extensively. Assuming the annual precipitation of 1,000 mm, of which 70% concentrates in the wet season, and the runoff coefficient of 0.20, the total run-off volume available is calculated to be 1.96 million m^3 over the six month period. This is almost twice as large as the storage volume of the reservoir. The reservoir may be planned in a larger scale.

For effective collection of surface run-off, an intake channel will be constructed on all the four sides of the reservoir. A pump will also be installed on the four sides.

Expected effects

As the area is located close to Nakhon Ratchasima, vegetable growing may be promising. In this case, some 280 ha can be irrigated for two kinds of vegetables during the dry season. An alternatives is for water supply to neighboring villages. Assuming a per capita water use of 50 l/day, 110,000 people can be supported.

The area has a wide open landscape with rural atmosphere. Creation of large water body may enhance the attractiveness of the area for recreation.

Project costs

Project costs have been estimated on the same basis as used for the Chock Chai reservoir. The total is estimated at 99 million bahts (Table 4).

(5) Ban Don Yao Yai pumping reservoir

Site

The proposed reservoir site is located 14 km east-northeast of Nakhon Ratchasima at north latitude 15°26'30" and east longitude 102°32'30" (Figure 10). It is on the left bank of the Huai Yang, 3.5 km downstreams of the confluences with the Huai Pla river and the Huai Wang Chow Phu river.

The site is on flat land between the national highway route no.2 to the northeast and the route no.209 to the southeast. A few villages exist within 1.0-1.5 km distance. Land use is dominantly for paddy. The area suffers from acute shortage of water for drinking and domestic animals.

Paddy fields are inundated during the rainy season. No drainage canal is available, and access between paddy fields is limited.

Dimensions

The reservoir is planned with dimensions of 300 m x 500 m with 6.0 m depth (Figure 11). Effective storage volume will be 600,000 m^3.

Available flow

The catchment area above the site is 360 km^2. No gauging station exists in the upper catchment area. Assuming the annual rainfalls of 900 mm, which is assumed to concentrate 70% during the rainy season, and runoff coefficient of 0.20, the available flow is calculated to be 45.4 million m^3 over six months in the dry season. Taking account of water extraction in the upstream by existing weirs, 50% of the

calculated flow is taken as the flow available at the site. Still the available flow is almost 40 times the required storage.

Project costs

Project costs are estimated on the same basis as in the case of the Chok Chai reservoir. The total becomes 60 million bahts (Table 5).

(6) Ban Khok Yang pumping reservoir

Site

The proposed reservoir site BU-1 is located 70 km south-west of Buri Ram at north latitude 14°41'40" (Figure 10). It is 15 km south-west of Amphoe Nang Rong.

The site is the lowland on the left bank of Lam Plai Mat river. Land use around the site is paddy and small feed area of duck and chicken. Lack of water prohibits, the paddy production during the dry season, and inundation by the overflow of the Lam Plai Mat river. One of the problems is a heavily damaged weir which located at immediately near the proposed site. The water level rises always during flooding due to remaining obstacles.

It is necessary for the improvement of weir, even regardless of the construction of proposed reservoir.

Dimensions

Planned dimensions of the reservoir are 100 m wide, 200 m long and 6 m deep. The effective storage volume is calculated to be 73,000 m^3. In this proposed reservoir particularly is planned to be connected with existing reservoir having 2 to 3 m depth to use the water effectively (Figure 11).

Weir improvement

As described previously, existing remaining obstacles of heavily damaged weir should be taken out, and made a new weir should be constructed to reserve water and carry out gate operation at the time of flood in rainy season (Figure 12).

Project cost

Project cost are estimated on the same basis as in the case of Ban Khok Yan reservoir. The total becomes 11 million bahts (Table 6).

(7) Huai Chorakhe Mak and Huai Talad reservoir

Site

There are two big reservoirs located 12 km south-west by west of Buri Ram. Those are the Huai Chorakhe Mak and Huai Talad reservoirs, which lie like twin brothers in parallel (Figure 13). These reservoir areas are roughly calculated as follows.

Huai Chorakhe Mak reservoir	:	9.00 km^2
Huai Talad reservoir	:	10.00 km^2

Historically, these two reservoirs have been created as natural reservoirs due to a topographic characteristic to be located in large lowland area.

Total drainage area of the two reservoirs is about 270 km^2, with only a small river can be found in the upstream basin. Annual rainfall intensity in this basin is about 1,200 mm. Assuming discharge coefficient and annual evaporation at 0.1 and 1,500 mm, annual inflow to the reservoir is calculated as follows.

$$V = 270\,km^2 \times 1{,}200\,mm \times 0.1 - 19.0\,km^2 \times 1{,}500\,mm$$
$$= 32.4 \times 10^6\,m^3 - 28.5 \times 10^6\,m^3 = 3.90 \times 10^6\,m^3$$

Present situation

Much sediment soil and a water weed can be found easily in and around the reservoir. These will have an adverse impact on the reservoir by way of reducing the reservoir storage capacity in the future.

Water is being supplied to the Buri Ram city at about 9,600 m^3/day maximum through the water supply station situated immediately north of part of the Huai Chorakhe Mak reservoir.

According to the stations office, water can be supplied for about 12,000 households in Buri Ram city.

Present situation in water resources capacity of the two reservoirs and the water consumed by customers in Buri Ram city is as follows.

- Annual reservoir storage capacity : $3.90 \times 10^6\,m^3$
- Annual water supply volume : $3.25 \times 10^6\,m^3$ in 1990

Population assumed in Buri Ram city for the two targeted years are as follows based on household member of 4.5 persons.

2000	112,578 persons (25,016 households)
2010	222,336 persons (49,408 households)

From the above, it can be judged easily that water supply capacity should be increased by 2.1 times by 2000 and 4.1 times by 2010 respectively. Thus, reservoir storage volume are expected as follows

Year	Expected storage volume
2000	$6.83 \times 10^6\,m^3$
2010	$13.33 \times 10^6\,m^3$

On-going project

Fortunately, water conveyance works is on-going from the existing Lam Plai Mat weir to the Huai Chorakhe Mak reservoir by using facilities such as reinforced concrete pipes using 1,000 ~ 1,500 mm in diameter for three lanes and connecting canal to the upstream portion of the river of the Huai Chorakhe reservoir (Figure 13).

Proposed Huai Chorakhe Mak reservoir excavation

Both reservoirs have already been connected by canal situated in Ban Samet and Ban Khok Klang villages to share water for the purposes of mainly water supply and irrigation.

The water conveyance works from the existing Lam Plai Mat weir to the Huai Chorakhe Mak reservoir is completed. The main purpose of this work is irrigation water supply for 5,600 ha. Remaining maximum 1,000 m^3/day only can be supplied during the wet season to the Huai Chorakhe Mak reservoir, according to the first planning of the project. Water supply during the dry season would be neglected because the main purpose is for supplying irrigation water is unstable.

In order to use the existing reservoir effectively, bottom excavation of the Huai Chorakhe Mak reservoir is recommended.

With the assumed reservoir area of 4.5 km^2 and bottom excavation of 3.0 m depth, water storage capacity will increase by 13.50 x 10^6 m^3, expanding the total storage volume 17.4 x 10^6 m^3. This capacity will be sufficient to meet the demand in 2010.

Project cost

Project cost are estimated on the same basis as in the case of Huai Chorakhe Mak reservoir. The total becomes 150 million bahts (Table 7).

(8) Ban Yang pumping reservoir

Site

The proposed reservoir site BU-3 is located 50 km north of Buri Ram at north latitude 15°26'00" and east longitude 103°00'30" (Figure 14). It is 10 km south of Amphoe Phutthaisong.

The site is the lowland on the right bank of the Lam Sa Thaet river, which is being confluenced with Mun river about 500 m downstream of the site. Existing weir with 3 m height and its maintenance bridge with 80 m long and 1.70 m wide has been constructed in 1989 for the irrigation purpose. Even with this weir, water storage capacity around the site is not sufficient in dry season.

In order to use river water effectively, construction of a reservoir is proposed with the size of 300 square m at the immediate upstream of the existing weir.

Dimensions

Due to the reasons above, proposed reservoir is planned to be a 300 m by 300 m square with the depth 6.0 m. The effective storage volume is calculated to be 360,000 m^3 (Figure 15).

Available flow

The drainage area of the proposed reservoir is calculated 2,100 km^2 excluding the catchment area of the existing dams and weirs in the upstream.

Average flow of the Lam Sa Thaet river available at the site is estimated to be 2.50 m^3/sec during wet season. There are no water records nor any gaging stations in dry season. Only the flow during the wet season can be depended upon.

Intake rate

The number of days to be required to fill in the reservoir is calculated for different intake ratios as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.13	32.1
10	0.25	16.7
15	0.38	11.0
20	0.50	8.3
30	0.75	5.6

As shown, if 10% of the flow available in the Lam Sa Thaet river is diverted, the reservoir will become full in less than 17 days.

Project cost

Project costs are estimated on the same basis as in the case of Ban Yang reservoir. The total becomes 37 million bahts (Table 8).

(9) Ban Sawang Phatthana pumping reservoir

Site

The proposed reservoir site SU-1 is located 40 km south-west of Surin at north latitude 14°36'30", and east longitude 103°14'30" (Figure 16). It is 20 km west of Amphoe Prasat.

The site is the lowland on the right bank of the Chi river. There is an existing reservoir for irrigation purpose mainly to be formed like an ellipse with 700 m long 300 m wide (Figure 17).

While water depth of the existing reservoir is 1.5 to 2.5 m, storage water is almost empty in dry season. The area around the reservoir has a scenic beauty like highland resorts, especially during October to December period. Considering this water resources development can aim not only irrigation and drinking purpose but also for resort and fishery development.

Trees named "Kung", looking like highland trees, with the height of 10 to 15 m are found in and around the proposed site. The tree is known as the material for cottage's roof and furniture. The proposed reservoir should be developed to be enlarged like a rectangle and excavated more deeply.

Dimensions

Proposed reservoir is planned to be 700 m long, and 300 m wide with the depth of 6.0 m. The effective storage volume is calculated to be 850,000 m^3 (Figure 17).

Available flow

The drainage area corresponding to the proposed site is calculated 500 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Average flow of the Chi river available at the site is estimated to be 5.32 m^3/sec during wet season, and 0.23 m^3/sec during dry season. Only the flow during the wet season would be dependable.

Intake rate

The number of days to be required to fill in the reservoir is calculated for different intake ratio as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.27	36.4
10	0.53	18.6
15	0.80	12.3
20	1.06	9.3
30	1.60	6.1

As shown, if 10% of the flow available in the Chi river is diverted, the reservoir will become full in less than 19 days.

Project costs

Project costs are estimated on the same basis as in the case of Ban Suwan Phatthana reservoir. The total becomes 71 million bahts (Table 9).

(10) Ban Sawai pumping reservoir

Site

The proposed site SU-2 is located 36 km south-east of Surin at north latitude 14°41'00" and east longitude 103°48'60" (Figure 18). It is located 8.0 km north-west of Amphoe Sangkha.

The site is the lowland on the right bank of Huai Thap Than river. Provincial highway no.2077 runs just in front of the site. Land use around the proposed site is typical paddy area. Forests can be seen here and there.

Lack of water prohibits the paddy production and shortage of drinking water during the dry season, and inundation by the overflow of the Huai Thap Than river and limited access constrains the paddy cultivation during the rainy season.

Dimensions

Proposed reservoir is planned to be 500 m long and 300 m wide with the depth of 6.0 m. The effective storage volume is calculated to be 600,000 m^3 (Figure 19).

Available flow

The drainage area corresponding to the proposed site is calculated 450 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream.

Average flow of the Huai Thap Than river is estimated to be 7.26 m^3/sec during wet season, and 0.24 m^3/sec during dry season. Only the flow during the wet season would be depend upon.

Intake rate

The number of days to be required to fill in the reservoir is calculated for different intake ratios as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.36	19.3
10	0.73	9.5
15	1.09	6.4
20	1.45	4.8
30	2.18	3.2

As shown, if 10% of the flow available in the Huai Thap Than river is diverted, the reservoir will become full in less than 10 days.

Project cost

Project costs are estimated on the same basis as in the case of Ban Sawai reservoir. The total becomes 60.5 million bahts (Table 10).

(11) Ban Kran pumping reservoir

Site

The proposed site is S1-1 located 45 km south of Si Sa Ket at north latitude 14°41'00" and east longitude 104°25'00" (Figure 20). It is 28 km of Amphoe Khukhan.

The site is the lowland on the right bank of the Huai Tha river. National highway no.24 runs just in front of the site. Land use around the proposed site is typical paddy area, with some eucalyptus trees planted. Production of kenaf (kind of jute) can also be seen from place to place.

Shortage of water prohibits not only the paddy production but also kenaf production and tree growing during the dry season.

Dimensions

Proposed reservoir is planned to be 300 m long and 200 m wide with the depth 6.0 m. The effective storage volume is calculated to be 234,000 m^3 (Figure 21).

Available flow

The drainage area corresponding to the proposed site is calculated 400 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream.

Average flow of the Huai Tha river is estimated to be 6.07 m^3/sec during wet season, and 0.57 m^3/sec during dry season. Only the flow during the wet season would be depend upon.

Intake rate

The number of days required to fill in the reservoir is calculated for different intake ratios as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.30	9.0
10	0.61	4.4
15	0.91	3.0
20	1.21	2.2
30	1.82	1.5

As shown, if 10% of the flow available in the Huai Tha river is diverted, the reservoir will become full in about 4 days.

Project cost

Project costs are estimated on the same basis as in the case of Ban Kran reservoir. The total becomes 26 million bahts (Table 11).

(12) Ban Khilek pumping reservoir and mini hydroelectric power station

Site

The proposed site is S1-2 located 25 km south east of Si Sa Ket at north latitude 14°55'40" and east longitude 104°29'30" (Figure 22).

The site is the normal cultivated land on the left of the Huai Tha river forming 80 m wide and 10 m high from the crossing bridge to the riverbed approximately. Sandstone beds alternating with alluvium valley hill and river gravel can be seen in the river.

Land use around the area is typical paddy field. The water level in the river fluctuates between wet and dry season. Water shortage is serious in dry season. The river course around the site is formed relatively deep and riverbeds foundation seems to be available to construct a concrete weir.

In order to use water resources effectively, a multipurpose weir construction is proposed for irrigation and drinking water as well as for mini hydroelectric power plant particularly in dry season. Mini hydro power plant, can be used for the operation of pumping water from the reservoir in dry season, although the operating hour will be limited (Figure 24).

There is an irrigation weir constructed in March 1992 at the tributary about 1.0 km upstream of the site. The proposed project does not seem to be affect this existing weir according the findings of he site inspection.

Dimension of reservoir

Proposed reservoir is planned to be 500 m long and 300 m wide the depth of 6.0m. The effective storage volume is calculated to be 600,000 m^3 (Figure 23).

Available flow

The drainage area corresponding to the proposed site is calculated 750 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream.

Average flow of the Huai Tha river is estimated 11.38 m^3/sec during wet season, and 1.07 m^3/sec during dry season. Only the flow during the wet season would be depended upon.

Intake rate

The number of days required to fill in the reservoir is calculated for different ratios as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.57	12.1
10	1.14	6.1
15	1.71	4.1
20	2.28	3.0
30	3.41	2.0

As shown, if 10% of the flow available in the Huai Tha river is diverted, the reservoir will become full in 6 days.

Dimensions of weir and mini hydro electric power station

The proposed concrete weir and mini hydroelectric power station would be constructed at about 100 m upstream of the crossing bridge juding from on the topographic condition. The proposed pumping reservoir will be constructed at a suitable point in the upstream within 50 to 100 m from the proposed weir. The mini hydroelectric power station would be installed on the left bank side of the weir based on the topographic condition (Figure 23).

The calculation of design flood, among the drainage area, largest recorded flood (L.F) and ratio between drainage area and L.F can be roughly made by applying the equation as follows.

$$Y = 0.0679\ X^{0.722} + 0.16$$

where, Y : $X/L.F$
X : Drainage Area (km^2)
L.A : Largest recorded flood (m^3/sec)

For example, if the drainage area is 1,092 km^2, design flood of 100 years return period (Q100) is calculated to be 650 m^3/sec. In the same way, design discharge at the proposed weir with a drainage area of 750 km^2 is calculated as follows.

(1) = X (Km^2)	(2) = Y	(3) = X/Y	Q100 (m^3/sec)
1,092	10.76	101.49	650
750	8.25	90.91	580

As shown above, required discharge of Q100 would be calculated in proportion to the ratio between X and Y value.

The annual energy production would be calculated based on the 10 years dry year records.

Preliminary dimensions of the weir and power station are as follows.

Weir:

- Drainage area : 750 km^2
- Height of weir of non-overflow part : 11.50 m
- Height of weir of overflow part : 8.50 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 120.00 m
- Adopted return period of design flood : 100 years
- Spillway design discharge : 580 m^3/sec
- Spillway gate : Movable rubber dam

Power station:

- Maximum discharge : 8.00 m^3/sec
- Maximum head : 8.00 m
- Minimum head : 5.50 m
- Installed capacity : 550 kW
- Annual energy production : 1,600,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

Project cost

Project costs are estimated on the same basis as in the case of Ban Khielek reservoir. The total becomes 142.5 million bahts (Table 12).

(13) Ban Rat Samran pumping reservoir and mini hydroelectric power station

Site

The proposed site is UR-1 located 15 km south-west by west of Ubon Ratchathani at north latitude 15°08'00" and east longitude 104°44'00" (Figure 25). It is also 15 km from Amphoe Muang, Ubon Ratchathani.

