8.2 Selection of Dam Sites

8.2.1 Nam Ngao Project

Three alternative dam sites, Site No. 1, No. 2 and No. 3 were studied from topographical, geological and economic viewpoint. Since the result of the study shows that Site No. 2 is superior to Site No. 1 and No. 3, Site No. 2 is selected as the dam site for the Nam Ngao project. The details of the study are described below.

(1) Topographical and Geological Viewpoints

- The layout of each of the three alternative dam sites is shown in DWG. 8-1, 8-2 and 8-3 for Site No. 1, No. 2 and No. 3, respectively.

The comparison of the three sites is described in Table 8-1. The evaluation of each site is as follows.

Site No. 1

Site No. 1 has many disadvantageous points such as the treatment of saddles on the right bank and gullies on the left bank as the foundation of the spillway and limitation of NHWL to EL.245 m.

Site No. 2

Although the slope of both abutments are the steepest among the three sites, the topography of the dam site is the most suitable from the layout viewpoint. The upper limit of NHWL is about EL.260 - 270 m, judging from the topography and geology.

Site No. 3

The length of the spillway and diversion tunnel is relatively short. However, the treatment for the saddle on the left bank might be necessary and excavation volume for the spillway is enormous. The upper limit of NHWL is about EL.260 - 270 m, judging from the topography and geology.

On the whole, it can be said that Site No. 2 is superior to Site No. 1 and No. 3.

- From a planning and river utilization point of view, attention should be paid to the following:

  ∘ Site No. 3 cannot utilize the runoff of a tributary running into the Ngao river downstream of the dam site. The catchment area (79 km^2) of the tributary is about 10% of the catchment area of Site No. 3 (756 km^2). Therefore, it can be said that the Ngao river cannot be utilized effectively.

  ∘ The available water head (Ha) for power generation between TWL and possible NHWL is shown in the table below.

Site	NHWL (m)	TWL (m)	Ha (m)	CA (km^2)
No. 1	245	159 (170)	86 (75)	848
No. 2	270	163 (170)	107 (100)	835
No. 3	270	174	96 (96)	756

Note: ( ) is the case that NHWL is EL.170 m for the Mae Lama Luang Project.

Although the TWL of the Nam Ngao project depends on the Mae Lama Luang project's NHWL being assumed to be in the range EL.155 m to 170 m, the superiority of Site No. 2 does not change considering the figures for Ha and CA in the table above.

(2) Economic Viewpoint

The economic comparison study is shown in Table 8-2. The values of B/C and B-C are as follows.

	Site No. 1	Site No. 2		Site No. 3	
NHWL (m)	245	260	280	260	280
Installed Capacity (MW)	104	122	153	98	129
B/C	0.91	1.04	1.12	0.92	1.06
B-C (M฿)	-38	19	64	-30	29

Note: effective storage 320 MCM

Judging from the B/C and B-C, Site No. 2 is superior to Site No. 1 and No. 3.

(3) Determination of the Site

Considering the above, Site No. 2 was selected as the dam site of the Nam Ngao project.

8.2.2 Mae Lama Luang Project

Three alternative dam sites of Site No. 4, No. 5 and NEA were studied from topographical, geological and economical viewpoints.

Since the result of the study shows that Site No. 5 is superior to Site No. 4 and Site NEA, Site No. 5 is selected as the dam site for the Mae Lama Luang project. The details of the study are described below.

(1) Topographical and Geological Viewpoints

- The each layout of the three alternative dam sites is shown in DWG. 8-4, 8-5 and 8-6 for Site No. 4, No. 5 and NEA respectively.

The comparison of the three dam sites is described in Table 8-3. The evaluation of each dam site is as follows.

Site No. 4

Since both abutments are very steep, excavation volume for the structures is enormous and the excavated area might have a big problem in the stability of the slope. The construc-

tion workability at the site is not good due to the steep abutments and very narrow shape of the valley. The direction of released flood discharge is not suitable from the layout point of view.

Site No. 5

The topography of the dam site is the most suitable, judging from the layout of civil structures and construction workability.

Site NEA

Since there is a enough space for construction, this site has the best workability for construction. However, the length of spillway and diversion tunnel is long.

On the whole, it can be said that Site No. 5 is superior to Site No. 4 and No. NEA.

- From a planning and river utilization point of view, attention should be paid to the following:

  - Site NEA cannot utilize the runoff of the tributary called Mae Lama (CA is about 100 km^2) running into the Yuam river downstream of the site. On the other hand, Site No. 4 and No. 5 can utilize the tributary.

  - The available water head (Ha) for power generation between TWL and possible NHWL, and catchment area (CA) at each site are shown in the table below.

Site	NHWL (m)	TWL (m)	Ha (m)	CA (km^2)
No. 4	160	68	92	6029
No. 5	160	66	94	6030
NEA	160	72	88	5920

As seen in the figure above, Site No. 4 and No. 5 can utilize the Yuam river more effectively than Site NEA for the same NHWL.

(2) Economic Viewpoint

The economic comparison study for each dam site is shown in Table 8-4. The values of B/C and B-C are as follows.

	Site No. 4		Site No. 5		Site NEA	
NHWL (m)	160	170	160	170	160*	170
Installed Capacity (MW)	154	184	157	186	121	170
B/C	1.53	1.80	1.52	1.78	1.58	1.79
B-C (M฿)	238	404	240	405	220	356

Note: effective storage 270 MCM (* 180 MCM)

As seen in the table above, the values of B-C of Site No. 4 and No. 5 are almost same and larger than those of Site NEA. Therefore Site No. 4 and No. 5 have the almost same merit from an economic viewpoint, and are superior to Site No. NEA.

(3) Determination of the Site

Although the B-C of Site No. 5 is almost same value as Site No. 4, Site No. 5 has better workability during construction and does not have the problem of slope stability concerning the excavated area of the spillway. Judging from the characteristics mentioned above, Site No. 5 was selected as the dam site of the Mae Lama Luang project.

Table 8-1 Topographical and Geological Comparison of Alternative Dam Sites of Nam Ngao Project

Item \ Site	Site No. 1	Site No. 2	Site No. 3
1. Topography of Dam Site			
(1) General Topography	Complicated with many gullies at both banks, especially right bank.	Rather gentle.	Two large gullies are developed at left bank.
(2) Dam			
(a) Height (m) x Dam Volume (MCM)	100 x 3.9 (for NHWL 245)	115 x 6.1 (for NHWL 260)	115 x 6.4 (NHWL 270)
(b) Treatment for Saddle	Necessary for right bank.	Might not necessary for NHWL 250 - 270.	Necessary for left bank.
(c) Difficulty of Construction	Easier than Site No. 2.	Not difficult because of wide valley although the slope of both banks is rather steep.	Easier than Site No. 1 and 2.
(3) Other Civil Structures			
(a) Spillway	Treatment of two gullies is necessary.	Construction is rather difficult because the slope of the foundation is rather steep.	Volume of excavation is high, however, direction of spillway and river is ideal.
(b) Diversion Tunnel	Long	Short because of short cut of river.	Rather short.
(c) Headrace, Penstock, Powerhouse	There is no significant difference among three sites.		
(4) Limit of NHWL	Should be lower than EL 245.	Should be lower than EL 270 - 280.	Should be lower than EL 270 - 280.
2. Geology of Dam Site			
(1) Geology	Alteration of sandstone and shale.	Same as Site No. 1.	Same as Site No. 1.
(2) Limit of NHWL		Weathered zone of ridge of right bank is thick, limit of NHWL should be in the range of EL 260 - EL 270.	Weathered zone on the left bank might be thick, limit of NHWL should be in the range of EL 260 - EL 270.
(3) Others			Outcrop of limestone is observed in the river bed, so the cost of foundation treatment might be huge.

Table 8-2 Economic Comparison Study on Nam Ngao Dam Site

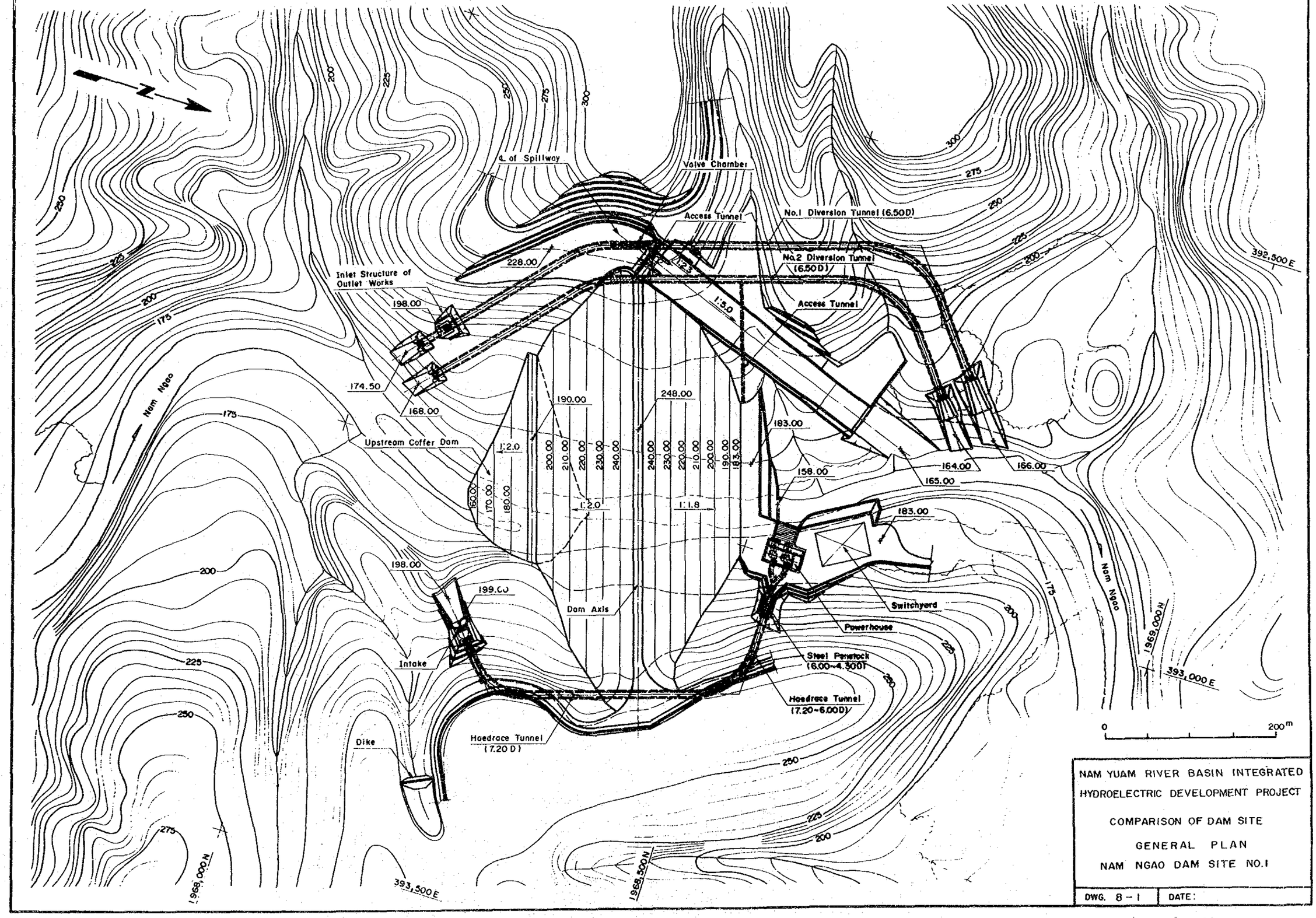
Item	Unit	No. 1	No. 2		No. 3	
		N1-245 -320	N2-260 -320	N2-280 -320	N3-260 -320	N3-280 -320
1. Project Feature						
Catchment Area	km^2	848	835	835	756	756
Annual Inflow	MCM	1,387	1,366	1,366	1,237	1,237
Total Storage Capacity	MCM	482	684	1,067	512	913
Effective Storage Capacity	MCM	320	320	320	320	320
NHWL	m	245	260	280	260	280
Available Drawdown	m	28.1	20.3	12.5	27.4	15.2
Normal Intake Water Level	m	235.6	253.2	275.8	250.9	274.9
TWL	m	159.1	162.8	162.8	173.8	173.8
Normal Effective Head	m	72.6	85.9	107.3	73.2	96.0
95% Firm Discharge	m^3/sec	24.6	24.4	24.4	23.0	23.0
Max. Turbine Discharge	m^3/sec	163.9	162.6	162.6	153.1	153.1
Installed Capacity	MW	103.6	122.1	153.4	97.6	128.8
Firm Capacity	MW	67.3	94.9	136.1	64.6	109.3
Annual Firm Energy	GWh	88.4	124.7	178.8	84.9	143.6
Annual Secondary Energy	GWh	143.1	150.3	171.7	123.8	138.2
Annual Energy Production	GWh	231.5	275.0	350.5	208.7	281.8
Annual Capacity Factor	%	25.5	25.7	26.1	24.4	25.0
2. Project Economy						
Annual Benefit	M฿	355.6	450.1	601.7	327.9	483.5
for Firm Capacity	M฿	121.8	171.8	246.3	116.9	197.8
for Firm Energy	M฿	91.0	128.3	184.0	87.4	147.8
for Secondary Energy	M฿	142.8	150.0	171.4	123.6	137.9
Construction Cost	M฿	3,389	3,720	4,634	3,090	3,917
Annual Cost	M฿	393.1	431.5	537.5	358.4	454.4
B - C	M฿	-37.5	18.6	64.2	-30.5	29.1
B / C	-	0.905	1.043	1.119	0.915	1.064

Table 8-3 Topographical and Geological Comparison of Alternative Dam Sites of Mae Lama Luang Project

Item / Site	Site No. 4	Site No. 5	Site No. NEA
1. Topography of Dam Site			
(1) General Topography	Both banks are steep, especially the upstream of the right abutment is very steep. The upstream area for temporary construction facility is not wide enough.	Both abutments are rather steep.	Right abutment is gentle, left is steep.
(2) Dam (Height (m) x Volume (MCM))	115 x 3.1 for NHWL 160 Dam volume is the smallest among three sites. However, as topography is very steep and narrow, construction of site road and embankment of dam are the most difficult among three sites.	118 x 3.6 for NHWL 160 Construction is easier than Site No. 4 but more difficult than Site NEA, because powerhouse and spillway are almost adjacent to dam.	110 x 3.3 for NHWL 160 Construction is the easiest among three sites, because of the reason below. ° Dam and spillway can be constructed separately. ° Slope of abutments are gentle.
(3) Other Civil Structures			
(a) Spillway	Excavation volume of entrance of spillway is enormous. As it is located on a steep slope, concrete volume is huge and construction is hard. Direction of spillway is not ideal from layout view point.	As the slope of the abutment of the spillway's entrance is gentle, excavation volume is small.	Although construction is rather easy, excavation and concrete volumes are high because length of spillway is twice as long as the other sites.
(b) Diversion Tunnel	Relatively short because of the short cut of river	Long	Long
(c) Headrace, Penstock, Powerhouse	There is no significant difference among three sites.		
(4) Limit of NHWL	There is no limit for assumed range of NHWL (EL 170 m).		
2. Geology of Dam Site			
(1) Geology	Same as Site No. 5.	Quartzite, Quartz Shist	Same as Site No. 5.
	There is no significant difference among three sites.		
(2) Limit of NHWL	There are no problems up to NHWL of 170.		

Table 8-4 Economic Comparison Study on Mae Lama Luang Dam Site

Item	Unit	No. 4		No. 5		NEA	
		M4-160 -270	M4-170 -270	M5-160 -270	M5-170 -270	MN-160 -180	MN-170 -270
1. Project Feature							
Catchment Area	km^2	6,029	6,029	6,030	6,030	5,920	5,920
Annual Inflow	MCM	2,992	2,992	2,992	2,992	2,928	2,928
Total Storage Capacity	MCM	403	594	403	594	279	444
Effective Storage Capacity	MCM	270	270	270	270	180	270
NHWL	m	160	170	160	170	160	170
Available Drawdown	m	31.9	16.1	31.9	16.1	26.4	21.5
Normal Intake Water Level	m	149.4	164.6	149.4	164.6	151.2	162.8
TWL	m	67.7	67.7	66.4	66.4	71.8	72.2
Normal Effective Head	m	77.6	92.0	78.9	93.3	75.4	86.1
95% Firm Discharge	m^3/sec	34.2	34.2	34.2	34.2	27.7	33.8
Max. Turbine Discharge	m^3/sec	227.8	227.8	227.8	227.8	184.3	225.3
Installed Capacity	MW	154.1	183.5	156.8	186.1	121.1	169.5
Firm Capacity	MW	94.0	151.5	96.4	154.1	80.3	127.9
Annual Firm Energy	GWh	123.5	199.1	126.7	202.5	105.5	168.1
Annual Secondary Energy	GWh	388.7	429.3	394.7	435.2	348.5	403.3
Annual Energy Production	GWh	512.2	628.4	521.4	637.7	454.0	571.4
Annual Capacity Factor	%	37.9	39.1	38.0	39.1	42.8	38.5
2. Project Economy							
Annual Benefit	M฿	685.2	907.6	698.9	921.7	601.8	807.0
for Firm Capacity	M฿	170.1	274.2	174.5	278.9	145.3	231.5
for Firm Energy	M฿	127.1	204.9	130.4	208.4	108.6	173.0
for Secondary Energy	M฿	388.0	428.5	394.0	434.4	347.9	402.5
Construction Cost	M฿	3,857	4,344	3,955	4,455	3,291	3,892
Annual Cost	M฿	447.4	503.9	458.8	516.8	381.8	451.5
B - C	M฿	237.8	403.7	240.1	404.9	220.0	355.5
B / C	-	1.532	1.801	1.523	1.783	1.576	1.787



