.607	5.607	14868009	0.182	187.682
14.25	52.1	43.70	0.000	8.565	8.565	14962802	0.252	187.752
15.00	69.0	60.54	0.000	13.926	13.926	15088750	0.344	187.844
15.75	87.5	78.23	0.000	22.263	22.263	15239870	0.455	187.955
16.50	106.0	96.77	0.000	33.858	33.858	15409734	0.579	188.079
17.25	125.6	115.82	0.000	43.693	43.693	15590979	0.712	188.212
18.00	145.2	135.38	0.000	66.386	66.386	15777267	0.849	188.349
18.75	165.3	155.25	0.000	86.382	86.382	15963197	0.986	188.486
19.50	185.5	175.41	0.000	108.017	108.017	16145159	1.119	188.619
20.25	205.5	195.50	0.000	130.697	130.697	16320131	1.247	188.747
21.00	225.5	215.52	0.000	153.823	153.823	16486700	1.370	188.870
21.75	225.7	225.63	0.000	176.975	176.975	16618079	1.466	188.966
22.50	226.0	225.86	0.000	195.985	195.985	16693736	1.525	189.025
23.25	221.9	223.94	0.000	207.972	207.972	16741846	1.557	189.057
24.00	217.8	219.87	0.000	214.475	214.475	16756419	1.568	189.068
24.75	211.6	214.74	0.000	216.639	216.639	16751164	1.564	189.064
25.50	205.4	208.55	0.000	215.890	215.890	16731338	1.549	189.049
26.25	198.1	201.80	0.000	212.334	212.334	16701409	1.527	189.027
27.00	190.8	194.50	0.000	208.373	208.373	16663949	1.500	189.000
27.75	182.1	186.47	0.000	202.773	202.773	16619977	1.468	188.968
28.50	173.4	177.76	0.000	196.264	196.264	16570023	1.431	188.931
29.25	164.1	168.73	0.000	188.957	188.957	16515415	1.391	188.891
30.00	154.7	159.39	0.000	181.075	181.075	16456875	1.348	188.848
30.75	144.3	149.51	0.000	172.751	172.751	16394114	1.302	188.802
31.50	133.9	139.07	0.000	163.973	163.973	16326877	1.252	188.752
32.25	123.0	128.45	0.000	154.739	154.739	16255893	1.200	188.700
33.00	112.2	117.64	0.000	145.187	145.187	16181522	1.146	188.646
33.75	100.6	106.44	0.000	135.399	135.399	16103322	1.089	188.589
34.50	89.0	94.83	0.000	125.355	125.355	16020901	1.028	188.528
35.25	77.8	83.39	0.000	115.053	115.053	15935419	0.965	188.465
36.00	66.5	72.13	0.000	104.684	104.684	15847514	0.901	188.401
36.75	54.9	60.72	0.000	94.367	94.367	15756670	0.834	188.334
37.50	43.4	49.18	0.000	84.066	84.066	15662413	0.765	188.265
38.25	35.1	39.26	0.000	73.846	73.846	15567029	0.696	188.196
39.00	26.8	30.97	0.000	64.147	64.147	15479450	0.631	188.131
39.75	23.3	25.05	0.000	55.282	55.282	15397826	0.571	188.071
40.50	19.7	21.50	0.000	47.595	47.595	15327373	0.519	188.019
41.25	17.4	18.53	0.000	41.276	41.276	15266082	0.474	187.974
42.00	15.1	16.27	0.000	36.029	36.029	15212746	0.435	187.935
42.75	13.5	14.29	0.000	31.660	31.660	15165955	0.400	187.900
43.50	11.8	12.63	0.000	27.978	27.978	15124419	0.370	187.870
44.25	10.6	11.19	0.000	24.853	24.853	15087536	0.343	187.843
45.00	9.4	9.98	0.000	22.177	22.177	15054597	0.319	187.819
45.75	8.5	8.94	0.000	19.874	19.874	15025062	0.297	187.797
46.50	7.6	8.07	0.000	17.882	17.882	14998563	0.278	187.778
47.25	7.1	7.35	0.000	16.156	16.156	14974794	0.260	187.760
48.00	6.5	6.79	0.000	14.658	14.658	14953550	0.245	187.745
48.75	6.2	6.34	0.000	13.361	13.361	14934597	0.231	187.731
49.50	5.8	6.01	0.000	12.238	12.238	14917772	0.218	187.718
50.25	5.7	5.78	0.000	11.269	11.269	14902949	0.208	187.708
51.00	5.6	5.66	0.000	10.438	10.438	14890047	0.198	187.698
51.75	5.6	5.60	0.000	9.732	9.732	14878891	0.190	187.690
52.50	5.6	5.60	0.000	9.135	9.135	14869346	0.183	187.683

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

Table 2.21 Flood Control Study

(4) Huai Khon Kaen Dam (Return Period 10 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
1.00	14.1	14.10	0.000	0.000	0.000	28113160	0.035	211.535
2.00	14.1	14.10	0.000	1.133	1.133	28159841	0.066	211.566
3.00	14.1	14.10	0.000	3.013	3.013	28199753	0.093	211.593
4.00	14.1	14.10	0.000	5.043	5.043	28232556	0.116	211.616
5.00	14.1	14.12	0.000	6.741	6.741	28258206	0.133	211.633
6.00	14.2	14.16	0.000	8.584	8.584	28278295	0.147	211.647
7.00	14.3	14.25	0.000	9.738	9.738	28293813	0.157	211.657
8.00	14.4	14.38	0.000	11.029	11.029	28305864	0.166	211.666
9.00	14.9	14.61	0.000	11.701	11.701	28315616	0.172	211.672
10.00	15.1	14.95	0.000	12.623	12.623	28323992	0.176	211.676
11.00	34.6	24.87	0.000	13.255	13.255	28365807	0.206	211.706
12.00	54.1	44.37	0.000	16.557	16.557	28465940	0.274	211.774
13.00	80.6	67.38	0.000	25.396	25.396	28617063	0.377	211.877
14.00	107.1	93.89	0.000	40.926	40.926	28807726	0.507	212.007
15.00	136.5	121.80	0.000	63.747	63.747	29016712	0.649	212.149
16.00	165.6	151.11	0.000	92.357	92.357	29228221	0.793	212.293
17.00	196.6	181.18	0.000	124.705	124.705	29431513	0.931	212.431
18.00	227.4	211.99	0.000	158.707	158.707	29623348	1.062	212.562
19.00	259.9	243.64	0.000	193.205	193.205	29804703	1.185	212.685
20.00	292.3	276.11	0.000	227.876	227.876	29976541	1.303	212.803
21.00	325.9	309.11	0.000	262.771	262.771	30145350	1.417	212.917
22.00	359.1	342.49	0.000	297.820	297.820	30306152	1.526	213.026
23.00	384.4	361.76	0.000	332.965	332.965	30409801	1.596	213.096
24.00	369.7	367.06	0.000	356.301	356.301	30448540	1.623	213.123
25.00	364.3	367.00	0.000	365.157	365.157	30455107	1.627	213.127
26.00	358.9	361.56	0.000	364.684	364.684	30436824	1.615	213.115
27.00	349.3	354.07	0.000	362.471	362.471	30406582	1.594	213.094
28.00	339.7	344.47	0.000	355.568	355.568	30366613	1.567	213.067
29.00	327.1	333.41	0.000	346.513	346.513	30319425	1.535	213.035
30.00	314.6	320.87	0.000	335.924	335.924	30265305	1.498	212.998
31.00	299.6	307.14	0.000	323.914	323.914	30204921	1.457	212.957
32.00	284.7	292.16	0.000	310.687	310.687	30138212	1.412	212.912
33.00	269.3	276.49	0.000	296.291	296.291	30066944	1.363	212.863
34.00	252.0	260.15	0.000	281.164	281.164	29991300	1.312	212.812
35.00	233.9	242.96	0.000	265.400	265.400	29910512	1.257	212.757
36.00	215.9	224.92	0.000	248.902	248.902	29824159	1.198	212.698
37.00	197.9	206.83	0.000	231.662	231.662	29734937	1.137	212.637
38.00	179.8	188.85	0.000	214.269	214.269	29643354	1.075	212.575
39.00	161.5	170.68	0.000	196.731	196.731	29548866	1.011	212.511
40.00	143.2	152.39	0.000	179.543	179.543	29451101	0.944	212.444
41.00	125.2	134.20	0.000	162.125	162.125	29350580	0.876	212.376
42.00	107.1	116.13	0.000	144.844	144.844	29247216	0.806	212.306
43.00	89.4	98.23	0.000	127.765	127.765	29141906	0.733	212.233
44.00	71.6	80.51	0.000	110.961	110.961	29031281	0.659	212.159
45.00	58.1	64.88	0.000	94.490	94.490	28924732	0.586	212.086
46.00	44.6	51.36	0.000	79.332	79.332	28824021	0.518	212.018
47.00	38.2	41.40	0.000	65.843	65.843	28736015	0.458	211.958
48.00	31.8	35.02	0.000	54.771	54.771	28664908	0.410	211.910
49.00	28.1	29.98	0.000	46.332	46.332	28606039	0.370	211.870
50.00	24.4	26.26	0.000	39.710	39.710	28557700	0.337	211.837
51.00	22.0	23.21	0.000	34.553	34.553	28516720	0.309	211.809
52.00	19.5	20.75	0.000	30.357	30.357	28482326	0.286	211.786
53.00	18.0	18.74	0.000	26.958	26.958	28452729	0.265	211.765
54.00	16.4	17.17	0.000	24.159	24.159	28427577	0.248	211.749
55.00	15.5	15.96	0.000	21.862	21.862	28406335	0.234	211.734
56.00	14.7	15.10	0.000	19.983	19.983	28388774	0.222	211.722
57.00	14.4	14.53	0.000	18.472	18.472	28374591	0.212	211.712
58.00	14.1	14.24	0.000	17.281	17.281	28363658	0.205	211.705
59.00	14.1	14.10	0.000	16.381	16.381	28355446	0.199	211.699
60.00	14.1	14.10	0.000	15.716	15.716	28349629	0.195	211.695

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

Table 2.21 Flood Control Study

(5) Huai Khon Kaen Dam (Return Period 30 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
1.00	17.4	17.40	0.000	0.000	0.000	28125040	0.043	211.343
2.00	17.4	17.40	0.000	1.553	1.553	28182089	0.081	211.581
3.00	17.4	17.40	0.000	4.102	4.102	28229761	0.114	211.614
4.00	17.4	17.40	0.000	6.795	6.795	28268139	0.140	211.640
5.00	17.4	17.42	0.000	9.245	9.245	28297574	0.160	211.660
6.00	17.5	17.46	0.000	11.298	11.298	28319770	0.175	211.675
7.00	17.7	17.57	0.000	12.935	12.935	28336455	0.186	211.686
8.00	17.8	17.74	0.000	14.213	14.213	28349151	0.195	211.695
9.00	18.4	18.10	0.000	15.212	15.212	28359553	0.202	211.702
10.00	18.9	18.65	0.000	16.047	16.047	28368936	0.208	211.708
11.00	49.9	34.44	0.000	16.814	16.814	28432381	0.252	211.752
12.00	81.0	65.45	0.000	22.295	22.295	28587743	0.357	211.857
13.00	120.7	100.84	0.000	37.722	37.722	28814968	0.512	212.012
14.00	160.5	140.61	0.000	64.678	64.678	29088308	0.698	212.198
15.00	203.7	182.11	0.000	102.943	102.943	29373310	0.892	212.392
16.00	247.0	225.36	0.000	148.695	148.695	29649291	1.079	212.579
17.00	292.0	269.48	0.000	198.042	198.042	29906469	1.254	212.754
18.00	337.0	314.48	0.000	248.066	248.066	30145496	1.417	212.917
19.00	384.2	360.59	0.000	297.851	297.851	30371367	1.570	213.070
20.00	431.4	407.81	0.000	347.566	347.566	30588189	1.718	213.218
21.00	479.5	455.47	0.000	397.678	397.678	30796255	1.859	213.359
22.00	527.6	503.57	0.000	447.815	447.815	30996977	1.996	213.496
23.00	530.7	529.15	0.000	496.028	496.028	31189013	2.072	213.572
24.00	533.7	532.21	0.000	526.819	526.819	31328414	2.065	213.565
25.00	523.4	528.55	0.000	531.860	531.860	31116516	2.077	213.577
26.00	513.0	518.19	0.000	528.767	528.767	31078431	2.051	213.551
27.00	497.5	505.24	0.000	518.707	518.707	31029224	2.018	213.518
28.00	481.9	489.71	0.000	506.260	506.260	30969636	1.977	213.477
29.00	462.8	472.37	0.000	491.084	491.084	30902273	1.931	213.431
30.00	443.7	453.23	0.000	474.115	474.115	30827098	1.880	213.380
31.00	421.3	432.43	0.000	455.415	455.415	30744526	1.824	213.324
32.00	398.9	410.11	0.000	435.166	435.166	30654315	1.763	213.263
33.00	375.1	387.03	0.000	413.397	413.397	30559393	1.698	213.198
34.00	351.3	363.24	0.000	390.895	390.895	30459036	1.630	213.130
35.00	325.4	338.38	0.000	367.753	367.753	30354043	1.559	213.059
36.00	299.5	312.45	0.000	343.694	343.694	30241605	1.482	212.982
37.00	273.6	286.54	0.000	318.701	318.701	30125811	1.403	212.903
38.00	247.7	260.65	0.000	293.639	293.639	30007049	1.323	212.823
39.00	221.4	234.54	0.000	268.657	268.657	29884243	1.239	212.739
40.00	195.1	208.22	0.000	243.614	243.614	29756816	1.152	212.652
41.00	169.1	182.09	0.000	218.507	218.507	29625707	1.063	212.563
42.00	143.2	156.16	0.000	193.643	193.643	29490753	0.971	212.471
43.00	117.3	130.49	0.000	169.118	169.118	29351698	0.877	212.377
44.00	92.4	105.09	0.000	145.031	145.031	29207682	0.779	212.279
45.00	73.6	83.01	0.000	121.456	121.456	29059468	0.685	212.185
46.00	54.9	64.26	0.000	100.121	100.121	28940355	0.597	212.097
47.00	47.0	50.93	0.000	81.493	81.493	28830305	0.522	212.022
48.00	39.1	43.02	0.000	66.665	66.665	28745196	0.464	211.964
49.00	34.5	36.79	0.000	55.895	55.895	28676433	0.418	211.918
50.00	30.0	32.24	0.000	47.668	47.668	28620893	0.380	211.880
51.00	26.7	28.45	0.000	41.349	41.349	28574470	0.348	211.848
52.00	25.9	25.43	0.000	36.302	36.302	28535347	0.322	211.822
53.00	22.0	22.97	0.000	32.222	32.222	28502047	0.299	211.799
54.00	20.1	21.07	0.000	28.880	28.880	28473916	0.280	211.780
55.00	19.1	19.60	0.000	26.153	26.153	28450137	0.264	211.764
56.00	18.1	18.59	0.000	23.937	23.937	28431068	0.251	211.751
57.00	17.7	17.91	0.000	22.176	22.176	28415699	0.240	211.740
58.00	17.4	17.57	0.000	20.804	20.804	28404052	0.232	211.732
59.00	17.4	17.40	0.000	19.784	19.784	28395470	0.227	211.727
60.00	17.4	17.40	0.000	19.043	19.043	28389555	0.222	211.722

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

Table 2.21 Flood Control Study

(6) Huai Khon Kaen Dam (Return Period 50 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
1.00	18.7	18.70	0.000	0.000	0.000	28129720	0.046	211.5[illegible]
2.00	18.7	18.70	0.000	1.730	1.730	28190810	0.087	211.587
3.00	18.7	18.72	0.000	4.557	4.557	28241797	0.122	211.622
4.00	18.8	18.76	0.000	7.528	7.528	28282248	0.150	211.650
5.00	18.9	18.83	0.000	10.212	10.212	28313263	0.171	211.671
6.00	19.0	18.91	0.000	12.448	12.448	28336536	0.186	211.686
7.00	19.2	19.06	0.000	14.220	14.220	28353967	0.198	211.698
8.00	19.4	19.27	0.000	15.597	15.597	28367204	0.207	211.707
9.00	20.1	19.72	0.000	16.671	16.671	28378178	0.215	211.715
10.00	20.7	20.40	0.000	17.560	17.560	28388326	0.222	211.722
11.00	56.2	38.43	0.000	18.434	18.434	28460478	0.271	211.771
12.00	91.7	73.95	0.000	24.882	24.882	28637128	0.391	211.891
13.00	136.6	114.14	0.000	43.165	43.165	28892646	0.565	212.065
14.00	181.5	159.05	0.000	74.946	74.946	29195415	0.771	212.271
15.00	230.2	205.83	0.000	119.478	119.478	29506284	0.982	212.482
16.00	278.8	254.49	0.000	171.884	171.884	29803673	1.184	212.684
17.00	329.3	304.06	0.000	227.633	227.633	30076810	1.371	212.871
18.00	379.8	354.54	0.000	283.664	283.664	30333955	1.545	213.045
19.00	432.7	406.23	0.000	339.173	339.173	30575356	1.709	213.209
20.00	485.6	459.13	0.000	394.651	394.651	30807493	1.867	213.367
21.00	537.3	512.45	0.000	450.580	450.580	31030213	2.018	213.518
22.00	593.0	566.17	0.000	506.514	506.514	31244979	2.164	213.664
23.00	645.3	594.15	0.000	562.477	562.477	31359013	2.242	213.742
24.00	597.5	596.40	0.000	592.977	592.977	31371324	2.250	213.750
25.00	589.3	571.40	0.000	596.302	596.302	31353680	2.238	213.738
26.00	573.0	579.17	0.000	591.539	591.539	31309137	2.208	213.708
27.00	555.2	564.10	0.000	573.571	573.571	31253444	2.170	213.670
28.00	537.3	546.21	0.000	564.722	564.722	31186783	2.125	213.625
29.00	515.5	526.40	0.000	547.120	547.120	31112187	2.074	213.574
30.00	493.8	504.68	0.000	527.643	527.643	31029517	2.018	213.518
31.00	468.6	481.23	0.000	506.335	506.335	30939122	1.956	213.456
32.00	443.4	456.04	0.000	483.373	483.373	30840709	1.889	213.389
33.00	416.3	430.13	0.000	458.732	458.732	30737570	1.819	213.319
34.00	390.2	403.51	0.000	433.474	433.474	30629711	1.746	213.246
35.00	361.2	375.70	0.000	407.524	407.524	30515140	1.668	213.168
36.00	332.2	346.69	0.000	380.551	380.551	30393243	1.585	213.085
37.00	303.2	317.71	0.000	352.538	352.538	30267877	1.500	213.000
38.00	274.3	288.77	0.000	324.481	324.481	30139304	1.412	212.912
39.00	244.9	259.57	0.000	296.524	296.524	30006273	1.322	212.822
40.00	215.4	230.13	0.000	268.476	268.476	29868149	1.228	212.728
41.00	186.4	200.91	0.000	240.393	240.393	29726017	1.131	212.631
42.00	157.4	171.92	0.000	212.577	212.577	29579665	1.032	212.532
43.00	129.0	143.23	0.000	185.152	185.152	29428759	0.929	212.429
44.00	100.6	114.84	0.000	158.228	158.228	29272570	0.823	212.323
45.00	79.9	90.25	0.000	131.388	131.388	29122678	0.721	212.221
46.00	59.1	69.46	0.000	106.160	106.160	28983368	0.626	212.126
47.00	50.5	54.81	0.000	97.559	97.559	28865463	0.546	212.046
48.00	42.0	46.29	0.000	71.295	71.295	28775437	0.485	211.985
49.00	37.1	39.58	0.000	59.647	59.647	28703179	0.436	211.936
50.00	32.2	34.69	0.000	50.817	50.817	28645115	0.396	211.896
51.00	29.0	30.62	0.000	44.063	44.063	28596705	0.363	211.863
52.00	25.8	27.39	0.000	38.692	38.692	28556009	0.336	211.836
53.00	23.7	24.75	0.000	34.357	34.357	28521407	0.312	211.812
54.00	21.7	22.69	0.000	30.808	30.808	28492191	0.292	211.792
55.00	20.6	21.11	0.000	27.914	27.914	28467706	0.276	211.776
56.00	19.5	20.01	0.000	25.563	25.563	28447697	0.262	211.762
57.00	19.1	19.26	0.000	23.694	23.694	28431747	0.251	211.751
58.00	18.7	18.89	0.000	22.238	22.238	28419690	0.243	211.743
59.00	18.7	18.70	0.000	21.153	21.153	28410845	0.237	211.737
60.00	18.7	18.70	0.000	20.377	20.377	28404807	0.233	211.733

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S.