The site is the normal cultivated land on the right bank of the Huai Phap river, which confluencs with the Mun River about 2 km downstream site. The river around the

site is formed 80 m wide and 10 m high from the crossing bridge to riverbed approximately. Sand-stone beds alternating with alluvium valley hill and river gravel can be seen in the river.

The provincial highway no.2193 runs just in front of the site. Land use around the area is typical paddy field. The water level fluctuates between wet and dry season. Water shortage is serious in dry season. The river course around the site relatively deep and riverbeds foundation seems to be available to construct a concrete weir.

In order to use water resources effectively, a multipurpose weir construction for irrigation and drinking water as well as mini hydroelectric power development particularly in wet season is proposed. Mini hydro power plant is expected to be used for the operation of pumping water from reservoir in dry season. Operating hour, however, will be limited.

Dimensions of reservoir

Proposed reservoir is planned to be 500 m long and 300 m wide with the depth of 6.0 m. The effective storage volume is calculated to be 600,000 m^3 (Figure 26).

Available flow

The drainage area corresponding to the proposed site is calculated 350 km^2 excluding the catchment area of existing and on-going weirs in the upstream. Average flow of the Huai Phap river is estimated to be 16.36 m^3/sec during wet season, and 1.92 m^3/sec during dry season. Only the flow during the wet season would be depend upon.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.82	8.5
10	1.64	4.2
15	2.45	2.8
20	3.27	2.1
30	4.91	1.4

As shown, if 10% of the flow available in the Huai Phap river is diverted, the reservoir will become full in 4 days.

Dimensions of weir and mini hydro electric power station

The proposed site of the concrete weir and mini hydroelectric power station would be about 100 m upstream of the crossing bridge judging from the topographic condition. The proposed pumping reservoir will be provided at a suitable point in the upstream within 50 to 100 m of the proposed weir. The mini hydroelectric power station would be provided on the right bank of the weir based on the topographic condition (Figure 26).

Preliminary dimensions of weir and power station are as follows.

Weir:

- Drainage area : 350 km^2
- Height of weir of non-overflow part : 11.50 m

- Height of weir of overflow part : 8.50 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 120.00 m
- Adopted return period of design flood : 100 years
- Spillway design discharge : 465 m^3/sec
- Spillway gate : Movable rubber dam

Power station:

- Maximum discharge : 800 m^3/sec
- Maximum head : 8.00 m
- Minimum head : 5.50 m
- Installed capacity : 270 kW
- Annual energy production : 1,000,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

Project cost

Project costs are estimated on the same basis as in the case of Ban Rat Samran reservoir. The total becomes 123.5 million bahts (Table 13).

(14) Ban Kud Kua Noi pumping reservoir

Site

Proposed site UR-2 is located 30 km east of Ubon Ratchathani at north latitude 15°19'00" and east longitude 105°06'30" (Figure 27). It is located within Muang Ubon Ratchathani.

The site is the normal cultivated land on the left bank of the Lam Se Bok river, which flows towards to the southeast and is confluenced with the Mun river in the 1.0 km downstream of the site. The river around the site is 100 m wide and 10 m high from the crossing bridge to riverbed approximately.

Land use around the area is typical paddy field. The water level fluctuates between wet and dry season. Water shortage is serious in dry season, because the water depth during wet season is about 6.0 m, while during the dry season is about 0.50 m. In order to use river flow during the wet season effectively, a pumping reservoir is recommended.

Dimensions

Planned dimensions of the reservoir are 300 m wide and 500 m long with 6.0 m depth. The effective storage volume is calculated to be 600,000 m^3 (Figure 28).

Available flow

The drainage area of the Lam Se Bok river corresponding to the proposed site is calculated to be 2,000 km^2, excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Mean discharge available at the site is estimated to be 31.82 m^3/sec during the wet season and 0.93 m^3/sec during the dry season. Only the flow during the wet season would be depend upon.

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	1.59	4.4
10	3.18	2.2
15	4.77	1.5
20	6.36	1.1
30	9.55	0.7

As shown, if 10% of the flow available in the Lam Se Bok river is diverted, the reservoir will become completely in 2 days.

Project cost

Project costs are estimated on the same basis as in the case of Ban Kud Kua Noi reservoir. The total becomes 61.6 million bahts (Table 14).

(15) Ban Nong Bo Baeng pumping reservoir and mini hydroelectric power station

Site

Proposed site UR-3 is located 30 km northeast by north of Ubon Ratchathani in Amphoe Muang Samsib at north latitude 15°30'00" and east longitude 104°58'20" (Figure 29).

The site is in the normal cultivated land on the left bank of the Lam Se Bok river, which is formed 80 m wide and 12 m high from the crossing bridge to the riverbeds approximately. The water level gaging station managed by R.I.D. can be found at just upstream of the left bank of the bridge.

Land use around the area is typical paddy field. The river water level fluctuates between wet and dry season. Water shortage is serious during the dry season. Water depth during the wet season is about 8 m, while during the dry season is about 0.70 m.

In and around the site, sandstone beds alternating with alluvium valleyhill and river gravel can be found, so that, a concrete weir can be constructed. In order to use the river water during the wet season effectively, not only the pumping reservoir for irrigation and drinking water but also the mini hydroelectric power is developed.

Dimensions of pumping reservoir

Planned dimensions of the reservoir are 300 m wide and 500 m along with 6.0 m depth. The effective storage volume is calculated to be 600,000 m^3 (Figure 30).

Available flow

The drainage area of the Lam Se Bok river corresponding to the proposed site is calculated to be 1,700 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Mean discharge available at the

site is estimated to be 27.00 m^3/sec during the wet season and 0.79 m^3/sec during the dry season. Only the flow during the wet season would be depend upon.

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	1.35	5.1
10	2.70	2.6
15	4.05	1.7
20	5.40	1.3
30	8.10	0.9

As shown, if 10% of the flow available in the Lam Se Bok river is diverted, the reservoir will become full in less than 3 days.

Dimensions of weir and mini hydro electric power station

The proposed site of the concrete weir and mini hydroelectric power station would be in about 100 m upstream of the crossing bridge based on the topographic condition. The proposed pumping reservoir will accordingly be provided at a suitable point in the upstream within 50 to 100 from the proposed weir. The mini hydroelectric power station would be provided on the right bank of the weir based on the topographic condition (Figure 30).

Preliminary dimensions of weir and power station are as follows.

Weir:

- Drainage area : 1,700 km^2
- Height of weir of non-overflow part : 13.50 m
- Height of weir of overflow part : 11.50 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 120.00 m
- Adopted return period of design flood : 100 years
- Spillway design discharge : 740 m^3/sec
- Spillway gate : Movable rubber dam

Power station:

- Maximum discharge : 12.00 m^3/sec
- Maximum head : 10.00 m
- Minimum head : 6.50 m
- Installed capacity : 1,000 kW
- Annual energy production : 2,900,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

Project cost

Project costs are estimated on the same basis as in the case of Ban Nong Bo Baeng reservoir. The total becomes 178 million bahts (Table 15).

(16) Ban Nong Chang Yai pumping reservoir and mini hydroelectric power station

Site

Proposed site UR-4 is located 37 km north of Ubon Ratchathani at north latitude 15°36'00" and east longitude 104°50'00" (Figure 31). It falls within Amphoe Muang Samsib.

The site is in normal cultivated land on the left bank of the Lam Se Bok river, which is 100 m wide and 12 m high from the crossing bridge to the riverbeds approximately.

Land use around the area is about 80% paddy field. Compared with other sites, more forest trees are observed. The river water level fluctuates between wet and dry season. Water shortage is serious during the dry season. The water depth during the wet season it is about 8 m, while dry season it is less than 1.0 m.

In and around the river, sandstone beds alternating with alluvium valleyhill and river gravel can be found, so that a concrete weir can be constructed. In order to use the river water during wet season effectively, the pumping reservoir for irrigation and drinking water as well as the mini hydroelectric power can be developed.

Dimensions of pumping reservoir

Planned dimensions of the reservoir are 300 wide and 500 m long with 6.0 m depth. The effective storage volume is calculated to be 600,000 m^3 (Figure 32).

Available flow

The drainage area of the Lam Se Bok river corresponding to the proposed site is calculated to be 1,200 km^2 excluding catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Mean discharge available at the site is estimated to be 19.06 m^3/sec during the wet season and 0.56 m^3/sec during the dry season. Only the flow during the wet season would be depend upon.

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.95	7.3
10	1.91	3.6
15	2.86	2.4
20	3.81	1.8
30	5.72	1.2

As shown, if 10% of the flow available in the Lam Se Bok river is diverted, the reservoir will become full in less than 4 days.

Project cost

Project costs are estimated on the same basis as in the case of Ban Nong Chang Yai reservoir. The total becomes 200.3 million bahts (Table 16).

Dimensions of weir and mini hydro electric power station

The proposed site of the concrete weir and mini hydroelectric power station would be in about 100 m upstream of the crossing bridge based on the topographic condition. The proposed pumping reservoir will accordingly be provided at a suitable point in the upstream within 50 to 100 m from the proposed weir. The mini hydroelectric power station would be provided on the right bank of the weir based on the topographic condition (Figure 32).

Preliminary dimensions of weir and power station are as follows.

Weir:

- Drainage area : 1,200 km^2
- Height of weir of non-overflow part : 13.00 m
- Height of weir of overflow part : 10.50 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 120.00 m
- Adopted return period of design flood : 100 years
- Spillway design discharge : 670 m^3/sec
- Spillway gate : Movable rubber dam

Power station:

- Maximum discharge : 20.00 m^3/sec
- Maximum head : 10.00 m
- Minimum head : 6.50 m
- Installed capacity : 1,700 kW
- Annual energy production : 5,600,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

(17) Nong Om Kaeo pumping reservoir

Site

The proposed site YT-1 is located 19 km east of Yasothon at north latitude 16°48'00" and east longitude 104°20'30" (Figure 33). It falls also within Muang, Yasothon.

The site is in normal cultivated land on the left bank of the Huai Phai river. The concrete weir construed in 1991 for mainly irrigation purpose can be found. This existing weir's dimensions are 3.0 m high and 40 m long approximately. In the left bank of the weir, a natural lake forming a circule with a small island in the center can be found.

Land use around the area is typical paddy field. Although a concrete weir was constructed in 1991, water shortage is still serious in dry season, because the storage volume of the weir is very limited and river flow is very small in dry season. Pumping reservoir development is, therefore, recommended to use the river water during the wet season as much as possible for the purposes not only the irrigation and drinking water but also fishery and resort development, etc.

Proposed reservoir would be constructed so as to be joined with the existing natural lake. Excavation of the natural lake does not seem to be necessary, because of beautiful sight in the surrounding much appreciated by the villagers (Figure 34).

Dimensions

The reservoir is planned with dimensions of 300 m x 300 m with 60 m depth. Effective storage volume will be 360,000 m^3.

Available flow

The drainage area of the Huai Phai river corresponding to the proposed site is calculated to be 450 km2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Mean discharge available at the site is estimated to be 2.00 m^3/sec during the wet season, 0.03 m^3/sec during the dry season. Only the flow during the wet season would be depended upon.

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.1	41.7
10	0.2	20.8
15	0.3	13.9
20	0.4	10.4
30	0.6	6.9

As shown, if 10% of the flow available in the Huai Phai river is diverted, the reservoir will become full in 21 days.

Project cost

Project costs are estimated on the same basis as in the case of Nong Om Kaeo reservoir. The total becomes 41 million bahts (Table 17).

(18) Nong Wai pumping reservoir and mini hydroelectric power station

Site

Proposed site YT-2 is located 32 km east of Yasothon at north latitude 15°50'20" and east longitude 104°28'00" (Figure 35). It falls within in Amphoe Pa Tiu.

The site is in normal cultivated land on the right bank of the Lam Se Bai river. Some forest can be seen along the national highway no.202 which runs just in front of the site. River course around the site is deep at about 15 m from the bridge to the riverbed, and 50 m wide.

Land use around the area is typical paddy field, while some trees planted can be seen from place to place. Water shortage is serious in dry season although water depth is still about 2.0 m due to the existing weir located about 5.0 m downstream of the proposed site. Water depth during wet season is recorded at about 10 m from the riverbed.

In and around the river of the site, sandstone beds alternating with alluvium valleyhill and river gravel can be found, so that a concrete weir can be constructed. In order to use the river water during the wet season effectively, it is recommended that not only

pumping reservoir for the irrigation and drinking water but also mini hydroelectric power be developed.

Dimensions of pumping reservoir

The proposed reservoir would be connected with the existing pondage in 50 m wide and 150 m long. Planned dimensions of the proposed reservoir are 300 m wide and 500 m long with 6.0 m depth, which would cover or include the existing pondage. The effective storage volume is calculated to be 600,000 m^3 (Figure 36).

Available flow

The drainage area of the Lam Se Bai river corresponding to the proposed site is calculated to be 600 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Mean discharge available at the site is estimated to be 22.70 m^3/sec during the wet season and 0.50 m^3/sec during the dry season. Only the flow during the wet season would be depended upon.

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	1.13	6.1
10	2.27	3.1
15	3.41	2.0
20	4.54	1.5
30	6.81	1.0

As shown, if 10% of the flow available in the Lam Se Bai river is diverted, the reservoir will become completely in 3 days.

Project costs

Project costs are estimated on the same basis as in the case of Nong Wai reservoir. The total becomes 219 million bahts (Table 18).

Dimensions of weir and mini hydro electric power station

The proposed site of the concrete weir and mini hydroelectric power station would be in about 100 m upstream of the crossing bridge based on the topographic condition. The proposed pumping reservoir will be provided at a suitable point in the upstream within 50 to 100 m from the proposed weir. The mini hydroelectric power station would be provided on the right bank of the weir based on the topographic condition.

Preliminary dimensions of weir and power station are as follows.

Weir:

- Drainage area : 600 km^2
- Height of weir of non-overflow part : 11.50 m
- Height of weir of overflow part : 10.00 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 120.00 m

- Adopted return period of design flood : 100 years
- Spillway design discharge : 550 m^3/sec
- Spillway gate : Movable rubber dam

Power station:
- Maximum discharge : 30.00 m^3/sec
- Maximum head : 10.00 m
- Minimum head : 6.50 m
- Installed capacity : 2,550 kW
- Annual energy production : 7,300,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

(19) Ban Kut Chum pumping reservoir

Site

Proposed site YT-3 is located 33 km northeast of Yasothon at north latitude 16°02'00" and east longitude 104°21'31" (Figure 37). It falls within Amphoe Kut Chum.

The site is in the lowland on the right bank of the Huai Pong river. Land use around the site is paddy. Lack of water prohibits the paddy production during the dry season, and inundation by the overflow of the Huai Pong river and limited access constrains the paddy cultivation during the rainy season.

As one of the problems during rainy season, rise of water surface can be seen at the existing weir situated 1.0 km downstream of the proposed site. Since this weir's height is 1.5 to 2.0 m, it should be improved to make a down of elevation of the top of the weir partly. This improvement is important to avoid the flood damages on not only the construction of pumping reservoir but for the water resources development.

Dimenstions

Proposed reservoir would be connected with the existing pondage in a 100 m square approximately. Planned dimensions of the proposed reservoir is 300 m square with 6.0 m depth. The effective storage volume is calculated to be 360,000 m^3 (Figure 38).

Available flow

The drainage area corresponding to the proposed site is calculated at 600 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Average flow of the Huai Pong river available at the site is estimated to be 7.07 m^3/sec during wet season and 0.40 m^3/sec during the dry season. Only the flow during the wet reason would be depended upon.

Intake rate

The number of days to be required to fill in the reservoir is calculated for different ratio as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.35	11.9
10	0.71	5.9
15	1.06	3.9
20	1.41	3.0
30	2.12	2.0

As shown, if 10% of the flow available in the Huai Pong river is diverted, the reservoir will become full in 6 days.

Project cost

Project costs are estimated on the same basis as in the case of Ban Kut Chum reservoir. The total becomes 39 million bahts (Table 19).

(20) Wat Na Chan pumping reservoir

Site

Proposed site MK-1 is located 18 km south of Mukdahan at north latitude 16°22'30" and east longitude 104°40'30" (Figure 39). It falls within Amphoe Muang, Mukdahan.

The site is in the lowland on the right bank of the Huai Ta Lom river which is a tributary of the Huai Bang I river. Land use around the site is paddy. Lack of water prohibits the paddy production during the dry season, and inundation by the overflow of the Huai Ta Lom river is observed.

An intake weir was constructed at the immediate downstream of the proposed pumping reservoir in 1991. However, this weir was heavily damaged due to the flooding on rainy season in the same year. The improvement of this weir, therefore, is also recommended together with the construction of pumping reservoir (Figure 41).

Dimensions

Proposed reservoir would be connected with the existing pondage forming a 100 m square approximately. Planned dimensions of the proposed reservoir is 300 m square with 6.0 m depth. The effective storage volume is calculated to be 360,000 m^3 (Figure 40).

Available flow

The discharge area corresponding to the proposed site is calculated at 50 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Average flow of the Huai Ta Lom river at the site is estimated to be 2.43 m^3/sec during the wet season and 0.16 m^3/sec during the dry season. Only the flow during the wet season would be depended upon.

Intake rate

The number of days to be required to fill in the reservoir is calculated for different ratios as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.12	34.7
10	0.20	17.4
15	0.36	11.6
20	0.49	8.5
30	0.73	5.7

As shown, if 10% of the flow available in the Huai Ta Lom river is diverted, the reservoir will become full in about 17 days.