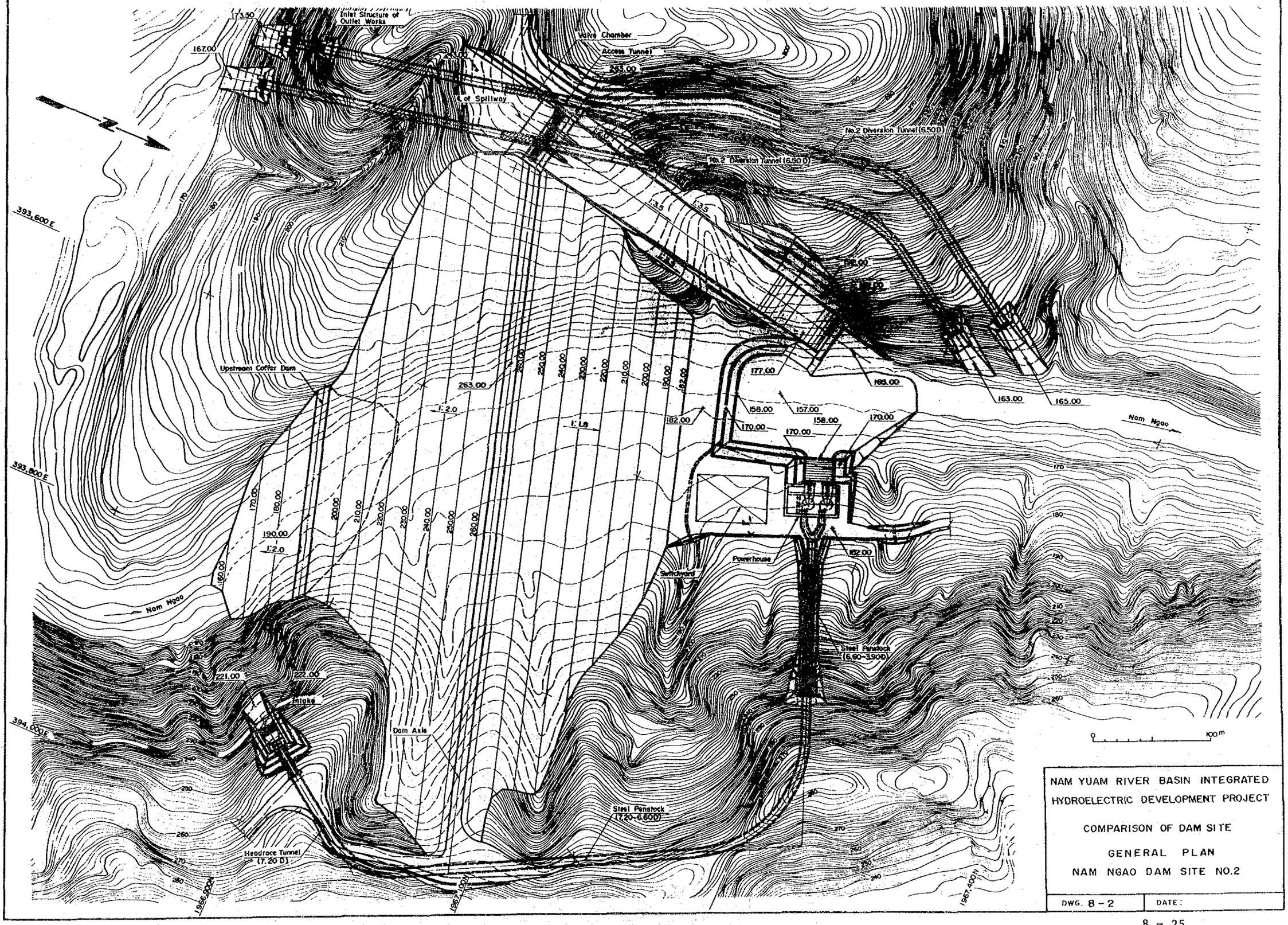
NAM YUAM RIVER BASIN INTEGRATED HYDROELECTRIC DEVELOPMENT PROJECT

COMPARISON OF DAM SITE

GENERAL PLAN

NAM NGAO DAM SITE NO.1

DWG. 8 – 1	DATE:



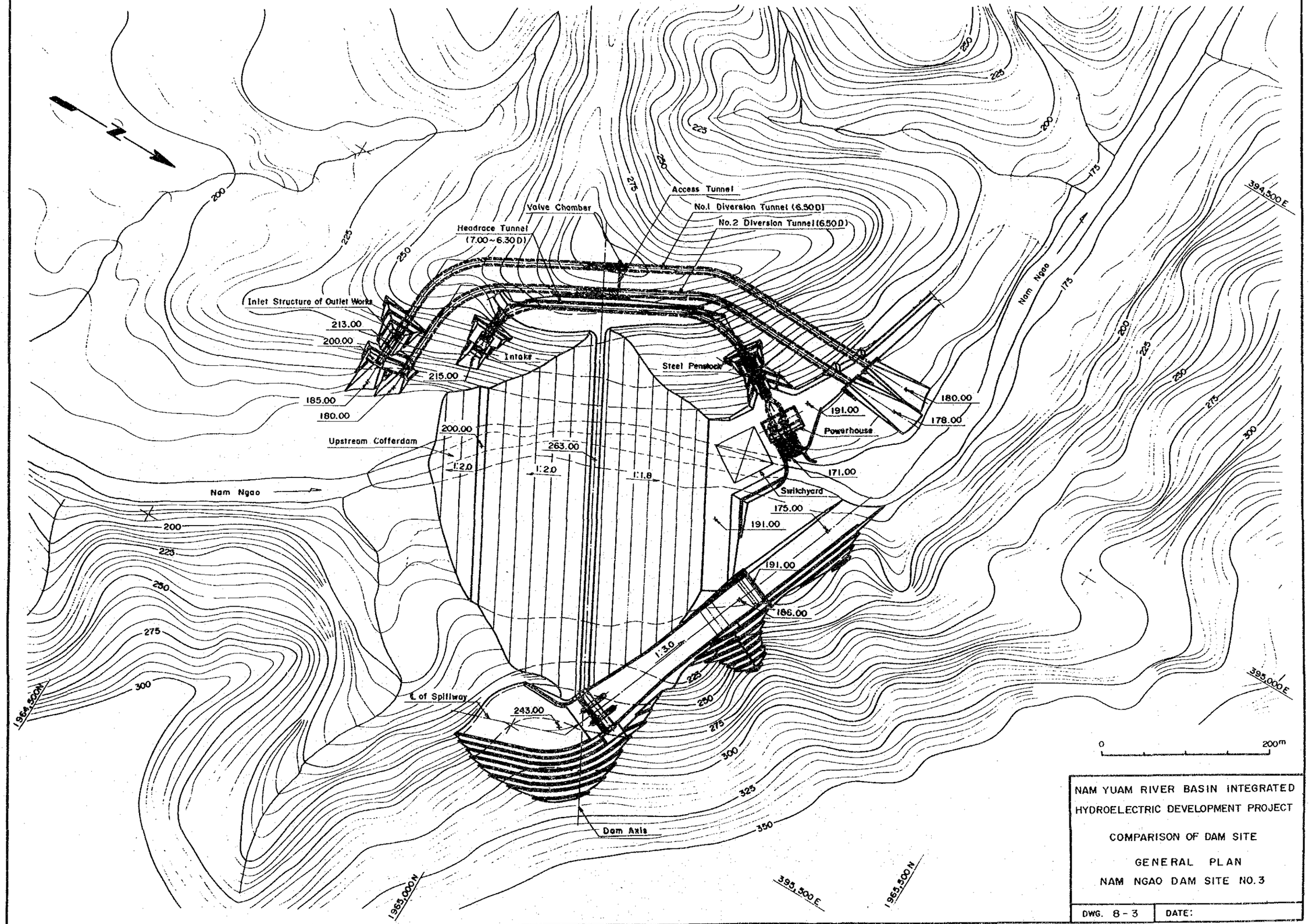
NAM YUAM RIVER BASIN INTEGRATED HYDROELECTRIC DEVELOPMENT PROJECT

COMPARISON OF DAM SITE

GENERAL PLAN

NAM NGAO DAM SITE NO.2

DWG. 8 - 2	DATE :



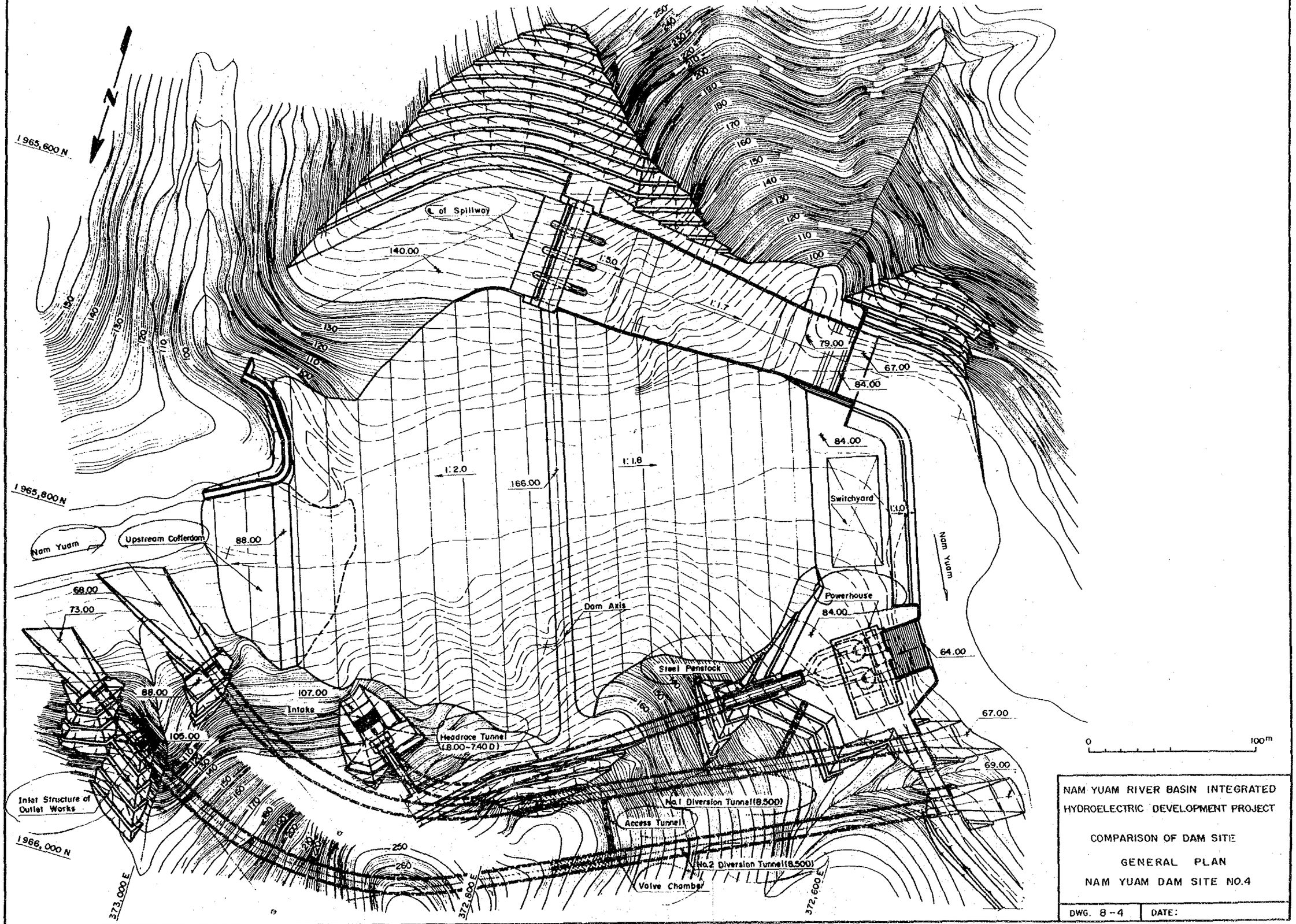
NAM YUAM RIVER BASIN INTEGRATED
HYDROELECTRIC DEVELOPMENT PROJECT

COMPARISON OF DAM SITE

GENERAL PLAN

NAM NGAO DAM SITE NO.3

DWG. 8 - 3	DATE:



NAM YUAM RIVER BASIN INTEGRATED HYDROELECTRIC DEVELOPMENT PROJECT

COMPARISON OF DAM SITE

GENERAL PLAN

NAM YUAM DAM SITE NO.4

DWG. 8-4	DATE:

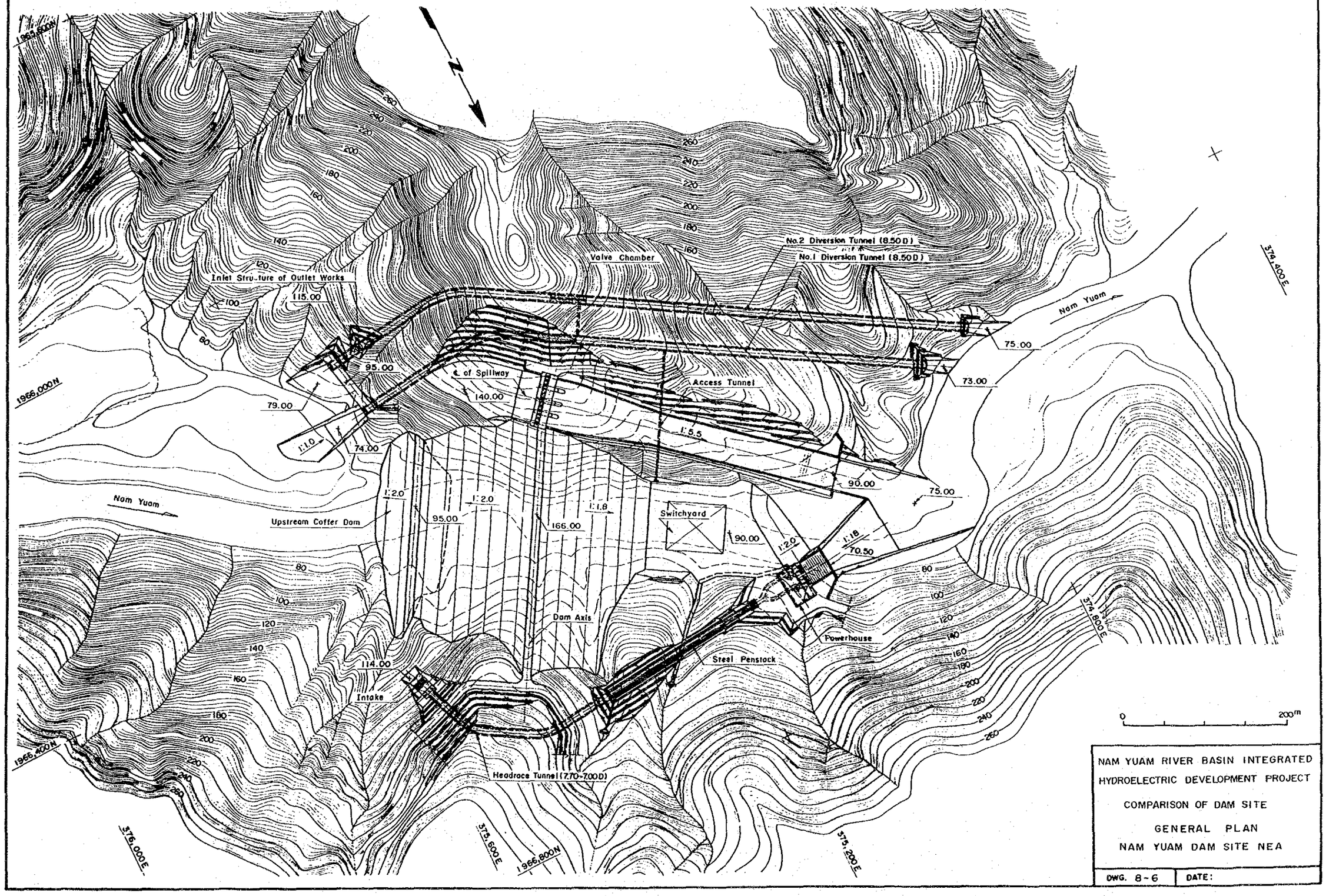
NAM YUAM RIVER BASIN INTEGRATED HYDROELECTRIC DEVELOPMENT PROJECT

COMPARISON OF DAM SITE

GENERAL PLAN

NAM YUAM DAM SITE NO.5

DWG. 8-5 | DATE: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1966,000N
1966,400N
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376,000E
375,600E
375,200E
374,400E
374,800E
Nam Yuam
Upstream Coffer Dam
Inlet Structure of Outlet Works
115.00
95.00
79.00
74.00
95.00
114.00
Intake
Valve Chamber
No.2 Diversion Tunnel (8.50D)
No.1 Diversion Tunnel (8.50D)
℄ of Spillway
140.00
Access Tunnel
166.00
Dam Axis
Headrace Tunnel (7.70-7.00D)
Switchyard
90.00
75.00
73.00
70.50
Steel Penstock
Powerhouse
1:2.0
1:1.8
1:1.0
1:1.5
1:1.8
0
200m
NAM YUAM RIVER BASIN INTEGRATED
HYDROELECTRIC DEVELOPMENT PROJECT
COMPARISON OF DAM SITE
GENERAL PLAN
NAM YUAM DAM SITE NEA
DWG. 8-6
DATE:

8.3 Optimization Study on Individual Development (Investigation Stage)

The Nam Ngao dam site No. 2 shown in DWG. 8-2 and the Mae Lama Luang dam site No. 5 in DWG. 8-5 were selected as the dam sites in the previous section. Hereafter, they are called the Nam Ngao dam site and the Mae Lama Luang dam site.

8.3.1 Nam Ngao Project

(1) Study on Normal High Water Level and Effective Storage Capacity

The mass curve of the Nam Ngao project is shown in Fig. 8-6 and in Appendix.

The 15 alternative development plans varying the NHWL, effective storage and installed capacity are examined. The dam is a rockfill type dam, considering the topography and the geology. The power house is planned to be on the right bank, adjacent to the downstream side of the dam. On the basis of the layout seen in DWG. 8-2, alternative development plans are formulated and listed in Table 8-5.

All of the alternatives are compared from an economic viewpoint. The result of the study is shown in Table 8-5 and Fig. 8-7. As seen in Fig. 8-7, in the case that the NHWL is fixed, the optimum effective storage is 260 MCM for NHWL 250 m and 320 MCM for NHWL 260 - 280 m.

The values of B/C and B-C of the alternatives with the optimum effective storage for each NHWL are shown below.

NHWL (m)	250	260	270	280
Effective Storage* (MCM)	260	320	320	320
Installed Capacity (MW)	97	122	138	153
B/C	1.00	1.04	1.10	1.12
B-C (M฿)	1	19	47	64

Note: * Optimum effective storage for the NHWL

As seen in the table above and Fig. 8-7, the higher the NHWL, the more economical the project. Therefore, it can be concluded that the NHWL should be raised up to the level that the topography and geology allow.