Table 2.21 Flood Control Study

(7) Huai Yai Dam (Return Period 10 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	w.L (MSL m)
0.75	3.2	3.20	0.000	0.000	0.000	8170640	0.007	207.007
1.50	3.2	3.20	0.000	0.004	0.004	8179107	0.016	209.016
2.25	3.2	3.20	0.000	0.177	0.177	8187265	0.027	209.027
3.00	3.2	3.20	0.000	0.321	0.321	8195039	0.035	209.035
3.75	3.2	3.20	0.000	0.479	0.479	8202334	0.043	209.043
4.50	3.2	3.20	0.000	0.648	0.648	8209275	0.050	209.050
5.25	3.2	3.20	0.000	0.821	0.821	8215699	0.057	209.057
6.00	3.2	3.20	0.000	0.993	0.993	8221657	0.063	209.063
6.75	3.2	3.21	0.000	1.163	1.163	8227137	0.069	209.069
7.50	3.2	3.23	0.000	1.329	1.329	8232332	0.074	209.074
8.25	3.3	3.27	0.000	1.489	1.489	8237136	0.079	209.079
9.00	3.3	3.31	0.000	1.644	1.644	8241643	0.084	209.084
9.75	3.5	3.42	0.000	1.794	1.794	8246023	0.089	209.089
10.50	3.7	3.58	0.000	1.945	1.945	8250434	0.093	209.093
11.25	3.5	6.59	0.000	2.100	2.100	8262570	0.106	209.106
12.00	15.4	12.47	0.000	2.546	2.546	8289352	0.134	209.134
12.75	23.1	19.25	0.000	3.623	3.623	8331542	0.179	209.179
13.50	30.8	26.96	0.000	5.574	5.574	8389290	0.240	209.240
14.25	40.0	35.41	0.000	8.651	8.651	8461543	0.316	209.316
15.00	49.2	44.61	0.000	13.089	13.089	8548637	0.406	209.406
15.75	58.8	54.00	0.000	19.045	19.045	8641015	0.506	209.506
16.50	68.4	63.60	0.000	26.469	26.469	8741260	0.612	209.612
17.25	75.3	71.86	0.000	35.199	35.199	8840233	0.716	209.716
18.00	82.2	78.76	0.000	44.595	44.595	8932524	0.813	209.813
18.75	83.1	82.67	0.000	54.000	54.000	9009744	0.895	209.895
19.50	84.0	83.55	0.000	62.340	62.340	9067208	0.956	209.956
20.25	81.8	82.92	0.000	69.760	69.760	9105432	0.996	209.996
21.00	79.7	80.78	0.000	73.161	73.161	9126004	1.015	210.015
21.75	77.8	78.75	0.000	75.277	75.277	9135364	1.024	210.024
22.50	75.8	76.81	0.000	76.219	76.219	9136965	1.025	210.025
23.25	72.8	74.35	0.000	76.381	76.381	9131470	1.020	210.020
24.00	69.8	71.34	0.000	75.828	75.828	9119363	1.009	210.009
24.75	66.0	67.90	0.000	74.614	74.614	9101247	0.992	209.992
25.50	62.1	64.03	0.000	72.875	72.875	9077894	0.967	209.967
26.25	57.5	59.79	0.000	69.982	69.982	9050369	0.938	209.938
27.00	52.9	55.21	0.000	66.853	66.853	9018952	0.905	209.905
27.75	47.6	50.28	0.000	63.336	63.336	8983670	0.867	209.867
28.50	42.4	44.99	0.000	59.467	59.467	8944613	0.826	209.826
29.25	36.6	39.45	0.000	55.276	55.276	8901973	0.781	209.781
30.00	30.9	33.74	0.000	50.820	50.820	8855865	0.733	209.733
30.75	25.7	28.28	0.000	46.145	46.145	8807625	0.682	209.682
31.50	20.5	23.09	0.000	41.418	41.418	8758133	0.629	209.629
32.25	17.7	19.10	0.000	36.743	36.743	8710474	0.579	209.579
33.00	14.9	16.30	0.000	32.430	32.430	8666933	0.533	209.533
33.75	13.1	13.99	0.000	28.646	28.646	8627352	0.491	209.491
34.50	11.2	12.14	0.000	25.345	25.345	8591709	0.454	209.454
35.25	7.9	10.54	0.000	22.437	22.437	8559442	0.420	209.420
36.00	6.5	9.17	0.000	20.004	20.004	8530195	0.389	209.389
36.75	7.5	7.98	0.000	17.937	17.937	8503586	0.361	209.361
37.50	6.5	6.97	0.000	15.939	15.939	8479366	0.335	209.335
38.25	5.7	6.10	0.000	14.274	14.274	8457287	0.312	209.312
39.00	5.0	5.37	0.000	12.811	12.811	8437194	0.291	209.291
39.75	4.5	4.76	0.000	11.526	11.526	8418913	0.271	209.271
40.50	4.0	4.26	0.000	10.397	10.397	8402268	0.254	209.254
41.25	3.7	3.86	0.000	9.407	9.407	8387366	0.238	209.238
42.00	3.4	3.57	0.000	8.542	8.542	8373405	0.224	209.224
42.75	3.3	3.37	0.000	7.790	7.790	8361938	0.211	209.211
43.50	3.2	3.26	0.000	7.140	7.140	8351478	0.200	209.200
44.25	3.2	3.20	0.000	6.566	6.566	8342355	0.190	209.190
45.00	3.2	3.20	0.000	6.115	6.115	8334464	0.182	209.182
45.75	3.2	3.20	0.000	5.719	5.719	8327692	0.175	209.175
46.50	3.2	3.20	0.000	5.364	5.364	8321705	0.169	209.169

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of ...

Table 2.21 Flood Control Study

(8) Huai Yai Dam (Return Period 30 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (M.S.L m)
0.75	3.7	3.70	0.000	0.000	0.000	8171970	0.011	209.011
1.50	3.7	3.70	0.000	0.080	0.080	8181765	0.021	209.021
2.25	3.7	3.70	0.000	0.222	0.222	8191156	0.031	209.031
3.00	3.7	3.70	0.000	0.397	0.397	8200073	0.040	209.040
3.75	3.7	3.70	0.000	0.593	0.593	8208461	0.049	209.049
4.50	3.7	3.70	0.000	0.800	0.800	8216292	0.057	209.057
5.25	3.7	3.71	0.000	1.010	1.010	8223586	0.065	209.065
6.00	3.7	3.73	0.000	1.220	1.220	8230375	0.072	209.072
6.75	3.8	3.77	0.000	1.427	1.427	8236696	0.079	209.079
7.50	3.8	3.81	0.000	1.630	1.630	8242592	0.085	209.085
8.25	3.9	3.88	0.000	1.827	1.827	8248142	0.091	209.091
9.00	4.0	3.97	0.000	2.019	2.019	8253424	0.097	209.097
9.75	4.3	4.14	0.000	2.207	2.207	8258630	0.102	209.102
10.50	4.5	4.36	0.000	2.398	2.398	8263939	0.108	209.108
11.25	14.0	7.23	0.000	2.597	2.597	8281639	0.127	209.127
12.00	23.5	18.73	0.000	3.312	3.312	8323456	0.170	209.170
12.75	35.7	29.57	0.000	5.180	5.180	8387278	0.240	209.240
13.50	47.6	41.75	0.000	8.652	8.652	8478654	0.334	209.334
14.25	62.0	54.92	0.000	14.226	14.226	8588525	0.450	209.450
15.00	76.2	69.08	0.000	22.240	22.240	8715006	0.584	209.584
15.75	90.7	83.45	0.000	32.833	32.833	8851670	0.728	209.728
16.50	105.3	98.01	0.000	45.727	45.727	8992843	0.877	209.877
17.25	115.3	110.28	0.000	60.464	60.464	9127342	1.016	210.016
18.00	125.2	120.24	0.000	75.413	75.413	9248380	1.145	210.145
18.75	125.4	125.30	0.000	87.879	87.879	9347425	1.217	210.217
19.50	125.5	125.46	0.000	98.761	98.761	9421510	1.282	210.282
20.25	121.1	123.33	0.000	106.780	106.780	9466195	1.322	210.322
21.00	116.7	118.91	0.000	111.854	111.854	9485254	1.337	210.337
21.75	113.1	114.88	0.000	114.042	114.042	9487514	1.341	210.341
22.50	109.4	111.23	0.000	114.302	114.302	9479216	1.334	210.334
23.25	104.3	106.87	0.000	113.347	113.347	9461717	1.313	210.313
24.00	99.3	101.79	0.000	111.342	111.342	9435928	1.285	210.285
24.75	93.1	96.16	0.000	108.406	108.406	9402844	1.265	210.265
25.50	86.9	89.96	0.000	104.683	104.683	9363094	1.229	210.229
26.25	79.8	83.33	0.000	100.266	100.266	9317381	1.188	210.188
27.00	72.7	76.26	0.000	95.264	95.264	9266113	1.141	210.141
27.75	64.8	68.78	0.000	89.753	89.753	9209470	1.090	210.090
28.50	56.9	60.84	0.000	83.802	83.802	9147478	1.035	210.035
29.25	48.5	52.66	0.000	77.443	77.443	9080673	0.976	209.976
30.00	40.0	44.24	0.000	70.289	70.289	9010244	0.896	209.896
30.75	32.6	36.30	0.000	62.373	62.373	8936566	0.821	209.821
31.50	25.1	28.85	0.000	54.773	54.773	8860624	0.747	209.747
32.25	21.5	23.32	0.000	47.547	47.547	8784434	0.678	209.678
33.00	17.9	19.70	0.000	41.111	41.111	8746626	0.617	209.617
33.75	15.7	16.77	0.000	35.667	35.667	8695556	0.563	209.563
34.50	13.4	14.54	0.000	31.118	31.118	8650772	0.516	209.516
35.25	11.6	12.59	0.000	27.284	27.284	8611119	0.474	209.474
36.00	10.1	10.93	0.000	24.030	24.030	8575757	0.437	209.437
36.75	8.9	9.49	0.000	21.247	21.247	8544013	0.403	209.403
37.50	7.7	8.27	0.000	18.851	18.851	8515455	0.373	209.373
38.25	6.8	7.22	0.000	16.777	16.777	8489647	0.346	209.346
39.00	5.9	6.33	0.000	14.974	14.974	8466319	0.321	209.321
39.75	5.3	5.59	0.000	13.405	13.405	8445234	0.299	209.299
40.50	4.7	5.00	0.000	12.035	12.035	8426245	0.279	209.279
41.25	4.3	4.52	0.000	10.845	10.845	8409177	0.261	209.261
42.00	4.0	4.17	0.000	9.811	9.811	8393937	0.245	209.245
42.75	3.8	3.92	0.000	8.913	8.913	8380429	0.231	209.231
43.50	3.7	3.77	0.000	8.150	8.150	8368607	0.218	209.218
44.25	3.7	3.70	0.000	7.496	7.496	8358353	0.207	209.207
45.00	3.7	3.70	0.000	6.947	6.947	8347567	0.196	209.196
45.75	3.7	3.70	0.000	6.497	6.497	8342063	0.190	209.190
46.50	3.7	3.70	0.000	6.100	6.100	8335562	0.183	209.183

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

Table 2.21 Flood Control Study

(9) Huai Yai Dam (Return Period 50 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
0.75	3.9	3.90	0.000	0.000	0.000	8172530	0.011	209.011
1.50	3.9	3.90	0.000	0.086	0.086	8180827	0.022	209.022
2.25	3.9	3.90	0.000	0.240	0.240	8192709	0.032	209.032
3.00	3.9	3.90	0.000	0.430	0.430	8202679	0.042	209.042
3.75	3.9	3.90	0.000	0.641	0.641	8210879	0.052	209.052
4.50	3.9	3.90	0.000	0.863	0.863	8219080	0.060	209.060
5.25	3.9	3.91	0.000	1.087	1.087	8226701	0.068	209.068
6.00	3.9	3.93	0.000	1.314	1.314	8233777	0.076	209.076
6.75	4.0	3.97	0.000	1.545	1.545	8240346	0.083	209.083
7.50	4.0	4.01	0.000	1.751	1.751	8246456	0.089	209.089
8.25	4.2	4.09	0.000	1.960	1.960	8252218	0.095	209.095
9.00	4.3	4.21	0.000	2.163	2.163	8257741	0.101	209.101
9.75	4.5	4.40	0.000	2.365	2.365	8263246	0.107	209.107
10.50	4.8	4.68	0.000	2.572	2.572	8268932	0.113	209.113
11.25	16.0	10.43	0.000	2.792	2.792	8289550	0.135	209.135
12.00	27.3	21.65	0.000	3.037	3.037	8338196	0.186	209.186
12.75	41.3	34.30	0.000	5.705	5.705	8414870	0.267	209.267
13.50	55.4	48.37	0.000	10.152	10.152	8518070	0.376	209.376
14.25	71.7	63.55	0.000	16.764	16.764	8643865	0.509	209.509
15.00	88.0	79.84	0.000	26.706	26.706	8787337	0.660	209.660
15.75	104.6	96.29	0.000	39.431	39.431	8940724	0.822	209.822
16.50	121.2	112.90	0.000	54.864	54.864	9097410	0.988	209.988
17.25	132.3	126.76	0.000	72.230	72.230	9244650	1.122	210.122
18.00	143.5	137.89	0.000	87.465	87.465	9380750	1.245	210.245
18.75	143.1	143.29	0.000	102.220	102.220	9491635	1.345	210.345
19.50	142.8	142.95	0.000	114.777	114.777	9567702	1.413	210.413
20.25	137.3	140.06	0.000	123.668	123.668	9611970	1.453	210.453
21.00	131.9	134.63	0.000	126.943	126.943	9627317	1.467	210.467
21.75	127.6	129.75	0.000	130.739	130.739	9624507	1.465	210.465
22.50	123.3	125.43	0.000	130.450	130.450	9610943	1.452	210.452
23.25	117.3	120.27	0.000	128.820	128.820	9587870	1.432	210.432
24.00	111.3	114.29	0.000	126.062	126.062	9556086	1.403	210.403
24.75	104.1	107.70	0.000	122.276	122.276	9516639	1.367	210.367
25.50	96.9	100.52	0.000	117.681	117.681	9470343	1.326	210.326
26.25	88.8	92.86	0.000	112.329	112.329	9417790	1.278	210.278
27.00	80.7	84.75	0.000	106.361	106.361	9359442	1.226	210.226
27.75	71.7	76.17	0.000	99.803	99.803	9295479	1.168	210.168
28.50	62.6	67.13	0.000	92.896	92.896	9225910	1.105	210.105
29.25	53.1	57.84	0.000	85.517	85.517	9151182	1.038	210.038
30.00	43.5	48.29	0.000	77.818	77.818	9071469	0.966	209.966
30.75	35.2	39.34	0.000	69.246	69.246	8990715	0.893	209.893
31.50	26.8	30.97	0.000	60.231	60.231	8911705	0.821	209.821
32.25	22.9	24.85	0.000	51.826	51.826	8838385	0.755	209.755
33.00	19.0	20.98	0.000	44.460	44.460	8775462	0.698	209.698
33.75	16.6	17.85	0.000	38.362	38.362	8720067	0.648	209.648
34.50	14.3	15.45	0.000	33.285	33.285	8671916	0.604	209.604
35.25	12.5	13.37	0.000	29.071	29.071	8629525	0.566	209.566
36.00	10.7	11.60	0.000	25.522	25.522	8591946	0.532	209.532
36.75	9.4	10.07	0.000	22.503	22.503	8558359	0.502	209.502
37.50	8.1	8.76	0.000	19.923	19.923	8528227	0.475	209.475
38.25	7.2	7.64	0.000	17.695	17.695	8501063	0.451	209.451
39.00	6.2	6.70	0.000	15.764	15.764	8476422	0.429	209.429
39.75	5.6	5.92	0.000	14.090	14.090	8454563	0.409	209.409
40.50	5.0	5.29	0.000	12.634	12.634	8434745	0.391	209.391
41.25	4.6	4.78	0.000	11.372	11.372	8416958	0.375	209.375
42.00	4.2	4.40	0.000	10.278	10.278	8401030	0.360	209.360
42.75	4.1	4.13	0.000	9.333	9.333	8387026	0.348	209.348
43.50	3.9	3.98	0.000	8.522	8.522	8374750	0.337	209.337
44.25	3.9	3.90	0.000	7.835	7.835	8364127	0.328	209.328
45.00	3.9	3.90	0.000	7.255	7.255	8355068	0.320	209.320
45.75	3.9	3.90	0.000	6.773	6.773	8347311	0.313	209.313
46.50	3.9	3.90	0.000	6.369	6.369	8340645	0.307	209.307