Project cost

Project costs are estimated on the same basis as in the case of Wat Na Chan reservoir. The total becomes 38.5 million bahts (Table 20).

(21) Ban Na Tabaeng pumping reservoir and mini hydroelectric power station

Site

Proposed site MK-2 is located 28 km northwest by west of Mukdahan at north latitude 16°28'00" and east longitude 104°28'00" (Figure 42). It falls within Amphoe Kamcha -I.

The site is in the lowland on the left bank of the Huai Bang river. Land use around the site is paddy field. Lack of water prohibits the paddy production during the dry season, and inundation by the overflow of the Huai Bang river is observed. The bridge improvement works is going on at the crossing of the river just in front of the site.

The river course around the site is 100 m wide and 10 m high from the bridge to the river. Sandstone beds alternating the alluvium valleyhill and river gravel can be found.

In order to use the rive water effectively during the wet season, it is possible to develop not only water resources for the irrigation and drinking water but also for the mini hydroelectric power by applying the water head of the concrete weir.

Dimensions of pumping reservoir

Proposed reservoir is planned to be 300 m wide and 500 m long with the depth of 6.0 m. The effective storage volume is calculated to be 600,000 m^3 (Figure 43).

Available flow

The drainage area corresponding to the proposed site is 100 km^2 excluding the catchment area of existing, on-going and newly constructed dams and weir in the upstream. Average flow of the Huai Bang river is estimated to be 5.07 m^3/sec during wet season and 0.32 m^3/sec during the dry season. Only the flow during the wet season would be depended upon.

Intake rate

The number of days required to fill in the reservoir is calculated for different ratios as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.25	27.8
10	0.51	13.6
15	0.76	9.1
20	1.01	6.9
30	1.52	4.6

As shown, if 10% of the flow available in the Huai Bang river is diverted, the reservoir will become full in 14 days.

Dimensions of weir and mini hydro electric power station

The proposed site of the concrete weir and mini hydroelectric power station would be in about 100 m upstream of the crossing bridge based on the topographic condition. The proposed pumping reservoir will accordingly be provided at a suitable point in the upstream within 50 to 100 m of the proposed weir. Meanwhile, the mini hydroelectric power station would be provided on the right bank of the weir based on the topographic condition.

Preliminary dimensions of the weir and the power station are as follows.

Weir:

- Drainage area : 100 km^2
- Height of weir of non-overflow part : 9.50 m
- Height of weir of overflow part : 6.50 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 150.00 m
- Adopted return period of design flood : 100 years
- Spillway design discharge : 310 m^3/sec
- Spillway gate : Movable rubber dam

Power station:

- Maximum discharge : 2.00 m^3/sec
- Maximum head : 6.00 m
- Minimum head : 4.00 m
- Installed capacity : 100 kW
- Annual energy production : 300,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

Project cost

Project costs are estimated on the same basis as in the case of Ban Tabaeng reservoir. The total becomes 102.5 million bahts (Table 21).

(22) Ban Na Po Noi pumping reservoir and mini hydroelectric power station

Site

Proposed site MK-3 is located 2 km north of Mukdahan at north latitude 16°33'00" and east longitude 104°43'00" (Figure 44). It falls within Amphoe Muang Mukdahan.

The site is the lowland on the left bank of the Huai Muk river, which is being confluenced with the Mae Khong river to be biggest five in the world. Land use around the site is paddy field, particularly in the upstream of the point crossing national highway no.212. Lack of water prohibits the paddy production during the dry season. The water depth during the wet season is sometimes 8.0 m and less than 1.0 m during the dry season.

The river course around the site is 90 m wide and 15 m high from the bridge to riverbed. The sandstone beds alternating with alluvium valleyhills and river gravel can be found in the river.

In order to use water resources effectively, a multipurpose weir construction at the proposed site can be recommended. Mini hydroelectric power can be developed together with the pumping reservoir for the irrigation and drinking water purposes.

Dimensions of pumping reservoir

Proposed reservoir is planned to be 300 m wide and 500 m long with 6.0 m depth. The effective storage volume is calculated to be 600,000 m^3 (Figure 45).

Available flow

The drainage area corresponding to the proposed site is 450 km2 excluding the catchment area of existing, on-going and newly constructed dams and weirs in the upstream. Average flow of the Huai Muk river is estimated to be 21.50 m^3/sec during the wet season and 1.63 m^3/sec during the dry season. Only the flow during the wet season would be depended upon.

Intake rate

The number of days required to fill in the reservoir is calculated for different ratios as summarized below.

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	1.08	6.43
10	2.15	3.23
15	3.23	2.15
20	4.30	1.61
30	6.45	1.08

As shown, if 10% of the flow available in the Huai Bang river is diverted, the reservoir will become full in about 3 days.

Dimensions of weir and mini hydro electric power station

The proposed site of the concrete weir and mini hydroelectric power station would be in about 100 m upstream of the crossing bridge based on the topographic condition. The proposed pumping reservoir will accordingly be provided at a suitable point in the upstream within 50 to 100 m of the proposed weir. The mini hydroelectric power station would be provided on the right bank of the weir based on the topographic condition.

Preliminary dimensions of weir and power station are as follows.

Weir:

- Drainage area : 450 km^2
- Height of weir of non-overflow part : 12.50 m
- Height of weir of overflow part : 9.00 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 120.00 m
- Adopted return period of design flood : 100 years
- Spillway design discharge : 500 m^3/sec
- Spillway gate : Movable rubber dam

Power station:

- Maximum discharge : 11.00 m^3/sec
- Maximum head : 9.00 m
- Minimum head : 6.50 m
- Installed capacity : 840 kW
- Annual energy production : 2,600,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

Project cost

Project costs are estimated on the same basis as in the case of Ban Na Po Noi reservoir. The total becomes 152.3 million bahts (Table 22).

(23) Ban Tak Caet pumping reservoir

Site

Proposed site NN-1 is located 17 km north west by west of Nakhon Nayok at north latitude 14°16'30" and east longitude 101°04' (Figure 46). It falls within Amphoe Ban Na.

The site is the normal cultivated land on the right bank of the Khlong Bung Na river forming 30 m wide and 5 m high which is flowing from north to south. There are crossing bridge at the national highway No.33, 1.5 km downstream, and the existing gated weir 3.5 km downstream of the proposed site in the river respectively. The water depth between wet and dry season is different more than 3.0 m at the crossing bridge. Quantity of the water in the river seems to be polluted during the dry season due to soil erosion to be contaminated and the discharged sanitary water from households. In particular, the crossing gates which has a plan to reserve the water will be caused of the water pollution during the dry season, although the river water is not so polluted during wet season from the result of interview with inhabitants

around the site. Since the proposed site is relatively near from the central part of Amphoe Ban Na, which will be affected the more water pollution in the future.

Dimensions of pumping reservoir

Based on the above situation, the construction of a small pumping reservoir is recommended with size of 500 m long, and 300 m wide with the depth of 6.0 m, in order to use river water effectively. The effective storage volume is calculated to be 600,000 m^3 (Figure 47).

Available flow

The drainage area of the proposed reservoir is calculated 180 km^2 excluding the catchment area of the existing dams and weirs in the upstream.

Average flow of the Khlong Bung Na river at the site is estimated to be 13.2 m^3/sec during wet season and 0.5 m^3/sec during the dry season which applying the neighboring existing gaging station of NY1B as follows. Only the flow during the wet season would be depend upon.

Station	River	Drainage Area (km^2)	Mean Discharge (m^3/sec)	
			Wet Season	Dry Season
NY1B	Nakhon Nayok	519	40.7	2.2
Proposed site	Khlong Bung Na	180	14.2	0.8

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.7	9.9
10	1.4	5.0
15	2.1	3.3
20	2.8	2.5
30	4.2	1.7

As shown, if 10% of the flow available in the Khlong Bung Na river is diverted, the reservoir will become full in 5 days.

Project costs

Project costs are estimated on the same basis as in the case of *Ban Tak Caet* reservoir. The total becomes 61.6 million bahts (Table 23).

(24) Ban Kut Rang Nai pumping reservoir and mini hydroelectric power station

Site

Proposed site NN-2 is located 10 km north east of Nakhon Nayok at north latitude 14°15'30" and east longitude 101°17'00" (Figure 48). It falls within in Amphoe Muang Nakhon Nayok.

The site surrounding seems to be starting point of a ravine and forms like forest on both banks along the Mae Nam Nakhon river, which is raised from a range of the Khao Yai mountains such as Mt. Khao Khieo (EL.1,351 m), Mt. Khao Falami (EL. 1,112 m) and Mt. Khao Inthani (EL.1,052 m) etc. So that, quality of the river water looks like very clean and yet polluted.

The river course of the Nakhon Nayok river flows having direction from northeast to south west, in parallel the provincial highway no.3239 also runs in besides of the left bank side of said river.

Land use around the area is typical paddy field except a part of river course, while some vegetables planted can be seen from place to place. The river course around the site is deep at about 9 m from the suspension bridge to the riverbed, and 65 m wide. The river water depth between wet and dry season is difference about 6 m.

In and around the river of the site, granite or arkose beds alternating with alluvium valleyhill and river gravel can be found, so that a concrete weir can be constructed. In order to use the river water during the wet season effectively as much as possible, it is recommended that not only pumping reservoir for irrigation and drinking water but also mini hydroelectric power be developed.

Dimensions of pumping reservoir

Proposed reservoir is planned to be 300 m wide and 500 m long with the depth of 6.0 m of the right bank side of river. The effective storage volume is calculated to be 600,000 m^3 (Figure 49).

Available flow

The drainage area of the proposed reservoir is calculated 390 km^2 excluding the catchment area of existing dams and weirs in the upstream.

Average flow of the Nakhon Nayok river at the site is estimated to be 30.6 m^3/sec during wet season and 1.7 m^3/sec during the dry season, which applying the neighboring existing gaging station of NY1B as follows. Only the flow during the wet season would be depended upon.

Station	River	Drainage Area (km^2)	Mean Discharge (m^3/sec)	
			Wet Season	Dry Season
NY1B	Nakhon Nayok	519	40.7	2.2
Proposed site	-do-	390	30.6	1.7

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	2.0	3.5
10	4.0	1.7
15	6.1	1.1
20	8.1	0.9
30	12.2	0.6

As shown, if 10% of the flow available in the Nakhon Nayok river is diverted, the reservoir will become full in less that 2 days.

Dimensions of weir and mini hydroelectric power station

The proposed site of the concrete weir and mini hydroelectric power station would be about 200 m downstream of the crossing suspension bridge judging from the topographic condition. The proposed pumping reservoir will be provided at a suitable point in the upstream within 50 to 100 m of the proposed weir. The mini hydroelectric power station would be provided on the right bank of the weir based on the topographic condition (Figure 49).

Preliminary dimensions of weir and power station are as follows.

Weir:

- Drainage area : 390 km^2
- Height of weir of non-overflow part : 11.50 m
- Height of weir of overflow part : 8.50 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 90.00 m
- Adopted return period of design flood : 100 years
- Spillway design discharge : 480 m^3/sec
- Spillway gate : Movable rubber dam

Power station:

- Maximum discharge : 18.00 m^3/sec
- Maximum head : 8.00 m
- Minimum head : 5.50 m
- Installed capacity : 1,200 kW
- Annual energy production : 3,790,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

Project costs

Project costs are estimated on the same basis as in the case of *Ban Kut Rang Nai* reservoir. The total becomes 160 million bahts (Table 24).

(25) Ban Don Wai pumping reservoir and mini hydroelectric power station

Site

Proposed site PB-1 is located 40 km east of Prachin Buri at north latitude 13°58'00" and east longitude 101°44'30" (Figure 50). It falls within Amphoe Kabin Buri.

The site is the normal cultivated land on the right bank of the Khlong Phra Sathung river forming 100 m wide and 12 m high from the bridge to the riverbed which flowing from southeast to northeast. There are intake pipe tower and crossing bridge with national highway no.304 to the downstream 100 m and 200 m respectively.

The intake pipe tower having about 80 mm dia. is used for the water supply to the hospital from the river water directly according to the worker explanation at the house of the intake tower maintenance and operation. The quality of water is little bit

dulty affecting with eroded soil. While, it is clear that difference of water depth between wet and dry season is about 10 m from the inspection result. And also, the water shortage is much trouble particularly for the paddy production, the other crops and drinking water during the dry season.

In and around the river of the site, granite or arkose beds alternating with alluvium valleyhill and river gravel can be found although it has been weathered partly, so that concrete weir can be constructed. Based on these situation, the river water particularly during the wet season should be used as much as possible effectively. Thus, it is recommended that not only pumping for irrigation and drinking water but also mini hydroelectric power be developed.

Dimensions of pumping reservoir

Proposed reservoir is planned to be 300 m wide and 500 m long with the depth of 6.0 m of the right bank side of river. The effective storage volume is calculated to be 600,000 m^3 (Figure 51).

Available flow

The drainage area of proposed reservoir is calculated 3,500 km^2 excluding the catchment area of existing dams and weirs in the upstream.

Average flow of the Khlong Phra Sathung river is estimated to be 79.5 m^3/sec during the wet season and 3.8 m^3/sec during the dry season which applying the neighboring existing gaging station of Kgt. 13 as follows. Only the flow during the wet season would be depended upon.

Station	River	Drainage Area (km^2)	Mean Discharge (m^3/sec)	
			Wet Season	Dry Season
Kgt.13	K.Phra Sathung	5347	121.4	5.8
Proposed site	-do-	3500	79.5	3.8

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	4.0	1.7
10	8.0	0.9
15	11.9	0.6
20	15.9	0.4
30	23.9	0.3

As shown, if 10% of the flow available in the Khlong Phra Sathung river is diverted, the reservoir will become full about 1 day.

Dimensions of weir and mini hydroelectric power station

The proposed site of the concrete weir and mini hydroelectric power station would be about 200 m upstream from the crossing bridge with national highway No. 304 judging from the topographic condition. The proposed pumping reservoir will be provided at a suitable point in the upstream within 50 to 100 m of the proposed weir.

The mini hydroelectric power station would be provided on the right bank of the weir based on the topographic condition (Figure 51).

Preliminary dimensions of weir and power station are as follows.

Weir:

- Drainage area : 3,500 km^2
- Height of weir of non-overflow part : 13.00 m
- Height of weir of overflow part : 9.50 m
- Width of maintenance road of weir : 4.00 m
- Length of weir : 150.00 m
- Adopted return period of design flood : 100 years
- Spillway design discharge : 900 m^3/sec
- Spillway gate : Movable rubber dam

Power station:

- Maximum discharge : 28.00 m^3/sec
- Maximum head : 9.50 m
- Minimum head : 6.50 m
- Installed capacity : 2,300 kW
- Annual energy production : 7,640,000 kWh
- Turbine and generation : 2 units
- Size of power station : 8.00 m (L) x 6.00 (W) x 10.00 (H)

Project costs

Project costs are estimated on the same basis as in the case of *Ban dong Wai* reservoir. The total becomes 234.7 million bahts (Table 25).

(26) Ban Khao Chakan pumping reservoir and mini hydroelectric power station

Site

Proposed site PB-2 is located 85 km southeast by east of Prachin Buri at north latitude 13°39'30" and east longitude 102°04"30" (Figure 52). It falls within Amphoe Sa Kaeo.

The site is just 100 m upstream from crossing bridge with Khlong Phra Sathung river flowing from south to north. And also national highway No. 317 runs in parallel with the river.

The site surrounding seems to be ravin and forms like forest on both banks along the river, which is raised mainly tow basins. One is Khlong Phra Sathung river basin, the other is Ta Lang river basin. There are high mountains in the upstream of basin, such as Mt. Khao Soi Dao (EL. 1,556) and Mt. Khao Ngu Hao (EL.727) , etc. So that, quality of the water looks like very clean and yet polluted.

Land use around the area is typical paddy field except a part of river cource, while some vegetable planted can be seen from place to place. The river cource around the site is deep at about 13 m from the bridge to the riverbed and 80 m wide.

In and around the river at the site, granite or arkose beds alternating with alluvium valleyhill and river gravel can be found, so that concrete weir can be constructed. The river water during wet season should be used as much as possible effectively, because water depth between wet and dry season has a difference of 5-6 meters.

Based on this situation, this site also is recommended for two facilities such as pumping reservoir and mini hydroelectric power station.

Dimensions of pumping reservoir

Proposed reservoir is planned to be 300 m square with the depth of 6.0 m of the left bank side of river. The effective storage volume is calculated to be 360,000 m^3 (Figure 53).

Available flow

The drainage area of the proposed reservoir is calculated 1,500 km^2 excluding the catchment area of the existing dams and weirs in the upstream.

Average flow of the Khlong Phra Sathung river at the site is estimated to be 27.7 m^3/sec during wet season and 3.1 m^3/sec during the dry season, which applying the neighboring existing gaging station of Kgt.9 as follows. Only the flow during the wet season would be depended upon.

Station	River	Drainage Area (km^2)	Mean Discharge (m^3/sec)	
			Wet Season	Dry Season
Kgt.9	K. Phra Sathung	2,279	42.1	4.7
Proposed site	-do-	1,500	27.7	3.1

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	1.4	3.0
10	2.8	1.5
15	4.2	1.0
20	5.5	0.8
30	8.3	0.5

As shown, if 10% of the flow available in the Khlong Phra Sathung river is diverted, the reservoir will become full in 1.5 days.