(2) Topography and Geology of the Dam Site

The right and left abutments of the dam site consist of thin ridges caused by the gullies cutting from the Ngao river. There is a fear that leakage from the abutment, especially from the left abutment, might occur due to the thin ridge.

In the case of NHWL of 270 m, the width of the thinnest part of the ridges is 130 m for the right and left abutments. In order to improve the water tightness of the ridges, rim grouting is necessary for the concerned area.

Taking into account the above points, the survey team carefully investigated the site and examined drilling cores in November 1988 (the 2nd field investigation) and February 1989 (the 3rd field investigation).

As the result of the investigations, it is judged that the elevation of 270 m is the upper limit for the water level of the Nam Ngao reservoir.

Further, detail explanation concerning the geology and design (grouting) are described in Chapter 6 and 10, respectively.

(3) Resettlement of the Reservoir Area

There are few people living in the proposed reservoir area under NHWL 270 m, so there is no problem affecting the project feasibility for the possible NHWL of 270 m.

(4) Study on Maximum Power Discharge

As mentioned in item (1), (2) and (3) above, the optimum values for NHWL and effective storage capacity are EL.270 m and 320 MCM, respectively. An optimization study concerning the maximum power discharge (Qmax) was done on this case.

The result of the study is shown below and the details are shown in Table 8-6 and Fig. 8-8. Qmax of 163 m^3/sec was selected for the Nam Ngao project.

Qmax (m^3/sec)	116	139	163	186	210
Installed Capacity (MW)	99	118	138	158	178
B/C	1.06	1.06	1.10	1.07	1.04
B - C (M฿)	25	28	47	36	23

(Note) NHWL 270 m, Ve 320 MCM

(5) Selected Development Plan

The optimum development plan of the Nam Ngao project is shown below.

NHWL (m)	270
Effective Storage (MCM)	320
Effective Head (m)	97
Max. Power Discharge (m^3/s)	163
Installed Capacity (MW)	138
B/C	1.10
B-C (M฿)	47

8.3.2 Mae Lama Luang Project

(1) Study on Normal High Water Level and Effective Storage Capacity

The mass curve of the Mae Lama Luang project is shown in Fig. 8-9 and in Appendix.

The 16 alternative development plans varying the NHWL, effective storage capacity and installed capacity are examined. The dam is a rockfill type dam, considering the topography and the geology. The power house is planned to be on the right bank, adjacent to the downstream side of the dam. On the basis of the layout seen in DWG. 8-5, alternative development plans are formulated and listed in Table 8-7.

All of the alternatives are compared from economic viewpoint. The result of the study is shown in Table 8-7 and Fig. 8-10. As seen in Fig. 8-10, in the case that the NHWL is fixed, the optimum effective storage is about 180 - 270 MCM. The values of B/C and B-C of the alternatives with the optimum effective storage for each NHWL are shown below.

NHWL (m)	155	160	162	165	170
Effective Storage* (MCM)	180	240	240	240	270
Installed Capacity (MW)	126	151	157	165	186
B/C	1.52	1.59	1.64	1.69	1.78
B-C (M฿)	221	268	297	335	405

Note: * Optimum effective storage for the NHWL

As seen in the table above and Fig. 8-10, the higher the NHWL, the more economical the project. Therefore, it can be concluded that the NHWL should be raised to the level that the topography, geology and resettlement consideration allow.

The study on NHWL was made up to EL.170 m. There is no problems affecting the feasibility of the project up to the NHWL, judging from the topography and geology. However, the NHWL affects the villages located in the proposed reservoir area.

(2) Reservoir Water Level and Number of Households Inundated

- EGAT conducted the site investigation concerning the number of inundated households in 1988.

The result of the investigation is shown below, and the relation between the reservoir water level and inundated villages is shown in Fig. 8-11.

Reservoir Water Level (m)	Number of Inundated Household
160	112
163	146
165	156
170	237

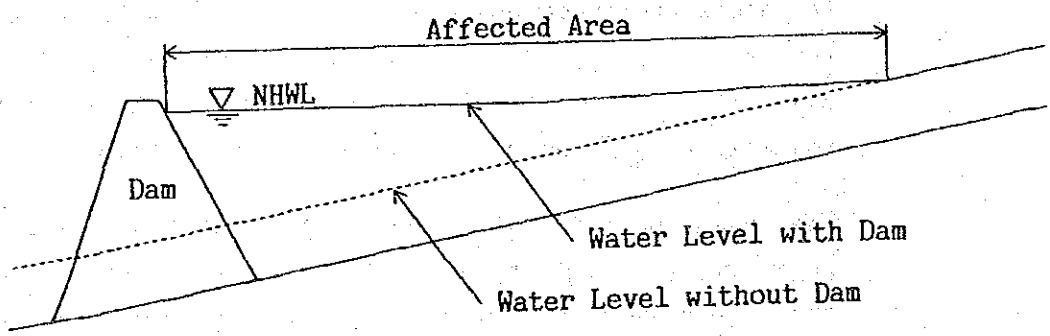
Judging from the number of inundated households, EL.165 m is preferable for the NHWL of the Mae Lama Luang reservoir

because it has less difficulty on the compensation and resettlement problem than EL.170 m,

- Backwater effect due to the reservoir during a flood is examined.

The following conditions are applied for the study.

- Area affected by a flood due to a dam is defined here as follows:



- Flood discharge for the calculation is 1,800 m^3/sec at the Mae Lama Luang dam site with 100 years return period.

- Detail of the calculation is attached in Appendix.

The affected area due to the flood is studied for the reservoir water level from 160 m to 165 m. The result is as follows:

Water Level at Dam Site (m)	Elevation of End of Backwater (m)	Main Villages Affected
160.0	162.1	Ban Mae Suat
161.0	162.3	Ban Mae Kha Tuan
162.0	164.9	ditto and
163.0	165.0	Ban Huai Mae
164.0	165.2	Thalu
165.0	166.2	ditto and Ban Huai Mae Mut

In the case of the water level 163 m at the dam site shown in the table above, the elevation of the backwater end is 165 m which is the same elevation as the preferable NHWL of 165 m.

Therefore, it is unnecessary to take additional counter-measure for the flood in case that the reservoir water level at the dam site is controlled to be lower than 163 m during flood season (July - October).

- Considering the above, the NHWL of 165 m is adopted.

(3) Study on Maximum Power Discharge

As mentioned in the item (1) and (2), the optimum values for NHWL and effective storage capacity are 165 m and 240 MCM, respectively. An optimization study concerning the maximum power discharge (Qmax) is done on this case.

The result is shown below and the details are shown in Table 8-8 and Fig. 8-12. Considering the B-C and B/C values, Qmax of 214 m^3/sec was selected for the Mae Lama Luang Project.

Qmax (m^3/sec)	160	187	214	242	269
Installed Capacity (MW)	123	144	165	185	206
B/C	1.61	1.66	1.69	1.66	1.63
B - C (M฿)	265	304	335	332	330

(Note) NHWL 165 m, Ve 240 MCM

(4) Selected Development Plan

The adopted development plan of the Mae Lama Luang project is shown below.

NHWL (m)	165
Effective Storage Capacity (MCM)	240
Effective Head (m)	88
Max. Power Discharge (m^3/sec)	214
Installed Capacity (MW)	165
B/C	1.69
B-C (M฿)	335

Table 8-5 (1) Study on NHWL and Effective Storage Capacity of Nam Ngao Project (Individual Development)

Item	Unit	(1) N2-250 -200	(2) N2-250 -260	(3) N2-250 -320	(4) N2-260 -260	(5) N2-260 -320	(6) N2-260 -380	(7) N2-260 -440	(8) N2-270 -260	(9) N2-270 -320	(10) N2-270 -380	(11) N2-270 -440
1. Project Feature												
Total Storage Capacity	MCM	508	508	508	684	684	684	684	902	902	902	902
Effective Storage Capacity	MCM	200	260	320	260	320	380	440	260	320	380	440
NHWL	m	250	250	250	260	260	260	260	270	270	270	270
Available Drawdown	m	14.6	19.0	23.4	15.6	20.3	25.4	31.0	12.2	15.5	19.1	23.0
Normal Intake Water Level	m	245.0	243.1	241.0	254.8	253.2	251.5	249.7	265.9	264.8	263.9	262.3
TWL	m	162.5	162.7	162.8	162.7	162.8	162.9	163.0	162.7	162.8	162.9	163.0
Normal Effective Head	m	78.4	76.4	74.3	87.5	85.9	84.2	82.4	98.1	96.9	95.7	94.3
95% Firm Discharge	m^3/sec	18.6	21.8	24.4	21.8	24.4	26.1	28.1	21.8	24.4	26.1	28.1
Max. Turbine Discharge	m^3/sec	124.2	145.3	162.6	145.3	162.6	173.8	187.3	145.3	162.6	173.8	187.3
Installed Capacity	MW	84.9	96.7	105.2	111.1	122.1	127.8	134.7	125.0	138.1	145.7	154.7
Firm Capacity	MW	66.6	71.3	70.2	90.4	94.9	92.6	91.2	109.3	116.9	118.4	121.2
Annual Firm Energy	GWh	87.5	93.7	92.2	118.8	124.7	121.7	119.8	143.6	153.6	155.6	159.3
Annual Secondary Energy	GWh	155.1	148.4	145.8	157.0	150.3	147.8	142.3	174.1	159.9	148.5	141.2
Annual Energy Production	GWh	242.6	242.1	238.0	275.8	275.0	269.5	262.1	317.7	313.5	304.1	300.5
Annual Capacity Factor	%	32.6	28.6	25.8	28.3	25.7	24.1	22.2	29.0	25.9	23.8	22.2
2. Project Economy												
Annual Benefit	M฿	365.3	373.6	367.5	442.5	450.1	440.3	430.4	519.4	529.3	522.6	524.2
for Firm Capacity	M฿	120.5	129.1	127.1	163.6	171.8	167.6	165.1	197.8	211.6	214.3	219.4
for Firm Energy	M฿	90.0	96.4	94.9	122.2	128.3	125.2	123.3	147.8	158.1	160.1	163.9
for Secondary Energy	M฿	154.8	148.1	145.5	156.7	150.0	147.5	142.0	173.8	159.6	148.2	140.9
Construction Cost	M฿	3,160	3,209	3,302	3,668	3,720	3,790	3,891	4,080	4,156	4,245	4,350
Annual Cost	M฿	366.6	372.2	383.0	425.5	431.5	439.6	451.4	473.3	482.1	492.4	504.6
B - C	M฿	-1.3	1.4	-15.5	17.0	18.6	0.7	-21.0	46.1	47.2	30.2	19.6
B / C	-	0.996	1.004	0.959	1.040	1.043	1.002	0.953	1.097	1.098	1.061	1.039

Table 8-5 (2) Study on NHWL and Effective Storage Capacity of Nam Ngao Project
(Individual Development)

Item	Unit	(12) N2-280 -260	(13) N2-280 -320	(14) N2-280 -380	(15) N2-280 -440
1. Project Feature					
Total Storage Capacity	MCM	1,067	1,067	1,067	1,067
Effective Storage Capacity	MCM	260	320	380	440
NHWL	m	280	280	280	280
Available Drawdown	m	9.8	12.5	15.1	18.0
Normal Intake Water Level	m	276.7	275.8	275.0	274.0
TWL	m	162.7	162.8	162.9	163.0
Normal Effective Head	m	108.3	107.3	106.5	105.4
95% Firm Discharge	m^3/sec	21.8	24.4	26.1	28.1
Max. Turbine Discharge	m^3/sec	145.3	162.6	173.8	187.3
Installed Capacity	MW	138.4	153.4	162.7	173.4
Firm Capacity	MW	125.6	136.1	140.4	146.6
Annual Firm Energy	GWh	165.0	178.8	184.5	192.6
Annual Secondary Energy	GWh	188.6	171.7	161.4	147.5
Annual Energy Production	GWh	353.6	350.5	345.9	340.1
Annual Capacity Factor	%	29.2	26.1	24.3	22.4
2. Project Economy					
Annual Benefit	M$	585.3	601.7	605.1	610.7
for Firm Capacity	M$	227.3	246.3	254.1	265.3
for Firm Energy	M$	169.8	184.0	189.9	198.2
for Secondary Energy	M$	188.2	171.4	161.1	147.2
Construction Cost	M$	4,525	4,634	4,758	4,890
Annual Cost	M$	524.9	537.5	551.9	567.2
B - C	M$	60.4	64.2	53.2	43.5
B / C	-	1.115	1.119	1.096	1.077

Table 8-6 Study on Maximum Power Discharge of Nam Ngao Project (Individual Development)

Item	Unit	N2-270-320				
		Q-116	Q-139	Q-163	Q-186	Q-210
1. Project Feature						
Total Storage Capacity	MCM	902.0	902.0	902.0	902.0	902.0
Effective Storage Capacity	MCM	320.0	320.0	320.0	320.0	320.0
Normal High Water Level	m	270.0	270.0	270.0	270.0	270.0
Available Drawdown	m	15.5	15.5	15.5	15.5	15.5
Normal Intake Water Level	m	264.8	264.8	264.8	264.8	264.8
Tail Water Level	m	162.4	162.6	162.8	163.0	163.2
Normal Effective Head	m	97.3	97.1	96.9	96.7	96.5
95% Firm Discharge	m^3/sec	24.4	24.4	24.4	24.4	24.4
Maximum Power Discharge	m^3/sec	115.6	139.1	162.6	186.2	209.6
Installed Capacity	MW	98.6	118.4	138.1	157.8	177.6
Firm Capacity	MW	83.5	95.3	116.9	119.2	118.6
Annual Firm Energy	GWh	109.7	125.2	153.6	156.6	155.8
Annual Secondary Energy	GWh	195.2	185.6	159.9	164.0	175.1
Annual Energy Production	GWh	304.9	310.8	313.5	320.6	330.9
Annual Capacity Factor	%	35.3	30.0	25.9	23.2	21.3
2. Project Economy						
Annual Benefit	MB	458.8	486.5	529.3	540.5	549.7
for Firm Capacity	MB	151.1	172.4	211.6	215.7	214.6
for Firm Energy	MB	112.8	128.8	158.1	161.1	160.3
for Secondary Energy	MB	194.8	185.2	159.6	163.6	174.7
Construction Cost	MB	3,738.0	3,950.0	4,156.0	4,353.0	4,544.0
Annual Cost	MB	433.6	458.2	482.1	504.9	527.1
B - C	MB	25.2	28.3	47.2	35.6	22.6
B / C	-	1.058	1.061	1.098	1.070	1.042

Table 8-7 (1) Study on NHWL and Effective Storage Capacity of Mae Lama Luang Project (Individual Development)

Item	Unit	(1) M5-155 -150	(2) M5-155 -180	(3) M5-155 -210	(4) M5-160 -210	(5) M5-160 -240	(6) M5-160 -270	(7) M5-160 -300	(8) M5-162 -240	(9) M5-165 -210	(10) M5-165 -240	(11) M5-165 -270
1. Project Feature												
Total Storage Capacity	MCM	336	336	336	403	403	403	403	436	486	486	486
Effective Storage Capacity	MCM	150	180	210	210	240	270	300	240	210	240	270
NHWL	m	155	155	155	160	160	160	160	162	165	165	165
Available Drawdown	m	17.2	22.3	28.3	21.1	26.0	31.9	38.7	22.6	15.4	18.8	22.7
Normal Intake Water Level	m	149.3	147.6	145.6	153.0	151.3	149.4	147.1	154.5	159.9	158.7	157.4
TWL	m	66.0	66.1	66.2	66.2	66.3	66.4	66.5	66.3	66.2	66.3	66.4
Normal Effective Head	m	79.2	77.4	75.4	82.5	80.8	78.9	76.6	83.8	89.0	87.8	86.5
95% Firm Discharge	m^3/sec	25.6	28.0	30.1	30.1	32.2	34.2	36.2	32.2	30.1	32.2	34.2
Max. Turbine Discharge	m^3/sec	170.7	186.6	200.6	200.6	214.3	227.8	241.1	214.3	200.6	214.3	227.8
Installed Capacity	MW	117.9	125.9	131.8	144.5	151.1	156.8	161.0	156.9	156.2	164.5	172.2
Firm Capacity	MW	92.5	90.2	84.3	105.9	103.6	96.4	85.2	114.4	128.7	129.7	127.7
Annual Firm Energy	GWh	121.5	118.5	110.8	139.2	136.5	126.7	112.0	150.3	169.1	170.4	167.8
Annual Secondary Energy	GWh	342.5	359.8	364.8	379.3	392.9	394.7	396.4	401.9	393.9	408.8	415.3
Annual Energy Production	GWh	464.0	478.3	475.6	518.5	529.4	521.4	508.4	552.2	563.0	579.2	583.1
Annual Capacity Factor	%	44.9	43.4	41.2	41.0	40.0	38.0	36.0	40.2	41.1	40.2	38.7
2. Project Economy												
Annual Benefit	M฿	634.3	644.4	630.7	713.5	720.7	698.9	665.1	762.9	800.1	818.1	818.3
for Firm Capacity	M฿	167.4	165.3	152.6	191.7	188.1	174.5	154.2	207.1	232.9	234.8	231.1
for Firm Energy	M฿	125.0	121.9	114.0	143.2	140.4	130.4	115.2	154.7	174.0	175.3	172.7
for Secondary Energy	M฿	341.9	359.2	364.1	378.6	392.2	394.0	395.7	401.1	393.2	408.8	414.5
Construction Cost	M฿	3,618	3,654	3,691	3,871	3,906	3,955	4,018	4,017	4,127	4,162	4,213
Annual Cost	M฿	419.7	423.9	428.2	449.0	453.1	458.8	466.1	466.0	478.7	482.8	488.7
B - C	M฿	214.6	220.5	202.5	264.5	267.6	240.1	199.0	296.9	321.4	335.3	329.6
B / C	-	1.511	1.520	1.473	1.589	1.591	1.523	1.427	1.637	1.671	1.694	1.674

Table 8-7 (2) Study on NHWL and Effective Storage Capacity of Mae Lama Luang Project
(Individual Development)