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

Table 2.21 Flood Control Study

(10) Khlong Chaliang Lab Dam (Return Period 10 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
0.75	3.2	3.20	0.000	0.000	0.000	2355340	0.027	196.527
1.50	3.2	3.20	0.000	0.325	0.325	2363104	0.051	196.551
2.25	3.2	3.20	0.000	0.849	0.849	2369451	0.071	196.571
3.00	3.2	3.20	0.000	1.367	1.367	2374347	0.086	196.586
3.75	3.2	3.20	0.000	1.858	1.858	2377971	0.097	196.597
4.50	3.2	3.20	0.000	2.235	2.235	2380577	0.105	196.605
5.25	3.2	3.20	0.000	2.520	2.520	2382414	0.111	196.611
6.00	3.2	3.20	0.000	2.727	2.727	2383689	0.115	196.615
6.75	3.2	3.21	0.000	2.875	2.875	2384590	0.118	196.618
7.50	3.2	3.23	0.000	2.981	2.981	2385251	0.120	196.620
8.25	3.3	3.25	0.000	3.059	3.059	2385770	0.122	196.622
9.00	3.3	3.29	0.000	3.121	3.121	2386213	0.123	196.623
9.75	3.4	3.36	0.000	3.174	3.174	2386720	0.125	196.625
10.50	3.5	3.48	0.000	3.235	3.235	2387386	0.127	196.627
11.25	7.9	5.72	0.000	3.517	3.517	2393362	0.147	196.647
12.00	12.2	10.06	0.000	4.139	4.139	2409051	0.197	196.697
12.75	16.1	15.18	0.000	6.413	6.413	2433531	0.270	196.770
13.50	24.0	21.68	0.000	10.340	10.340	2462535	0.361	196.861
14.25	30.9	27.45	0.000	15.932	15.932	2493622	0.457	196.957
15.00	37.7	34.27	0.000	22.758	22.758	2524712	0.554	197.054
15.75	45.0	41.33	0.000	30.352	30.352	2554347	0.646	197.146
16.50	52.3	48.61	0.000	38.238	38.238	2582348	0.733	197.233
17.25	59.8	56.05	0.000	46.228	46.228	2608864	0.816	197.316
18.00	67.4	63.65	0.000	54.246	54.246	2634246	0.895	197.395
18.75	71.1	69.26	0.000	62.312	62.312	2659065	0.954	197.454
19.50	74.8	72.95	0.000	68.528	68.528	2665016	0.991	197.491
20.25	75.0	74.83	0.000	72.577	72.577	2671236	1.010	197.510
21.00	75.2	75.06	0.000	74.715	74.715	2672169	1.013	197.513
21.75	74.0	74.57	0.000	75.037	75.037	2670699	1.009	197.509
22.50	72.8	73.40	0.000	74.598	74.598	2667664	0.999	197.499
23.25	70.9	71.84	0.000	73.435	73.435	2663235	0.985	197.485
24.00	68.9	69.90	0.000	71.969	71.969	2657646	0.968	197.468
24.75	66.4	67.65	0.000	70.071	70.071	2651097	0.947	197.447
25.50	63.8	65.09	0.000	67.869	67.869	2643581	0.924	197.424
26.25	60.6	62.19	0.000	65.371	65.371	2634983	0.897	197.397
27.00	57.3	58.95	0.000	62.552	62.552	2625259	0.867	197.367
27.75	53.6	55.47	0.000	59.414	59.414	2614607	0.834	197.334
28.50	49.9	51.74	0.000	56.039	56.039	2603007	0.798	197.298
29.25	45.7	47.79	0.000	52.439	52.439	2590443	0.759	197.259
30.00	41.5	43.60	0.000	48.631	48.631	2576856	0.716	197.216
30.75	36.9	39.23	0.000	44.622	44.622	2562297	0.671	197.171
31.50	32.4	34.67	0.000	40.453	40.453	2546671	0.622	197.122
32.25	27.9	30.14	0.000	36.139	36.139	2530477	0.572	197.072
33.00	23.4	25.64	0.000	31.835	31.835	2513742	0.520	197.020
33.75	19.7	21.53	0.000	27.590	27.590	2497370	0.469	196.969
34.50	15.9	17.80	0.000	23.635	23.635	2481613	0.420	196.920
35.25	13.9	14.91	0.000	20.026	20.026	2467800	0.377	196.877
36.00	11.8	12.86	0.000	17.031	17.031	2456540	0.342	196.842
36.75	10.4	11.14	0.000	14.711	14.711	2446899	0.312	196.812
37.50	9.1	9.75	0.000	12.818	12.818	2438623	0.286	196.786
38.25	8.0	8.55	0.000	11.263	11.263	2431302	0.263	196.763
39.00	7.0	7.54	0.000	9.944	9.944	2424904	0.243	196.743
39.75	6.3	6.66	0.000	8.821	8.821	2418961	0.225	196.725
40.50	5.5	5.91	0.000	7.850	7.850	2413723	0.209	196.709
41.25	5.0	5.27	0.000	7.012	7.012	2409013	0.194	196.694
42.00	4.5	4.74	0.000	6.287	6.287	2404832	0.181	196.681
42.75	4.1	4.29	0.000	5.664	5.664	2401127	0.169	196.669
43.50	3.8	3.94	0.000	5.131	5.131	2397897	0.159	196.659
44.25	3.6	3.65	0.000	4.681	4.681	2395124	0.151	196.651
45.00	3.3	3.45	0.000	4.306	4.306	2392806	0.144	196.644
45.75	3.3	3.31	0.000	4.001	4.001	2390941	0.138	196.638
46.50	3.2	3.24	0.000	3.761	3.761	2389526	0.133	196.633
47.25	3.2	3.20	0.000	3.592	3.592	2388496	0.130	196.630
48.00	3.2	3.20	0.000	3.453	3.453	2387812	0.128	196.628
48.75	3.2	3.20	0.000	3.369	3.369	2387357	0.127	196.627
49.50	3.2	3.20	0.000	3.313	3.313	2387052	0.126	196.626

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

Table 2.21 Flood Control Study

(11) Khlong Chaliang Lab Dam (Return Period 30 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
0.75	3.6	3.60	0.000	0.000	0.000	2356420	0.030	196.530
1.50	3.6	3.60	0.000	0.387	0.387	2365094	0.057	196.557
2.25	3.6	3.60	0.000	1.003	1.003	2372092	0.079	196.579
3.00	3.6	3.60	0.000	1.635	1.635	2377397	0.096	196.596
3.75	3.6	3.60	0.000	2.174	2.174	2381249	0.108	196.608
4.50	3.6	3.60	0.000	2.595	2.595	2383962	0.116	196.616
5.25	3.6	3.61	0.000	2.907	2.907	2385857	0.122	196.622
6.00	3.6	3.63	0.000	3.131	3.131	2387191	0.126	196.626
6.75	3.7	3.65	0.000	3.293	3.293	2388159	0.129	196.629
7.50	3.7	3.69	0.000	3.411	3.411	2388897	0.131	196.631
8.25	3.8	3.74	0.000	3.503	3.503	2389523	0.133	196.633
9.00	3.8	3.81	0.000	3.582	3.582	2390132	0.135	196.635
9.75	4.0	3.93	0.000	3.656	3.656	2390854	0.137	196.637
10.50	4.2	4.10	0.000	3.750	3.750	2391791	0.140	196.640
11.25	11.2	7.70	0.000	3.869	3.869	2402138	0.173	196.673
12.00	18.3	14.74	0.000	5.275	5.275	2427695	0.252	196.752
12.75	27.6	22.93	0.000	9.315	9.315	2464448	0.366	196.866
13.50	36.9	32.26	0.000	16.328	16.328	2507472	0.500	197.000
14.25	47.4	42.19	0.000	26.051	26.051	2551038	0.636	197.136
15.00	58.0	52.70	0.000	37.328	37.328	2592535	0.765	197.265
15.75	69.0	63.47	0.000	49.253	49.253	2630913	0.885	197.385
16.50	80.0	74.51	0.000	61.252	61.252	2666766	0.996	197.496
17.25	91.4	85.72	0.000	73.176	73.176	2700623	1.102	197.602
18.00	102.8	97.09	0.000	85.059	85.059	2733020	1.202	197.702
18.75	107.3	105.22	0.000	97.036	97.036	2755121	1.271	197.771
19.50	112.6	110.12	0.000	105.481	105.481	2767637	1.310	197.810
20.25	111.9	112.21	0.000	110.367	110.367	2772621	1.326	197.826
21.00	111.2	111.51	0.000	112.333	112.333	2770399	1.319	197.819
21.75	108.6	109.86	0.000	111.455	111.455	2766104	1.305	197.805
22.50	106.0	107.28	0.000	109.764	109.764	2759384	1.284	197.784
23.25	102.4	104.21	0.000	107.137	107.137	2751478	1.260	197.760
24.00	98.9	100.66	0.000	104.073	104.073	2742273	1.231	197.731
24.75	94.7	96.78	0.000	100.543	100.543	2732103	1.200	197.700
25.50	90.4	92.55	0.000	96.692	96.692	2720929	1.165	197.665
26.25	85.3	87.89	0.000	92.516	92.516	2708442	1.126	197.626
27.00	80.2	82.80	0.000	87.925	87.925	2694596	1.083	197.583
27.75	74.6	77.40	0.000	82.725	82.725	2679682	1.036	197.536
28.50	68.9	71.71	0.000	77.650	77.650	2663634	0.986	197.486
29.25	62.6	65.75	0.000	72.105	72.105	2646472	0.933	197.433
30.00	56.4	59.53	0.000	66.328	66.328	2628110	0.876	197.376
30.75	49.7	53.08	0.000	60.328	60.328	2608534	0.815	197.315
31.50	43.1	46.40	0.000	54.144	54.144	2587625	0.750	197.250
32.25	36.5	39.77	0.000	47.790	47.790	2566017	0.683	197.183
33.00	30.0	33.24	0.000	41.507	41.507	2543692	0.613	197.113
33.75	24.7	27.31	0.000	35.333	35.333	2522023	0.546	197.046
34.50	19.3	22.00	0.000	29.667	29.667	2501310	0.481	196.981
35.25	16.7	18.02	0.000	24.563	24.563	2483637	0.426	196.926
36.00	14.1	15.39	0.000	20.478	20.478	2469875	0.383	196.883
36.75	12.4	13.23	0.000	17.474	17.474	2459431	0.348	196.848
37.50	10.7	11.54	0.000	15.093	15.093	2448340	0.318	196.818
38.25	9.5	10.03	0.000	13.132	13.132	2440446	0.292	196.792
39.00	8.2	8.86	0.000	11.600	11.600	2433036	0.269	196.769
39.75	7.3	7.79	0.000	10.252	10.252	2426389	0.248	196.748
40.50	6.4	6.89	0.000	9.091	9.091	2420441	0.230	196.730
41.25	5.8	6.11	0.000	8.092	8.092	2415099	0.213	196.713
42.00	5.1	5.47	0.000	7.229	7.229	2410242	0.198	196.698
42.75	4.7	4.93	0.000	6.483	6.483	2406137	0.185	196.685
43.50	4.3	4.51	0.000	5.856	5.856	2402490	0.174	196.674
44.25	4.0	4.17	0.000	5.325	5.325	2399362	0.164	196.664
45.00	3.8	3.92	0.000	4.884	4.884	2396752	0.156	196.656
45.75	3.7	3.74	0.000	4.525	4.525	2394642	0.149	196.649
46.50	3.6	3.65	0.000	4.242	4.242	2393028	0.144	196.644
47.25	3.6	3.60	0.000	4.031	4.031	2391874	0.141	196.641
48.00	3.6	3.60	0.000	3.880	3.880	2391118	0.138	196.638
48.75	3.6	3.60	0.000	3.783	3.783	2390623	0.137	196.637
49.50	3.6	3.60	0.000	3.720	3.720	2390299	0.136	196.636

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

Table 2.21 Flood Control Study

(12) Khlong Chaliang Lab Dam (Return Period 50 Years)

Time (hr)	Qin (m3/s)	Qin ave (m3/s)	Qout E.S (m3/s)	Qout S.S (m3/s)	Qout Total (m3/s)	Storage (m3)	Dep. (m)	W.L (MSL m)
0.75	3.9	3.90	0.000	0.000	0.000	2357230	0.033	196.533
1.50	3.9	3.90	0.000	0.437	0.437	2366581	0.062	196.562
2.25	3.9	3.90	0.000	1.133	1.133	2374052	0.085	196.585
3.00	3.9	3.90	0.000	1.826	1.826	2379846	0.103	196.603
3.75	3.9	3.90	0.000	2.417	2.417	2383651	0.115	196.615
4.50	3.9	3.90	0.000	2.870	2.870	2386431	0.124	196.624
5.25	3.9	3.91	0.000	3.200	3.200	2388343	0.130	196.630
6.00	3.9	3.93	0.000	3.434	3.434	2389669	0.134	196.634
6.75	4.0	3.95	0.000	3.600	3.600	2390618	0.137	196.637
7.50	4.0	3.99	0.000	3.719	3.719	2391335	0.139	196.639
8.25	4.1	4.05	0.000	3.811	3.811	2391967	0.141	196.641
9.00	4.2	4.13	0.000	3.892	3.892	2392612	0.143	196.643
9.75	4.4	4.23	0.000	3.976	3.976	2393425	0.145	196.645
10.50	4.6	4.48	0.000	4.082	4.082	2394504	0.149	196.649
11.25	12.9	8.74	0.000	4.224	4.224	2406705	0.187	196.687
12.00	21.2	17.06	0.000	5.940	5.940	2436730	0.280	196.780
12.75	32.0	26.61	0.000	10.917	10.917	2479112	0.412	196.912
13.50	42.8	37.40	0.000	19.472	19.472	2527550	0.563	197.063
14.25	54.9	48.84	0.000	31.075	31.075	2575474	0.712	197.212
15.00	67.0	60.92	0.000	44.226	44.226	2620573	0.852	197.352
15.75	79.6	73.26	0.000	57.921	57.921	2661996	0.981	197.481
16.50	92.2	85.86	0.000	71.547	71.547	2700648	1.102	197.602
17.25	105.1	98.64	0.000	85.093	85.093	2737204	1.215	197.715
18.00	118.1	111.59	0.000	98.617	98.617	2772228	1.324	197.824
18.75	123.3	120.69	0.000	112.177	112.177	2795215	1.396	197.896
19.50	128.6	125.94	0.000	121.388	121.388	2807516	1.434	197.934
20.25	127.4	127.98	0.000	126.416	126.416	2811746	1.447	197.947
21.00	126.2	126.81	0.000	126.161	126.161	2808690	1.436	197.936
21.75	123.0	124.62	0.000	126.653	126.653	2802602	1.419	197.919
22.50	119.8	121.42	0.000	124.400	124.400	2794562	1.394	197.894
23.25	115.6	117.71	0.000	121.124	121.124	2785352	1.365	197.865
24.00	111.4	113.49	0.000	117.406	117.406	2774780	1.332	197.832
24.75	106.4	108.91	0.000	113.188	113.188	2763235	1.296	197.796
25.50	101.5	103.98	0.000	108.640	108.640	2750641	1.257	197.757
26.25	95.6	98.56	0.000	103.750	103.750	2736622	1.214	197.714
27.00	89.7	92.66	0.000	98.396	98.396	2721132	1.165	197.665
27.75	83.2	86.45	0.000	92.592	92.592	2704558	1.114	197.614
28.50	76.7	79.94	0.000	86.512	86.512	2686810	1.059	197.559
29.25	69.6	73.14	0.000	80.157	80.157	2667870	1.000	197.500
30.00	62.5	66.06	0.000	73.556	73.556	2647640	0.937	197.437
30.75	55.0	58.74	0.000	66.716	66.716	2626101	0.870	197.370
31.50	47.4	51.17	0.000	59.683	59.683	2603115	0.799	197.299
32.25	40.0	43.69	0.000	52.472	52.472	2579402	0.724	197.224
33.00	32.6	36.30	0.000	45.364	45.364	2554918	0.648	197.148
33.75	26.7	29.63	0.000	38.376	38.376	2531242	0.574	197.074
34.50	20.7	23.68	0.000	32.037	32.037	2506690	0.504	197.004
35.25	17.9	19.30	0.000	26.343	26.343	2489667	0.445	196.945
36.00	15.1	16.48	0.000	21.846	21.846	2475182	0.400	196.900
36.75	13.3	14.17	0.000	18.611	18.611	2463184	0.363	196.863
37.50	11.5	12.36	0.000	16.066	16.066	2453186	0.331	196.831
38.25	10.2	10.81	0.000	14.043	14.043	2444448	0.304	196.804
39.00	8.8	9.50	0.000	12.350	12.350	2436744	0.280	196.780
39.75	7.9	8.36	0.000	10.919	10.919	2429835	0.259	196.759
40.50	6.9	7.40	0.000	9.687	9.687	2423654	0.240	196.740
41.25	6.2	6.57	0.000	8.627	8.627	2418110	0.222	196.722
42.00	5.5	5.89	0.000	7.712	7.712	2413189	0.207	196.707
42.75	5.1	5.32	0.000	6.929	6.929	2408848	0.193	196.693
43.50	4.6	4.87	0.000	6.261	6.261	2405087	0.182	196.682
44.25	4.4	4.51	0.000	5.702	5.702	2401863	0.172	196.672
45.00	4.1	4.24	0.000	5.236	5.236	2399168	0.163	196.663
45.75	4.0	4.05	0.000	4.857	4.857	2396996	0.157	196.657
46.50	3.9	3.95	0.000	4.558	4.558	2395355	0.151	196.651
47.25	3.9	3.90	0.000	4.337	4.337	2394175	0.148	196.648
48.00	3.9	3.90	0.000	4.180	4.180	2393418	0.145	196.645
48.75	3.9	3.90	0.000	4.081	4.081	2392930	0.144	196.644
49.50	3.9	3.90	0.000	4.017	4.017	2392614	0.143	196.643

E.S means Emergency Spillway.
S.S means Service Spillway.
Dep. means Overflow Depth on Crest of S.S .