Dimensions of weir and mini hydroelectric power station

The proposed site of the concrete weir and mini hydroelectric power station would be in about 100 m upstream of the crossing bridge based on the topographic condition. The proposed pumping reservoir will be provided at a suitable point in the upstream within 50 to 100 m from the proposed weir. The mini hydroelectric power station would be provided on the left bank of the weir based on the topographic condition.

Preliminary dimensions of weir and power station are as follows.

Weir:

- Drainage area	:	1,500 km^2
- Height of weir of non-overflow part	:	11.50 m
- Height of weir of overflow part	:	10.00 m
- Width of maintenance road of weir	:	4.00 m
- Length of weir	:	120.00 m
- Adopted return period of design flood	:	100 years
- Spillway design discharge	:	710 m^3/sec
- Spillway gate	:	Movable rubber dam

Power station:

- Maximum discharge	:	10.00 m^3/sec
- Maximum head	:	10.00 m
- Minimum head	:	6.50 m
- Installed capacity	:	850 kW
- Annual energy production	:	2,780,000 kWh
- Turbine and generation	:	2 units
- Size of power station	:	8.00 m (L) x 6.00 (W) x 10.00 (H)

Project costs

Project costs are estimated on the same basis as in the case of *Ban Khao Chakan* reservoir. The total becomes 134 million bahts (Table 26).

(27) Ban Khlong Yai pumping reservoir

Site

Proposed site PB-3 is located 90 km southeast of Prachin Buri at north latitude 13°31'00" and east longitude 102°03'40" (figure 54). It falls within Amphoe Wan Na Yen.

The site is 100 m upstream from crossing bridge between provincial road and the Khlong Phra Sathung river, in parallel there is national highway No. 317 about 12 km far to the east.

The site PB-3 is located more upstream side than PB-1 and PB-2 in the Khlong Phra Sathung river basin. So that, the site surrounding also seems to be ravin and forms like forest especially on both bank along the river. Quality of the river water looks like very clean and yet polluted accordingly.

Land use around the area is typical paddy field except a part of river cource, while some vegetable planted can be seen from place to place. The river cource around the site is deep about 13 m from the bridge to the riverbed, and 35 m wide.

Although in and around the site seems to be possible the construction of the river crossing weir for mini hydroelectric power station, the proposed facility would be small pumping reservoir only because the existing weir was constructed at 2-3 km upstream side.

Dimensions of pumping reservoir

Proposed reservoir is planned to be 300 m square with the depth of 6.0 m of the right bank side of river. The effective storage volume is calculated to be 360,000 m^3 (Figure 55).

Available flow

The drainage area of the proposed reservoir is calculated 400 km^2 excluding the catchment area of the existing dams and weirs in the upstream.

Average flow of the Khlong Phra Sathung river at the site is estimated to be 7.4 m^3/sec during wet season and 0.8 m^3/sec during the dry season, which is applying the neighboring existing gaging station of Kgt.9 as follows. Only the flow during the wet season would be depended upon.

Station	River	Drainage Area (km^2)	Mean Discharge (m^3/sec)	
			Wet Season	Dry Season
Kgt.9	K. Phra Sathung	2,279	42.1	4.7
Proposed site	-do-	400	7.4	0.8

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.4	10.4
10	0.7	6.0
15	1.1	3.8
20	1.5	2.8
30	2.2	1.9

As shown, if 10% of the flow available in the Khlong Phra Sathung river is diverted, the reservoir will become full in 6 days.

Project costs

Project costs are estimated on the same basis as in the case of *Ban Khlong Yai* reservoir. The total becomes 38 million bahts (Table 27).

(28) Aranyaprathet pumping reservoir

Site

Proposed site PB-4 is located 130 km southeast by east of Prachin Buri at north latitude 13°40'00" and east longitude 102°32'00". It falls within Amphoe Aranyaprathet, which is far about 500 m southwest from the central part of city of Aranyaprathet (Figure 56).

The site surrounding seems to be ravin and forms like forest in spite of the near place from the central part of the city. Quality of the Huai Phnom Hot river water looks like clean and yet polluted because of the upstream in the basin still have forest about 30 percent more.

The river cource at the site flows from northwest to southeast, finally reached to the nation boundary at 6.0 km downstream with Cambodia and flows continue.

Land use around the area is typical paddy field except a part of river cource, while some vegetable planted can be seen from place to place. The river cource around the site is deep about 10 m from the bridge to the riverbed, and 30 m wide.

There are many small temporary dikes crossing the river to serve the water. The difference of water depth between wet and dry season is about 4~5 m. It is shown clearly that shortage of water is much urgent. So that pumping reservoir is recommended for irrigation water, drinking water and others in order to use the water durig the wet season effectively.

Dimension of pumping reservoir

Around the site is limited area for the large scale construction due to the central of the city. So that proposed reservoir is planned to be 100 m square with the depth of 6.0 m of the left bank of river. The effective storage volume is calculated to be 40,000 m^3 (Figure 57).

Available flow

The drainage area of the proposed reservoir is calculated 370 km^2 excluding the catchment area of the existing dams and weirs in the upstream.

Average flow of the Huai Phrom Hot river at the site is estimated to be 3.1 m^3/sec during the wet season and 0.3 m^3/sec during the dry season, which is applying the neighboring existing gaging station of TL.1 as follows. Only the flow during the wet season would be depended upon.

Station	River	Drainage Area (km^2)	Mean Discharge (m^3/sec)	
			Wet Season	Dry Season
TL.1	Huai Phrom Hot	571	4.8	0.4
Proposed site	-do-	370	3.1	0.3

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.2	2.3
10	0.3	1.5
15	0.5	0.9
20	0.6	0.8
30	0.9	0.5

As shown, if 10% of the flow available in the Huai Phrom Hot river is diverted, the reservoir will become full in 1.5 days.

Project costs

Project costs are estimated on the same basis as in the case of *Aranyaprathet* reservoir. The total becomes 6 million bahts (Table 28).

(29) Ban Non Mak Mun pumping station

Site

Proposed site PB-5 is located 25 km northeast by east of Aranyaprathet and corresponding to 155 km southeast by east of Prachin Buri (Figure 58). It falls within Amphoe Ta Phraya.

Although around the site is topographically flatted having elevation about 85 to 40 meters and actual drainage area is 530 m^2, its drainage area is very rare case because mountain range consists of Mt. Khao Lon (EL.547), Mt. Khao Dang (EL.424) and Mt. Khao Ta Phrom (EL.342) are laid in almost central part of drainage area. The forest area can roughly be measured about 60% more from the topographic map. Due to these reasons, quality of water seems to be clean and yet polluted.

Existing dike with earth embankment can be seen at the nearest site in the Huai Yang river by mean of the reserving of water during the wet season. However, due to this facility, the Huai Yang river is being amputated at crossing dike for upstream and downstream sides.

Since the land use around the area is typical paddy field, the water is especial not only for the paddy production but for the other crops. So that, the pumping reservoir is recommended in order to use water during wet season effectively. If the pumping reservoir is constructed in near future, existing crossing dike in the river should be reopened. Thus, the situation of the Huai Yang river will be better and returned to the original river. Because there is nation boundary with Cambodia at about 3.0 km downstream along the river.

Dimensions

Planned dimensions of reservoir are 300 m wide and 500 m long with 60 m depth. The effective storage volume is calculated to be 600,000 m^3 (Figure 59).

Available flow

The drainage area of the proposed reservoir is calculated 370 km^2 excluding the catchment area of the existing dams and weirs in the upstream.

Average flow of the Huai Yang river at the site is estimated to be 5.5 m^3/sec during wet season and 0.3 m^3/sec during the dry season, which is applying the neighboring existing gaging station of TL.1 as follows. Only the flow during the wet season would be depended upon.

Station	River	Drainage Area (km^2)	Mean Discharge (m^3/sec)	
			Wet Season	Dry Season
TL.1	Huai Phrom Hot	571	8.5	0.4
Proposed site	Huai Yang	370	5.5	0.3

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.3	23.1
10	0.6	11.5
15	0.8	8.7
20	1.1	6.3
30	1.7	4.1

As shown, if 10% of the flow available in the Huai Yang river is diverted, the reservoir will become full in 11.5 days.

Project costs

Project costs are estimated on the same basis as in the case of *Ban Non Mek Mun* reservoir. The total becomes 60.5 million bahts (Table 29).

(30) Ban Khok Thahan pumping reservoir

Site

Proposed site PB-6 is located 55 km northeast of Aranyaprathet and corresponding to 160 km east of Prachin Buri (Figure 60). It falls within Amphoe Ta Phraya.

The site is in the lowland on the left bank of the Khlong Lund Krat river, which is being crossed with the Provincial highway No.3068. the river flows passing and continue of the nation boundary with Cambodia at about 4.5 km downstream from the site. In and around the site is topographically flatted having about EL. 50 meters, but left side of upstream in the basin have mountain range of middle class such as Mt. Khao Pran Nut (EL.579) and Mt. Khao Wong (EL.474), while the right side forms forests and paddy field.

Due to the interview result with villager, it is clear that the river discharge during the wet and dry season is big different although the mountain range and the forests are laid in the upstream basin.

Land use around the site is typical paddy field, and the shortage of water is much problem for the agricultural productions and drinking water etc. So that pumping reservoir is recommended in order to use the water during the wet season effectively.

In addition to the above, an existing concrete box culvert which was constructed in 1988 has laid at the proposed site in the river cource. The purposes of it seems to be collected and opened the river water during the wet season.

During the construction of pumping reservoir in the future, this existing concrete box culvert is also recommended to improve particularly on both sides of embankment portions.

Dimensions

Planned dimensions of reservoir are 300 m wide and 500 m long with 6.0 m depth. The effective storage volume is calculated to be 600,000 m^3 (Figure 61).

Available flow

The drainage area of the proposed reservoir is calculated 470 km^2 excluding the catchment area of the existing dams and weirs in the upstream.

Average flow of the Khlong Lund Krat river at the site is estimated to be 7.3 m^3/sec during wet season and 0.3 m^3/sec during the dry season, which is applying the gaging station of TL.1 as follows. Only the flow during the wet season would be depended upon.

Station	River	Drainage Area (km^2)	Mean Discharge (m^3/sec) Wet Season	Dry Season
	Huai Phrom Hot	571	8.5	0.4
TL.1 Proposed site	K.Lund Krat	490	7.3	0.3

Intake rate

Intake water ratio (%)	Inflow (m^3/sec)	Days to be full
5	0.4	17.4
10	0.7	9.9
15	1.1	6.3
20	1.5	4.6
30	2.2	3.2

As shown, if 10% of the flow available in the Khlong Lund Krat river is diverted, the reservoir will become full in 10 days.

Project costs

Project costs are estimated on the same basis as in the case of *Ban Khok Thahan* reservoir. The total becomes 61 million bahts (Table 30).

4. Project Evaluation

(1) Project costs

The total construction cost of the 30 identified pumping reservoirs becomes 2,700 million bahts. This includes costs of mini-hydro generating facilities but not costs of irrigation development, aquaculture and water transmission and reticulation.

The field water requirement to grow vegetables is estimated to be about 600 mm during the growing season. If the total effective storage of 29,927,000 m^3 is used for the irrigation, some 5,000 ha can be irrigated under vegetables. Additional costs for irrigation system may be 200 million bahts in total at 40,000 baht/ha for 5,000 ha.

Including an additional 100 million bahts for aquaculture facilities, the total project cost would be 3,000 million bahts.

The annual operation and maintenance costs are estimated at 50,000 bahts on an average for each reservoir. The total operation and maintenance cost becomes 1,500,000 bahts for 30 reservoirs.

(2) Revenue

Project revenue may be calculated based on the use of stored water for irrigation, aquaculture and mini-hydro. Net income from vegetable growing under irrigation is assumed to be 6,000 baht/rai or 37,500 baht/ha. The total net revenue from 5,000 ha is calculated to be 187.5 million baht.

The total surface area of all the reservoirs available for aquaculture is roughly estimated at 500 ha. Assuming net benefit of 30 baht/kg and 10 ton/ha yield for a three month period of high water levels, the annual revenue from aquaculture is calculated to be 150 million baht.

With the total installed capacity of 11.36 MW, all the mini-hydro generating facilities would produce electrical energy of 35.5 GWh annually. Assuming the energy value of 2 baht/kWh, the total revenue is calculated at 71 million baht. The total annual revenue from irrigation, aquaculture and mini-hydro becomes 408.5 million baht.

(3) Project viability

Based on the estimated costs and revenue, a cash flow table is prepared as shown in Table 32. The total construction cost is distributed equally over the proposed initial implementation period of 1994-96. For the project life of 20 years including the construction period, internal rate of return is calculated to be 11.7%.

The estimated revenue is on a conservative side. The project life may be much longer than 20 years with proper maintenance and management. Thus the project with the 30 small pumping reservoirs seems reasonably viable collectively.

(4) Viability of individual schemes

Viability of individual small pumping reservoir schemes vary depending on the construction costs, water availability, and water use. On the same assumptions made above, representative schemes with or without the mini-hydro option are evaluated. The Chock Chai pumping reservoir scheme without mini-hydro and the Nong Wai pumping reservoir scheme with mini-hydro are selected for illustration.

Cash flow tables of these schemes are given in Table 33. The total annual revenue of the Chock Chai scheme is 7,875,000 bahts, consisting of 3.375,000 bahts from irrigation and 4,500,000 bahts from aquaculture. The revenue of the Nong Wai scheme includes an addition of 14.6 million bahts from mini-hydro to make the total 22,475,000 bahts. The total construction cost including the irrigation system and aquaculture facilities is 66 million bahts for the Chock Chai scheme and 226 million bahts for the Nong Wai scheme.

From Table 33, internal rate of return is calculated to be 9.88% for the Chock Chai scheme and 7.34% for the Nong Wai scheme with mini-hydro. Thus these schemes

appear only marginally viable. These schemes, however, would deserve serious consideration in view of benefits not reflected in the estimated revenue. These benefits include reduction of risks associated with water shortages, and provision of opportunities for local people to organize themselves for joint management of facilities as well as recreational and other benefits from local economy point of view rather than purely financial point of view.

5. Recommendation

The small pumping reservoirs development project should start implementation in the nearest future. In particular, the 30 schemes identified by the Master Plan should be implemented during the Seventh Five Year Plan period, since they have collectively the internal rate of return of 11.7% even based on a conservative estimate of revenue. Their early implementation is particularly recommendable, since most of them would contribute to rural development in the least developed areas of the kingdom, generating sources of cash income and reducing risks of acute water shortages.

Although the construction costs are relatively high, they can be substantially reduced by using self-help efforts by local people. Excavated soil can be partly used for embankment to reduce the volume to be excavated.

A committee should be organized for any area where a potential reservoir site has been identified, consisting of representatives of local people, local administrations and relevant central government agencies. To be discussed and resolved in the committee would be the use of the reservoir, management organization, contribution to construction (born in cash and in kind), and other parties to be invited to make the scheme more viable such as an agri-business firm.

Land acquisition may be a critical issue for some schemes. The principle should be that the government would purchase land for both reservoirs and access roads at prices reflecting opportunity costs of the land that can otherwise be used for rain-fed agriculture. Maintenance and management should be primarily the responsibilities of local farmers.

While these identified schemes are further developed and implemented, studies should be carried out to identify other sites. These studies may be carried out as part of the comprehensive river basin development and management studies of selected river basins as recommended also by the Master Plan. These river basins are Lam Nam Chi/Lam Plai Mat, Nakhon Nayok, Prachin Buri, Lam Don Yai/Huai Tha, and Huai Bang Sai.