Item	Unit	(12) M5-165 -300	(13) M5-170 -240	(14) M5-170 -270	(15) M5-170 -300	(16) M5-170 -330
1. Project Feature						
Total Storage Capacity	MCM	486	594	594	594	594
Effective Storage Capacity	MCM	300	240	270	300	330
NHWL	m	165	170	170	170	170
Available Drawdown	m	27.2	13.7	16.1	18.7	21.8
Normal Intake Water Level	m	155.9	165.4	164.6	163.8	162.7
TWL	m	66.5	66.3	66.4	66.5	66.5
Normal Effective Head	m	85.0	94.2	93.3	92.5	91.4
95% Firm Discharge	m^3/sec	36.2	32.2	34.2	36.2	38.0
Max. Turbine Discharge	m^3/sec	241.1	214.3	227.8	241.1	253.5
Installed Capacity	MW	179.1	176.8	186.1	195.3	202.8
Firm Capacity	MW	123.0	151.1	154.1	155.7	155.2
Annual Firm Energy	GWh	161.6	198.5	202.5	204.6	203.9
Annual Secondary Energy	GWh	415.9	436.8	435.2	432.9	429.8
Annual Energy Production	GWh	577.5	635.3	637.7	637.5	633.7
Annual Capacity Factor	%	36.8	41.0	39.1	37.3	35.7
2. Project Economy						
Annual Benefit	M฿	804.0	913.8	921.7	924.4	919.7
for Firm Capacity	M฿	222.6	273.5	278.9	281.8	280.9
for Firm Energy	M฿	166.3	204.3	208.4	210.5	209.8
for Secondary Energy	M฿	415.1	436.0	434.4	432.1	429.0
Construction Cost	M฿	4,272	4,403	4,455	4,514	4,594
Annual Cost	M฿	495.6	510.7	516.8	523.6	532.9
B - C	M฿	308.4	403.1	404.9	400.8	386.8
B / C	-	1.613	1.789	1.783	1.761	1.726

Table 8-8 Study on Maximum Power Discharge of Mae Lama Luang Project (Individual Development)

Item	Unit	Y2-165-240				
		Q-160	Q-187	Q-214	Q-242	Q-269
1. Project Feature						
Total Storage Capacity	MCM	486.0	486.0	486.0	486.0	486.0
Effective Storage Capacity	MCM	240.0	240.0	240.0	240.0	240.0
Normal High Water Level	m	165.0	165.0	165.0	165.0	165.0
Available Drawdown	m	18.8	18.8	18.8	18.8	18.8
Normal Intake Water Level	m	158.7	158.7	158.7	158.7	158.7
Tail Water Level	m	65.9	66.1	66.3	66.5	66.7
Normal Effective Head	m	88.2	88.0	87.8	87.6	87.4
95% Firm Discharge	m^3/sec	32.2	32.2	32.2	32.2	32.2
Maximum Power Discharge	m^3/sec	160.2	187.3	214.3	242.3	269.4
Installed Capacity	MW	123.4	143.9	164.5	185.1	205.6
Firm Capacity	MW	96.8	113.5	129.7	132.3	131.6
Annual Firm Energy	GWh	127.2	149.1	170.4	173.8	172.9
Annual Secondary Energy	GWh	397.0	406.2	408.8	418.7	438.7
Annual Energy Production	GWh	524.2	555.3	579.2	592.5	611.6
Annual Capacity Factor	%	48.5	44.1	40.2	36.5	34.0
2. Project Economy						
Annual Benefit	M฿	702.3	764.2	818.1	836.2	854.0
for Firm Capacity	M฿	175.2	205.4	234.7	239.5	238.2
for Firm Energy	M฿	130.8	153.4	175.3	178.8	177.9
for Secondary Energy	M฿	396.2	405.4	408.0	417.9	437.9
Construction Cost	M฿	3,772.0	3,972.0	4,162.0	4,344.0	4,515.0
Annual Cost	M฿	437.5	460.7	482.7	503.9	523.7
B - C	M฿	264.8	303.5	335.3	332.3	330.3
B / C	-	1.605	1.658	1.694	1.659	1.631

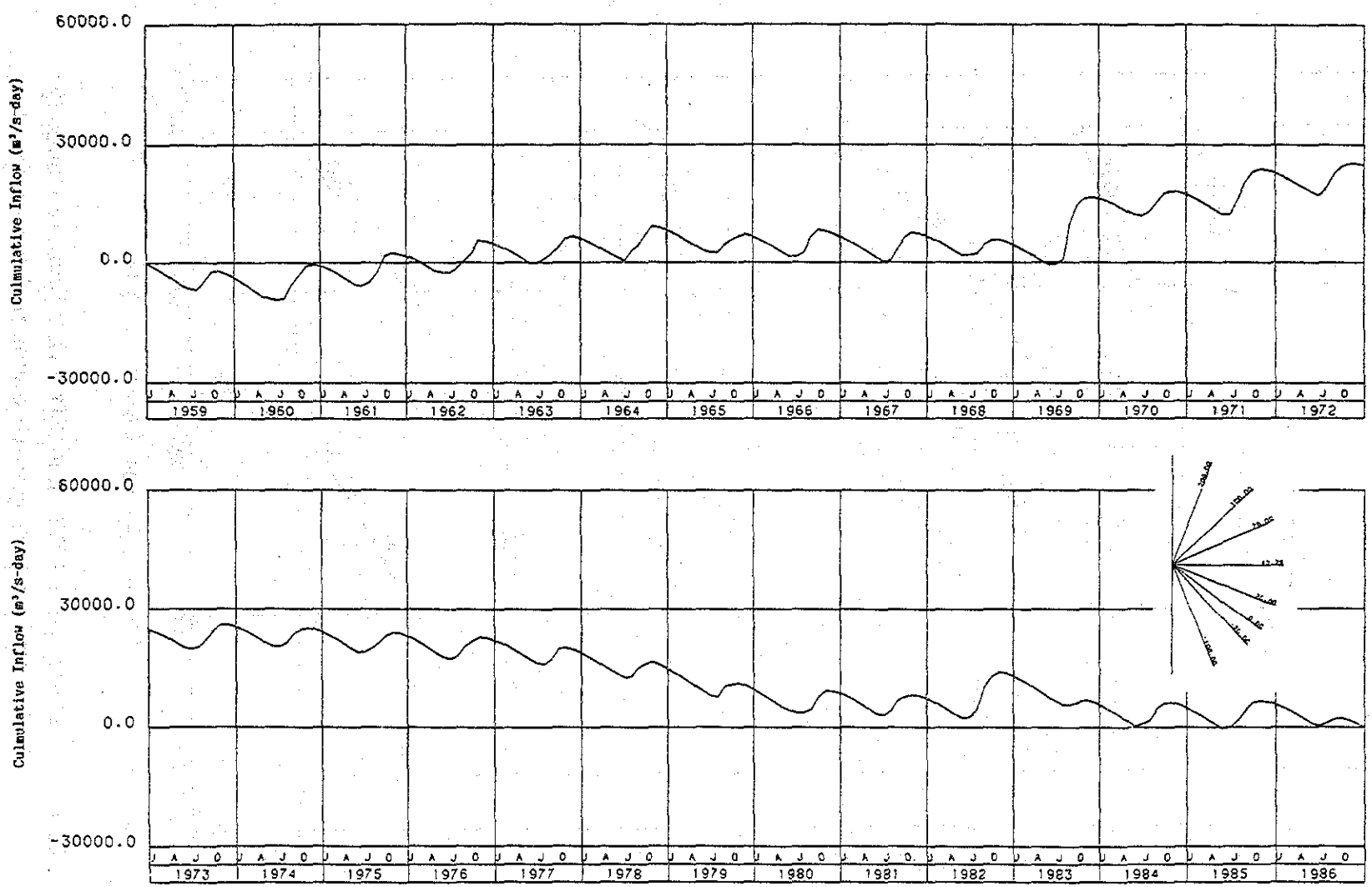


Fig. 8-6 Mass Curve of Nam Ngao Project

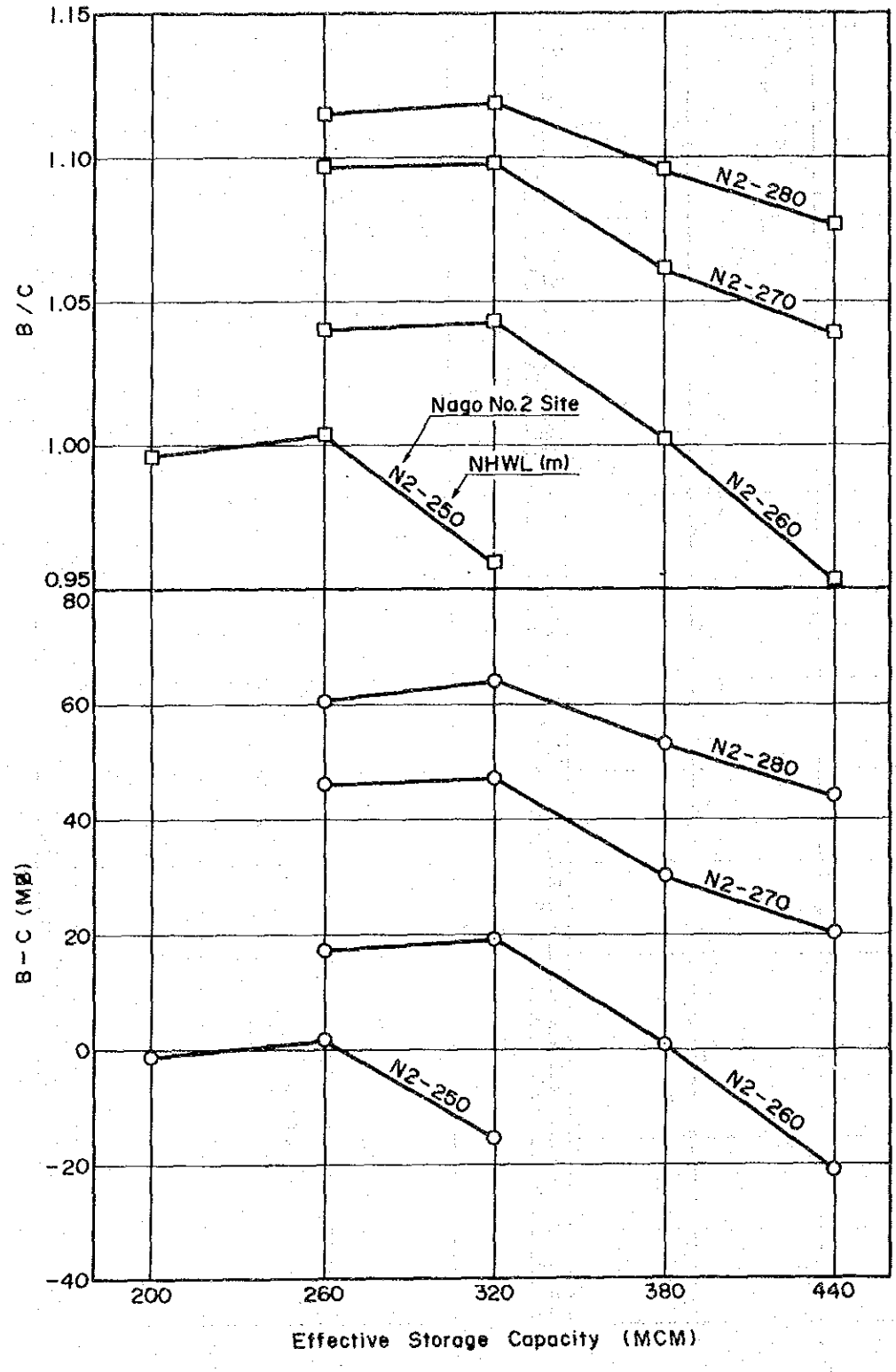


Fig.8- 7 Study on NHWL and Effective Storage Capacity of Nam Ngao Project (Individual Development)

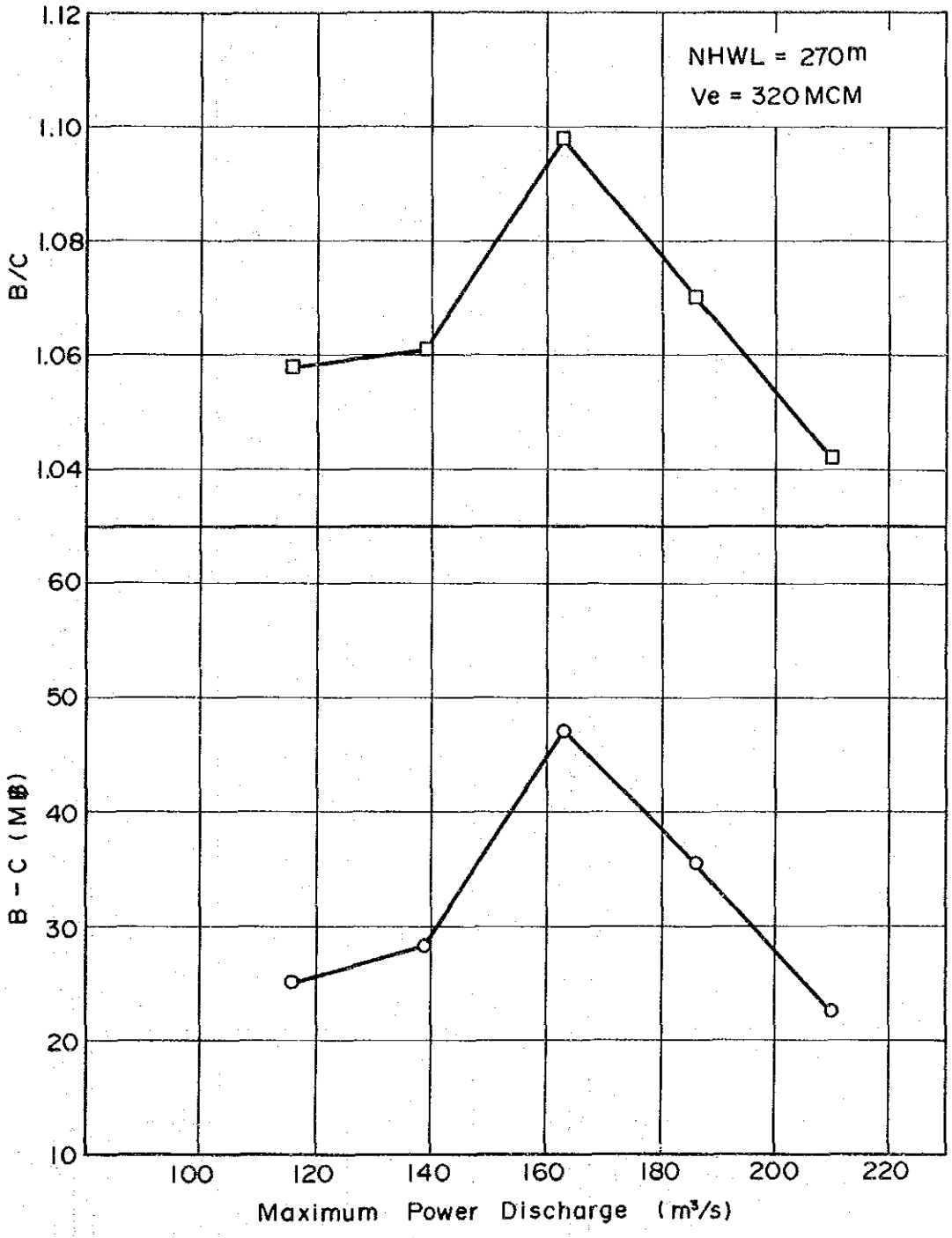


Fig. 8-8 Study on Maximum Power Discharge of Nam Ngao Project (Individual Development)

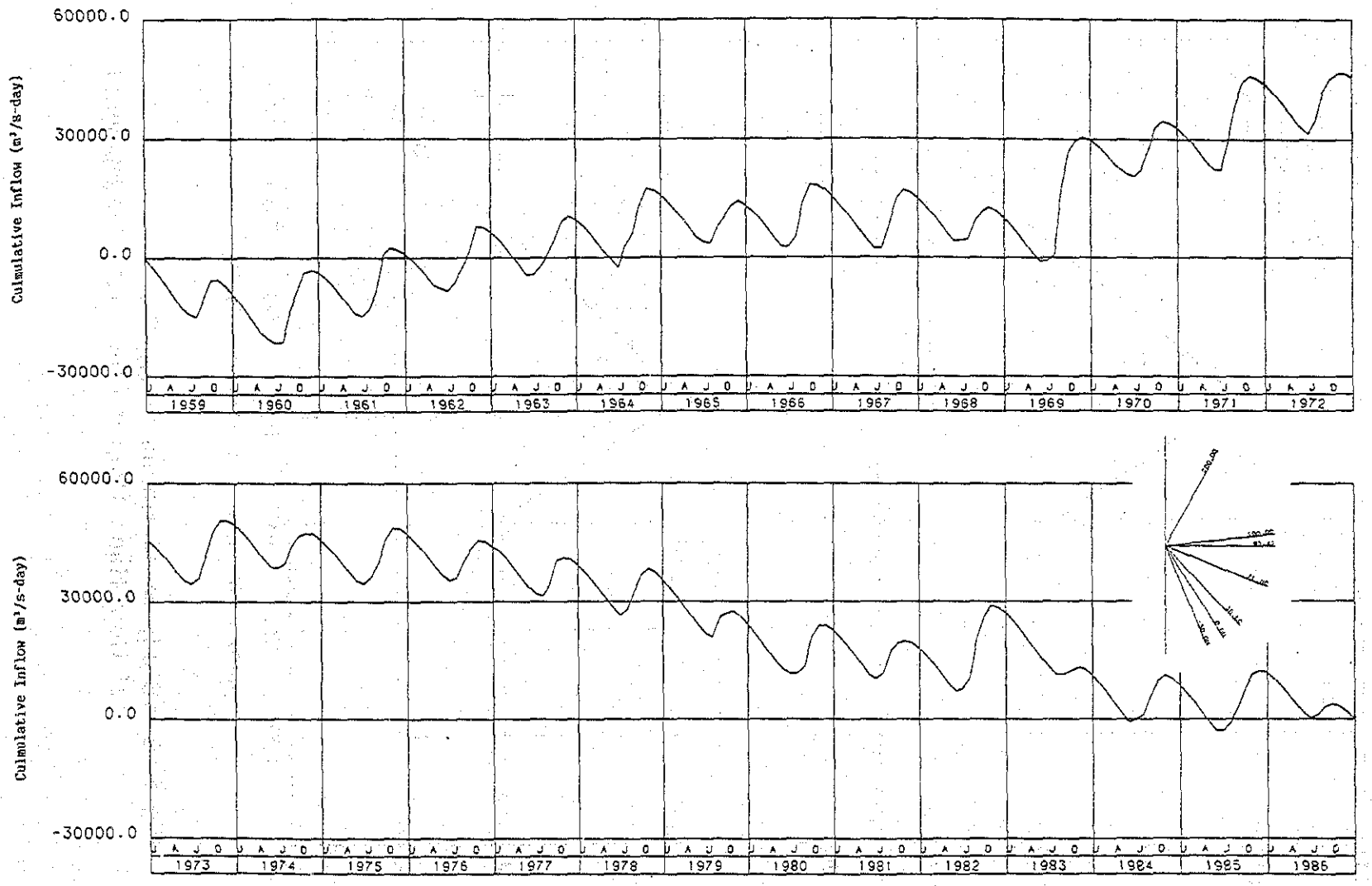


Fig. 6-9 Mass Curve of Nae Lama Luang Project (Individual Development)