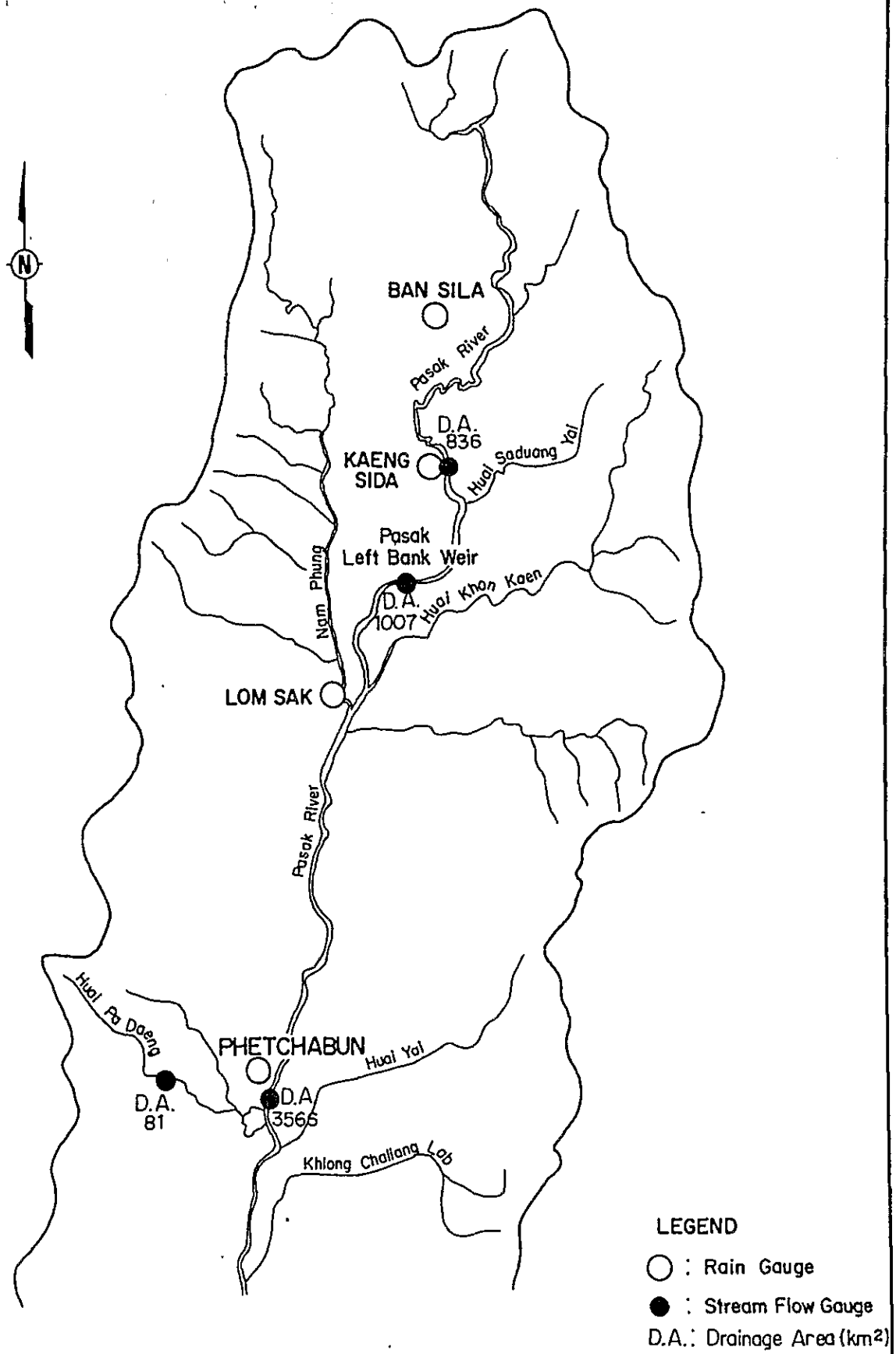


FIG. 2.1 LOCATION OF GAUGING STATION

(Upper Pasak Basin)

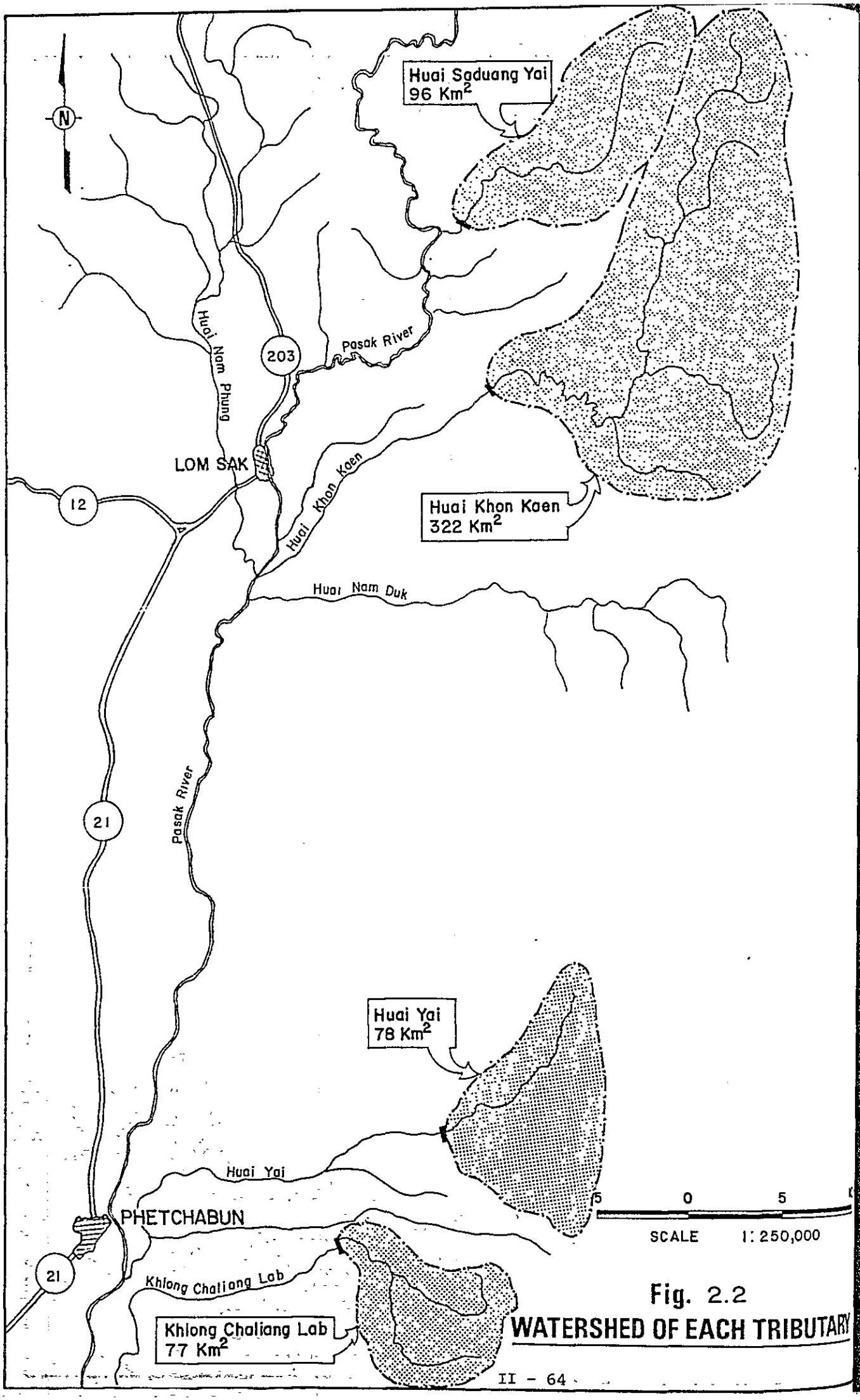


Fig. 2.2
WATERSHED OF EACH TRIBUTARY

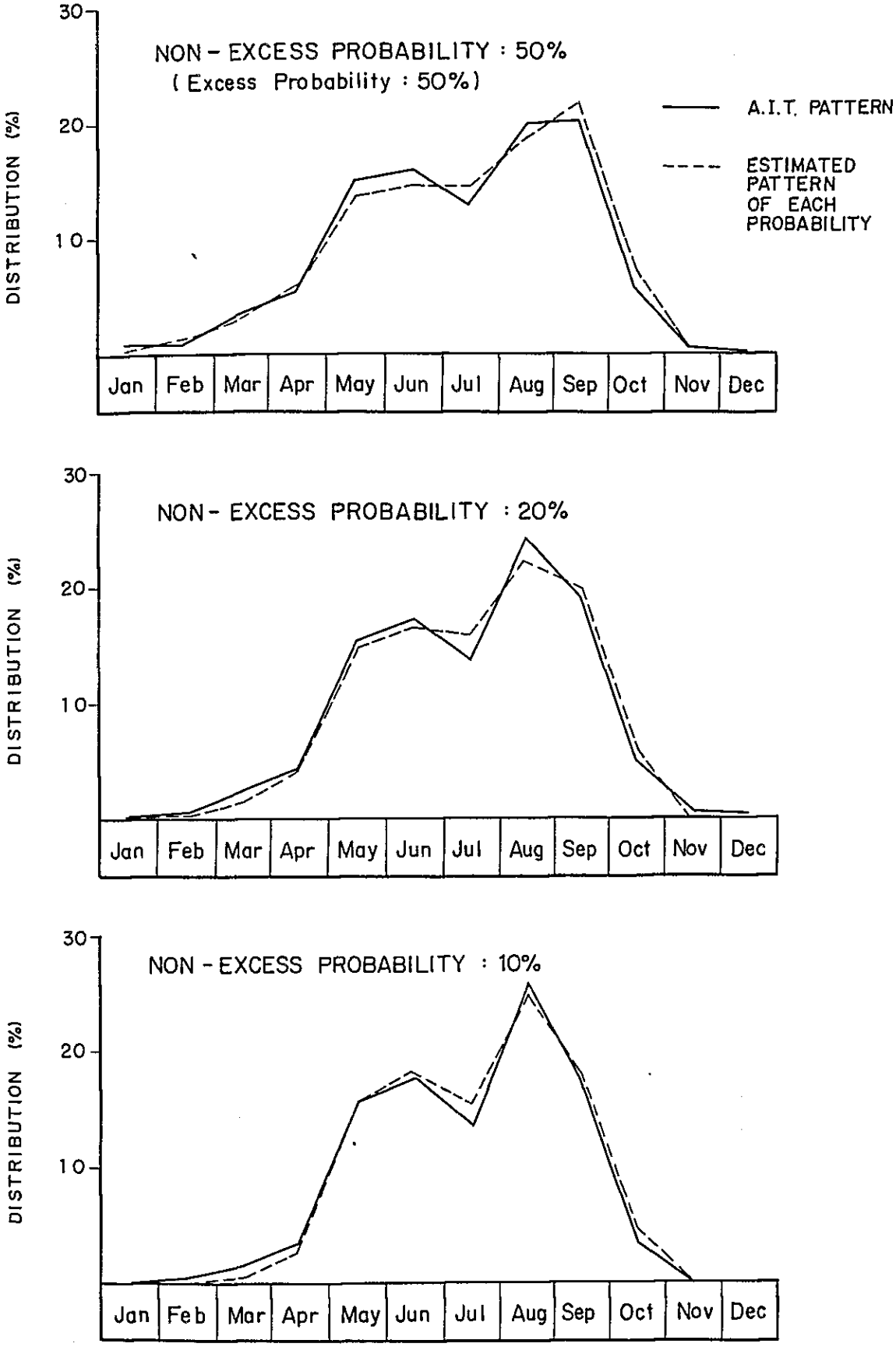


Fig.2.3 (1) MONTHLY RAINFALL DISTRIBUTION OF LOM SAK
(DROUGHTY YEAR)

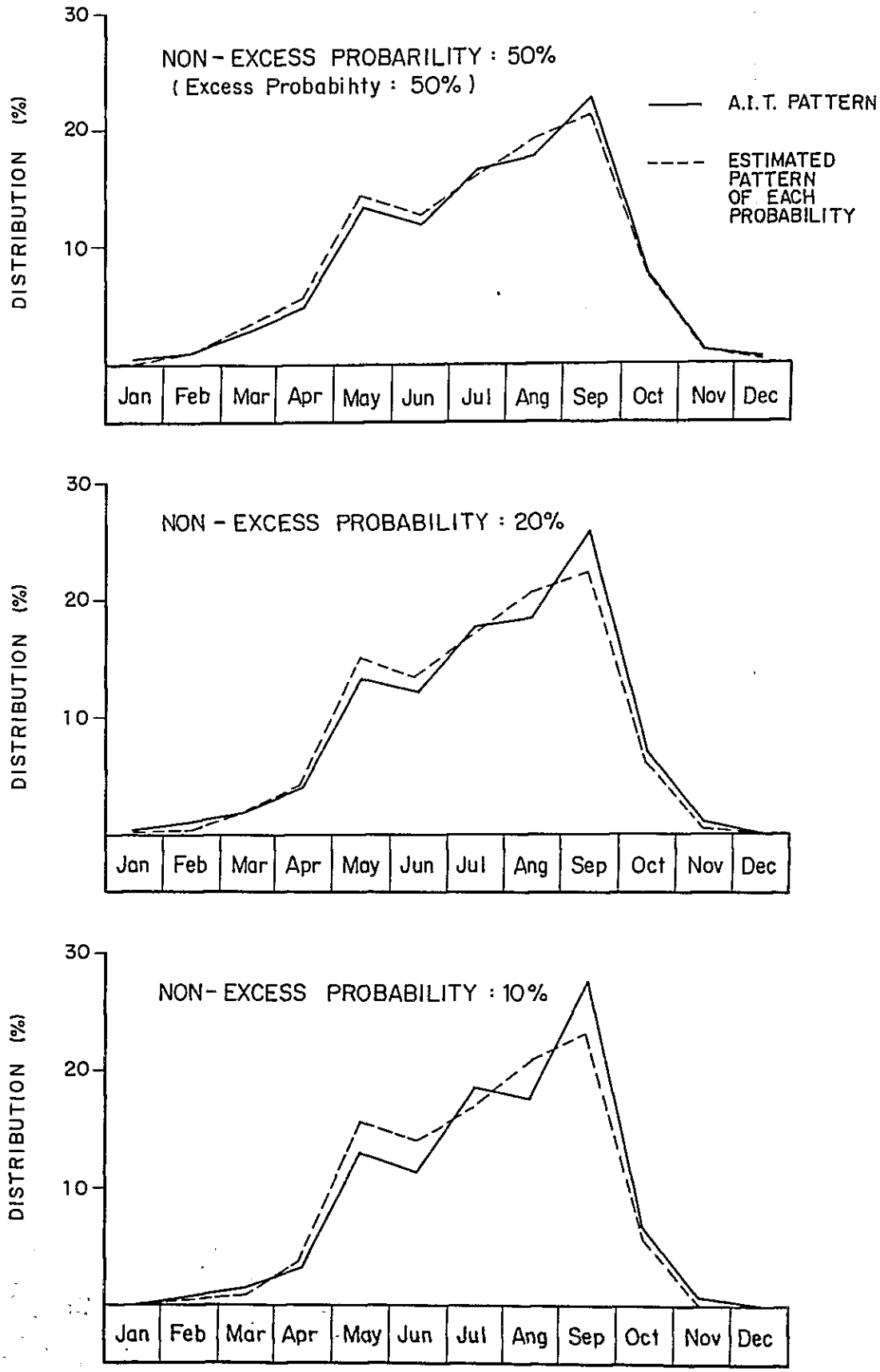
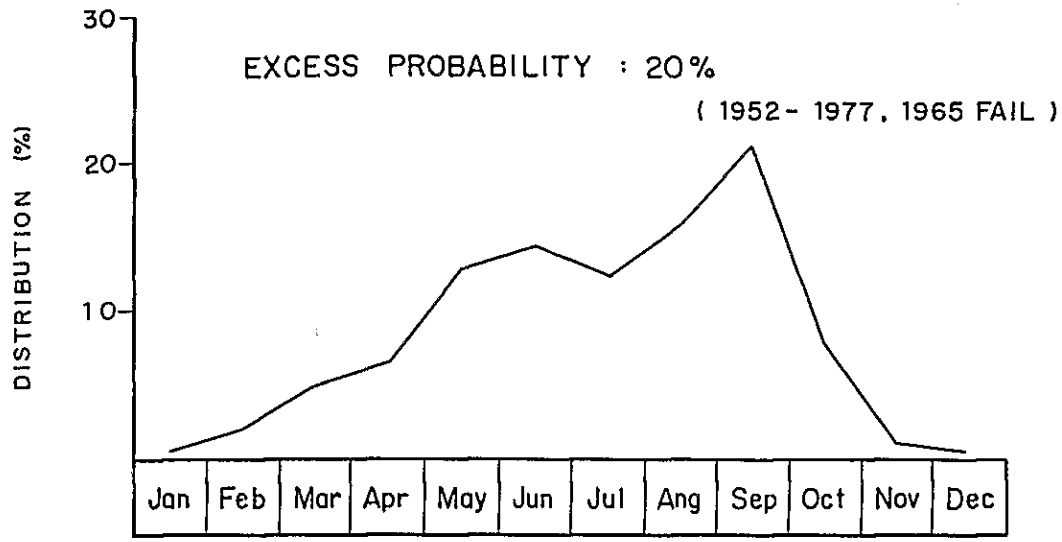