Tables

Table 1 Preliminary Construction Cost on Chok Chai Pumping Reservoir (NR-1)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	500	1,000	0.50	
1.7	Pump	Set	2	220,000	0.44	
1.8	Sluice gate	Set	2	10,000	0.02	
	Sub total				**43.82**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.3%)				1.88	
2.2	Benefit for contractor (Direct cost x 7.5%)				3.28	
2.3	Government tax (Direct cost x 7.96%)				3.48	
2.4	Engineering cost for government side (Direct cost x 3%)				1.31	
2.5	Engineering services for consultants (Direct cost x 6%)				2.63	
	Sub total				**12.58**	
3.	Land acquisition					
3.1	Proposed reservoir		18.4 ha	125,000	2.30	
3.2	Access road and others		1.0 ha	312,500	0.31	
	Sub total				**2.61**	
	Total			**59.01**	**≈ 59.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 2 Preliminary Construction Cost on Ban Dan Kata Pumping Reservoir (NR-2)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost					
1.1	Excavation	m^3	520,000	45.6	23.71	
1.2	Embankment	m^3	18,000	36.5	0.66	
1.3	Sod facing	m^2	143,000	60.0	0.86	
1.4	Macadam Pv.	m^2	7,400	96.0	0.71	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	2,000	1,000	2.00	
1.7	Pump	Set	2	220,000	0.44	
1.8	Sluice gate	Set	2	10,000	0.02	
	Sub total				**28.61**	
2.	Overhead					
2.1	Project contingency (Direct cost x 5.0%)				1.43	
2.2	Benefit for contractor (Direct cost x 7.5%)				2.15	
2.3	Government tax (Direct cost x 7.96%)				2.28	
2.4	Engineering cost for government side (Direct cost x 3%)				0.86	
2.5	Engineering services for consultants (Direct cost x 6%)				1.72	
	Sub total				**8.44**	
3.	Land acquisition					
3.1	Proposed reservoir		11.6 ha	125,000	1.45	
3.2	Access road and others		1.0 ha	312,500	0.31	
	Sub total				**1.76**	
	Total			**37.38**	**≈ 38.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 3 Preliminary Construction Cost on Tha Chang Pumping Reservoir (NR-3)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost					
1.1	Excavation	m^3	460,000	45.6	20.98	
1.2	Embankment	m^3	21,000	36.5	0.77	
1.3	Sod facing	m^2	17,000	60.0	1.02	
1.4	Macadam Pv.	m^2	9,000	96.0	0.86	
1.5	Intake conduit	L/S			0.48	
1.6	Access road	m	500	1,000	0.50	
1.7	Pump	Set	4	220,000	0.88	
1.8	Sluice gate	Set	2	10,000	0.02	
	Sub total				**25.51**	
2.	Overhead					
2.1	Project contingency (Direct cost x 5.0%)				1.28	
2.2	Benefit for contractor (Direct cost x 7.5%)				1.91	
2.3	Government tax (Direct cost x 7.96%)				2.03	
2.4	Engineering cost for government side (Direct cost x 3%)				0.77	
2.5	Engineering services for consultants (Direct cost x 6%)				1.53	
	Sub total				**7.52**	
3.	Land acquisition					
3.1	Proposed reservoir		14.4 ha	125,000	1.80	
3.2	Access road and others		1.0 ha	312,500	0.31	
	Sub total				**2.11**	
	Total				**35.14 ≈ 35.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 4 Preliminary Construction Cost on Ban Krathin Pumping Reservoir (NR-4)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost					
1.1	Excavation	m^3	1,480,000	45.6	67.49	
1.2	Embankment	m^3	30,000	36.5	1.10	
1.3	Sod facing	m^2	23,000	60.0	1.38	
1.4	Macadam Pv.	m^2	13,000	96.0	1.25	
1.5	Intake conduit	L/S			0.85	
1.6	Access road	m	1,000	1,000	1.00	
1.7	Pump	Set	4	220,000	0.88	
1.8	Sluice gate	Set	4	10,000	0.04	
	Sub total				**73.99**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.0%)				2.96	
2.2	Benefit for contractor (Direct cost x 7.5%)				5.55	
2.3	Government tax (Direct cost x 7.96%)				5.89	
2.4	Engineering cost for government side (Direct cost x 3%)				2.22	
2.5	Engineering services for consultants (Direct cost x 6%)				4.44	
	Sub total				**21.06**	
3.	Land acquisition					
3.1	Proposed reservoir		29 ha	125,000	3.63	
3.2	Access road and others		1 ha	312,500	0.31	
	Sub total				**3.94**	
	Total			**98.99**	**≈ 99.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 5 Preliminary Construction Cost on Ban Don Yao Yai Pumping Reservoir (NR-5)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000	1.00	
1.7	Pump	Set	2	220,000	0.44	
1.8	Sluice gate	Set	2	10,000	0.02	
	Sub total				**44.32**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.3%)				1.90	
2.2	Benefit for contractor (Direct cost x 7.5%)				3.32	
2.3	Government tax (Direct cost x 7.96%)				3.52	
2.4	Engineering cost for government side (Direct cost x 3%)				1.33	
2.5	Engineering services for consultants (Direct cost x 6%)				2.57	
	Sub total				**12.64**	
3.	Land acquisition					
3.1	Proposed reservoir		18.4 ha	125,000	2.30	
3.2	Access road and others		1.0 ha	312,500	0.31	
	Sub total				**2.61**	
	Total			**59.57**	**≈ 60.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 6 Preliminary Construction Cost on Ban Khok Yang Pumping Reservoir (BU-1)

(Reservoir scale 100 x 200 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	110,000	45.6	5.02	
1.2	Embankment	m^3	8,000	36.5	0.29	
1.3	Sod facing	m^2	5,600	60.0	0.34	
1.4	Macadam Pv.	m^2	3,300	96.0	0.32	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	500	1,000.0	0.50	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**7.14**	
2.	Direct cost of weir improvement					
2.1	Diversion works	L/S			0.23	50% of item 2.2 to 2.5
2.2	Dismantling of existing weir	L/S			0.01	
2.3	Excavation	m^3	300	145	0.04	
2.4	Concrete	m^3	200	1,500	0.30	
2.5	Boulder	m^3	60	160	0.10	
	Sub total				**0.68**	
3.	Overhead					
3.1	Project contingency (Direct cost x 6.0%)				0.47	
3.2	Benefit for contractor (Direct cost x 8.5%)				0.66	
3.3	Government tax (Direct cost x 7.96%)				0.62	
3.4	Engineering cost for government side (Direct cost x 3%)				0.23	
3.5	Engineering services for consultants (Direct cost x 6%)				0.47	
	Sub total				**2.45**	
4.	Land acquisition					
4.1	Proposed reservoir		3.0 ha	200,000	0.60	
4.2	Access road and others		0.5 ha	200,000	0.10	
	Sub total				**0.70**	
	Total				**10.97 ≈ 11.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 7 Preliminary Construction Cost on Huai Chorakhe Mak Reservoir Excavation (BU-2)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	794,000	144.0	114.30	Note (1)
1.2	Macadam Pv.	m^2	10,000	96.0	0.96	
1.3	Access road	m	2,000	1,000.0	2.00	
	Sub total				**117.26**	
2.	Overhead					
2.1	Project contingency (Direct cost x 3.5%)				4.10	
2.2	Benefit for contractor (Direct cost x 6.5%)				7.62	
2.3	Government tax (Direct cost x 7.96%)				9.33	
2.4	Engineering cost for government side (Direct cost x 3%)				3.52	
2.5	Engineering services for consultants (Direct cost x 6%)				7.04	
	Sub total				**31.61**	
3.	Land acquisition					
3.1	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**1.00**	
	Total				**149.87 ≈ 150.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Note (1) Excavation volume in the reservoir terminated is about 13.5 x $10^6 m^3$ until the year 2010. To balance the budget and execute a smooth excavation such much volume, this project would be long term of 17 years from 1993 to 2010. So that preliminary construction cost would be divided into 17 years except the costs of pavement, access road and land acquisition.

Table 8 Preliminary Construction Cost on Ban Yang Pumping Reservoir (BU-3)

(Reservoir scale 300 x 300 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	520,000	45.6	23.71	
1.2	Embankment	m^3	18,000	36.5	0.66	
1.3	Sod facing	m^2	14,300	60.0	0.86	
1.4	Macadam Pv.	m^2	7,400	96.0	0.71	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	500	1,000.0	0.50	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**27.11**	
2.	Overhead					
2.1	Project contingency (Direct cost x 5.0%)				1.36	
2.2	Benefit for contractor (Direct cost x 7.5%)				2.03	
2.3	Government tax (Direct cost x 7.96%)				2.16	
2.4	Engineering cost for government side (Direct cost x 3%)				0.81	
2.5	Engineering services for consultants (Direct cost x 6%)				1.63	
	Sub total				**7.99**	
3.	Land acquisition					
3.1	Proposed reservoir		10.9 ha	125,000	1.37	
3.2	Access road and others		0.5 ha	312,500	0.16	
	Sub total				**1.53**	
	Total				**36.63 ≈ 37.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 9 Preliminary Construction Cost on Ban Sawan Phatthana Pumping Reservoir (SU-1)

(Reservoir scale 300 x 700 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	980,000	45.6	44.69	
1.2	Embankment	m^3	25,000	36.5	0.91	
1.3	Sod facing	m^2	16,500	60.0	0.99	
1.4	Macadam Pv.	m^2	12,400	96.0	1.19	
1.5	Intake conduit	L/S			1.79	
1.6	Access road	m	2,000	1,000.0	2.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**52.03**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.3%)				2.24	
2.2	Benefit for contractor (Direct cost x 7.5%)				3.90	
2.3	Government tax (Direct cost x 7.96%)				4.14	
2.4	Engineering cost for government side (Direct cost x 3%)				1.56	
2.5	Engineering services for consultants (Direct cost x 6%)				3.12	
	Sub total				**14.96**	
3.	Land acquisition					
3.1	Proposed reservoir		24.1 ha	125,000	3.01	
3.2	Access road and others		2.0 ha	312,500	0.63	
	Sub total				**3.64**	
	Total				**70.63 ≈ 71.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 10 Preliminary Construction Cost on Ban Sawai Pumping Reservoir (SU-2)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	500	1,000.0	0.50	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**43.82**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.3%)				1.88	
2.2	Benefit for contractor (Direct cost x 7.5%)				3.29	
2.3	Government tax (Direct cost x 7.96%)				3.49	
2.4	Engineering cost for government side (Direct cost x 3%)				1.31	
2.5	Engineering services for consultants (Direct cost x 6%)				2.63	
	Sub total				**12.60**	
3.	Land acquisition					
3.1	Proposed reservoir		17.5 ha	200,000	3.50	
3.2	Access road and others		1.0 ha	500,000	0.50	
	Sub total				**4.00**	
	Total				**60.42 ≈ 60.50**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 11 Preliminary Construction Cost on Ban Kran Pumping Reservoir (SI-1)

(Reservoir scale 200 x 300 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	342,000	45.6	15.60	
1.2	Embankment	m^3	12,900	36.5	0.47	
1.3	Sod facing	m^2	6,800	60.0	0.41	
1.4	Macadam Pv.	m^2	8,600	96.0	0.83	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	500	1,000.0	0.50	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**18.48**	
2.	Overhead					
2.1	Project contingency (Direct cost x 5.0%)				0.92	
2.2	Benefit for contractor (Direct cost x 8.5%)				1.57	
2.3	Government tax (Direct cost x 7.96%)				1.47	
2.4	Engineering cost for government side (Direct cost x 3%)				0.55	
2.5	Engineering services for consultants (Direct cost x 6%)				1.11	
	Sub total				**5.62**	
3.	Land acquisition					
3.1	Proposed reservoir		7.6 ha	200,000	1.52	
3.2	Access road and others		0.5 ha	500,000	0.25	
	Sub total				**1.77**	
	Total				**25.87 ≈ 26.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 12 Preliminary Construction Cost on Ban Khiellek Pumping Reservoir, River Crossing Weir and Mini Hydroelectric Power Station (SI-2)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**44.32**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			3.62	30% of item 2.1 to 2.4
2.2	Excavation	m^3	4,500	72.0	0.32	
2.3	Concrete	m^3	6,000	1,494.0	8.96	
2.4	Foundation treatment	L/S			2.78	30% of item 2.2 to 2.3
2.5	Rubber gate	L/S			23.90	
2.6	Sluice gate	Unit	4		1.12	
2.7	Turbine/Generator	Unit	2		18.20	
2.8	Powerhouse Building	L/S			5.46	30% of item 2.7
	Sub total				**64.36**	
3.	Overhead					
3.1	Project contingency (Direct cost x 3.5%)				3.80	
3.2	Benefit for contractor (Direct cost x 6.5%)				7.06	
3.3	Government tax (Direct cost x 7.96%)				8.65	
3.4	Engineering cost for government side (Direct cost x 3%)				3.26	
3.5	Engineering services for consultants (Direct cost x 6%)				6.52	
	Sub total				**29.29**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total				**142.47 ≈ 142.50**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 13 Preliminary Construction Cost on Ban Rat Samran Pumping Reservoir, River Crossing Weir and Mini Hydroelectric Power Station (UR-1)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2		0.02	
	Sub total				**44.32**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			3.62	
2.2	Excavation	m^3	4,500	72.0	0.32	
2.3	Concrete	m^3	6,000	1,494.0	8.96	
2.4	Foundation treatment	L/S			2.78	
2.5	Rubber gate	L/S			19.30	
2.6	Sluice gate	Unit	4		0.88	
2.7	Turbine/Generator	Unit	2		9.80	
2.8	Powerhouse Building	L/S			2.94	
	Sub total				**48.60**	
3.	Overhead					
3.1	Project contingency (Direct cost x 4.0%)				3.72	
3.2	Benefit for contractor (Direct cost x 7.0%)				6.50	
3.3	Government tax (Direct cost x 7.96%)				7.40	
3.4	Engineering cost for government side (Direct cost x 3%)				2.79	
3.5	Engineering services for consultants (Direct cost x 6%)				5.58	
	Sub total				**25.99**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total			**123.41**	**≈ 123.50**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 14 Preliminary Construction Cost on Ban Kud Kua Noi Pumping Reservoir (UR-2)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**44.32**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.3%)				1.91	
2.2	Benefit for contractor (Direct cost x 7.5%)				3.32	
2.3	Government tax (Direct cost x 7.96%)				3.53	
2.4	Engineering cost for government side (Direct cost x 3%)				1.33	
2.5	Engineering services for consultants (Direct cost x 6%)				2.66	
	Sub total				**12.75**	
3.	Land acquisition					
3.1	Proposed reservoir		17.5 ha	200,000	3.50	
3.2	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total				**61.57 ≈ 61.60**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 15 Preliminary Construction Cost on Ban Nong Bo Baeng Pumping Reservoir, River Crossing Weir and Mini Hydroelectric Power Station (UR-3)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	2,000	1,000.0	2.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**45.32**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			5.00	
2.2	Excavation	m^3	6,200	72.0	0.45	
2.3	Concrete	m^3	8,300	1,494.0	12.40	
2.4	Foundation treatment	L/S			3.86	
2.5	Rubber gate	L/S			30.70	
2.6	Sluice gate	Unit			0.72	
2.7	Turbine/Generator	Unit			29.40	
2.8	Powerhouse Building	L/S			8.82	
	Sub total				**91.35**	
3.	Overhead					
3.1	Project contingency (Direct cost x 3.5%)				4.78	
3.2	Benefit for contractor (Direct cost x 6.5%)				8.88	
3.3	Government tax (Direct cost x 7.96%)				10.88	
3.4	Engineering cost for government side (Direct cost x 3%)				4.10	
3.5	Engineering services for consultants (Direct cost x 6%)				8.20	
	Sub total				**36.84**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total				**178.01 ≈ 178.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 16 Preliminary Construction Cost on Ban Nong Chang Yai Pumping Reservoir, River Crossing Weir and Mini Hydroelectric Power Station (UR-4)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	2,000	1,000.0	2.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**45.32**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			4.70	
2.2	Excavation	m^3	5,800	72.0	0.42	
2.3	Concrete	m^3	7,700	1,494.0	11.50	
2.4	Foundation treatment	L/S			3.60	
2.5	Rubber gate	L/S			27.60	
2.6	Sluice gate	Unit	4		1.00	
2.7	Turbine/Generator	Unit	2		46.20	
2.8	Powerhouse Building	L/S			13.86	
	Sub total				**108.88**	
3.	Overhead					
3.1	Project contingency (Direct cost x 3.5%)				5.40	
3.2	Benefit for contractor (Direct cost x 6.5%)				10.02	
3.3	Government tax (Direct cost x 7.96%)				12.27	
3.4	Engineering cost for government side (Direct cost x 3%)				4.63	
3.5	Engineering services for consultants (Direct cost x 6%)				9.25	
	Sub total				**41.57**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total				**200.27 ≈ 200.30**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 17 Preliminary Construction Cost on Nang Om Kaeo Pumping Reservoir (YT-1)

(Reservoir scale 300 x 300 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	520,000	45.6	23.71	
1.2	Embankment	m^3	18,000	36.5	0.66	
1.3	Sod facing	m^2	14,300	60.0	0.86	
1.4	Macadam Pv.	m^2	7,400	96.0	0.71	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	3,000	1,000.0	3.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**29.61**	
2.	Overhead					
2.1	Project contingency (Direct cost x 5.0%)				1.48	
2.2	Benefit for contractor (Direct cost x 7.5%)				2.22	
2.3	Government tax (Direct cost x 7.96%)				2.36	
2.4	Engineering cost for government side (Direct cost x 3%)				0.89	
2.5	Engineering services for consultants (Direct cost x 6%)				1.78	
	Sub total				**8.73**	
3.	Land acquisition					
3.1	Proposed reservoir		10.9 ha	125,000	1.36	
3.2	Access road and others		3.0 ha	312,500	0.94	
	Sub total				**2.30**	
	Total				**40.64 ≈ 41.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 18 Preliminary Construction Cost on Nong Wai Pumping Reservoir, River Crossing Weir and Mini Hydroelectric Power Station (YT-2)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Unit	2	220,000.0	0.44	
1.8	Sluice gate	Unit	2	10,000.0	0.02	
	Sub total				**44.32**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			3.60	
2.2	Excavation	m^3	4,500	72.0	0.32	
2.3	Concrete	m^3	6,000	1,494.0	8.96	
2.4	Foundation treatment	L/S			2.80	
2.5	Rubber gate	L/S			22.80	
2.6	Sluice gate	Unit	4		0.84	
2.7	Turbine/Generator	Unit	2		65.60	
2.8	Powerhouse Building	L/S			19.68	
	Sub total				**124.60**	
3.	Overhead					
3.1	Project contingency (Direct cost x 3.5%)				5.91	
3.2	Benefit for contractor (Direct cost x 6.5%)				10.98	
3.3	Government tax (Direct cost x 7.96%)				13.45	
3.4	Engineering cost for government side (Direct cost x 3%)				5.07	
3.5	Engineering services for consultants (Direct cost x 6%)				10.14	
	Sub total				**45.55**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		1.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total				**218.97 ≈ 219.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 19 Preliminary Construction Cost on Ban Kut Chum Pumping Reservoir (YT-3)