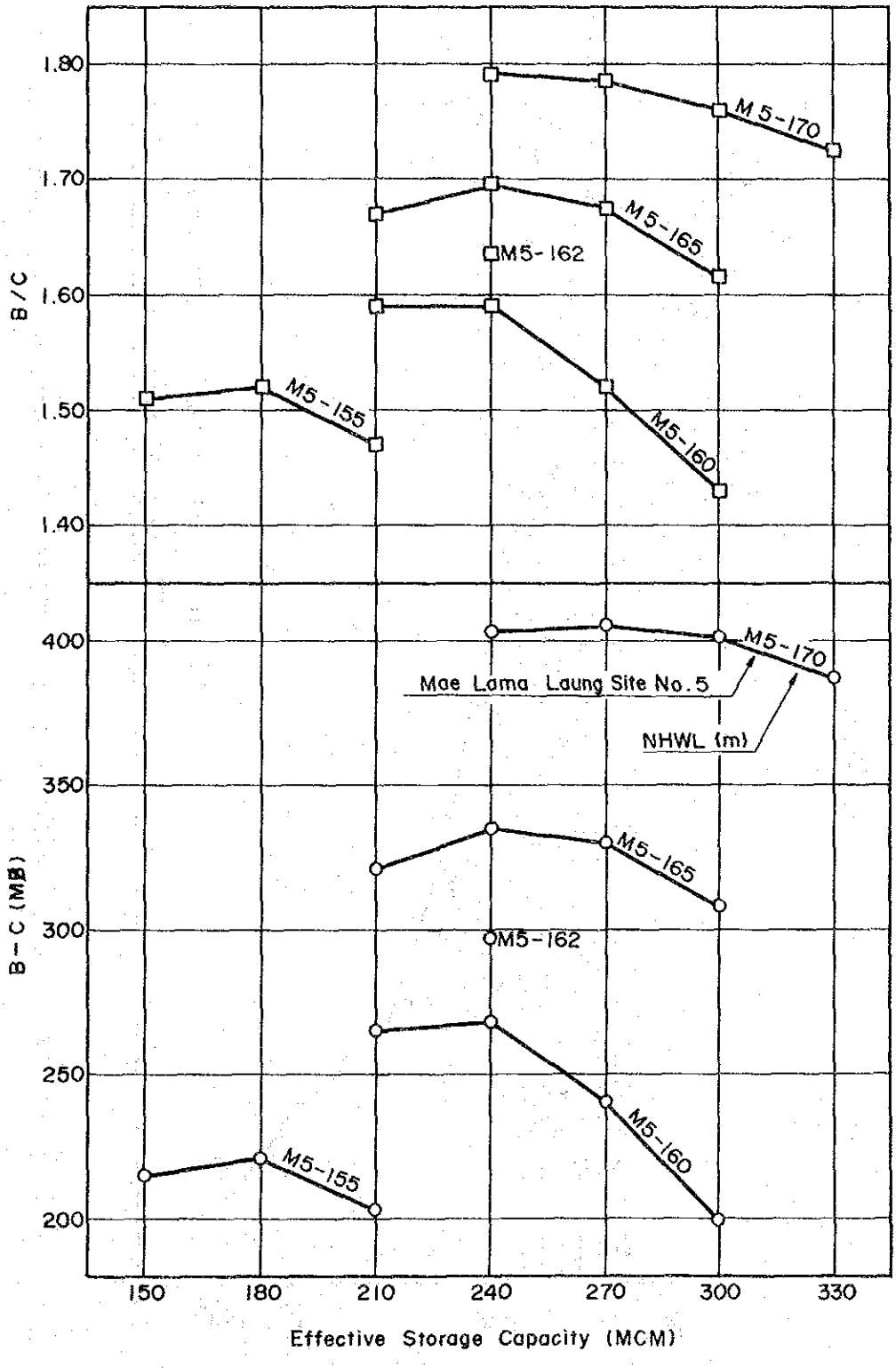


Fig.8-10 Study on NHWL and Effective Storage Capacity of Mae Lama Luang Project (Individual Development)

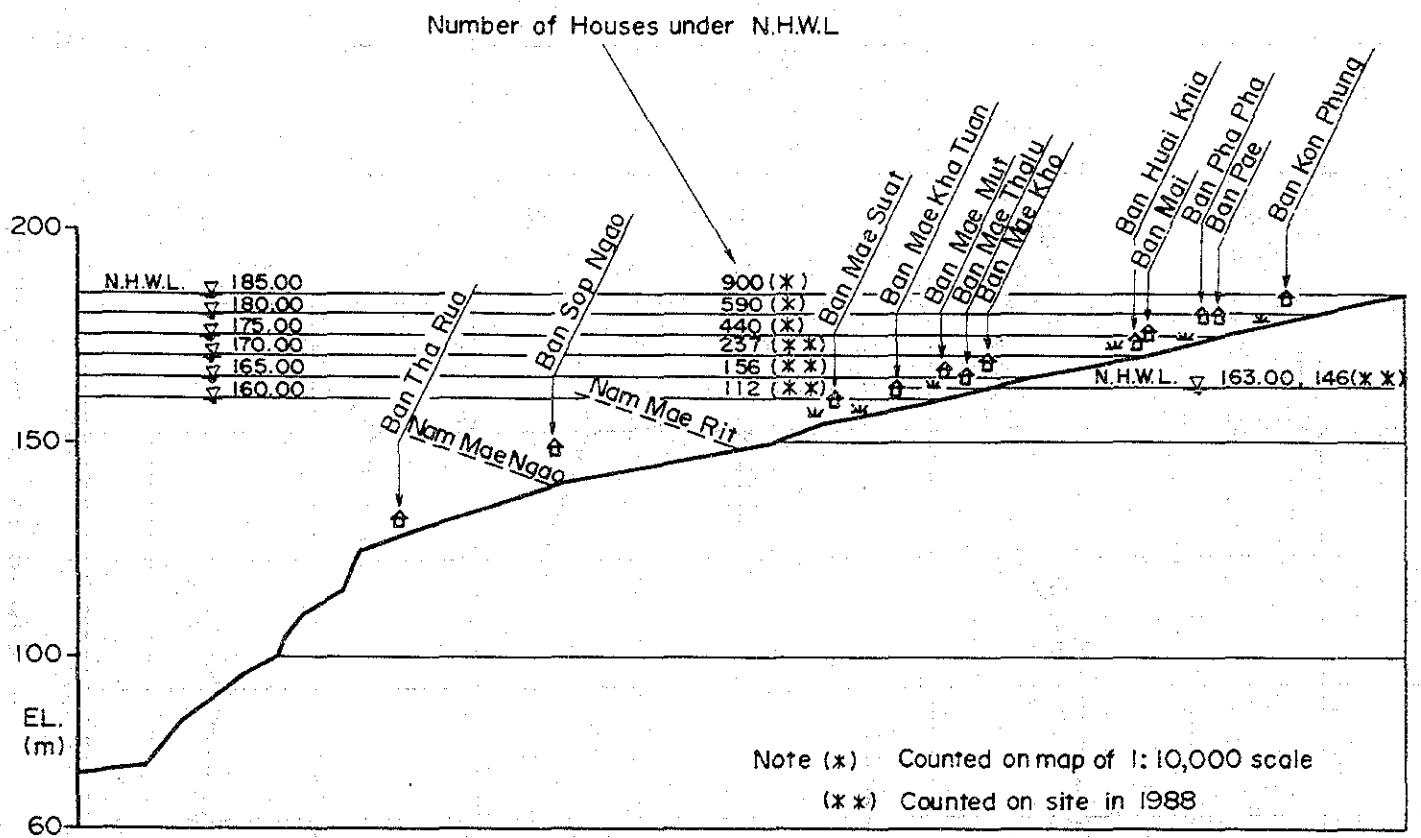


Fig. 8-11 Location of Villages and Number of Households to be Resettled

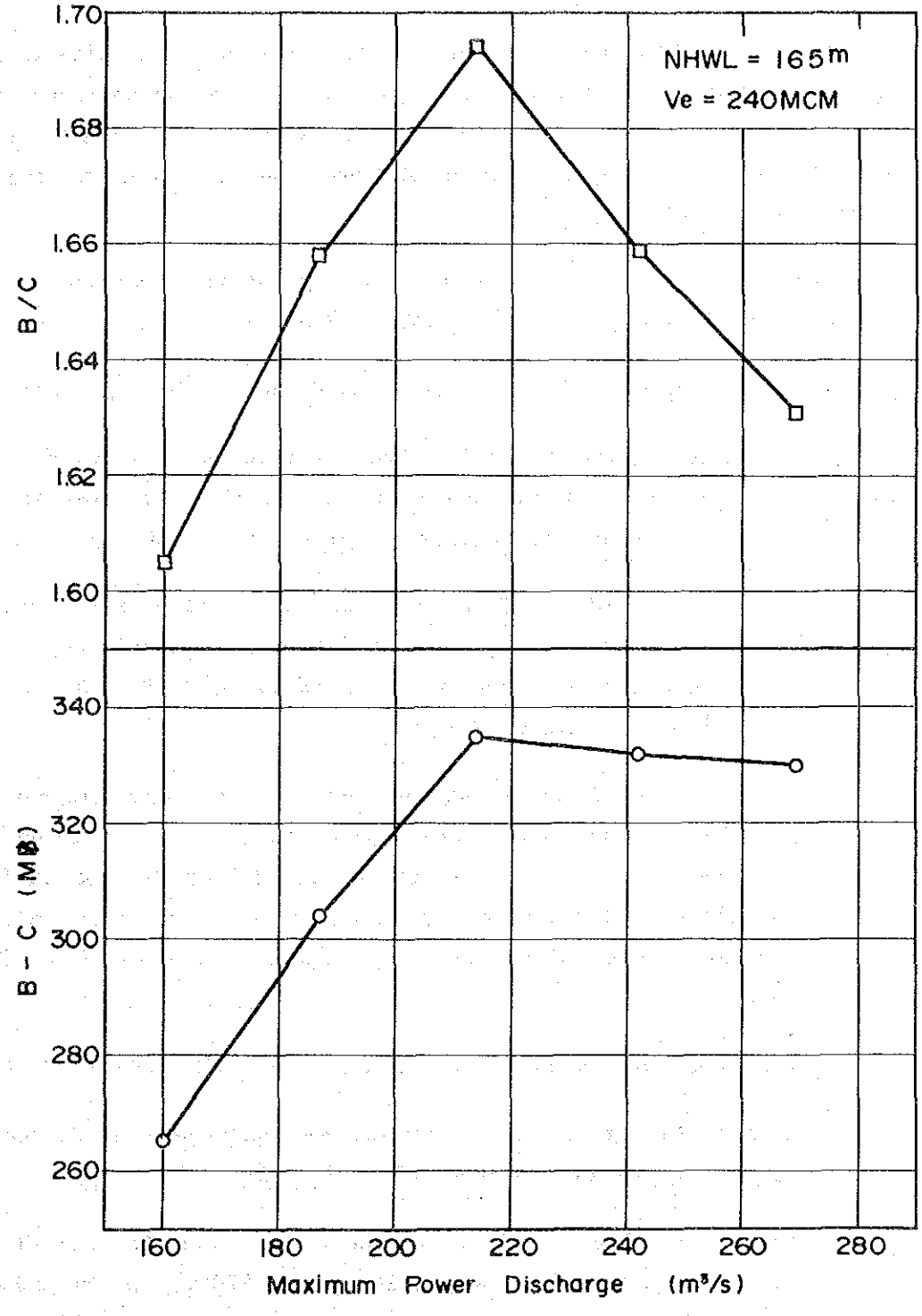


Fig. 8-12 Study on Maximum Power Discharge of Mae Lama Luang Project (Individual Development)

8.4 Optimization Study on Integrated Development (Investigation Stage)

The location of dam sites for the integrated development plan is Site No. 2 and Site No. 5 for the Nam Ngao project and the Mae Lama Luang project, respectively. Hereafter, the Nam Ngao site No. 2 and the Mae Lama Luang site No. 5 are called the Nam Ngao dam site and the Mae Lama Luang dam site.

The layout of civil structures and the type of the dams are same as the individual plans, as shown in DWG. 8-2 and DWG. 8-5.

(1) Study on Normal High Water Level and Effective Storage Capacity

- The mass curve for the Nam Ngao project is shown in Fig. 8-6 and the curve for the Mae Lama Luang project is shown in Fig. 8-13. The values of these mass curves are shown in Appendix.

  Varying the NHWL, effective storage capacity and installed capacity of the Nam Ngao and Mae Lama Luang projects, all of the alternative development plans shown in Table 8-9 are examined from economic viewpoint.

  The optimum effective storage of the Nam Ngao project was 320 MCM for individual development. In the case of integrated development, an effective storage of 380 MCM is also studied, considering the better regulating effect for the available discharge of the Mae Lama Luang project by the Nam Ngao reservoir.

  The result of the study is shown in Table 8-9 and Fig. 8-14.

  As seen in Fig. 8-14, the optimum effective storage of the Mae Lama Luang project is about 150 - 210 MCM.

  The table below shows the optimum combinations for the NHWL of the Nam Ngao project at EL.260 m and 270 m, in the case of fixing the NHWL of the Mae Lama Luang project at EL.170 m.

Item	Combination	
	(A)	(B)
(Nam Ngao Project)		
NHWL (m)	260	270
Effective Storage (MCM)	320	320
Installed Capacity (MW)	117	133
(Mae Lama Luang Project)		
NHWL (m)	170	170
Effective Storage (MCM)	210	210
Installed Capacity (MW)	266	266
(Overall)		
Installed Capacity (MW)	383	399
B/C	1.50	1.50
B-C (M฿)	503	532

As seen in the table above and Fig. 8-14, the higher the NHWL of the Nam Ngao project, the more economical the overall project.

Fixing the Nam Ngao project to the figure of combination (B), a comparison by varying the NHWL of the Mae Lama Luang project is shown below.

Item	NHWL of Mae Lama Luang Project (m)			
	155	160	165	170
(Nam Ngao Project)				
Effective Storage (MCM)	320	320	320	320
Installed Capacity (MW)	138	138	138	133
(Mae Lama Luang Project)				
Effective Storage (MCM)	210	210	210	210
Installed Capacity (MW)	210	230	243	266
(Overall Project)				
Installed Capacity (MW)	348	368	381	399
B/C	1.28	1.36	1.48	1.50
B-C (M฿)	279	367	494	532

The table above indicates that the higher the NHWL of the Mae Lama Luang project, the more economical the overall project. Further, the economics of the overall project mainly depends on the Mae Lama Luang project.

- The NHWLs of the Nam Ngao and Mae Lama Luang projects were determined to be EL.270 m and EL.165 m respectively because of the following reasons.

(Nam Ngao project)

° The water level of 270 m is the upper limit for the reservoir water level, judging from topography and geology.

(Mae Lama Luang project)

° The water level of 165 m is the upper limit from compensation viewpoint.

Further, the detail concerning the upper limit of NHWL for the both projects is described in section 8.3.1 and 8.3.2.

(2) Study on Maximum Power Discharge

As mentioned in item (1) above, the optimum values for NHWL and effective storage capacity are as follows:

	Nam Ngao Project	Mae Lama Luang Project
NHWL (m)	270	165
Effective Storage (MCM)	320	210

An optimization study concerning the maximum power discharge (Qmax) is done by fixing the NHWL and effective storage above.

The result of the study is shown in Table 8-10, Fig. 8-15 and below. The optimum Qmax of the Nam Ngao project does not change for each alternative.

Case	(NQ-163)+ (MQ-227)	(NQ-163)+ (MQ-274)	(NQ-163)+ (MQ-322)	(NQ-163)+ (MQ-369)	(NQ-163)+ (MQ-418)
(Nam Ngao Project)					
Qmax (m3/sec)	163	163	163	163	163
Installed Capacity (MW)	138	138	138	138	138
(Mae Lama Luang Project)					
Qmax (m3/sec)	227	274	322	369	418
Installed Capacity (MW)	175	212	248	284	320
(Overall Project)					
Installed Capacity (MW)	313	350	386	422	458
B/C	1.40	1.43	1.45	1.42	1.39
B-C (M฿)	389	428	469	455	435

The result shows the most economic combination is the case of (NQ-163) + (MQ-322) having the Qmax of 163 m3/sec and 322 m3/sec for the Nam Ngao and Mae Lama Luang projects respectively.

(3) Selected Development Plan

The following development scale for the integrated development was determined at the investigation stage.