Fig. 2.3(2) MONTHLY RAINFALL DISTRIBUTION OF PHETCHABUN
(DROUGHTY YEAR)



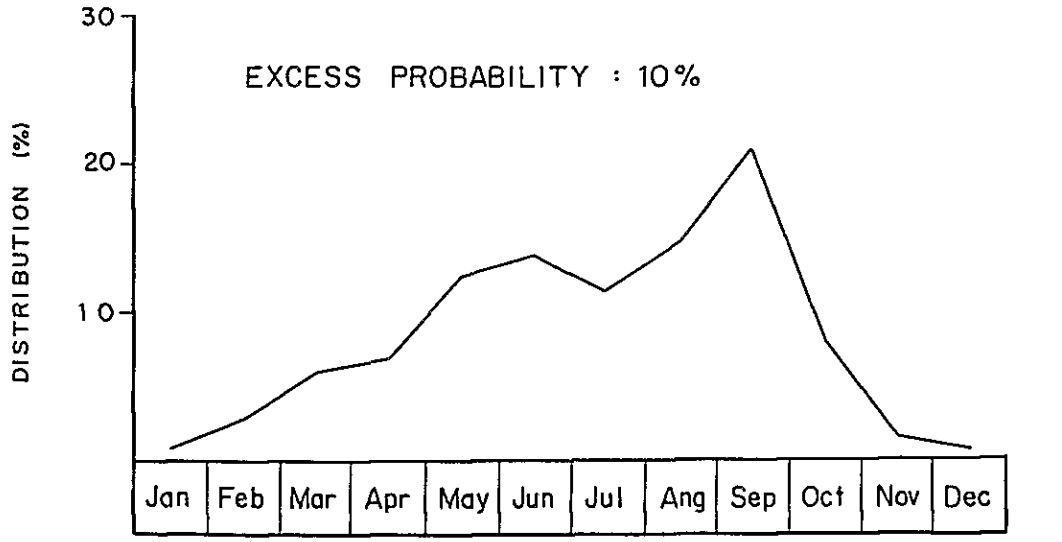
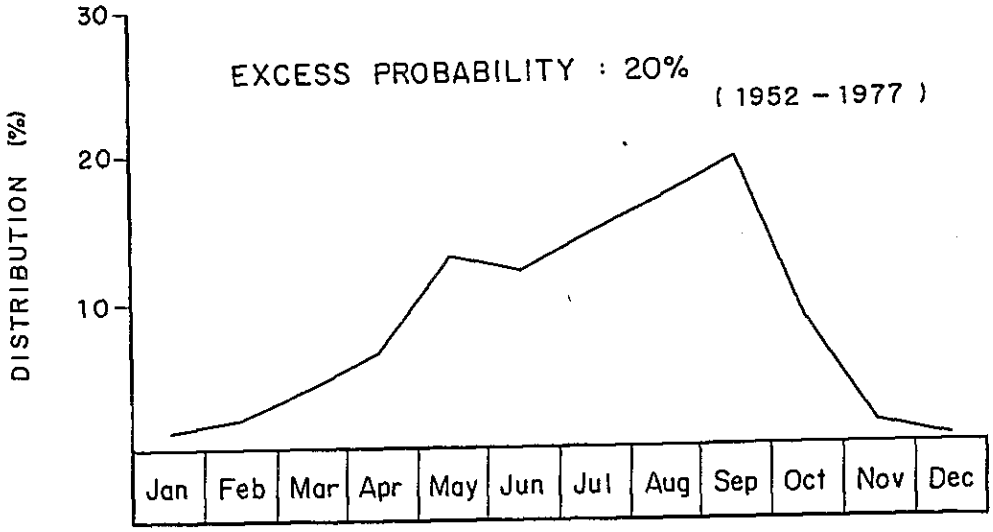


Fig. 2.3 (3) MONTHLY RAINFALL DISTRIBUTION OF LOM SAK
(PLUVIOUS YEAR)



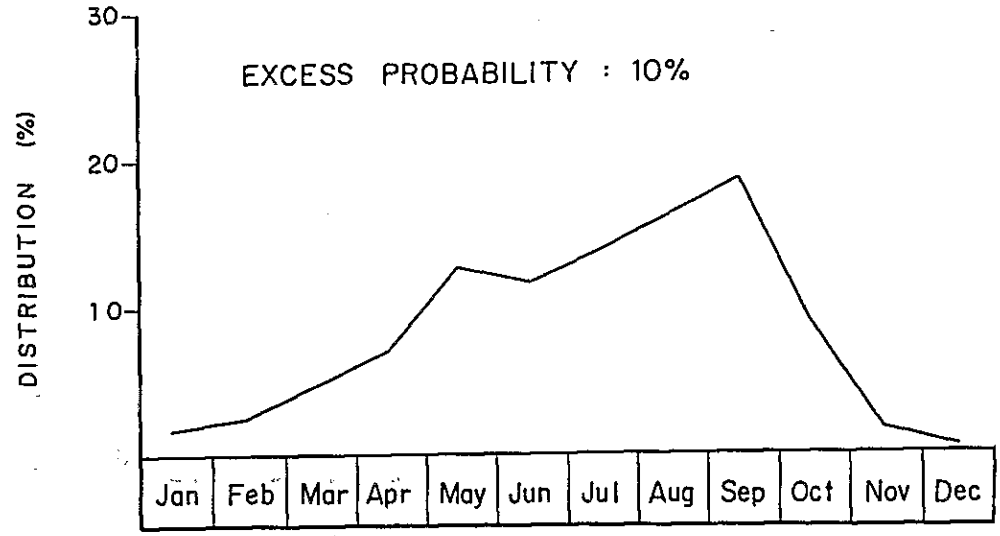


Fig. 2.3 (4) MONTHLY RAINFALL DISTRIBUTION OF PHETCHABUN
(PLUVIOUS YEAR)

Type of Terrain

A — Steep mountainous area, no paddy field.

B — Rather steep area, open forest.

C — Rolling area, open forest, some paddy fields.

D — Gentle slope area, many paddy fields.

E — Flat area, many paddy fields.

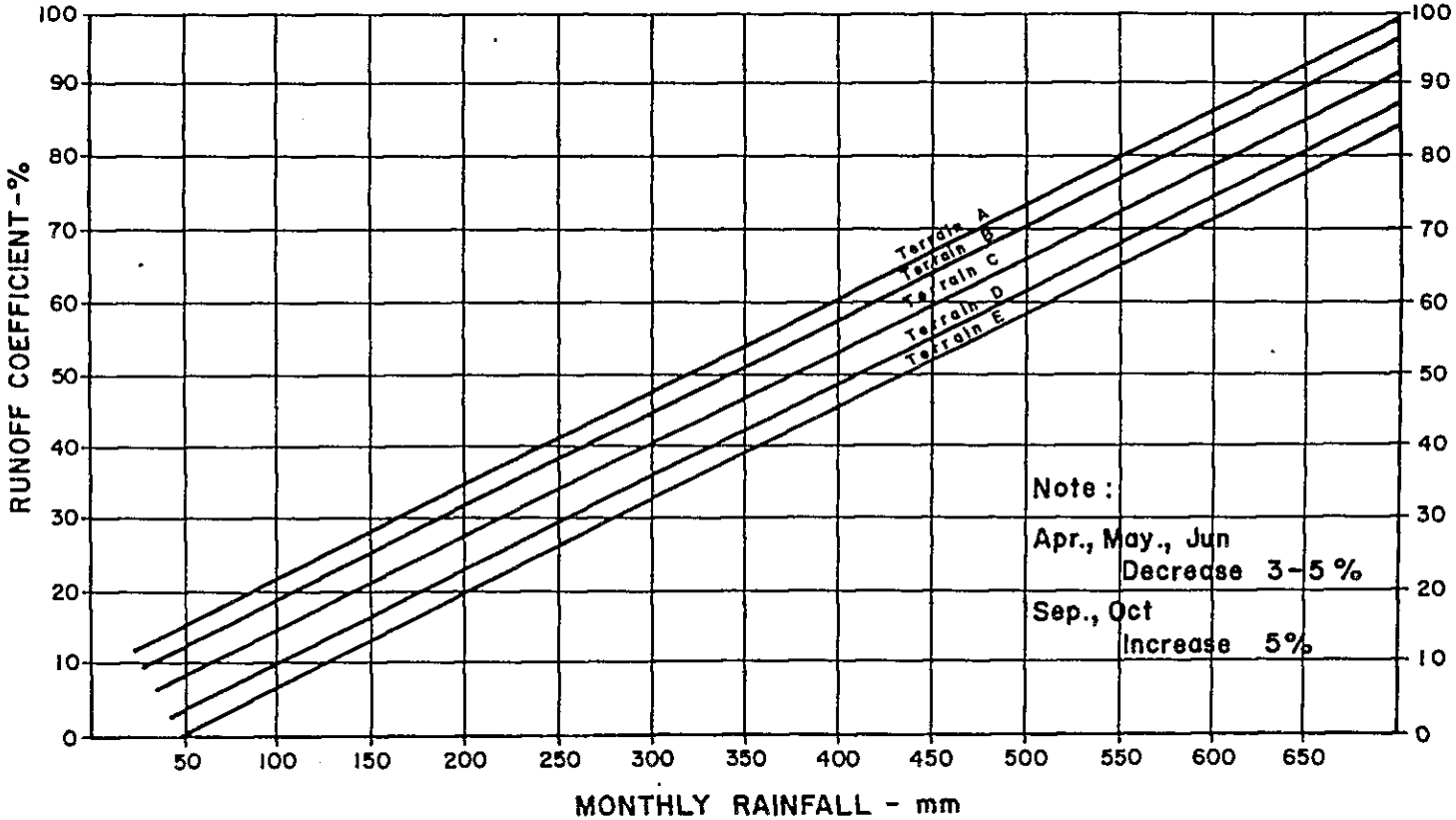


Fig.2.4 ESTIMATE OF RUNOFF COEFFICIENT

(Developed by RID)

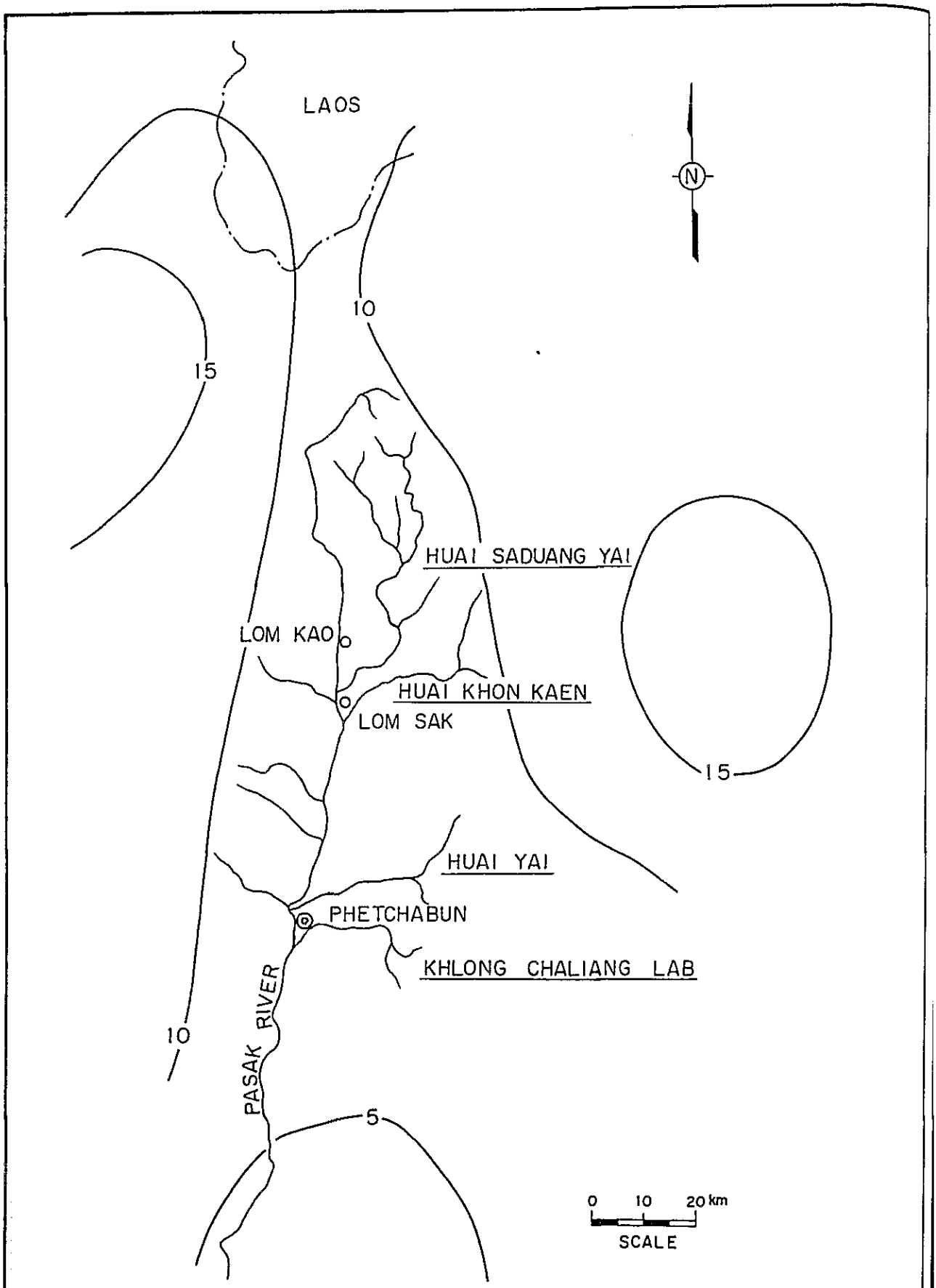


FIG. 2.5 AVERAGE YIELD OF RUNOFF

(ℓ / Sec / km^2)

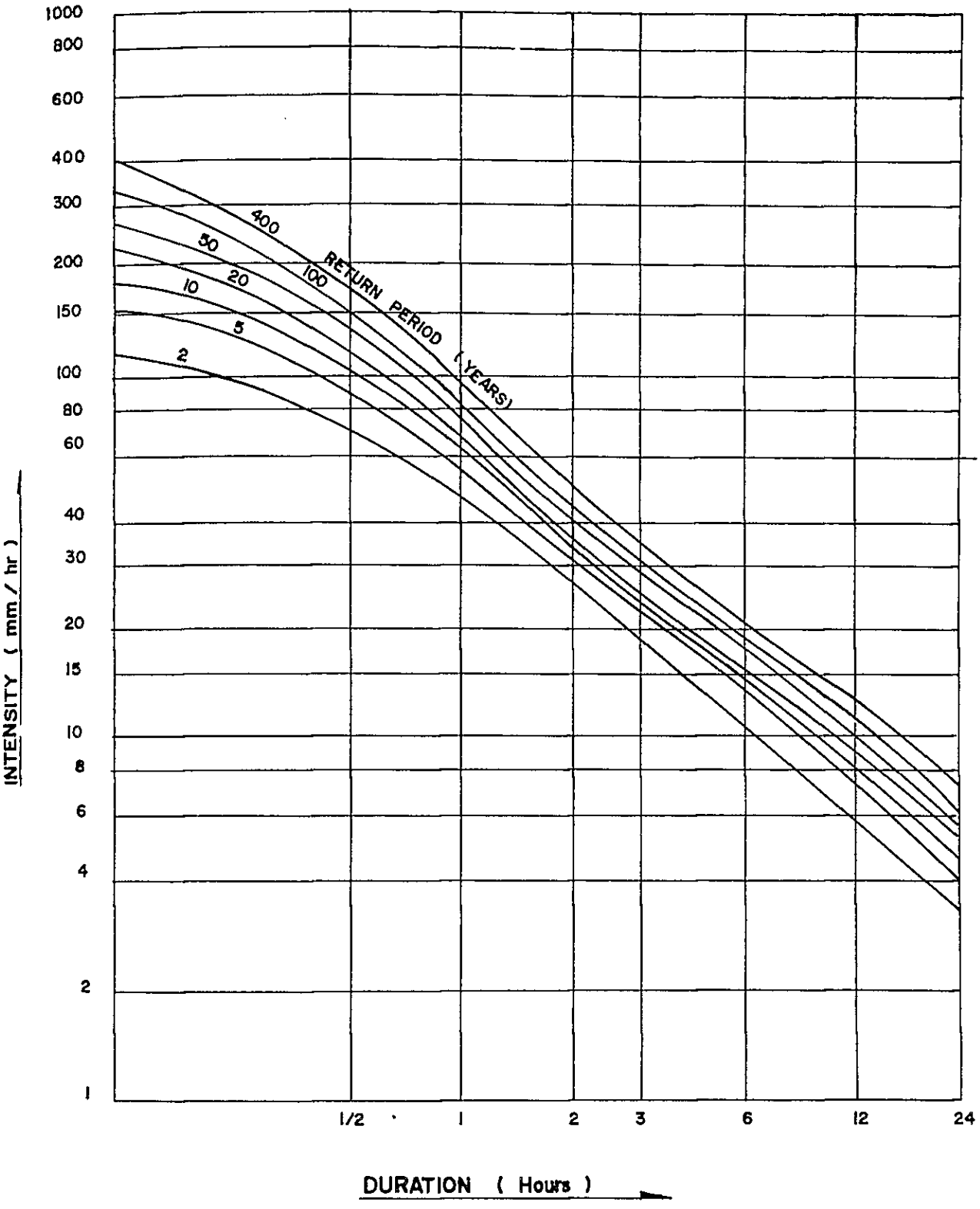
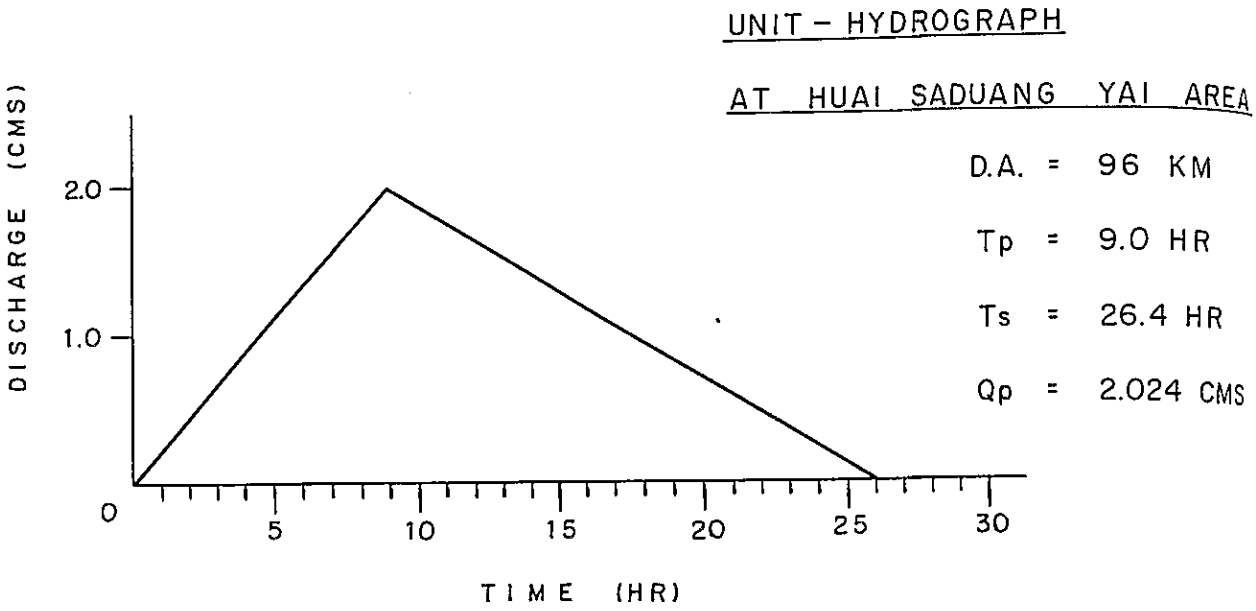