(Reservoir scale 300 x 300 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	520,000	45.6	23.71	
1.2	Embankment	m^3	18,000	36.5	0.66	
1.3	Sod facing	m^2	14,300	60.0	0.86	
1.4	Macadam Pv.	m^2	7,400	96.0	0.71	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	2,000	1,000.0	2.00	
1.7	Pump	Unit	2	220,000.0	0.44	
1.8	Sluice gate	Unit	2	10,000.0	0.02	
	Sub total				**28.61**	
2.	Overhead					
2.1	Project contingency (Direct cost x 5.0%)				1.43	
2.2	Benefit for contractor (Direct cost x 7.5%)				2.15	
2.3	Government tax (Direct cost x 7.96%)				2.28	
2.4	Engineering cost for government side (Direct cost x 3%)				0.86	
2.5	Engineering services for consultants (Direct cost x 6%)				1.72	
	Sub total				**8.44**	
3.	Land acquisition					
3.1	Proposed reservoir		10.9 ha	125,000	1.36	
3.2	Access road and others		2.0 ha	312,500	0.63	
	Sub total				**1.99**	
	Total				**39.04 ≈ 39.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 20 Preliminary Construction Cost on Wat Na Chan Pumping Reservoir (MK-1)

(Reservoir scale 300 x 300 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	520,000	45.6	23.71	
1.2	Embankment	m^3	18,000	36.5	0.66	
1.3	Sod facing	m^2	14,300	60.0	0.86	
1.4	Macadam Pv.	m^2	7,400	96.0	0.71	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Unit	2	220,000.0	0.44	
1.8	Sluice gate	Unit	2	10,000.0	0.02	
	Sub total				**27.61**	
2.	Overhead					
2.1	Project contingency (Direct cost x 5.0%)				1.38	
2.2	Benefit for contractor (Direct cost x 7.5%)				2.07	
2.3	Government tax (Direct cost x 7.96%)				2.20	
2.4	Engineering cost for government side (Direct cost x 3%)				0.83	
2.5	Engineering services for consultants (Direct cost x 6%)				1.66	
	Sub total				**8.14**	
3.	Land acquisition					
3.1	Proposed reservoir		10.9 ha	200,000	2.18	
3.2	Access road and others		1.0 ha	500,000	0.50	
	Sub total				**2.68**	
	Total			**38.43**	**≈ 38.50**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 21 Preliminary Construction Cost on Ban Na Tabaeng Pumping Reservoir, River Crossing Weir and Mini Hydroelectric Power Station (MK-2)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Unit	2	220,000.0	0.44	
1.8	Sluice gate	Unit	2	10,000.0	0.02	
	Sub total				**44.32**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			3.10	
2.2	Excavation	m^3	3,800	72.0	0.27	
2.3	Concrete	m^3	5,200	1,494.0	7.77	
2.4	Foundation treatment	L/S			2.40	
2.5	Rubber gate	L/S			12.90	
2.6	Sluice gate	Unit	4		0.48	
2.7	Turbine/Generator	Unit	2		4.40	
2.8	Powerhouse Building	L/S			1.32	
	Sub total				**32.64**	
3.	Overhead					
3.1	Project contingency (Direct cost x 4.0%)				3.08	
3.2	Benefit for contractor (Direct cost x 7.0%)				5.39	
3.3	Government tax (Direct cost x 7.96%)				6.13	
3.4	Engineering cost for government side (Direct cost x 3%)				2.31	
3.5	Engineering services for consultants (Direct cost x 6%)				4.62	
	Sub total				**21.53**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		1.0 ha	500,000	0.50	
	Sub total				**4.00**	
	Total				**102.49 ≈ 102.50**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 22 Preliminary Construction Cost on Ban Na Po Noi Pumping Reservoir, River Crossing Weir and Mini Hydroelectric Power Station (MK-3)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	500	1,000.0	0.50	
1.7	Pump	Unit	2	220,000.0	0.44	
1.8	Sluice gate	Unit	2	10,000.0	0.02	
	Sub total				**43.82**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			4.30	
2.2	Excavation	m^3	5,300	72.0	0.38	
2.3	Concrete	m^3	7,100	1,494.0	10.60	
2.4	Foundation treatment	L/S			3.30	
2.5	Rubber gate	L/S			20.70	
2.6	Sluice gate	Unit	4		0.60	
2.7	Turbine/Generator	Unit	2		25.60	
2.8	Powerhouse Building	L/S			7.68	
	Sub total				**73.16**	
3.	Overhead					
3.1	Project contingency (Direct cost x 3.5%)				4.09	
3.2	Benefit for contractor (Direct cost x 6.5%)				7.60	
3.3	Government tax (Direct cost x 7.96%)				9.31	
3.4	Engineering cost for government side (Direct cost x 3%)				3.51	
3.5	Engineering services for consultants (Direct cost x 6%)				7.02	
	Sub total				**31.53**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		0.5 ha	500,000	0.25	
	Sub total				**3.75**	
	Total				**152.26 ≈ 152.30**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 23 Preliminary Construction Cost on Ban Tak Caet Pumping Reservoir (NN-1)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2		0.02	
	Sub total				**44.32**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.3%)				1.91	
2.2	Benefit for contractor (Direct cost x 7.5%)				3.32	
2.3	Government tax (Direct cost x 7.96%)				3.53	
2.4	Engineering cost for government side (Direct cost x 3%)				1.33	
2.5	Engineering services for consultants (Direct cost x 6%)				2.66	
	Sub total				**12.75**	
3.	Land acquisition					
3.1	Proposed reservoir		17.5 ha	200,000	3.50	
3.2	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total				**61.57 ≈ 61.60**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 24 Preliminary Construction Cost on Ban Kut Rang Nai Pumping Reservoir and Mini Hydroelectric Power Station (NN-2)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	2,000	1,000.0	2.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**45.32**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			2.72	
2.2	Excavation	m^3	3,400	72.0	0.24	
2.3	Concrete	m^3	4,500	1,494.0	6.72	
2.4	Foundation treatment	L/S			2.10	
2.5	Rubber gate	L/S			17.90	
2.6	Sluice gate	Unit	4	0.23	0.92	
2.7	Turbine/Generator	Unit	2		35.60	
2.8	Powerhouse Building	L/S			10.68	
	Sub total				**76.88**	
3.	Overhead					
3.1	Project contingency (Direct cost x 3.5%)				4.28	
3.2	Benefit for contractor (Direct cost x 6.5%)				7.94	
3.3	Government tax (Direct cost x 7.96%)				9.73	
3.4	Engineering cost for government side (Direct cost x 3%)				3.67	
3.5	Engineering services for consultants (Direct cost x 6%)				7.33	
	Sub total				**32.95**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total				**159.65 ≈ 160.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 25 Preliminary Construction Cost on Ban Don Wai Pumping Reservoir and Mini Hydroelectric Power Station (PB-1)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	2,000	1,000.0	2.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**45.32**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			5.91	
2.2	Excavation	m^3	7,200	72.0	0.52	
2.3	Concrete	m^3	9,800	1,494.0	14.64	
2.4	Foundation treatment	L/S			4.55	
2.5	Rubber gate	L/S			30.70	
2.6	Sluice gate	Unit	4	0.21	0.84	
2.7	Turbine/Generator	Unit	2		60.60	
2.8	Powerhouse Building	L/S			18.18	
	Sub total				**135.94**	
3.	Overhead					
3.1	Project contingency (Direct cost x 3.5%)				6.34	
3.2	Benefit for contractor (Direct cost x 6.5%)				11.78	
3.3	Government tax (Direct cost x 7.96%)				14.43	
3.4	Engineering cost for government side (Direct cost x 3%)				5.44	
3.5	Engineering services for consultants (Direct cost x 6%)				10.88	
	Sub total				**48.87**	
4.	Land acquisition					
4.1	Proposed reservoir		17.5 ha	200,000	3.50	
4.2	Access road and others		2.0 ha	500,000	1.00	
	Sub total				**4.50**	
	Total				**234.63 ≈ 234.7**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 26 Preliminary Construction Cost on Ban Khao Chakan Pumping Reservoir and Mini Hydroelectric Power Station (PB-2)

(Reservoir scale 300 x 300 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	520,000	45.6	23.71	
1.2	Embankment	m^3	18,000	36.5	0.66	
1.3	Sod facing	m^2	14,300	60.0	0.86	
1.4	Macadam Pv.	m^2	7,400	96.0	0.71	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	500	1,000.0	0.50	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**27.11**	
2.	Direct cost of river crossing weir and mini hydroelectric power station					
2.1	Diversion works	L/S			3.62	
2.2	Excavation	m^3	4,500	72.0	0.32	
2.3	Concrete	m^3	6,000	1,494.0	8.96	
2.4	Foundation treatment	L/S			2.78	
2.5	Rubber gate	L/S			26.40	
2.6	Sluice gate	Unit	4	0.19	0.76	
2.7	Turbine/Generator	Unit			25.60	
2.8	Powerhouse Building	L/S			7.68	
	Sub total				**76.12**	
3.	Overhead					
3.1	Project contingency (Direct cost x 3.5%)				3.61	
3.2	Benefit for contractor (Direct cost x 6.5%)				6.71	
3.3	Government tax (Direct cost x 7.96%)				8.22	
3.4	Engineering cost for government side (Direct cost x 3%)				3.10	
3.5	Engineering services for consultants (Direct cost x 6%)				6.19	
	Sub total				**27.83**	
4.	Land acquisition					
4.1	Proposed reservoir		10.9 ha	200,000	2.18	
4.2	Access road and others		1.0 ha	500,000	0.50	
	Sub total				**2.68**	
	Total				**133.74 ≈ 134.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 27 Preliminary Construction Cost on Ban Khlong Yai Pumping Reservoir (PB-3)

(Reservoir scale 300 x 300 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	520,000	45.6	23.71	
1.2	Embankment	m^3	18,000	36.5	0.66	
1.3	Sod facing	m^2	14,300	60.0	0.86	
1.4	Macadam Pv.	m^2	7,400	96.0	0.71	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	500	1,000.0	0.50	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**27.11**	
2.	Overhead					
2.1	Project contingency (Direct cost x 5.0%)				1.36	
2.2	Benefit for contractor (Direct cost x 7.5%)				2.03	
2.3	Government tax (Direct cost x 7.96%)				2.16	
2.4	Engineering cost for government side (Direct cost x 3%)				0.81	
2.5	Engineering services for consultants (Direct cost x 6%)				1.63	
	Sub total				**7.99**	
3.	Land acquisition					
3.1	Proposed reservoir		10.9 ha	200,000	2.18	
3.2	Access road and others		1.0 ha	500,000	0.50	
	Sub total				**2.68**	
	Total				**37.78 ≈ 38.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 28 Preliminary Construction Cost on Aranyaprathet Pumping Reservoir (PB-4)

(Reservoir scale 100 x 100 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	54,000	45.6	2.46	
1.2	Embankment	m^3	5,300	36.5	0.19	
1.3	Sod facing	m^2	3,900	60.0	0.23	
1.4	Macadam Pv.	m^2	2,200	96.0	0.21	
1.5	Intake conduit	L/S				
1.6	Access road	m	500	1,000.0	0.50	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**4.05**	
2.	Overhead					
2.1	Project contingency (Direct cost x 6.0%)				0.24	
2.2	Benefit for contractor (Direct cost x 9.5%)				0.38	
2.3	Government tax (Direct cost x 7.96%)				0.32	
2.4	Engineering cost for government side (Direct cost x 3%)				0.12	
2.5	Engineering services for consultants (Direct cost x 6%)				0.24	
	Sub total				**1.30**	
3.	Land acquisition					
3.1	Proposed reservoir		1.5 ha	200,000	0.30	
3.2	Access road and others		0.5 ha	500,000	0.25	
	Sub total				**0.55**	
	Total				**5.9 ≈ 6.0**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 29 Preliminary Construction Cost on Ban Non Mak Mun Pumping Reservoir (PB-5)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S			0.21	
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
	Sub total				**44.32**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.3%)				1.88	
2.2	Benefit for contractor (Direct cost x 7.5%)				3.29	
2.3	Government tax (Direct cost x 7.96%)				3.49	
2.4	Engineering cost for government side (Direct cost x 3%)				1.31	
2.5	Engineering services for consultants (Direct cost x 6%)				2.63	
	Sub total				**12.60**	
3.	Land acquisition					
3.1	Proposed reservoir		17.5 ha	200,000	3.50	
3.2	Access road and others		1.0 ha	500,000	0.50	
	Sub total				**4.00**	
	Total				**60.92 ≈ 61.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 30 Preliminary Construction Cost on Ban Kok Thahan Pumping Reservoir (PB-6)

(Reservoir scale 300 x 500 x 6 m)

Work Items		Unit	Quantity	Unit Prices (Baht)	Cost (x 10^6 Baht)	Remarks
1.	Direct cost of pumping reservoir					
1.1	Excavation	m^3	870,000	45.6	39.67	
1.2	Embankment	m^3	24,000	36.5	0.88	
1.3	Sod facing	m^2	19,000	60.0	1.14	
1.4	Macadam Pv.	m^2	10,000	96.0	0.96	
1.5	Intake conduit	L/S				
1.6	Access road	m	1,000	1,000.0	1.00	
1.7	Pump	Set	2	220,000.0	0.44	
1.8	Sluice gate	Set	2	10,000.0	0.02	
1.9	Improvement of existing box culvert	L/S			0.10	
	Sub total				**44.21**	
2.	Overhead					
2.1	Project contingency (Direct cost x 4.3%)				1.91	
2.2	Benefit for contractor (Direct cost x 7.5%)				3.33	
2.3	Government tax (Direct cost x 7.96%)				3.54	
2.4	Engineering cost for government side (Direct cost x 3%)				1.33	
2.5	Engineering services for consultants (Direct cost x 6%)				2.67	
	Sub total				**12.78**	
3.	Land acquisition					
3.1	Proposed reservoir		17.5 ha	200,000	3.50	
3.2	Access road and others		1.0 ha	500,000	0.50	
	Sub total				**4.00**	
	Total				**60.99 ≈ 61.00**	

Remarks: Overhead percentage is R.I.D.'s information.

Table 31 Summary of 30 Small Pumping Reservoirs

No.	Scheme	Effective storage (1,000 m^3)	Construction Costs (million baht)	Unit const. cost (Baht/m^3)	Mini-hydro capacity (kW)	Recreation potential
NR-1	Chok Chai	600	59	98.3		high
2	Ban Dan Kata	360	38	105.6		medium
3	Tha Chang	2,090	35	16.7		high
4	Ban Krathin	1,020	99	97.1		high
5	Ban Dan Yao Yai	600	60	100.0		medium
BU-1	Ban Khok Yang	73	11	150.7		low
2	Huai Chorkhe Mak	13,500 *	150	11.1		high
3	Ban Yang	360	37	102.8		low
SU-1	Ban Sawan Phattana	850	71	83.5		medium
2	Ban Sawai	600	60.5	100.8		medium
SI-1	Ban Kran	234	26	111.1		low
2	Ban Khilek	600	142.5	237.5	550	medium
UR-1	Ban Rat Samran	600	123.5	205.8	270	medium
2	Ban Kud Kua Noi	600	61.6	102.7		medium
3	Ban Nong Bo Baeng	600	178	296.7	1,000	medium
4	Ban Nong Chang Yai	600	200.3	333.8	1,700	medium
YT-1	Nong Om Kaeo	360	41	113.9		medium
2	Nong Wai	600	219	365.0	2,550	medium
3	Ban Kut Chum	360	39	108.3		low
MK-1	Wat Na Chan	360	38.5	106.9		medium
2	Ban Na Tabaeng	600	102.5	170.8	100	medium
3	Ban Na Po Noi	600	152.3	253.8	840	high
NN-1	Ban Tak Caet	600	61.6	102.7		medium
2	Ban Kut Rang Nai	600	160	266.7	1,200	high
PB-1	Ban Don Wai	600	234.7	391.2	2,300	low
2	Ban Khao Chakan	360	134	372.2	850	low
3	Ban Khlong Yai	360	38	105.6		low
4	Aranyaprathet	40	6	150		low
5	Ban Non Mek Mun	600	60.5	100.8		medium
6	Ban Khok Thahan	600	61	101.7		low
		29,927	27,000	90.3	11,360	

* Additional storage capacity

Table 32 Cash Flow for 30 Small Pumping Resevoirs and IRR Calculation

Year	Construction Cost (10^6 Bahts)	O & M Costs	Total Revenue	Net Cash Flow
1	1,000.0			-1,000.0
2	1,000.0	0.5	136.2	-864.3
3	1,000.0	1.0	272.3	-728.7
4		1.5	408.5	407.0
5		1.5	408.5	407.0
6		1.5	408.5	407.0
7		1.5	408.5	407.0
8		1.5	408.5	407.0
9		1.5	408.5	407.0
10		1.5	408.5	407.0
11		1.5	408.5	407.0
12		1.5	408.5	407.0
13		1.5	408.5	407.0
14		1.5	408.5	407.0
15		1.5	408.5	407.0
16		1.5	408.5	407.0
17		1.5	408.5	407.0
18		1.5	408.5	407.0
19		1.5	408.5	407.0
20		1.5	408.5	407.0
IRR				11.73%

Table 33 Cash Flow for the Chock Chai and the Nang Wa Schemes

(a) Chok Chai

Year	Construction Costs	O&M Costs	Total Revenue	Net Cash Flow
1	66,000			-66,000
2		50	7,875	7,825
3		50	7,875	7,825
4		50	7,875	7,825
5		50	7,875	7,825
6		50	7,875	7,825
7		50	7,875	7,825
8		50	7,875	7,825
9		50	7,875	7,825
10		50	7,875	7,825
11		50	7,875	7,825
12		50	7,875	7,825
13		50	7,875	7,825
14		50	7,875	7,825
15		50	7,875	7,825
16		50	7,875	7,825
17		50	7,875	7,825
18		50	7,875	7,825
19		50	7,875	7,825
20		50	7,875	7,825
IRR				9.88%