	Nam Ngao	Mae Lama Luang	Overall
NHWL (m)	270	165	-
Effective Storage Capacity (MCM)	320	210	-
Effective Head (m)	96.9	88.3	-
Max. Power Discharge (m3/sec)	163	322	-
Installed Capacity (MW)	138	248	386
B/C			1.45
B-C (M฿)			469

Table 8-9 (1) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(1)		(2)		(3)		(4)		(5)	
		N260-320-M155-150		N260-320-M155-210		N260-320-M160-150		N260-320-M160-210		N260-320-M160-270	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Feature											
Total Storage Capacity	MCM	684	336	684	336	684	403	684	403	684	403
Effective Storage Capacity	MCM	320	150	320	210	320	150	320	210	320	270
NHWL	m	260	155	260	155	260	160	260	160	260	160
Available Drawdown	m	20.3	17.2	20.3	28.3	20.3	13.0	20.3	21.1	20.3	31.9
Normal Intake Water Level	m	253.2	149.3	253.2	145.6	253.2	155.7	253.2	153.0	253.2	149.4
TWL	m	162.8	66.8	162.8	66.9	162.8	66.8	162.8	66.9	162.8	67.0
Normal Effective Head	m	85.9	78.4	85.9	74.4	85.9	84.5	85.9	81.8	85.9	78.3
95% Firm Discharge	m^3/sec	24.4	44.5	24.4	48.3	24.4	44.5	24.4	48.3	24.4	51.6
Max. Turbine Discharge	m^3/sec	162.6	296.9	162.6	322.1	162.6	296.9	162.6	322.1	162.6	344.1
Installed Capacity	MW	122.1	203.0	122.1	209.6	122.1	219.2	122.1	230.0	122.1	235.0
	MW	325.1		331.7		341.3		352.1		357.1	
Firm Capacity	MW	94.9	138.9	94.9	133.6	94.9	175.5	94.9	171.5	94.9	144.0
	MW	233.8		228.5		270.4		266.4		238.9	
Annual Firm Energy	GWh	124.7	182.5	124.7	175.6	124.7	230.6	124.7	225.4	124.7	189.2
	GWh	307.2		300.3		355.3		350.1		313.9	
Annual Secondary Energy	GWh	150.3	322.7	150.3	340.8	150.3	324.5	150.3	347.5	150.3	353.4
	GWh	473.0		491.1		474.8		497.8		503.7	
Annual Energy Production	GWh	275.0	505.2	275.0	516.4	275.0	555.1	275.0	572.9	275.0	542.6
	GWh	780.2		791.4		830.1		847.9		817.6	
Annual Capacity Factor	%	25.7	28.4	25.7	28.1	25.7	28.9	25.7	28.4	25.7	26.4
	%	27.4		27.2		27.8		27.5		26.1	
2. Project Economy											
Annual Benefit	M฿	1,083.0		1,183.2		1,300.4		1,309.4		1,227.9	
for Firm Capacity	M฿	423.2		413.6		489.4		482.2		432.4	
for Firm Energy	M฿	316.1		309.0		365.6		360.3		323.0	
for Secondary Energy	M฿	443.7		460.6		445.4		466.9		472.5	
Construction Cost	M฿	3,720	4,238	3,720	4,319	3,720	4,579	3,720	4,645	3,720	4,711
	M฿	7,958		8,039		8,299		8,365		8,431	
Annual Cost	M฿	923.1		932.5		962.7		970.3		978.0	
B - C	M฿	259.9		250.7		337.7		339.1		249.9	
B / C	-	1.282		1.269		1.351		1.349		1.256	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-9 (2) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(6) N260-320-M162-210		(7) N260-320-M165-150		(8) N260-320-M165-210		(9) N260-320-M165-270		(10) N260-320-M170-150	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Feature											
Total Storage Capacity	MCM	684	436	684	486	684	486	684	486	684	594
Effective Storage Capacity	MCM	320	210	320	150	320	210	320	270	320	150
NHWL	m	260	162	260	165	260	165	260	165	260	170
Available Drawdown	m	20.3	18.3	20.3	10.0	20.3	15.4	20.3	22.7	20.3	7.5
Normal Intake Water Level	m	253.2	155.9	253.2	161.7	253.2	159.9	253.2	157.4	253.2	167.5
TWL	m	162.8	66.9	162.8	66.8	162.8	66.9	162.8	67.0	167.5	66.8
Normal Effective Head	m	85.9	84.6	85.9	90.2	85.9	88.4	85.9	85.9	81.4	95.7
95% Firm Discharge	m^3/sec	24.4	48.3	24.4	44.5	24.4	48.3	24.4	51.6	24.4	44.5
Max. Turbine Discharge	m^3/sec	162.6	322.1	162.6	269.6	162.6	320.0	162.6	344.1	162.6	296.9
Installed Capacity	MW	122.1	238.1	122.1	209.6	122.1	243.2	122.1	254.4	115.5	249.0
	MW	360.2		331.7		365.3		376.5		364.5	
Firm Capacity	MW	94.9	185.9	94.9	218.5	94.9	218.7	94.9	202.5	94.9	229.2
	MW	280.8		313.4		313.6		297.4		324.1	
Annual Firm Energy	GWh	124.7	244.3	124.7	287.1	124.7	287.4	124.7	266.1	124.7	301.2
	GWh	369.0		411.8		412.1		390.8		425.9	
Annual Secondary Energy	GWh	150.3	350.3	150.3	332.6	150.3	345.4	150.3	344.2	136.8	363.2
	GWh	500.6		482.9		495.7		494.5		500.0	
Annual Energy Production	GWh	275.0	594.6	275.0	619.7	275.0	632.8	275.0	610.3	261.5	664.4
	GWh	869.6		894.7		907.8		885.3		925.9	
Annual Capacity Factor	%	25.7	28.4	25.7	33.8	25.7	29.7	25.7	27.4	25.8	30.5
	%	27.6		30.8		28.4		26.8		29.0	
2. Project Economy											
Annual Benefit	M฿	1,357.5		1,444.0		1,456.7		1,404.2		1,493.9	
for Firm Capacity	M฿	508.2		567.3		567.6		538.3		586.6	
for Firm Energy	M฿	379.7		423.7		424.1		402.1		438.3	
for Secondary Energy	M฿	469.6		453.0		465.0		463.8		469.0	
Construction Cost	M฿	3,720	4,725	3,720	4,736	3,720	4,819	3,720	4,832	3,666	4,893
	M฿	8,445		8,456		8,539		8,552		8,559	
Annual Cost	M฿	979.6		980.9		990.5		992.0		992.8	
B - C	M฿	377.9		463.1		466.2		412.2		501.1	
B / C	-	1.386		1.472		1.471		1.416		1.505	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-9 (3) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(11)		(12)		(13)		(14)		(15)	
		N260-320-M170-210		N260-320-M170-270		N260-380-M155-150		N260-380-M155-210		N260-380-M160-150	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Feature											
Total Storage Capacity	MCM	684	594	684	594	684	336	684	336	684	403
Effective Storage Capacity	MCM	320	210	320	270	380	150	380	210	380	150
NHWL	m	260	170	260	170	260	155	260	155	260	160
Available Drawdown	m	20.3	11.4	20.3	16.1	25.4	17.2	25.4	28.3	25.4	13.0
Normal Intake Water Level	m	253.2	166.2	253.2	164.6	251.5	149.3	251.5	145.6	251.5	155.7
TWL	m	166.3	66.9	164.7	67.0	162.9	66.8	162.9	67.0	162.9	66.8
Normal Effective Head	m	82.6	94.3	84.0	92.7	84.2	78.3	84.2	74.7	84.2	84.4
95% Firm Discharge	m^3/sec	24.4	48.3	24.4	51.6	26.1	46.0	26.1	49.8	26.1	46.0
Max. Turbine Discharge	m^3/sec	162.6	322.1	162.6	344.1	173.8	306.9	173.8	332.3	173.8	306.9
Installed Capacity	MW	117.3	266.1	119.3	279.3	127.8	209.6	127.8	216.3	127.8	226.3
	MW	383.4		398.6		337.4		344.1		354.1	
Firm Capacity	MW	94.9	233.4	94.9	231.0	92.6	144.1	92.6	137.7	92.6	181.4
	MW	328.3		325.9		236.7		230.3		274.0	
Annual Firm Energy	GWh	124.7	306.7	124.7	303.5	121.7	189.3	121.7	180.9	121.7	238.4
	GWh	431.4		428.2		311.0		302.6		360.1	
Annual Secondary Energy	GWh	138.5	365.5	139.2	354.9	147.8	322.7	147.8	336.5	147.8	317.0
	GWh	504.0		494.1		470.5		484.3		464.8	
Annual Energy Production	GWh	263.2	672.2	263.9	658.4	269.5	512.0	269.5	517.4	269.5	555.4
	GWh	935.4		922.3		781.5		786.9		824.9	
Annual Capacity Factor	%	25.6	28.8	25.3	26.9	24.1	27.9	24.1	27.3	24.1	28.0
	%	27.9		26.4		26.4		26.1		26.6	
2. Project Economy											
Annual Benefit	M฿	1,510.8		1,494.0		1,189.7		1,182.5		1,302.4	
for Firm Capacity	M฿	594.2		589.9		428.4		416.8		495.9	
for Firm Energy	M฿	443.9		440.6		320.0		311.4		370.5	
for Secondary Energy	M฿	472.7		463.5		441.3		454.3		436.0	
Construction Cost	M฿	3,689	5,003	3,710	5,113	3,790	4,296	3,790	4,377	3,790	4,651
	M฿	8,692		8,823		8,086		8,167		8,441	
Annual Cost	M฿	1,008.3		1,023.5		938.0		947.4		979.2	
B - C	M฿	502.5		470.5		251.7		235.1		323.2	
B / C	-	1.498		1.460		1.268		1.248		1.330	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-9 (4) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(16)		(17)		(18)		(19)		(20)	
		N260-380-M160-210		N260-380-M160-270		N260-380-M165-150		N260-380-M165-210		N260-380-M165-270	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Feature											
Total Storage Capacity	MCM	684	403	684	403	684	486	684	486	684	486
Effective Storage Capacity	MCM	380	210	380	270	380	150	380	210	380	270
NHWL	m	260	160	260	160	260	165	260	165	260	165
Available Drawdown	m	25.4	21.4	25.4	31.9	25.4	10.0	25.4	15.4	25.4	22.7
Normal Intake Water Level	m	251.5	153.0	251.5	149.4	251.5	161.7	251.5	159.9	251.5	157.4
TWL	m	162.9	67.0	162.9	67.1	162.9	66.8	162.9	67.0	162.9	67.1
Normal Effective Head	m	84.2	81.7	84.2	78.2	84.2	90.2	84.2	88.3	84.2	85.8
95% Firm Discharge	m^3/sec	26.1	49.8	26.1	53.2	26.1	46.0	26.1	49.8	26.1	53.2
Max. Turbine Discharge	m^3/sec	173.8	332.3	173.8	354.5	173.8	306.9	173.8	332.3	173.8	354.5
Installed Capacity	MW	127.8	237.0	127.8	241.8	127.8	238.3	127.8	252.6	127.8	261.8
	MW	364.8		369.6		366.1		380.4		389.6	
Firm Capacity	MW	92.6	176.7	92.6	148.2	92.6	225.8	92.6	225.5	92.6	208.3
	MW	269.3		240.8		318.4		318.1		300.9	
Annual Firm Energy	GWh	121.7	232.2	121.7	194.7	121.7	296.7	121.7	296.3	121.7	273.7
	GWh	353.9		316.4		418.4		418.0		395.4	
Annual Secondary Energy	GWh	147.8	341.1	147.8	348.6	147.8	323.4	147.8	337.2	147.8	336.6
	GWh	488.9		496.4		471.2		485.0		484.4	
Annual Energy Production	GWh	269.5	573.3	269.5	543.3	269.5	620.1	269.5	633.5	269.5	610.3
	GWh	842.8		812.8		889.6		903.0		879.8	
Annual Capacity Factor	%	24.1	27.6	24.1	25.6	24.1	29.7	24.1	28.6	24.1	26.6
	%	26.4		25.1		27.7		27.1		25.8	
2. Project Economy											
Annual Benefit	M$	1,310.2		1,227.0		1,448.8		1,460.8		1,405.9	
for Firm Capacity	M$	487.4		435.8		576.3		575.8		544.6	
for Firm Energy	M$	364.2		325.6		430.5		430.1		406.9	
for Secondary Energy	M$	458.6		465.6		442.0		454.9		454.4	
Construction Cost	M$	3,790	4,718	3,790	4,787	3,790	4,832	3,790	4,920	3,790	5,010
	M$	8,508		8,577		8,622		8,710		8,800	
Annual Cost	M$	986.9		994.9		1,000.2		1,010.4		1,020.8	
B - C	M$	323.3		232.1		448.6		450.4		385.1	
B / C	-	1.328		1.233		1.449		1.446		1.377	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-9 (5) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(21) N260-380-M170-150		(22) N260-380-M170-210		(23) N260-380-M170-270		(24) N270-320-M155-150		(25) N270-320-M155-210	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Festure											
Total Storage Capacity	MCM	684	594	684	594	684	594	902	336	902	336
Effective Storage Capacity	MCM	380	150	380	210	380	270	320	150	320	210
NHWL	m	260	170	260	170	260	170	270	155	270	155
Available Drawdown	m	25.4	7.5	25.4	11.4	24.5	16.1	15.5	17.2	15.5	28.3
Normal Intake Water Level	m	251.5	167.5	251.5	162.2	251.5	164.6	264.8	149.3	264.8	145.6
TWL	m	167.5	66.8	166.3	67.0	164.8	67.1	162.8	66.8	162.8	66.9
Normal Effective Head	m	79.8	95.6	81.0	94.3	82.4	92.6	96.9	78.4	96.9	74.7
95% Firm Discharge	m^3/sec	26.1	46.0	26.1	49.8	26.1	53.2	24.4	44.5	24.4	48.3
Max. Turbine Discharge	m^3/sec	173.8	306.9	173.8	332.3	173.8	354.5	162.6	296.9	162.6	322.1
Installed Capacity	MW	121.0	257.1	122.9	274.5	125.0	287.4	138.1	203.0	138.1	209.6
	MW	378.1		397.4		412.4		341.1		347.7	
Firm Capacity	MW	92.6	236.7	92.6	240.8	92.6	237.6	116.9	138.9	116.9	133.6
	MW	329.3		333.4		330.2		255.8		250.5	
Annual Firm Energy	GWh	121.7	311.0	121.7	316.4	121.7	312.2	153.6	182.5	153.6	177.6
	GWh	432.7		438.1		433.9		336.1		331.2	
Annual Secondary Energy	GWh	133.2	353.8	135.0	356.8	135.8	346.7	159.9	322.7	159.9	338.8
	GWh	487.0		491.8		482.5		482.6		498.7	
Annual Energy Production	GWh	254.9	664.8	256.7	673.2	257.5	658.9	313.5	505.2	313.5	516.4
	GWh	919.7		929.9		916.4		818.7		829.9	
Annual Capacity Factor	%	24.0	29.5	23.8	28.0	23.5	26.2	25.9	28.4	25.9	28.1
	%	27.8		26.7		25.4		27.4		27.2	
2. Project Economy											
Annual Benefit	M฿	1,498.0		1,515.6		1,496.8		1,261.5		1,262.0	
for Firm Capacity	M฿	596.0		603.5		597.7		463.0		453.4	
for Firm Energy	M฿	445.2		450.8		446.5		345.8		340.8	
for Secondary Energy	M฿	456.8		461.3		452.6		452.7		467.8	
Construction Cost	M฿	3,747	5,013	3,756	5,122	3,769	5,232	4,156	4,238	4,156	4,319
	M฿	8,760		8,878		9,001		8,394		8,475	
Annual Cost	M฿	1,016.2		1,029.8		1,044.1		973.7		983.1	
B - C	M฿	481.8		485.8		452.7		287.8		278.9	
B / C	-	1.474		1.472		1.434		1.296		1.284	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-9 (6) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(26) N270-320-M160-150		(27) N270-320-M160-210		(28) N270-320-M160-270		(29) N270-320-M165-150		(30) N270-320-M165-210	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Feature											
Total Storage Capacity	MCM	902	403	902	403	902	403	902	486	902	486
Effective Storage Capacity	MCM	320	150	320	210	320	270	320	150	320	210
NHWL	m	270	160	270	160	270	160	270	165	270	165
Available Drawdown	m	15.5	13.0	15.5	21.1	15.5	31.9	15.5	10.0	15.5	15.4
Normal Intake Water Level	m	264.8	155.7	264.8	153.0	264.8	149.4	264.8	161.7	264.8	159.9
TWL	m	162.8	66.8	162.8	66.9	162.8	67.0	162.8	66.8	162.8	66.9
Normal Effective Head	m	96.9	84.5	96.9	81.8	96.9	78.3	96.9	90.2	96.9	88.4
95% Firm Discharge	m^3/sec	24.4	44.5	24.4	48.3	24.4	51.6	24.4	44.5	24.4	48.3
Max. Turbine Discharge	m^3/sec	162.6	296.9	162.6	322.1	162.6	344.1	162.6	269.6	162.6	320.0
Installed Capacity	MW	138.1	219.2	138.1	230.0	138.1	235.0	138.1	209.6	138.1	243.2
	MW	357.3		368.1		373.1		347.7		381.3	
Firm Capacity	MW	116.9	175.5	116.9	171.5	116.9	144.0	116.9	218.5	116.9	218.7
	MW	292.4		288.4		260.9		335.4		335.6	
Annual Firm Energy	GWh	153.6	230.6	153.6	225.4	153.6	189.2	153.6	287.1	153.6	287.4
	GWh	384.2		379.0		342.8		440.7		441.0	
Annual Secondary Energy	GWh	159.9	324.5	159.9	347.5	159.9	353.4	159.9	332.6	159.9	345.4
	GWh	484.4		507.4		513.3		492.5		505.3	
Annual Energy Production	GWh	313.5	555.1	313.5	572.9	313.5	542.6	313.5	619.7	313.5	632.8
	GWh	868.6		886.4		856.1		933.2		946.3	
Annual Capacity Factor	%	25.9	28.9	25.9	28.4	25.9	26.4	25.9	33.8	25.9	29.7
	%	27.8		27.5		26.2		30.6		28.3	
2. Project Economy											
Annual Benefit	M฿	1,378.9		1,387.9		1,306.4		1,522.6		1,535.2	
for Firm Capacity	M฿	529.2		522.0		472.2		607.1		607.4	
for Firm Energy	M฿	395.3		390.0		352.7		453.5		453.8	
for Secondary Energy	M฿	454.4		475.9		481.5		462.0		474.0	
Construction Cost	M฿	4,156	4,579	4,156	4,645	4,156	4,711	4,156	4,736	4,156	4,819
	M฿	8,735		8,801		8,867		8,892		8,975	
Annual Cost	M฿	1,013.3		1,020.9		1,028.6		1,031.5		1,041.1	
B - C	M฿	365.6		367.0		277.8		491.1		494.1	
B / C	-	1.361		1.359		1.270		1.476		1.475	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-9 (7) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(31)		(32)		(33)		(34)		(35)	
		N270-320-M165-270		N270-320-M170-150		N270-320-M170-210		N270-320-M170-270		N270-380-M155-150	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Feature											
Total Storage Capacity	MCM	902	486	902	594	902	594	902	594	902	336
Effective Storage Capacity	MCM	320	270	320	150	320	210	320	270	380	150
NHWL	m	270	165	270	170	270	170	270	170	270	155
Available Drawdown	m	15.5	22.7	15.5	7.5	15.5	11.4	15.5	16.1	19.1	17.2
Normal Intake Water Level	m	264.8	157.4	264.8	167.5	264.8	166.2	264.8	164.6	263.6	149.3
TWL	m	162.8	67.0	167.5	66.8	166.3	66.9	164.7	67.0	162.9	66.8
Normal Effective Head	m	96.9	85.9	92.4	95.7	93.6	94.3	95.1	92.7	95.7	78.3
95% Firm Discharge	m^3/sec	24.4	51.6	24.4	44.5	24.4	48.3	24.4	51.6	26.1	46.0
Max. Turbine Discharge	m^3/sec	162.6	344.1	162.6	296.9	162.6	322.1	162.6	344.1	173.8	306.9
Installed Capacity	MW	138.1	254.4	131.5	249.0	133.3	266.1	135.5	279.3	145.7	209.6
	MW	392.5		380.5		399.4		414.8		355.3	
Firm Capacity	MW	116.9	202.5	116.9	229.2	116.9	233.4	116.9	231.0	118.4	144.1
	MW	319.4		346.1		350.3		347.9		262.5	
Annual Firm Energy	GWh	153.6	266.1	153.6	301.2	153.6	306.7	153.6	303.5	155.6	189.3
	GWh	419.7		454.8		460.3		457.1		344.9	
Annual Secondary Energy	GWh	159.9	344.2	146.4	363.2	148.1	365.5	149.1	354.9	148.5	322.7
	GWh	504.1		509.6		513.6		504.0		471.2	
Annual Energy Production	GWh	313.5	610.3	300.0	664.4	301.7	672.2	302.7	658.4	304.1	512.0
	GWh	923.8		966.4		973.9		961.1		816.1	
Annual Capacity Factor	%	25.9	27.4	26.0	30.5	25.8	28.8	25.5	26.9	23.8	27.9
	%	26.9		29.0		27.8		26.5		26.2	
2. Project Economy											
Annual Benefit	M฿	1,482.8		1,572.4		1,589.4		1,572.8		1,272.0	
for Firm Capacity	M฿	578.1		626.4		634.0		629.7		475.1	
for Firm Energy	M฿	431.9		468.0		473.6		470.4		354.9	
for Secondary Energy	M฿	472.8		478.0		481.8		472.7		442.0	
Construction Cost	M฿	4,156	4,832	4,101	4,893	4,121	5,003	4,143	5,113	4,245	4,296
	M฿	8,988		8,994		9,124		9,256		8,541	
Annual Cost	M฿	1,042.6		1,043.3		1,058.4		1,073.7		990.8	
B - C	M฿	440.2		529.1		531.9		499.1		281.2	
B / C	-	1.422		1.507		1.503		1.465		1.284	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-9 (8) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(36)		(37)		(38)		(39)		(40)	
		N270-380-M155-210		N270-380-M160-150		N270-380-M160-210		N270-380-M160-270		N270-380-M165-150	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Feature											
Total Storage Capacity	MCM	902	336	902	403	902	403	902	403	902	486
Effective Storage Capacity	MCM	380	210	380	150	380	210	380	270	380	150
NHWL	m	270	155	270	160	270	160	270	160	270	165
Available Drawdown	m	19.1	28.3	19.1	13.0	19.1	21.4	19.1	31.9	19.1	10.0
Normal Intake Water Level	m	263.6	145.6	263.6	155.7	263.6	153.0	263.6	149.4	263.6	161.7
TWL	m	162.9	67.0	162.9	66.8	162.9	67.0	162.9	67.1	162.9	66.8
Normal Effective Head	m	95.7	74.7	95.7	84.4	95.7	81.7	95.7	78.2	95.7	90.2
95% Firm Discharge	m^3/sec	26.1	49.8	26.1	46.0	26.1	49.8	26.1	53.2	26.1	46.0
Max. Turbine Discharge	m^3/sec	173.8	332.3	173.8	306.9	173.8	332.3	173.8	354.5	173.8	306.9
Installed Capacity	MW	145.7	216.3	145.7	226.3	145.7	237.0	145.7	241.8	145.7	238.3
	MW	362.0		372.0		382.7		387.5		384.0	
Firm Capacity	MW	118.4	137.7	118.4	181.4	118.4	176.7	118.4	148.2	118.4	225.8
	MW	256.1		299.8		295.1		266.6		344.2	
Annual Firm Energy	GWh	155.6	180.9	155.6	238.4	155.6	232.2	155.6	194.7	155.6	296.7
	GWh	336.5		394.0		387.8		350.3		452.3	
Annual Secondary Energy	GWh	148.5	336.5	148.5	317.0	148.5	341.1	148.5	348.6	148.5	323.4
	GWh	485.0		465.5		489.6		497.1		471.9	
Annual Energy Production	GWh	304.1	517.4	304.1	555.4	304.1	573.3	304.1	543.3	304.1	620.1
	GWh	821.5		859.5		877.4		847.4		924.2	
Annual Capacity Factor	%	23.8	27.3	23.8	28.0	23.8	27.6	23.8	25.6	23.8	29.7
	%	25.9		26.4		26.2		25.0		27.5	
2. Project Economy											
Annual Benefit	M฿	1,264.7		1,384.6		1,392.3		1,309.3		1,531.0	
for Firm Capacity	M฿	463.5		542.6		534.1		482.5		623.0	
for Firm Energy	M฿	346.3		405.4		399.0		360.5		465.4	
for Secondary Energy	M฿	454.9		436.6		459.2		466.3		442.6	
Construction Cost	M฿	4,245	4,377	4,245	4,651	4,245	4,718	4,245	4,787	4,245	4,832
	M฿	8,622		8,896		8,963		9,032		9,077	
Annual Cost	M฿	1,000.2		1,031.9		1,039.7		1,047.7		1,052.9	
B - C	M฿	264.5		352.7		352.6		261.6		478.1	
B / C	-	1.264		1.342		1.339		1.250		1.454	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-9 (9) Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(41)		(42)		(43)		(44)		(45)	
		N270-380-M165-210		N270-380-M165-270		N270-380-M170-150		N270-380-M170-210		N270-380-M170-270	
		N.N.*	M.L.L.**	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.	N.N.	M.L.L.
1. Project Feature											
Total Storage Capacity	MCM	902	486	902	486	902	594	902	594	902	594
Effective Storage Capacity	MCM	380	210	380	270	380	150	380	210	380	270
NHWL	m	270	165	270	165	270	170	270	170	270	170
Available Drawdown	m	19.1	15.4	19.1	22.7	19.1	7.5	19.1	11.4	19.1	16.1
Normal Intake Water Level	m	263.6	159.9	263.6	157.4	263.6	167.5	263.6	166.2	263.6	164.6
TWL	m	162.9	67.0	162.9	67.1	167.5	66.8	166.3	67.0	164.8	67.1
Normal Effective Head	m	95.7	88.3	95.7	85.8	91.3	95.6	92.5	94.3	93.9	92.6
95% Firm Discharge	m^3/sec	26.1	49.8	26.1	53.2	26.1	46.0	26.1	49.8	26.1	53.2
Max. Turbine Discharge	m^3/sec	173.8	332.3	173.8	354.5	173.8	306.9	173.8	322.3	173.8	354.5
Installed Capacity	MW	145.7	252.6	145.7	261.8	138.9	257.1	140.7	274.5	142.9	287.4
	MW	398.3		407.5		396.0		415.2		430.3	
Firm Capacity	MW	118.4	225.5	118.4	208.3	118.4	236.7	118.4	240.8	118.4	237.6
	MW	343.9		326.7		355.1		359.2		356.0	
Annual Firm Energy	GWh	155.6	296.3	155.6	273.7	155.6	311.0	155.6	316.4	155.6	312.2
	GWh	451.9		429.3		466.6		472.0		467.8	
Annual Secondary Energy	GWh	148.5	337.2	148.5	336.6	139.9	353.8	141.6	356.8	142.5	346.7
	GWh	485.7		485.1		493.7		498.4		489.2	
Annual Energy Production	GWh	304.1	633.5	304.1	610.3	295.5	664.8	297.2	673.2	298.1	658.9
	GWh	937.6		914.4		980.3		970.4		957.0	
Annual Capacity Factor	%	23.8	28.6	23.8	26.6	24.3	29.5	24.1	28.0	23.8	26.2
	%	26.9		25.6		28.3		26.7		25.4	
2. Project Economy											
Annual Benefit	M฿	1,543.1		1,488.0		1,585.9		1,603.3		1,584.7	
for Firm Capacity	M฿	622.5		591.3		642.7		650.1		644.4	
for Firm Energy	M฿	465.0		441.7		480.1		485.7		481.4	
for Secondary Energy	M฿	455.6		455.0		463.1		467.5		458.9	
Construction Cost	M฿	4,245	4,920	4,245	5,010	4,163	5,013	4,182	5,122	4,203	5,232
	M฿	9,165		9,255		9,176		9,304		9,435	
Annual Cost	M฿	1,063.1		1,073.6		1,064.4		1,079.3		1,094.5	
B - C	M฿	480.0		414.4		521.5		524.0		490.2	
B / C	-	1.452		1.386		1.490		1.485		1.448	