FIG. 2.6 INTENSITY - DURATION CURVE OF MAXIMUM DAILY RAINFALL
(1964 - 1974)



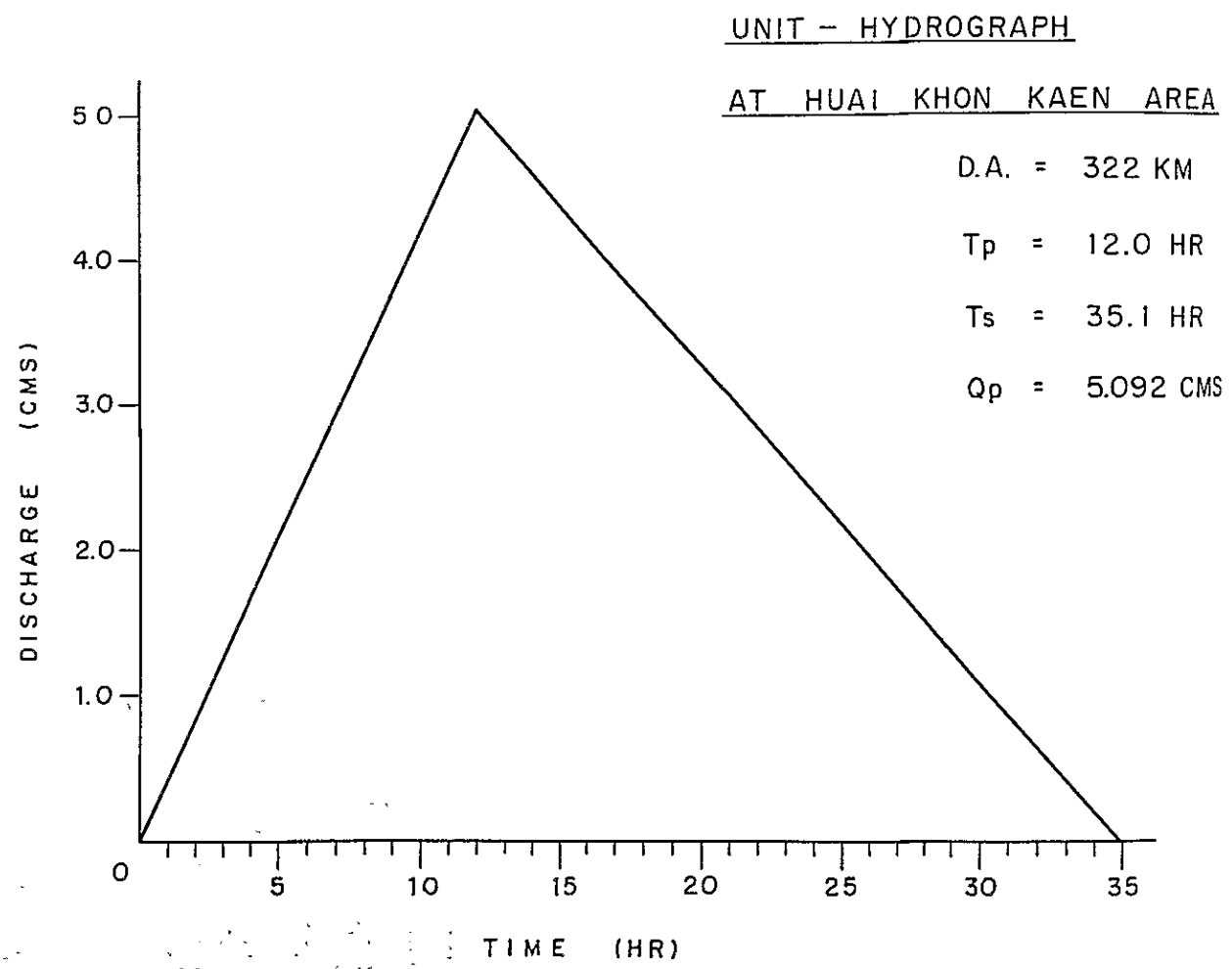
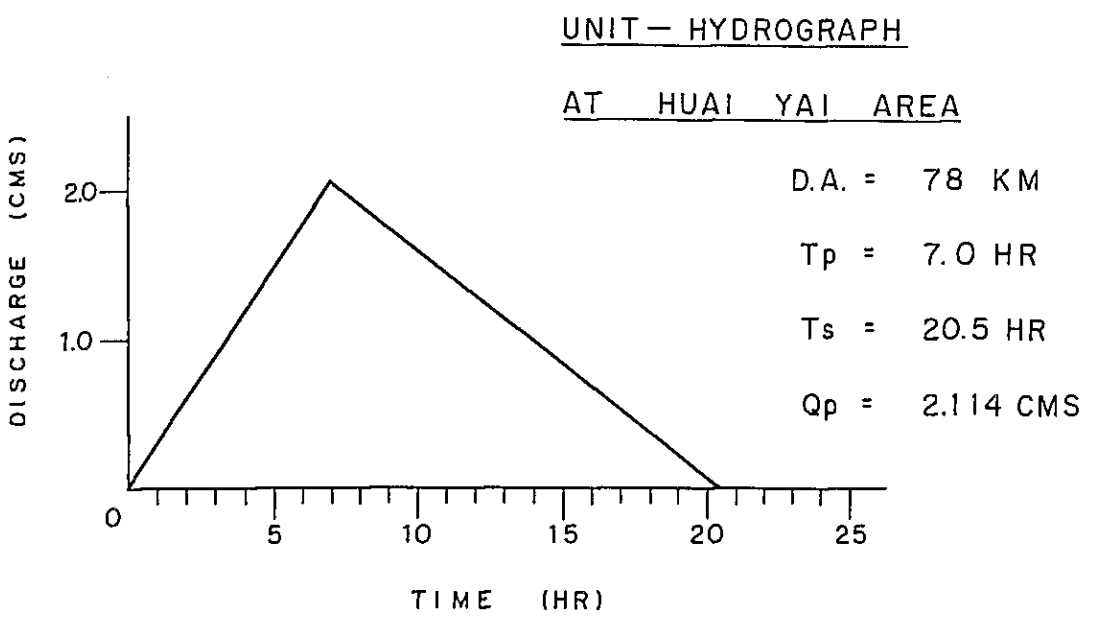


FIG. 2.7 (1) UNIT-HYDROGRAPH AT EACH SITE



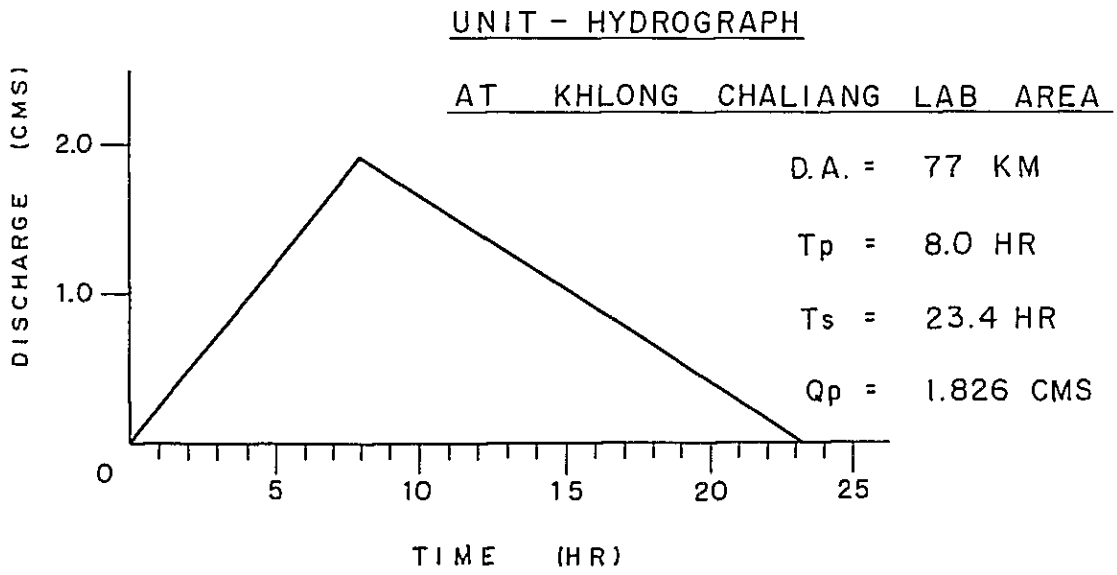
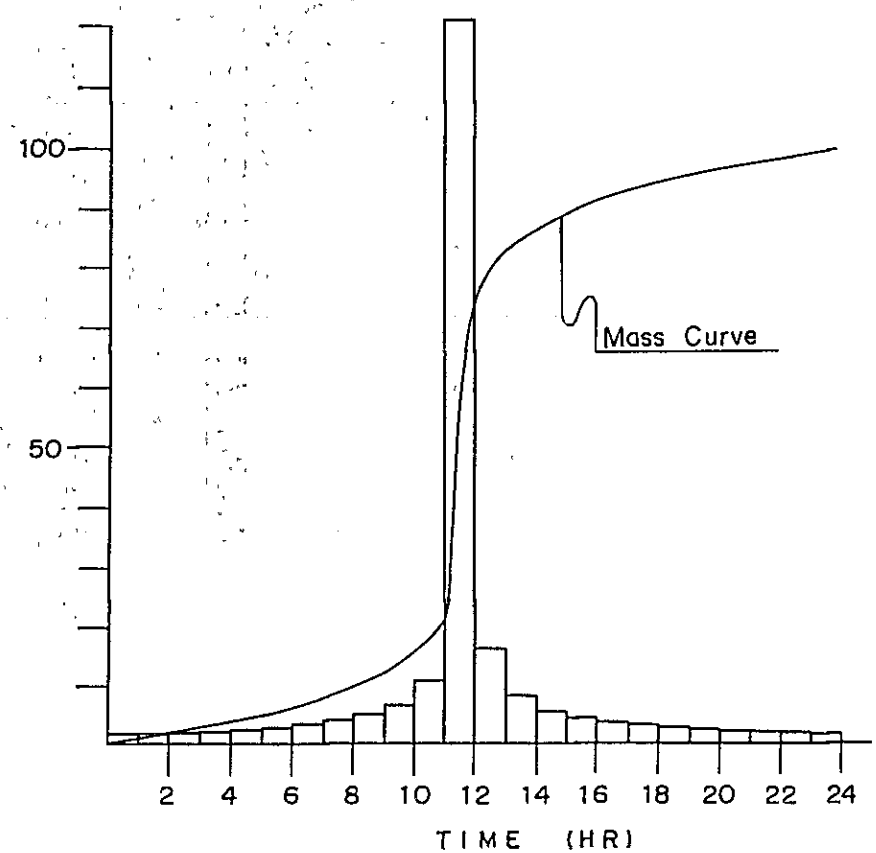
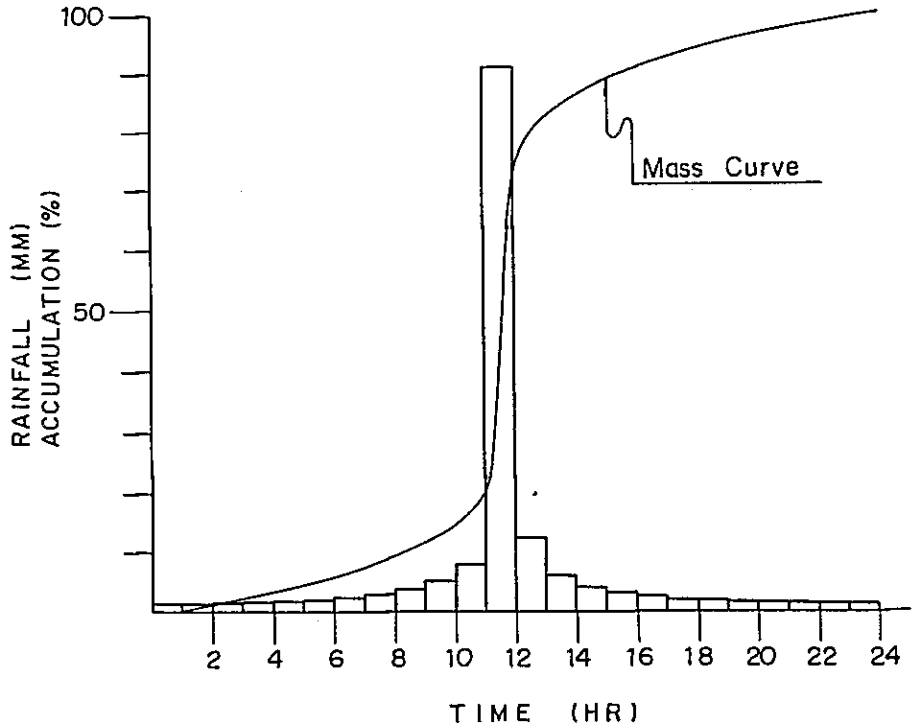