(b) Nang Wa

Year	Construction Costs	O&M Costs	Total Revenue	Net Cash Flow
1	226,000			-226,000
2		50	22,475	22,425
3		50	22,475	22,425
4		50	22,475	22,425
5		50	22,475	22,425
6		50	22,475	22,425
7		50	22,475	22,425
8		50	22,475	22,425
9		50	22,475	22,425
10		50	22,475	22,425
11		50	22,475	22,425
12		50	22,475	22,425
13		50	22,475	22,425
14		50	22,475	22,425
15		50	22,475	22,425
16		50	22,475	22,425
17		50	22,475	22,425
18		50	22,475	22,425
19		50	22,475	22,425
20		50	22,475	22,425
IRR				7.34%

Figures

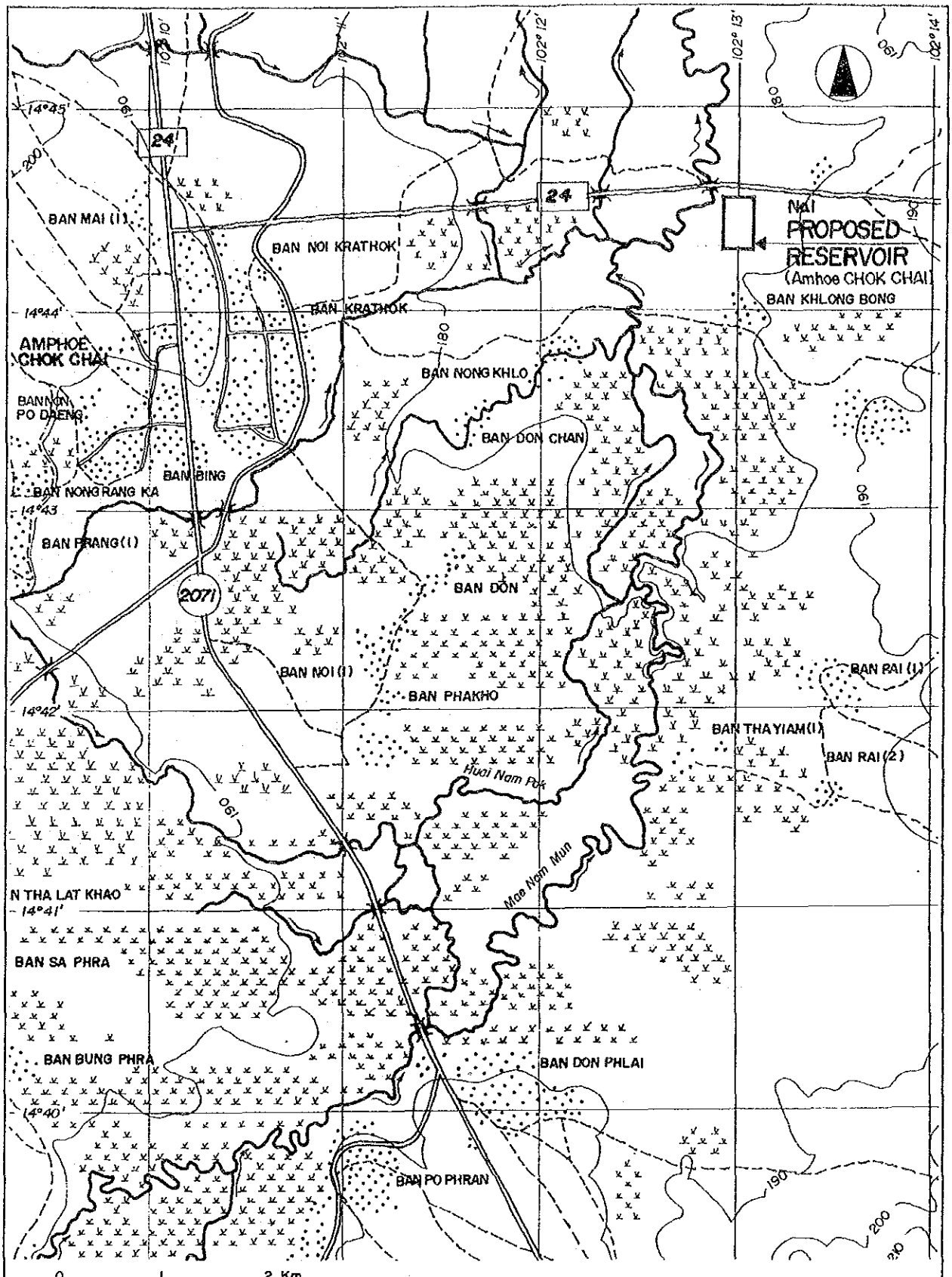
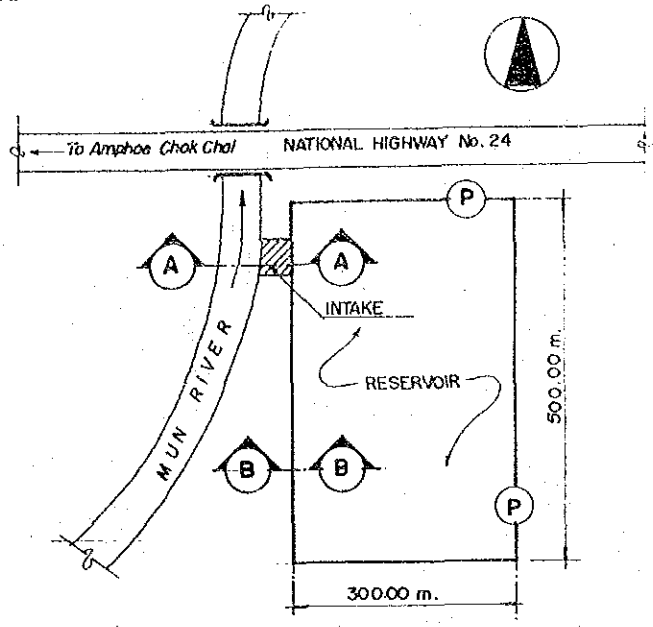
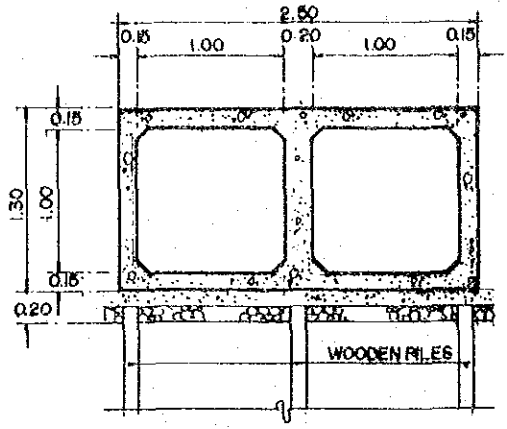


Figure 1 LOCATION OF PROPOSED CHOK CHAI PUMPING RESERVIOR (NR-1)

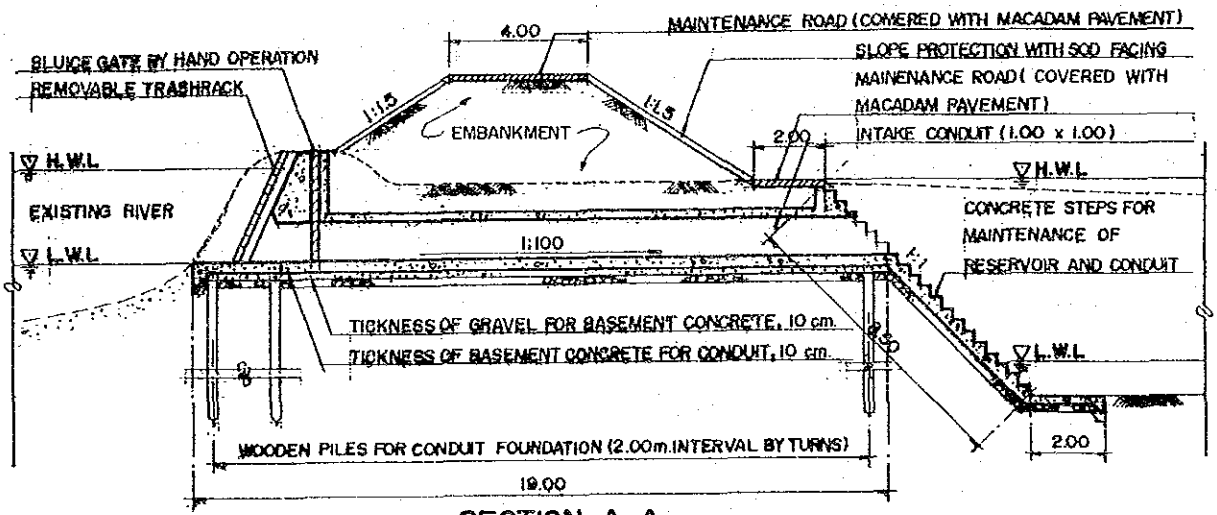
The Study on the Regional Development Plan
for the Lower Northeast and the Upper East Regions
in the Kingdom of Thailand



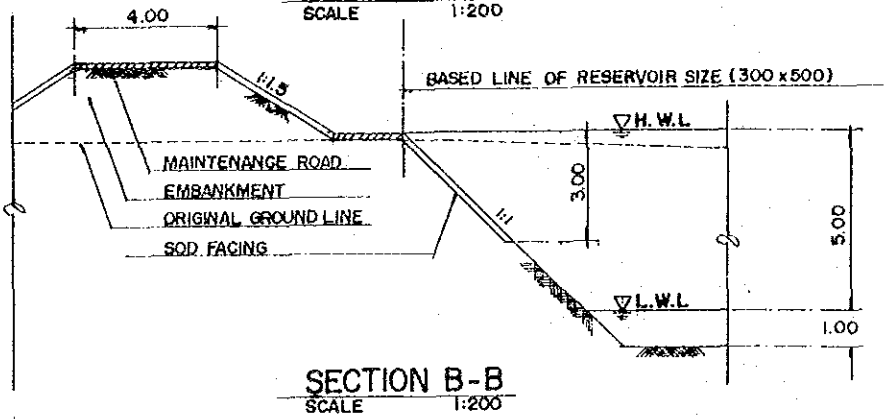
SKETCH OF RESERVOIR LOCATION
NON SCALE



SECTION OF CONDUIT
SCALE 1:50



SECTION A-A
SCALE 1:200



SECTION B-B
SCALE 1:200

Figure 2 PRELIMINARY DESIGN OF RESERVOIR AND INTAKE ON PROPOSED CHOK CHAI PUMPING RESERVOIR

The Study on the Regional Development Plan for the Lower Northeast and the Upper East Regions in the Kingdom of Thailand

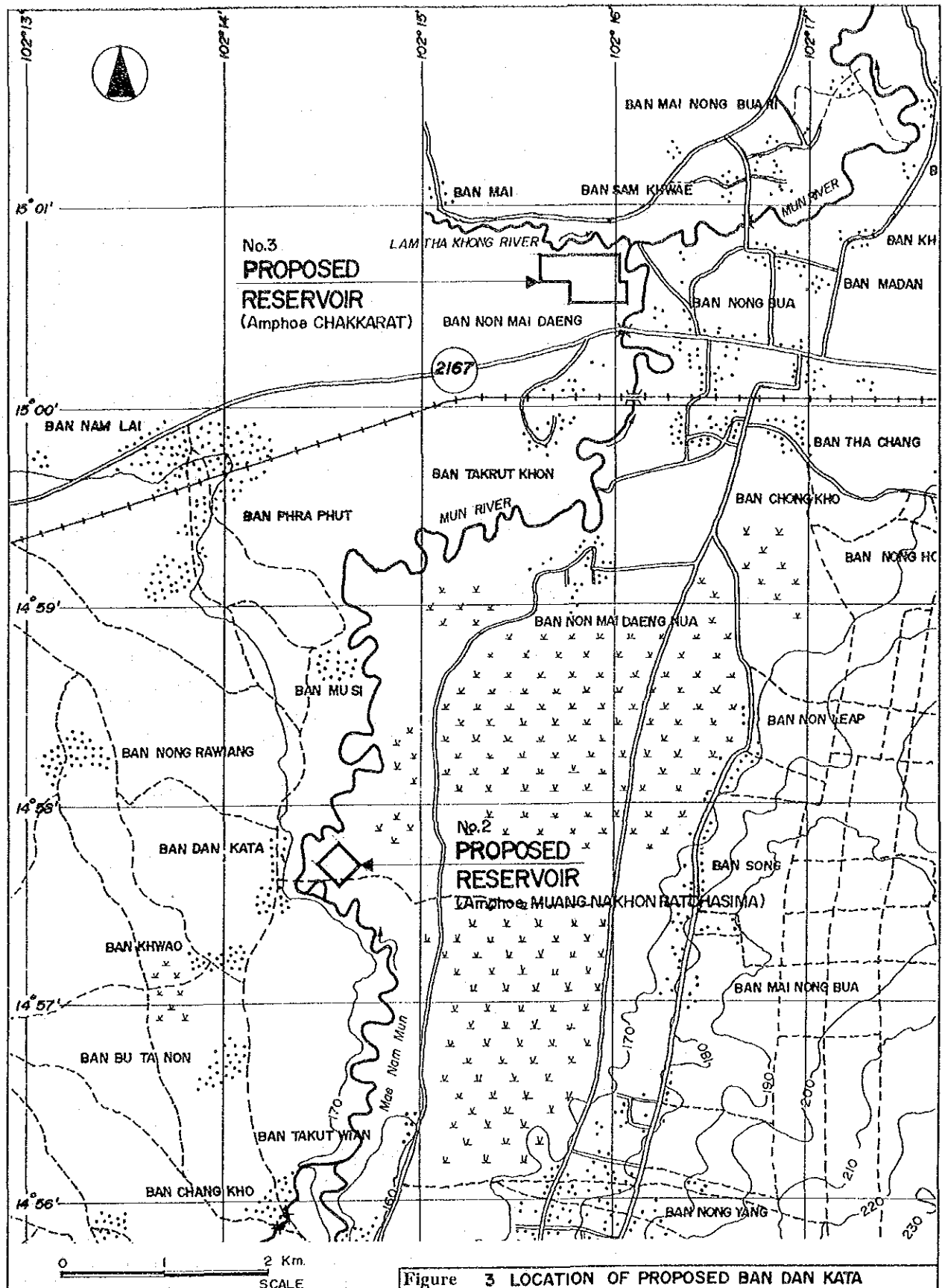
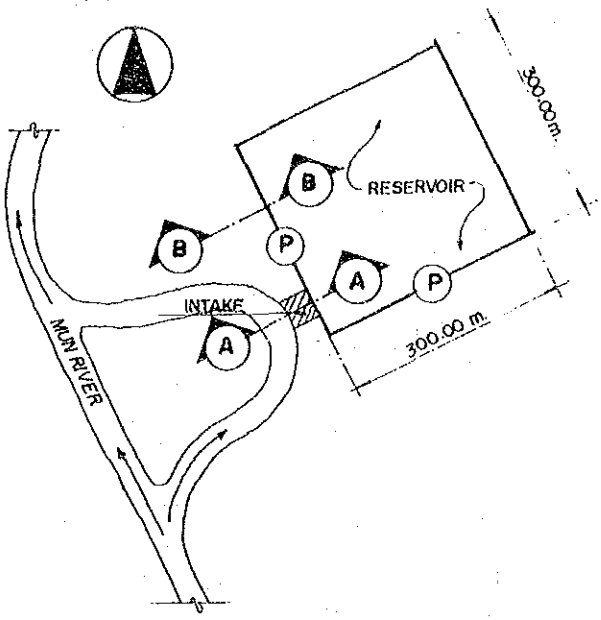
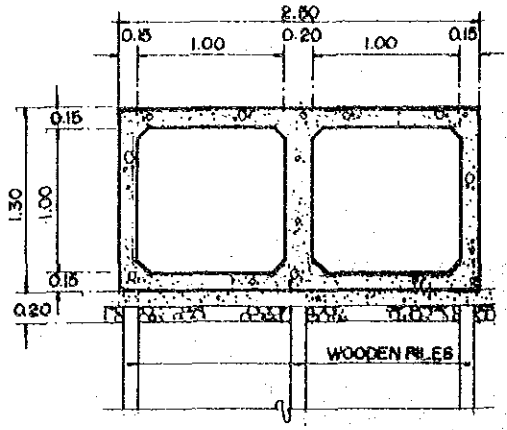


Figure 3 LOCATION OF PROPOSED BAN DAN KATA AND THA CHANG PUMPING RESERVOIR (NR-2 & NR-3)