Note N.N.: Nam Ngao Project, M.L.L.: Mae Lama Luang Project

Table 8-10 (1) Study on the Maximum Power Discharge of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(1)		(2)		(3)		(4)		(5)	
		NQ-116*	MQ-227*	NQ-116	MQ-274	NQ-116	MQ-322	NQ-116	MQ-369	NQ-116	MQ-418
1. Project Feature											
Total Storage Capacity	MCM	902	486	902	486	902	486	902	486	902	486
Effective Storage Capacity	MCM	320	210	320	210	320	210	320	210	320	210
NHWL	m	270	165	270	165	270	165	270	165	270	165
Available Drawdown	m	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4
Normal Intake Water Level	m	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9
TWL	m	162.4	66.4	162.4	66.7	162.4	67.0	162.4	67.2	162.4	67.4
Normal Effective Head	m	97.3	88.8	97.3	88.5	97.3	88.3	97.3	88.1	97.3	87.9
95% Firm Discharge	m^3/sec	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3
Max. Turbine Discharge	m^3/sec	115.6	226.5	115.6	273.8	115.6	322.1	115.6	369.4	115.6	417.7
Installed Capacity	MW	98.6	175.4	98.6	211.6	98.6	247.7	98.6	383.8	98.6	319.9
	MW	274.0		310.2		346.3		482.4		418.5	
Firm Capacity	MW	83.5	143.3	83.5	172.7	83.5	202.5	83.5	211.6	83.5	210.4
	MW	226.8		256.2		286.0		295.1		293.9	
Annual Firm Energy	GWh	109.7	188.3	109.7	226.9	109.7	266.1	109.7	278.0	109.7	276.5
	GWh	298.0		336.6		375.8		387.7		386.2	
Annual Secondary Energy	GWh	195.2	412.2	195.2	394.4	195.2	366.7	195.2	362.4	195.2	378.1
	GWh	607.4		589.6		561.9		557.6		573.3	
Annual Energy Production	GWh	304.9	600.5	304.9	621.3	304.9	632.8	304.9	640.4	304.9	654.6
	GWh	905.4		926.2		937.7		945.3		959.5	
Annual Capacity Factor	%	35.3	39.1	35.3	33.5	35.3	29.2	35.3	19.0	35.3	23.4
	%	37.7		34.1		30.9		22.4		26.2	
2. Project Economy											
Annual Benefit	M$	1,286.8		1,363.1		1,431.5		1,456.0		1,467.1	
for Firm Capacity	M$	410.5		463.7		517.7		534.1		532.0	
for Firm Energy	M$	306.6		346.4		386.7		398.9		397.4	
for Secondary Energy	M$	569.7		553.0		527.1		523.0		537.7	
Construction Cost	M$	3,738	4,214	3,738	4,522	3,738	4,819	3,738	5,097	3,738	5,364
	M$	7,952		8,260		8,557		8,835		9,102	
Annual Cost	M$	922.4		958.2		992.6		1,024.9		1,055.8	
B - C	M$	364.4		404.9		438.9		431.1		411.3	
B / C	-	1.395		1.423		1.442		1.421		1.390	

* NQ : Nam Ngao Project MQ : Mae Lama Luang Project

Table 8-10 (2) Study on the Maximum Power Discharge of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(6)		(7)		(8)		(9)		(10)	
		NQ-139*	MQ-227*	NQ-139	MQ-274	NQ-139	MQ-322	NQ-139	MQ-369	NQ-139	MQ-418
1. Project Feature											
Total Storage Capacity	MCM	902	486	902	486	902	486	902	486	902	486
Effective Storage Capacity	MCM	320	210	320	210	320	210	320	210	320	210
NHWL	m	270	165	270	165	270	165	270	165	270	165
Available Drawdown	m	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4
Normal Intake Water Level	m	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9
TWL	m	162.6	66.4	162.6	66.7	162.6	67.0	162.6	67.2	162.6	67.4
Normal Effective Head	m	97.1	88.8	97.1	88.5	97.1	88.3	97.1	88.1	97.1	87.9
95% Firm Discharge	m^3/sec	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3
Max. Turbine Discharge	m^3/sec	139.1	226.5	139.1	273.8	139.1	322.1	139.1	369.4	139.1	417.7
Installed Capacity	MW	118.4	175.4	118.4	211.6	118.4	247.7	118.4	283.8	118.4	319.9
	MW	293.8		330.0		366.1		402.2		438.3	
Firm Capacity	MW	95.3	143.3	95.3	172.7	95.3	202.5	95.3	211.6	95.3	210.4
	MW	238.6		268.0		297.8		306.9		305.7	
Annual Firm Energy	GWh	125.2	188.3	125.2	226.9	125.2	266.1	125.2	278.0	125.2	276.5
	GWh	313.5		352.1		391.3		403.2		401.7	
Annual Secondary Energy	GWh	185.6	412.2	185.6	394.4	185.6	366.7	185.6	362.4	185.6	378.1
	GWh	597.8		580.0		552.3		548.0		563.7	
Annual Energy Production	GWh	310.8	600.5	310.8	621.3	310.8	632.8	310.8	640.4	310.8	654.6
	GWh	911.3		932.1		943.6		951.2		965.4	
Annual Capacity Factor	%	30.0	39.1	30.0	33.5	30.0	29.2	30.0	25.8	30.0	23.4
	%	35.4		32.2		29.4		27.0		25.1	
2. Project Economy											
Annual Benefit	M$	1,315.2		1,391.4		1,459.7		1,484.4		1,495.3	
for Firm Capacity	M$	431.9		485.1		539.0		555.5		553.3	
for Firm Energy	M$	322.6		362.3		402.6		414.9		413.3	
for Secondary Energy	M$	560.7		544.0		518.1		514.0		528.7	
Construction Cost	M$	3,950	4,214	3,950	4,522	3,950	4,819	3,950	5,097	3,950	5,364
	M$	8,164.0		8,472		8,769		9,047		9,314	
Annual Cost	M$	947.0		982.8		1,017.2		1,049.5		1,080.4	
B - C	M$	368.2		408.6		442.5		434.9		414.9	
B / C	-	1.389		1.416		1.435		1.414		1.384	

* NQ : Nam Ngao Project MQ : Mae Lama Luang Project

Table 8-10 (3) Study on the Maximum Power Discharge of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(11)		(12)		(13)		(14)		(15)	
		NQ-163*	MQ-227*	NQ-163	MQ-274	NQ-163	MQ-322	NQ-163	MQ-369	NQ-163	MQ-418
1. Project Feature											
Total Storage Capacity	MCM	902	486	902	486	902	486	902	486	902	486
Effective Storage Capacity	MCM	320	210	320	210	320	210	320	210	320	210
NHWL	m	270	165	270	165	270	165	270	165	270	165
Available Drawdown	m	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4
Normal Intake Water Level	m	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9
TWL	m	162.8	66.4	162.8	66.7	162.8	67.0	162.8	67.2	162.8	67.4
Normal Effective Head	m	96.9	88.8	96.9	88.5	96.9	88.3	96.9	88.1	96.9	87.9
95% Firm Discharge	m^3/sec	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3
Max. Turbine Discharge	m^3/sec	162.6	226.5	162.6	273.8	162.6	322.1	162.6	369.4	162.6	417.7
Installed Capacity	MW	138.1	175.4	138.1	211.6	138.1	247.7	138.1	283.8	138.1	319.9
	MW	313.5		349.7		385.8		421.9		458.0	
Firm Capacity	MW	116.9	143.3	116.9	172.2	116.9	205.5	116.9	211.6	116.9	210.4
	MW	260.2		289.1		322.4		328.5		327.3	
Annual Firm Energy	GWh	153.6	188.3	153.6	226.3	153.6	270.0	153.6	278.0	153.6	276.5
	GWh	341.9		379.9		423.6		431.6		430.1	
Annual Secondary Energy	GWh	159.9	412.2	159.9	395.0	159.9	362.8	159.9	362.4	159.9	378.1
	GWh	572.1		554.9		522.7		522.3		538.0	
Annual Energy Production	GWh	313.5	600.5	313.5	621.3	313.5	632.8	313.5	640.4	313.5	654.6
	GWh	914.0		934.8		946.3		953.9		968.1	
Annual Capacity Factor	%	25.9	39.1	25.9	33.5	25.9	29.2	25.9	25.8	25.9	23.4
	%	33.3		30.5		28.0		25.8		24.1	
2. Project Economy											
Annual Benefit	M฿	1,359.4		1,434.7		1,509.7		1,528.6		1,539.6	
for Firm Capacity	M฿	471.0		523.3		583.5		594.6		592.4	
for Firm Energy	M฿	351.8		390.9		435.9		444.1		442.6	
for Secondary Energy	M฿	536.6		520.5		490.3		489.9		504.6	
Construction Cost	M฿	4,156	4,214	4,156	4,522	4,156	4,819	4,156	5,097	4,156	5,364
	M฿	8,370		8,678		8,975		9,253		9,520	
Annual Cost	M฿	970.9		1,006.6		1,041.1		1,073.3		1,104.3	
B - C	M฿	388.5		428.1		468.6		455.3		435.3	
B / C	-	1.400		1.425		1.450		1.424		1.394	