FIG.2.7(2) UNIT - HYDROGRAPH AT EACH SITE

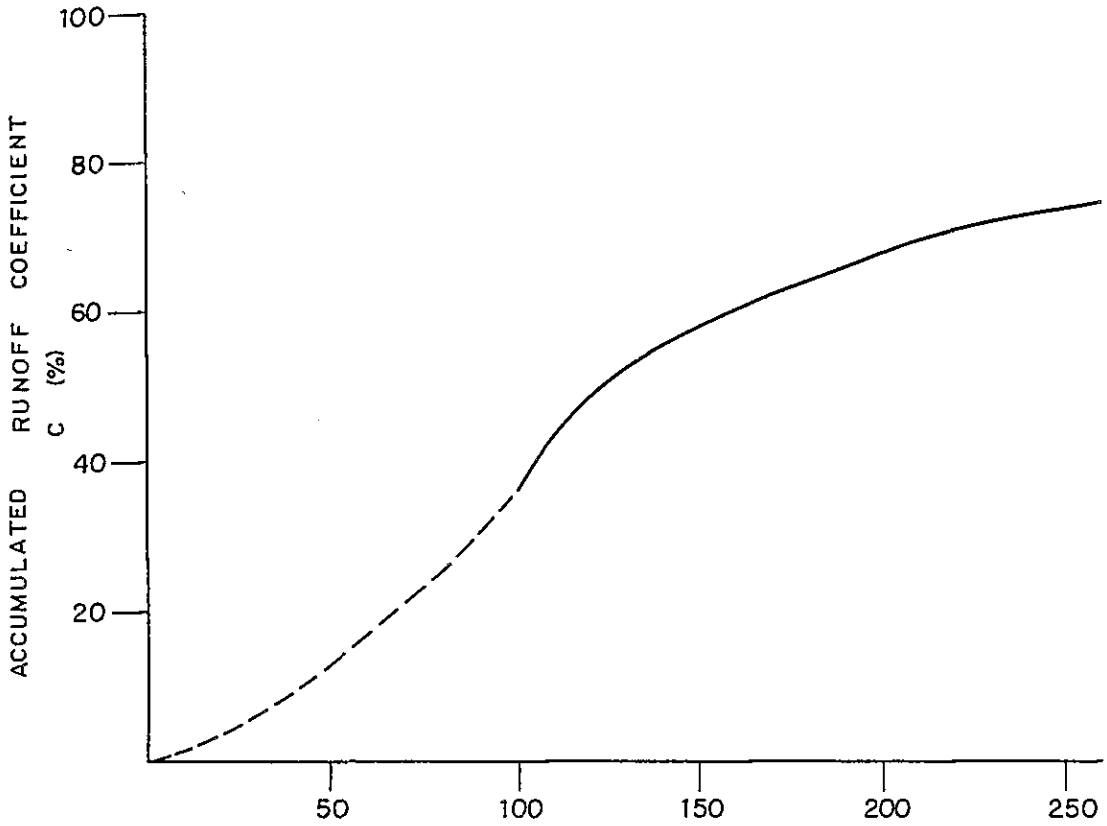


LOM SAK



PHETCHABUN

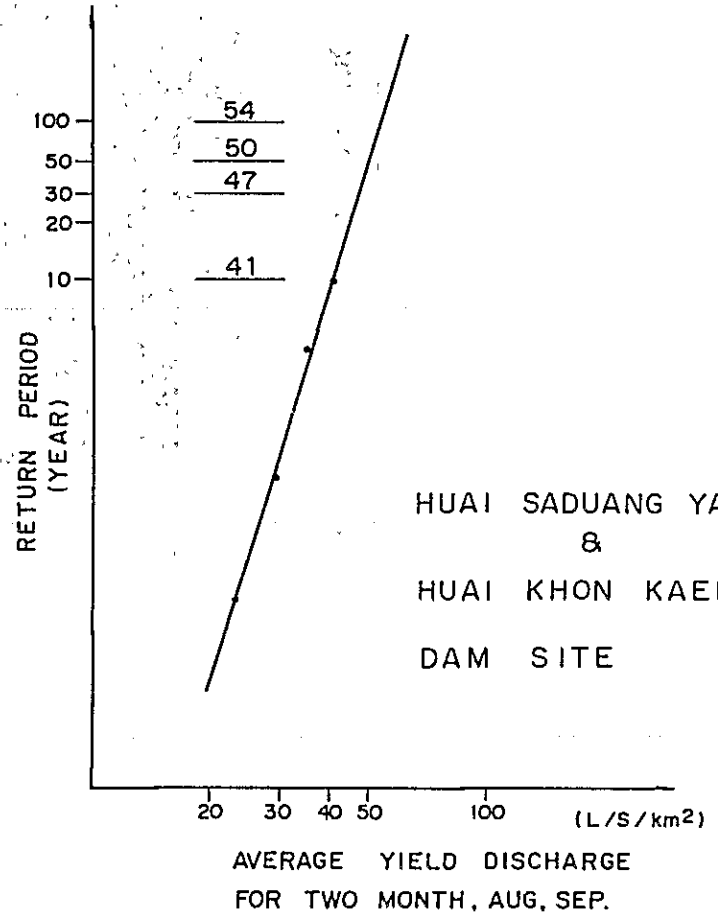
FIG. 2.8 HOURLY RAINFALL DISTRIBUTION



----- $R \leq 100$ MM, $C = 3.6 \times 10^{-2} R^{1.5}$

——— $R > 100$ MM, $C = \{(R-64)/R\} \times 100$

FIG. 2.9 RUNOFF COEFFICIENT CURVE



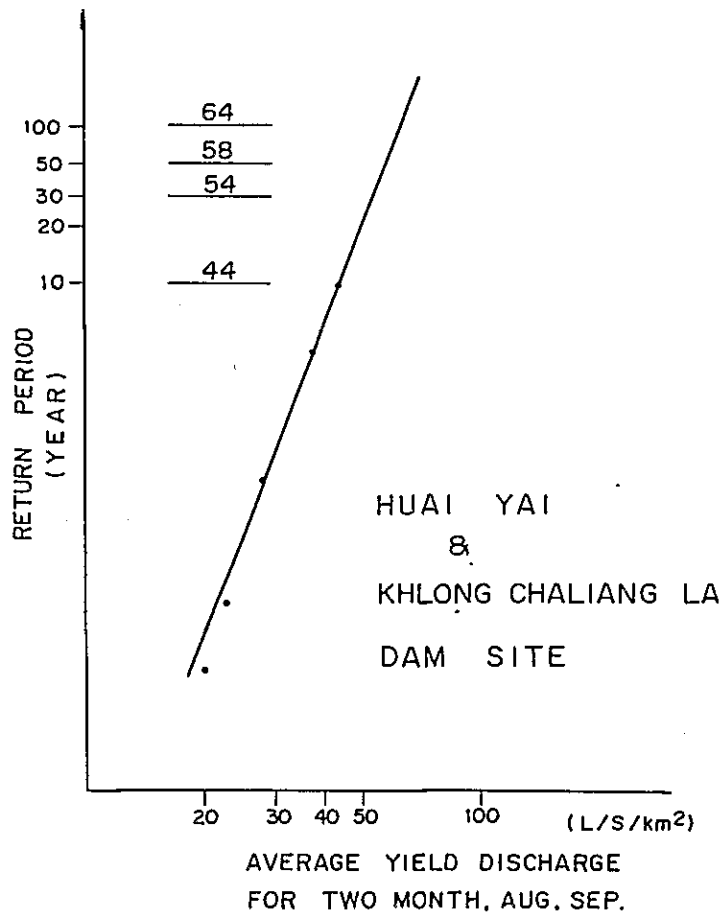


FIG. 2.10 BASE FLOW IN FLOOD TIME

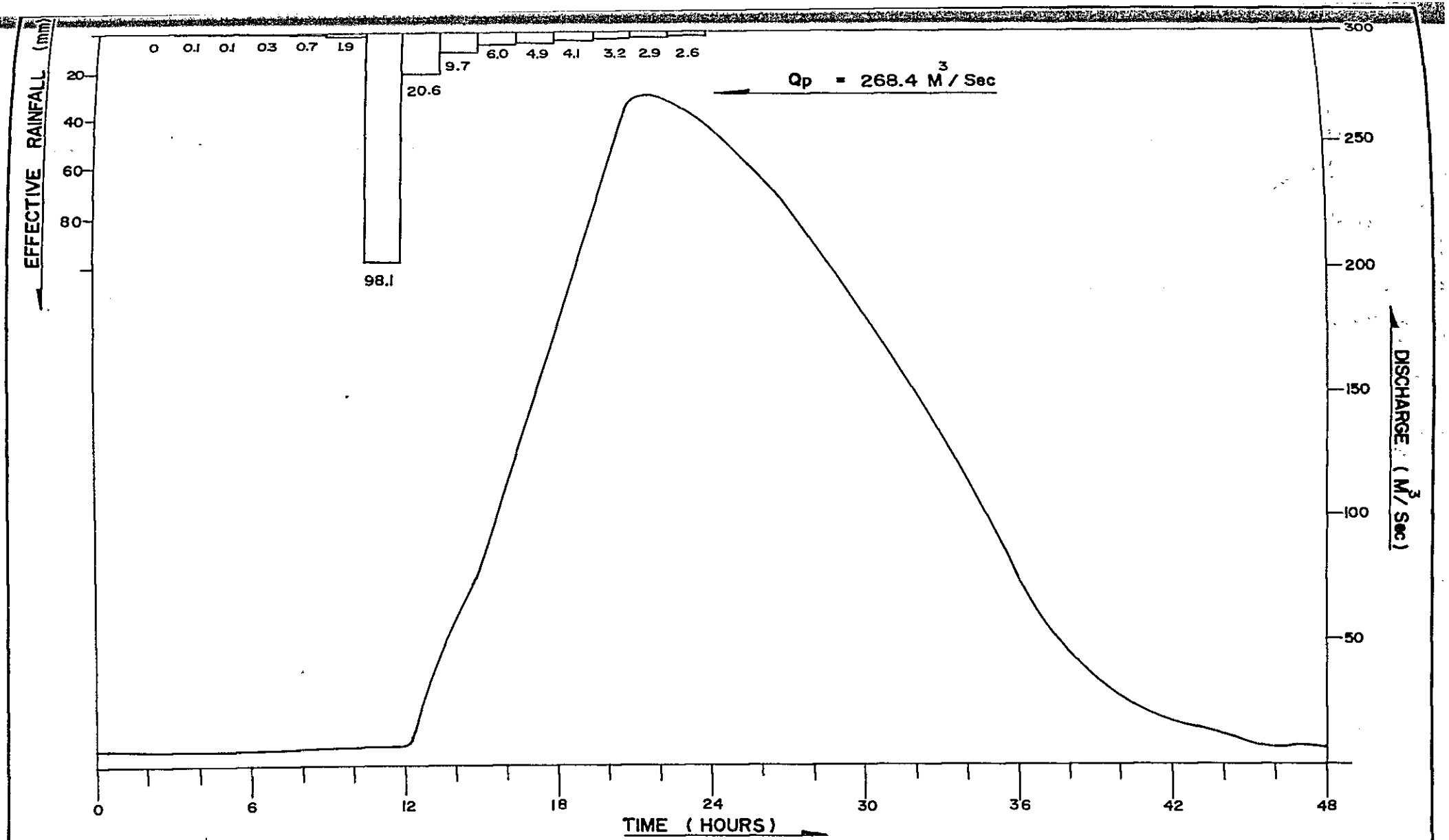


Fig. 2.11 HYDROGRAPH (1) HUAI SADUANG YAI DAM SITE

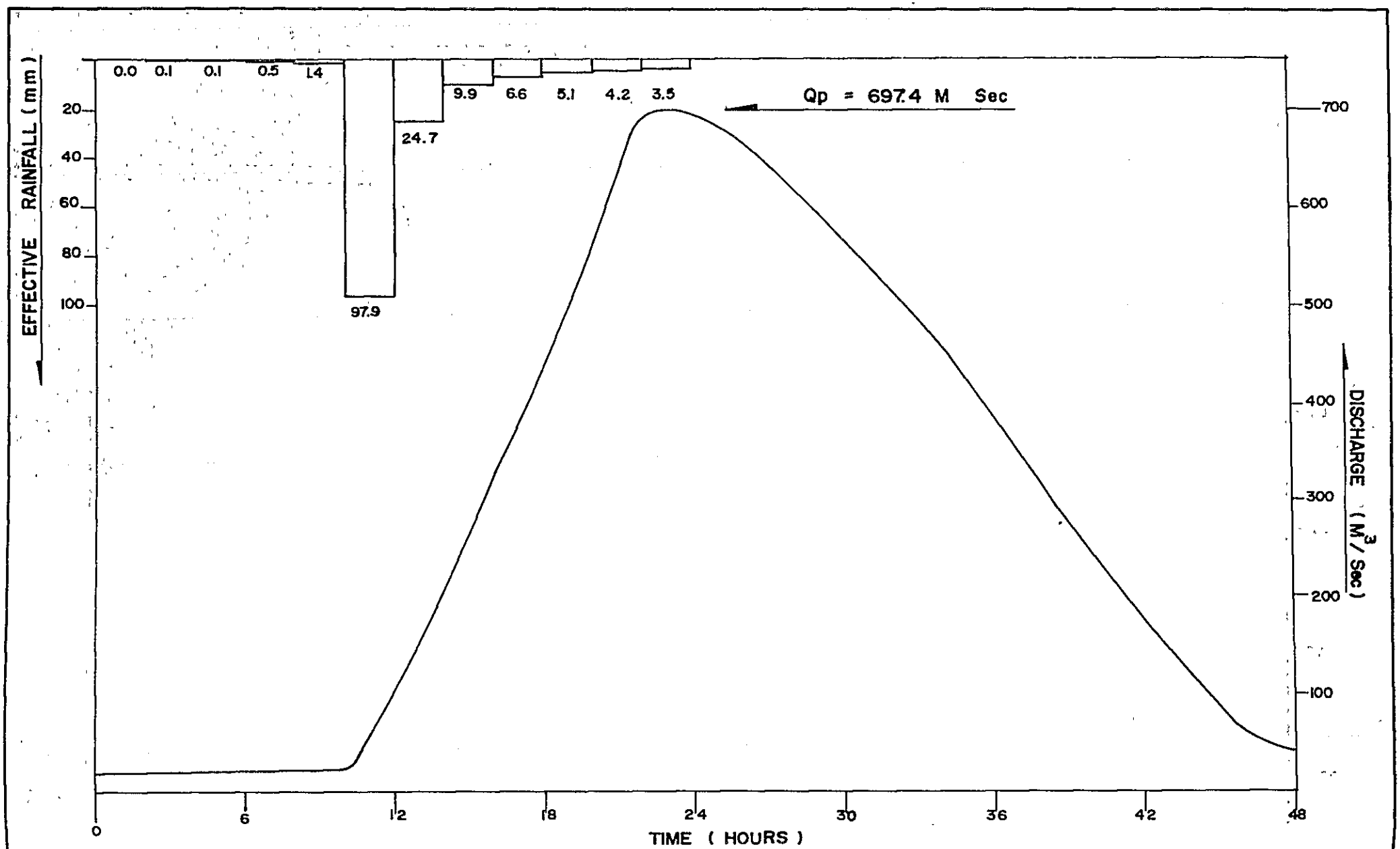


Fig. 2.11 HYDROGRAPH (2) HUAI KHON KAEN DAM SITE

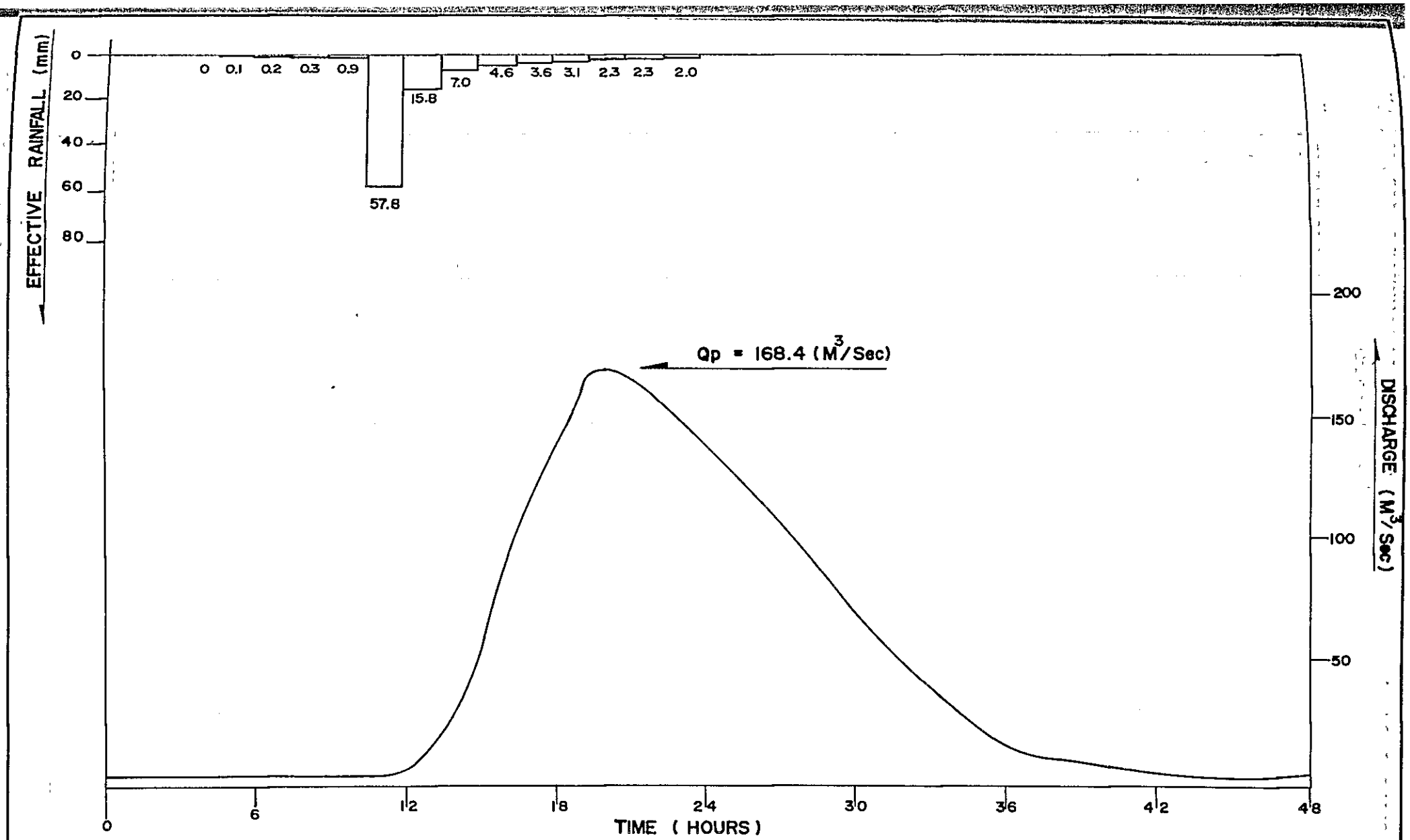


Fig. 2.11 HYDROGRAPH (3) HUAI YAI DAM SITE

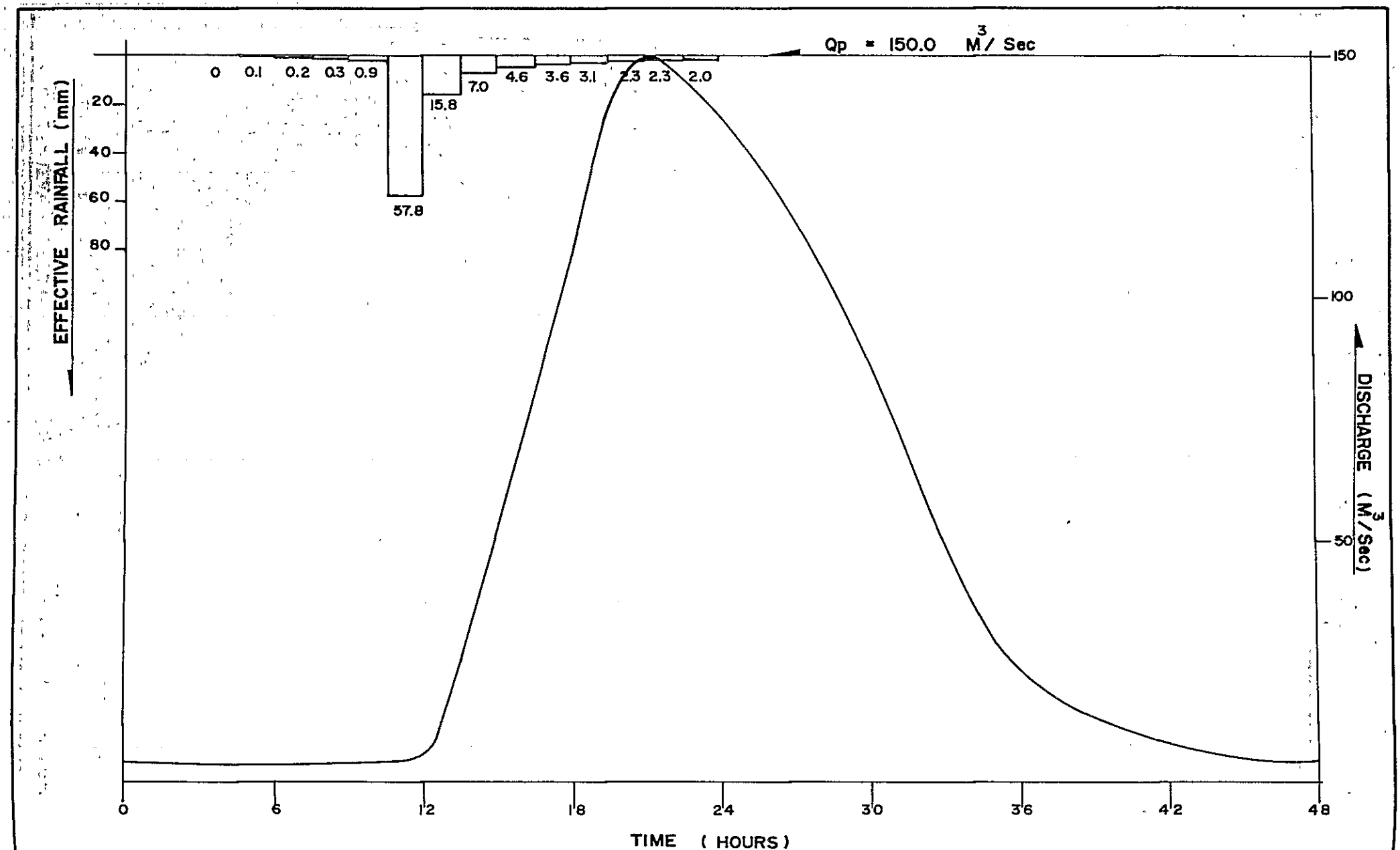
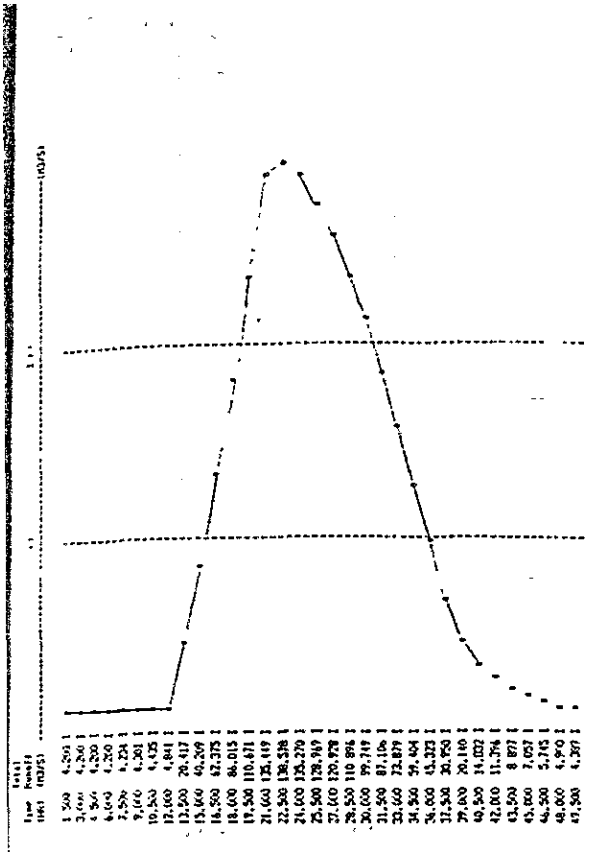
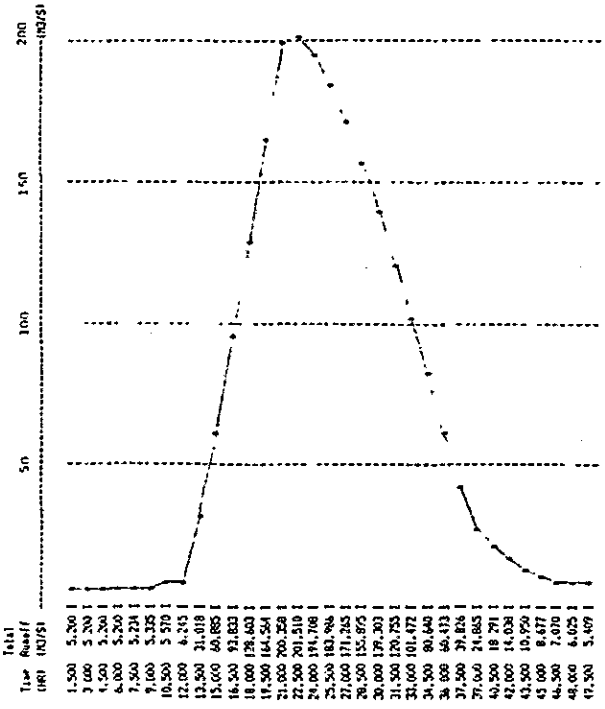


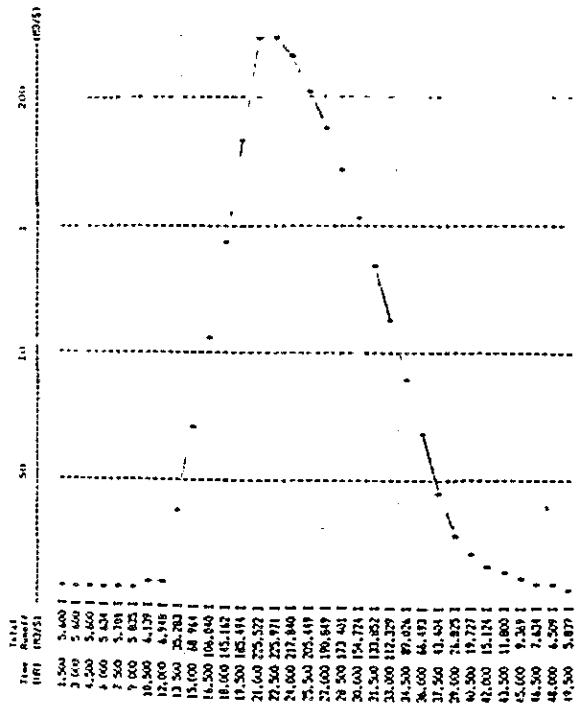
Fig.2.11 HYDROGRAPH (4) KHLONG CHALIANG LAB DAM SITE



10 Years Return Period



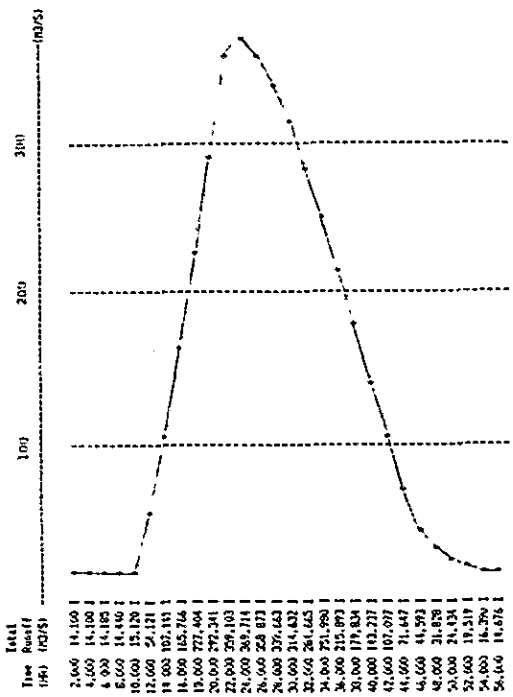
30 Years Return Period



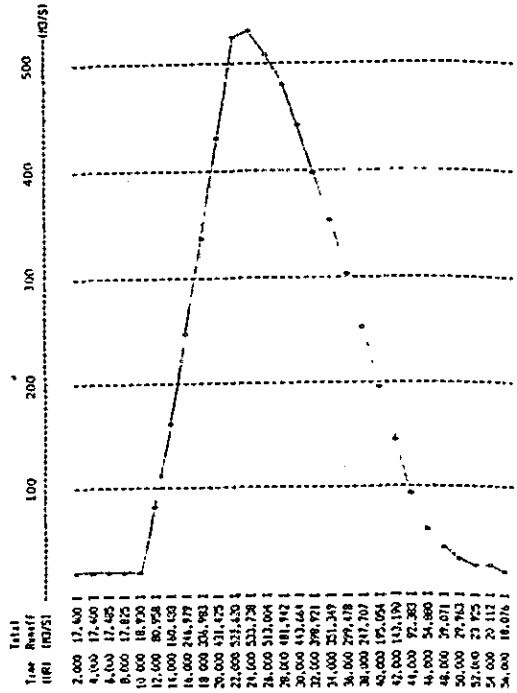
50 Years Return Period

Fig. 2.12 Probable Flood for Flood Control

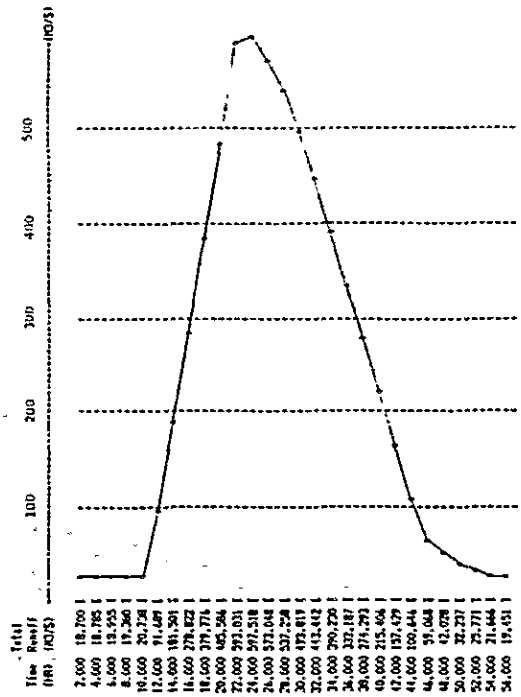
(1) Huai Saduang Yai



10 Years Return Period



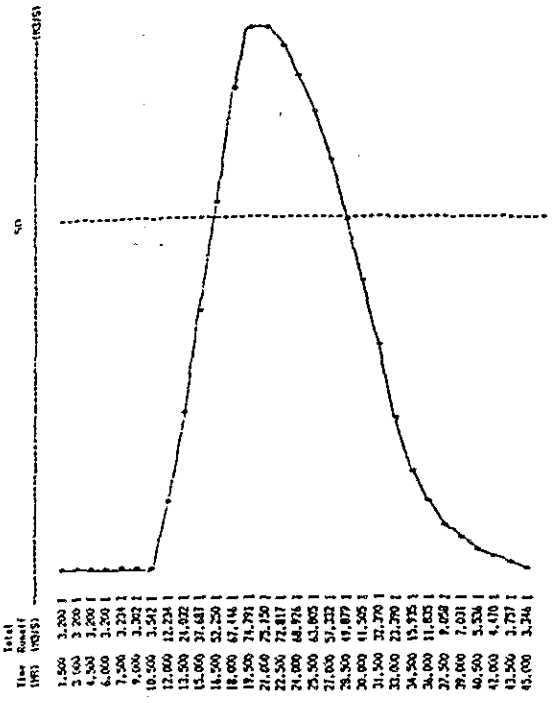
30 Years Return Period



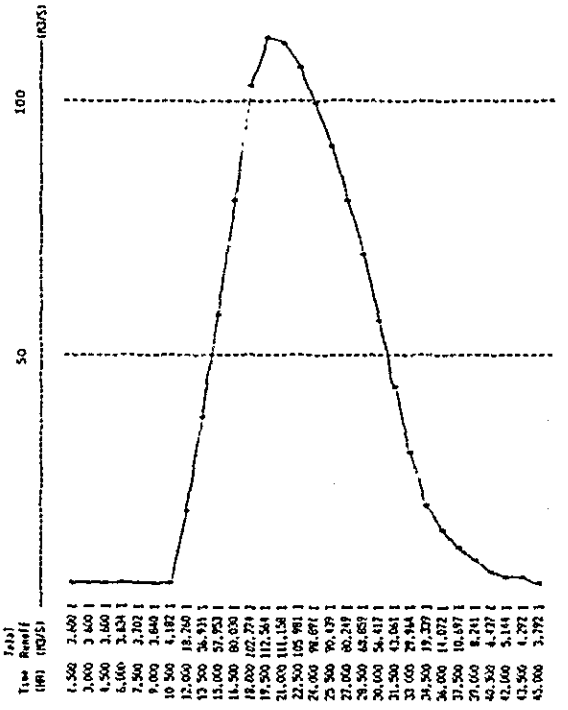
50 Years Return Period

Fig. 2.12 Probable Flood for Flood Control

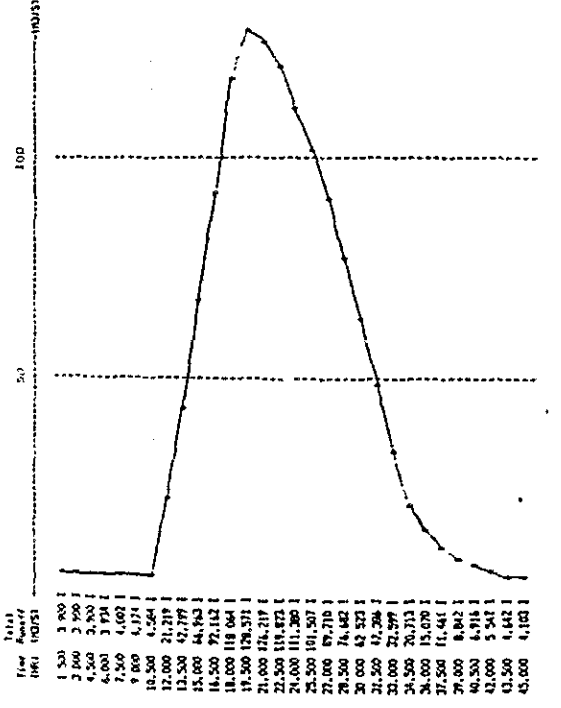
(2) Huai Khon Kaen



10 Years Return Period



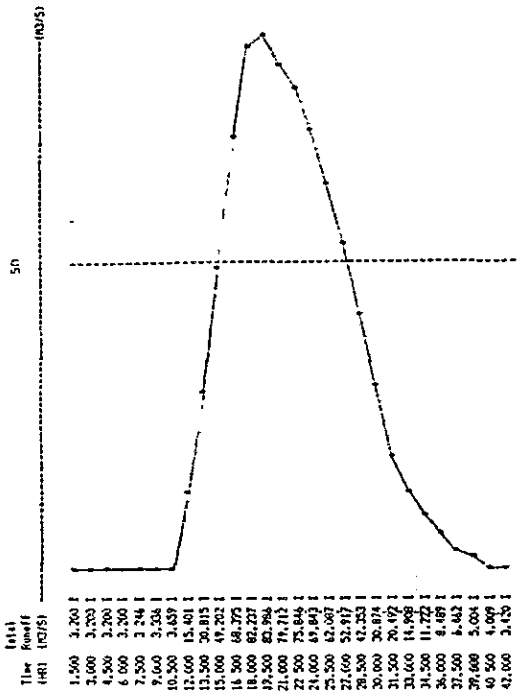
30 Years Return Period



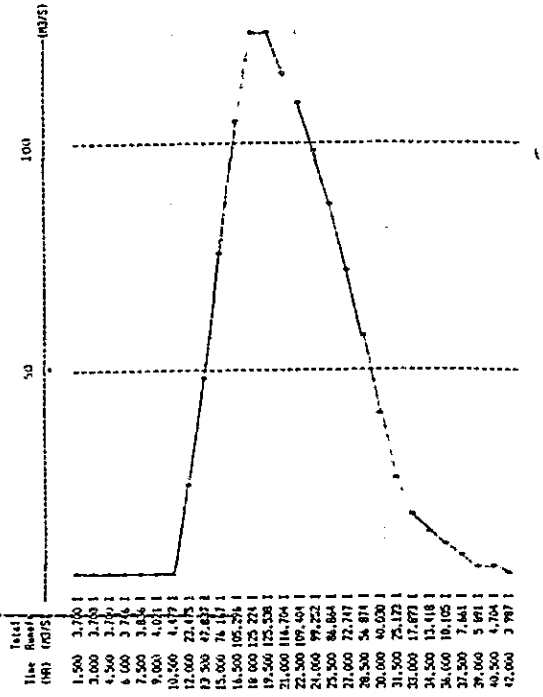
50 Years Return Period

Fig. 2.12 Probable Flood for Flood Control

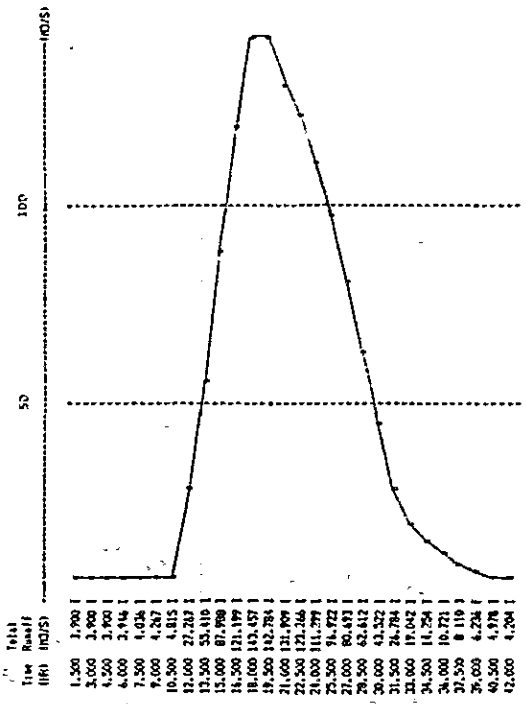
(3) Huai Yai



10 Years Return Period



30 Years Return Period



50 Years Return Period

Fig. 2.12 Probable Flood for Flood Control

(4) Khlong Chaliang Lab