* NQ : Nam Ngao Project MQ : Mae Lama Luang Project

Table 8-10 (4) Study on the Maximum Power Discharge of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(16)		(17)		(18)		(19)		(20)	
		NQ-186*	MQ-227*	NQ-186	MQ-274	NQ-186	MQ-322	NQ-186	MQ-369	NQ-186	MQ-418
1. Project Feature											
Total Storage Capacity	MCM	902	486	902	486	902	486	902	486	902	486
Effective Storage Capacity	MCM	320	210	320	210	320	210	320	210	320	210
NHWL	m	270	165	270	165	270	165	270	165	270	165
Available Drawdown	m	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4
Normal Intake Water Level	m	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9
TWL	m	163.0	66.4	163.0	66.7	163.0	67.0	163.0	67.2	163.0	67.4
Normal Effective Head	m	96.7	88.8	96.7	88.5	96.7	88.3	96.7	88.1	96.7	87.9
95% Firm Discharge	m^3/sec	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3
Max. Turbine Discharge	m^3/sec	186.2	226.5	186.2	273.7	186.2	322.1	186.2	369.4	186.2	417.7
Installed Capacity	MW	157.8	175.4	157.8	211.6	157.8	247.7	157.8	283.8	157.8	319.9
	MW	333.2		369.4		405.5		441.6		477.7	
Firm Capacity	MW	119.2	143.3	119.2	172.7	119.2	202.5	119.2	211.6	119.2	210.4
	MW	262.5		291.9		321.7		330.8		329.6	
Annual Firm Energy	GWh	156.6	188.3	156.6	226.9	156.6	266.1	156.6	278.0	156.6	276.5
	GWh	344.9		383.5		422.7		434.6		433.1	
Annual Secondary Energy	GWh	164.0	412.2	164.0	394.4	164.0	366.7	164.0	362.4	164.0	378.1
	GWh	576.2		558.4		530.7		526.4		542.1	
Annual Energy Production	GWh	320.6	600.5	320.6	621.3	320.6	632.8	320.6	640.4	320.6	654.6
	GWh	921.1		941.9		953.4		961.0		975.2	
Annual Capacity Factor	%	23.2	39.1	23.2	33.5	23.2	29.2	23.2	25.8	23.2	23.4
	%	31.6		29.1		26.8		24.8		23.3	
2. Project Economy											
Annual Benefit	M$	1,370.5		1,446.7		1,515.1		1,539.7		1,550.8	
for Firm Capacity	M$	475.1		528.3		582.3		598.7		596.6	
for Firm Energy	M$	354.9		394.6		435.0		447.2		445.7	
for Secondary Energy	M$	540.5		523.8		497.8		493.8		508.5	
Construction Cost	M$	4,353	4,214	4,353	4,522	4,353	4,819	4,353	5,097	4,353	5,364
	M$	8,567		8,875		9,172		9,450		9,717	
Annual Cost	M$	993.8		1,029.5		1,064		1,096.2		1,127.2	
B - C	M$	376.7		417.2		451.1		443.5		423.6	
B / C	-	1.379		1.405		1.424		1.405		1.376	

* NQ : Nam Ngao Project MQ : Mae Lama Luang Project

Table 8-10 (5) Study on the Maximum Power Discharge of Nam Ngao and Mae Lama Luang Projects (Integrated Development)

Item	Unit	(21)		(22)		(23)		(24)		(25)	
		NQ-210*	MQ-227*	NQ-210	MQ-274	NQ-210	MQ-322	NQ-210	MQ-369	NQ-210	MQ-418
1. Project Feature											
Total Storage Capacity	MCM	902	486	902	486	902	486	902	486	902	486
Effective Storage Capacity	MCM	320	210	320	210	320	210	320	210	320	210
NHWL	m	270	165	270	165	270	165	270	165	270	165
Available Drawdown	m	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4	15.5	15.4
Normal Intake Water Level	m	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9	264.8	159.9
TWL	m	163.2	66.4	163.2	66.7	163.2	67.0	163.2	67.2	163.2	67.4
Normal Effective Head	m	96.5	88.8	96.5	88.5	96.5	88.3	96.5	88.1	96.5	87.9
95% Firm Discharge	m^3/sec	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3	24.4	48.3
Max. Turbine Discharge	m^3/sec	209.6	226.5	209.6	273.8	209.6	322.1	209.6	369.4	209.6	417.7
Installed Capacity	MW	177.6	175.4	177.6	211.6	177.6	247.7	177.6	283.8	177.6	319.9
	MW	353.0		389.2		425.3		461.4		497.5	
Firm Capacity	MW	118.6	143.3	118.6	172.7	118.6	202.5	118.6	211.6	118.6	210.4
	MW	261.9		291.3		321.1		330.2		329.0	
Annual Firm Energy	GWh	155.8	188.3	155.8	226.9	155.8	266.1	155.8	278.0	155.8	276.5
	GWh	344.1		382.7		421.9		433.8		432.3	
Annual Secondary Energy	GWh	175.1	412.2	175.1	394.4	175.1	366.7	175.1	362.4	175.1	378.1
	GWh	587.3		569.5		541.8		537.5		553.2	
Annual Energy Production	GWh	330.9	600.5	330.9	621.3	330.9	632.8	330.9	640.4	330.9	654.6
	GWh	931.4		952.2		963.7		971.3		985.5	
Annual Capacity Factor	%	21.3	39.1	21.3	33.5	21.3	29.2	21.3	25.8	21.3	23.4
	%	30.1		27.9		25.9		24.0		22.6	
2. Project Economy											
Annual Benefit	M฿	1,379.0		1,455.3		1,523.5		1,548.3		1,559.2	
for Firm Capacity	M฿	474.0		527.3		581.2		597.7		595.5	
for Firm Energy	M฿	354.1		393.8		434.1		446.4		444.8	
for Secondary Energy	M฿	550.9		534.2		508.2		504.2		518.9	
Construction Cost	M฿	4,544	4,214	4,544	4,522	4,544	4,819	4,544	5,097	4,544	5,364
	M฿	8,758.0		9,066		9,363		9,641		9,908	
Annual Cost	M฿	1,015.9		1,051.7		1,086.1		1,118.4		1,149.3	
B - C	M฿	363.1		403.6		437.4		429.9		409.9	
B / C	-	1.357		1.384		1.403		1.384		1.357	

* NQ : Nam Ngao Project MQ : Mae Lama Luang Project

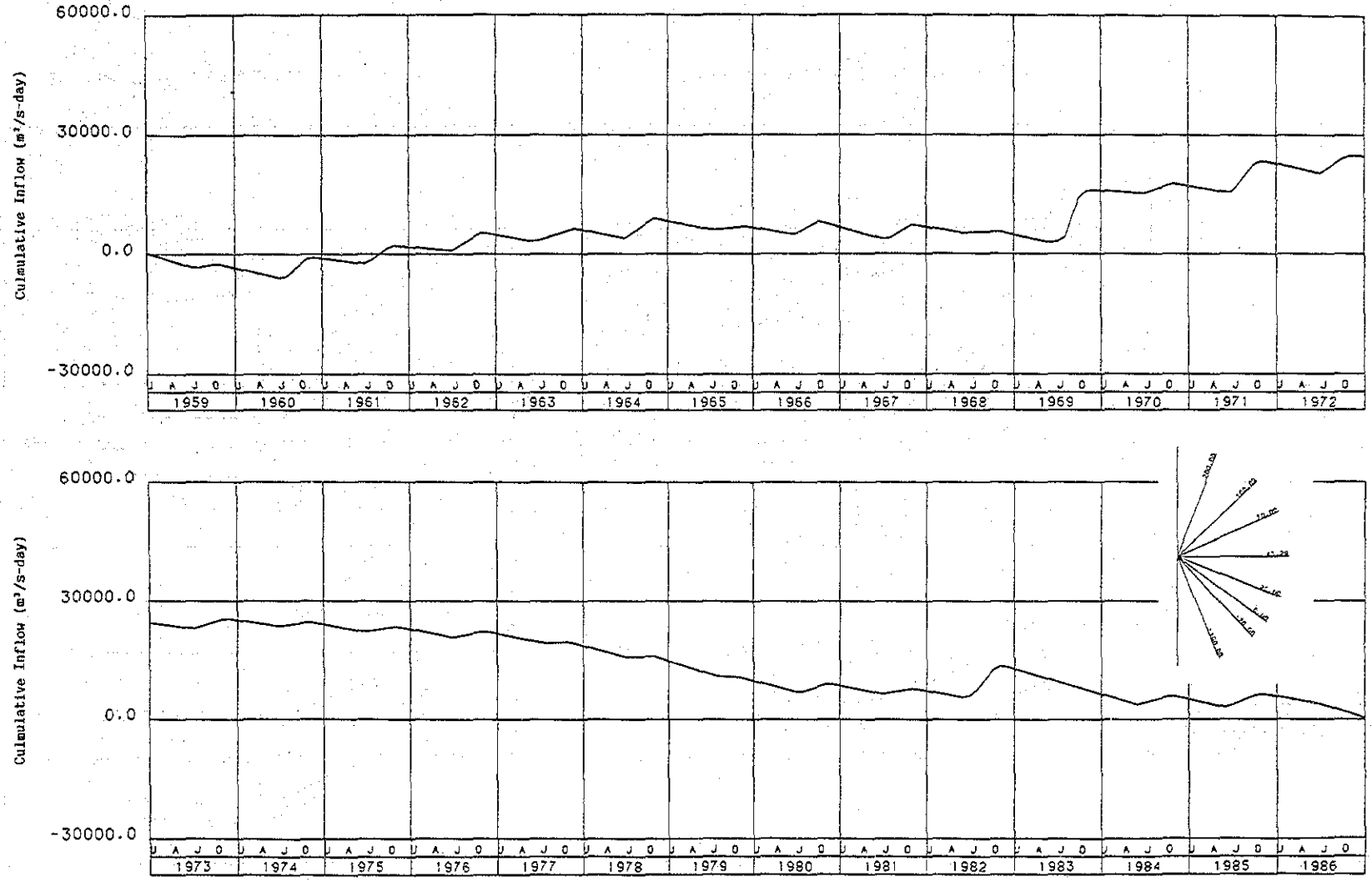


Fig. 8-13 Mass Curve of Mae Lama Luang Project (Integrated Development)

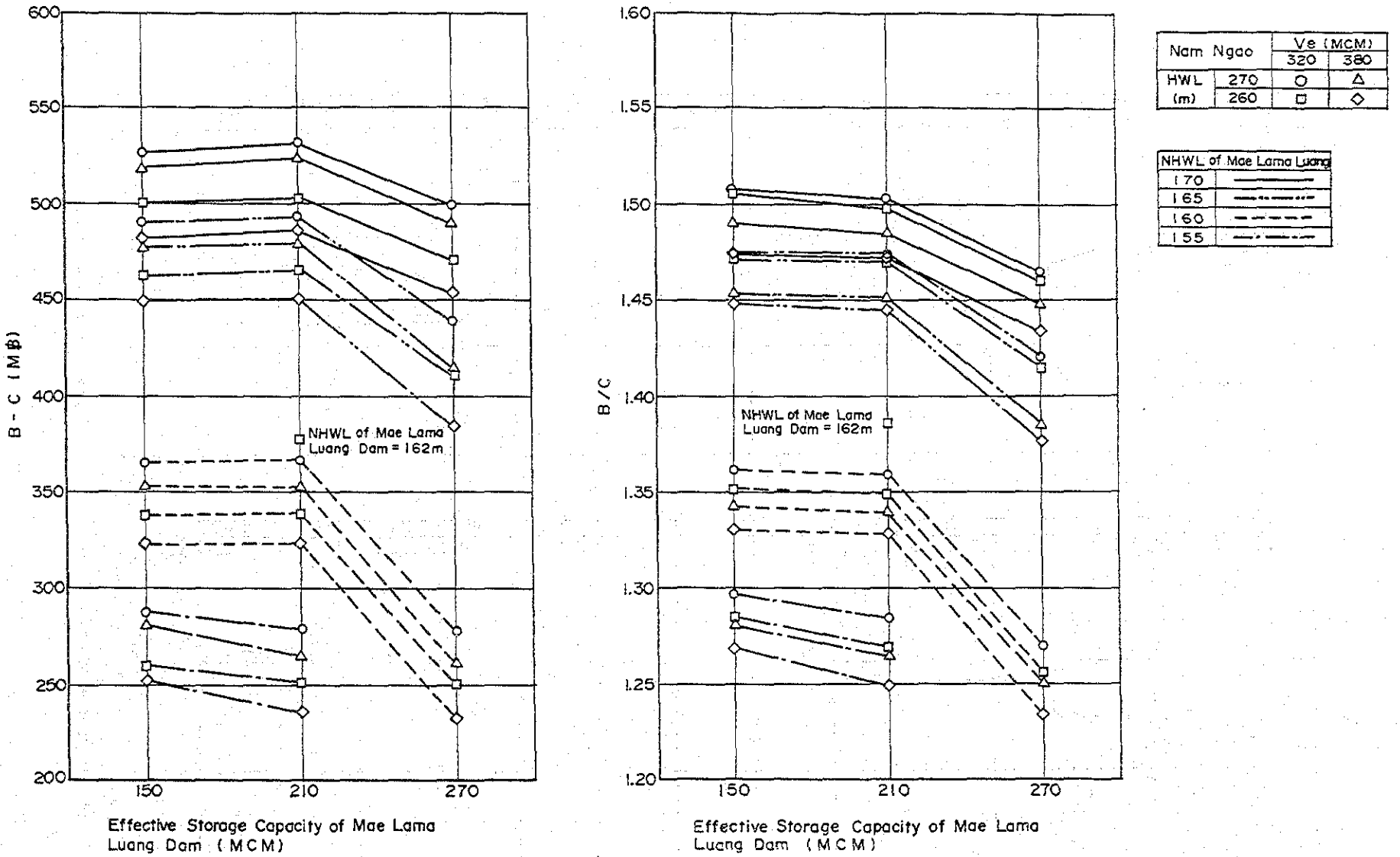


Fig. 8-14 Study on NHWL and Effective Storage Capacity of Nam Ngao and Mae Lama Luang Project (Intergrated Development)

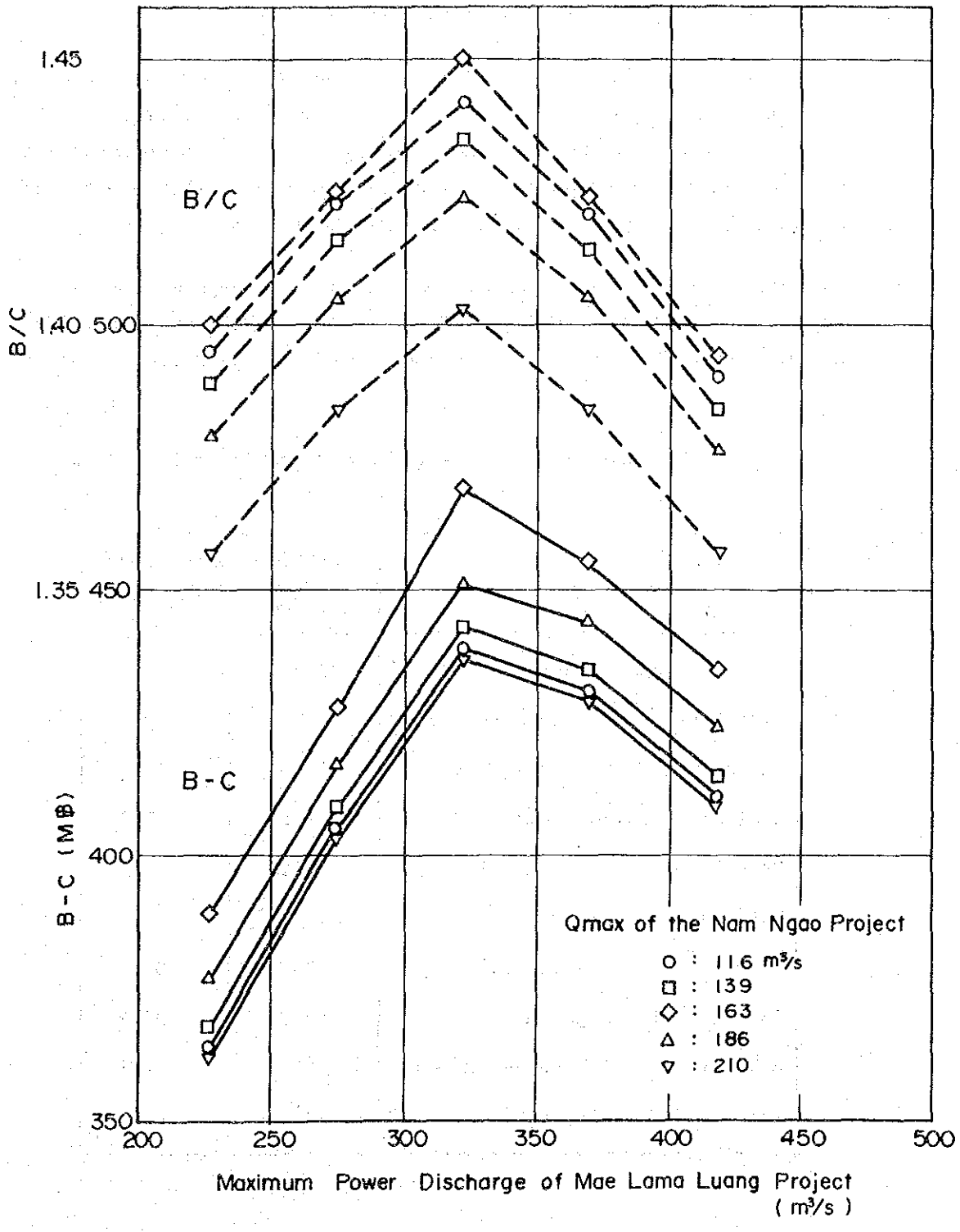


Fig. 8-15 Study on Maximum Power Discharge of Nam Ngao and Mae Lama Luang Project (Integrated Development)