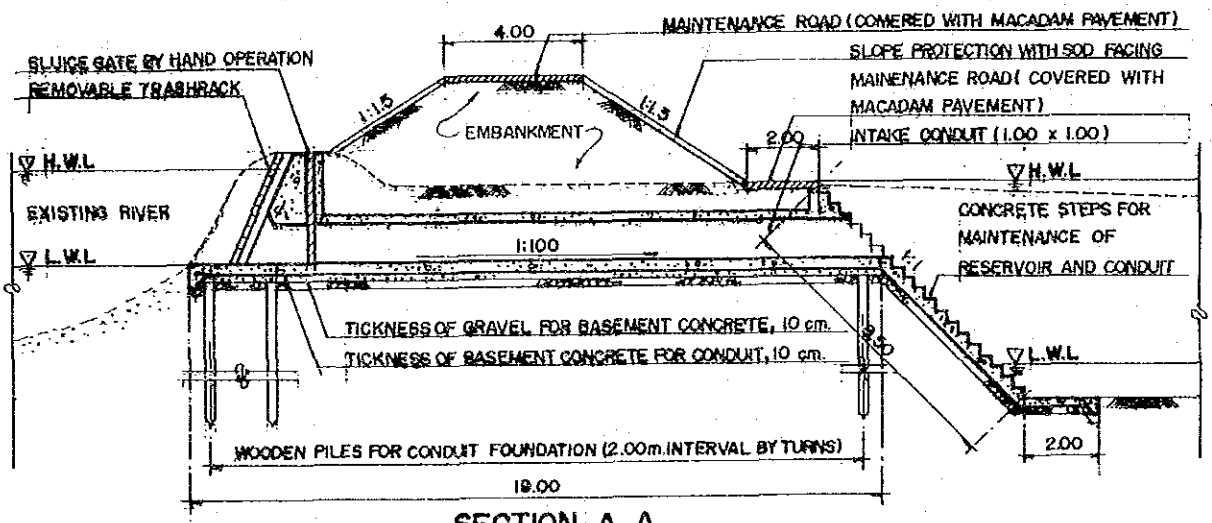
The Study on the Regional Development Plan for the Lower Northeast and the Upper East Regions in the Kingdom of Thailand



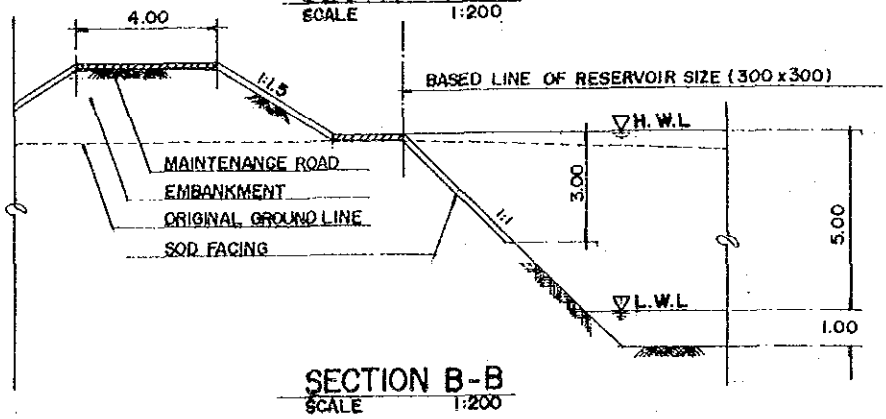
SKETCH OF RESERVOIR LOCATION
NON SCALE



SECTION OF CONDUIT
SCALE 1:50



SECTION A-A
SCALE 1:200



SECTION B-B
SCALE 1:200

Figure 4 PRELIMINARY DESIGN OF RESEVOIR AND INTAKE ON PROPOSED BAN DAN KATA PUMPING RESERVOIR

The Study on the Regional Development Plan for the Lower Northeast and the Upper East Regions in the Kingdom of Thailand

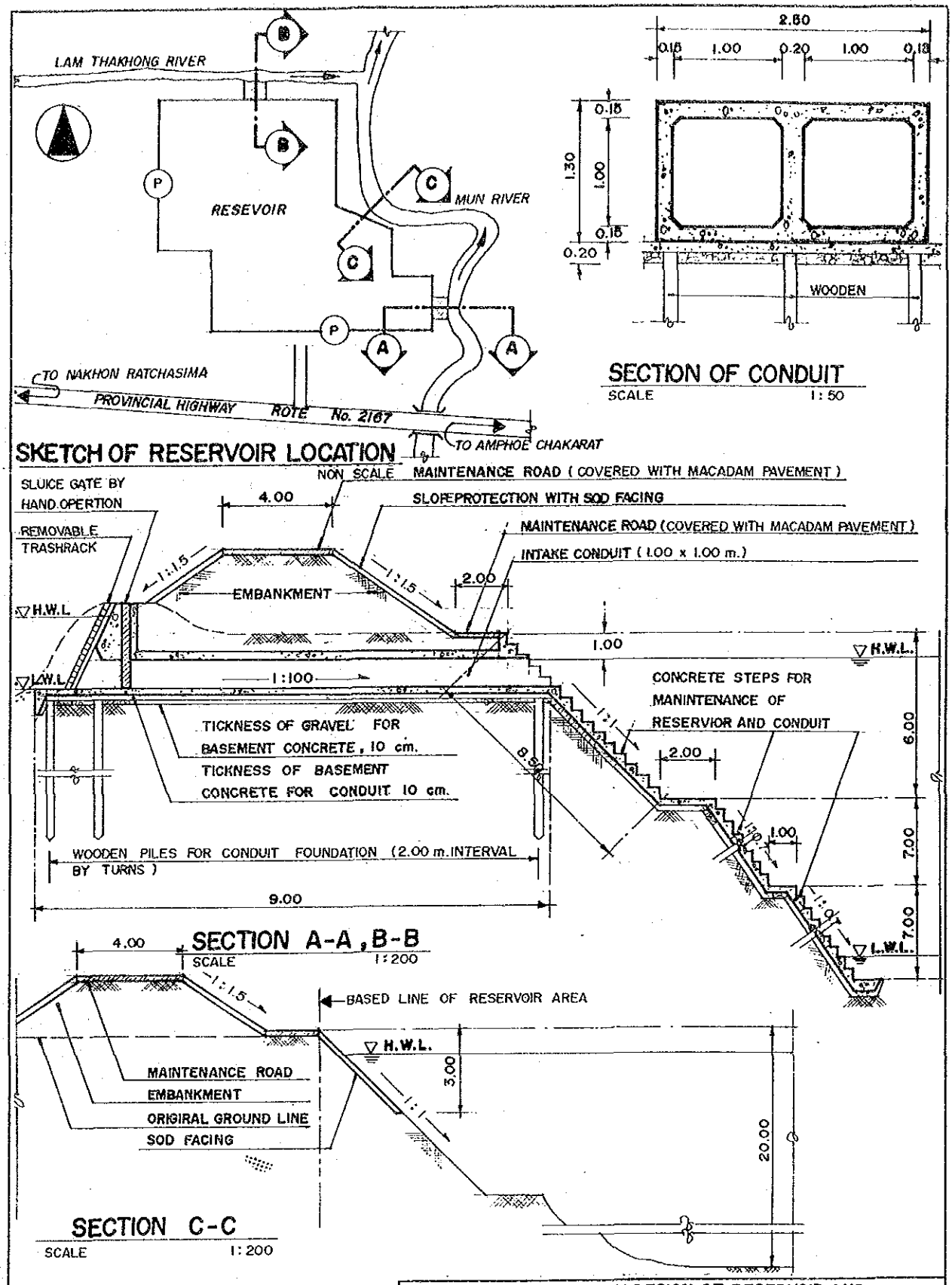


Figure 5 PRELIMINARY DESIGN OF RESERVOIR AND INTAKES OF PROPOSED THA CHANG PUMPING RESERVOIR

The Study on the Regional Development Plan for the Lower Northeast and the Upper East Regions in the Kingdom of Thailand

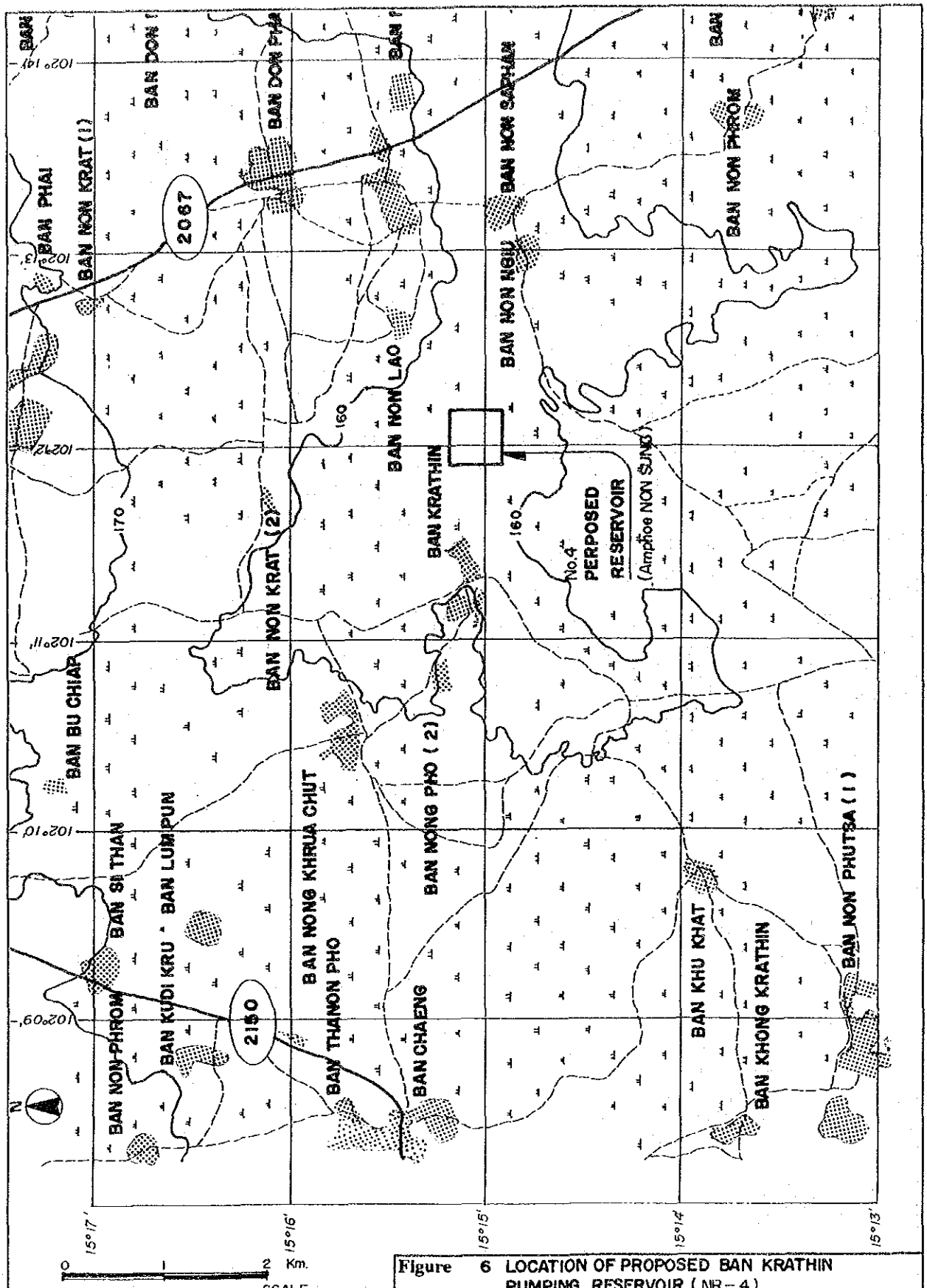
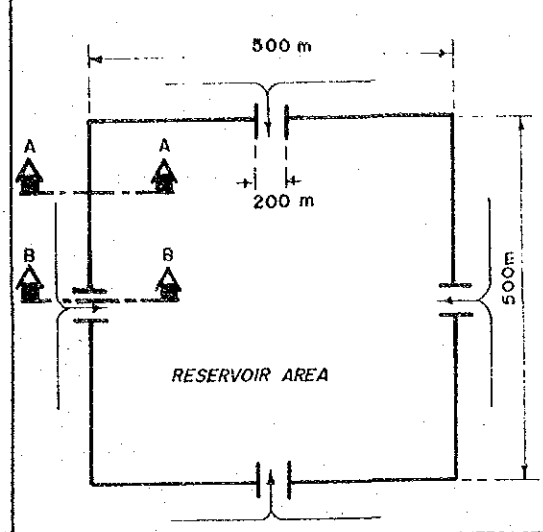
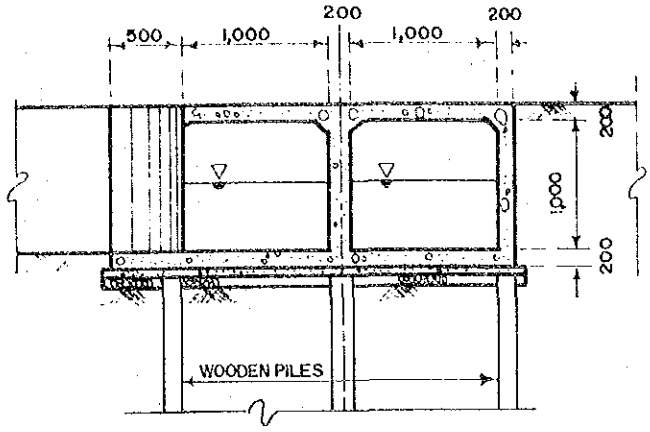


Figure 6 LOCATION OF PROPOSED BAN KRATHIN PUMPING RESERVOIR (NR – 4)

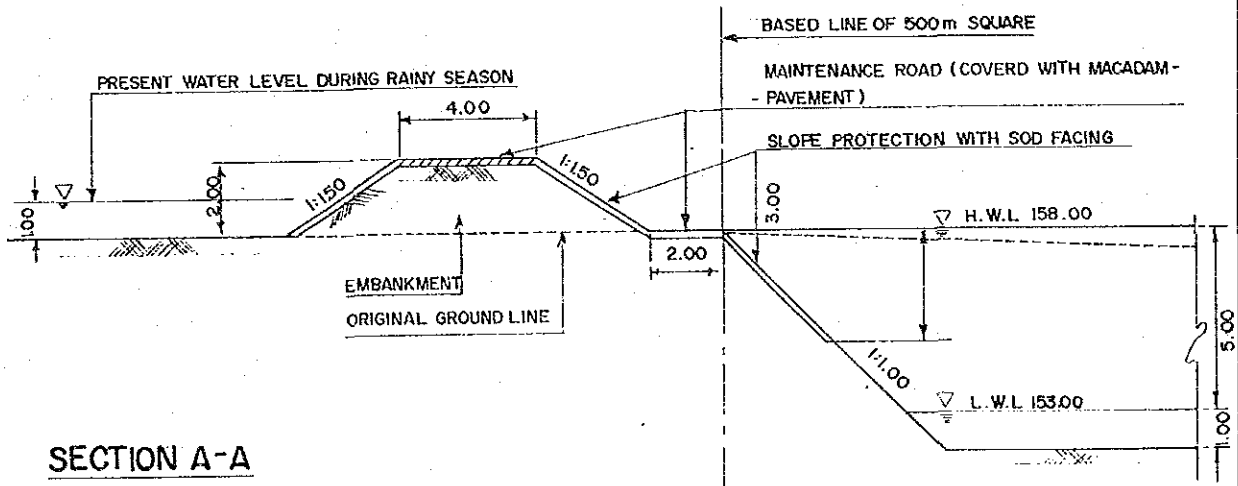
The Study on the Regional Development Plan
for the Lower Northeast and the Upper East Regions
in the Kingdom of Thailand



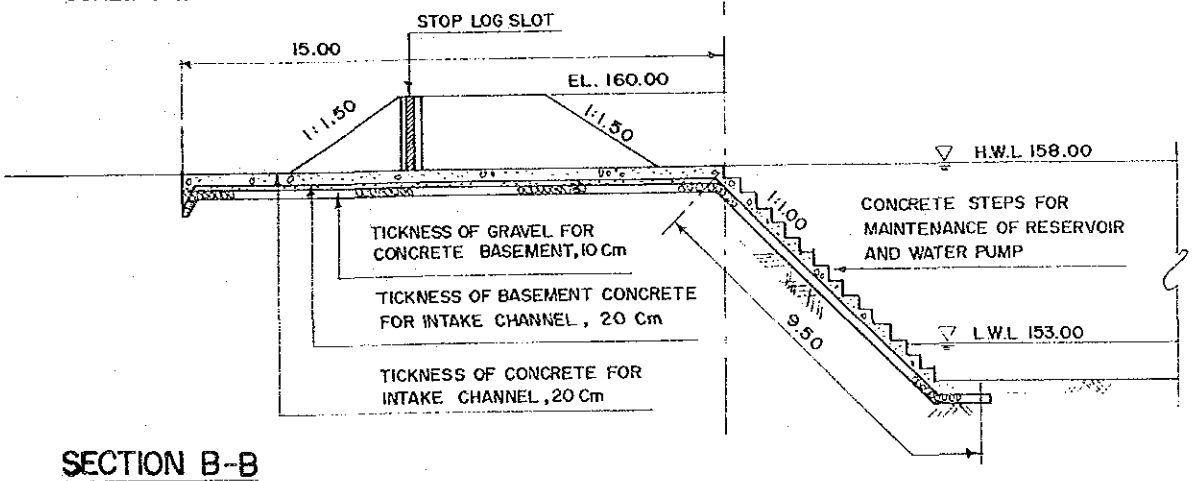
PLAN OF RESERVOIR AND INTAKE
(SCALE 1:10,000)



SECTION OF INTAKE CHANNEL
(SCALE 1 : 50)



SECTION A-A
SCALE 1:200



SECTION B-B
SCALE 1:200

Figure 7 PRELIMINARY DESIGN OF RESERVOIR AND INTAKES ON PROPOSED BAN KRATHIN PUMPING RESERVOIR

The Study on the Regional Development Plan
for the Lower Northeast and the Upper East Regions
in the Kingdom of Thailand

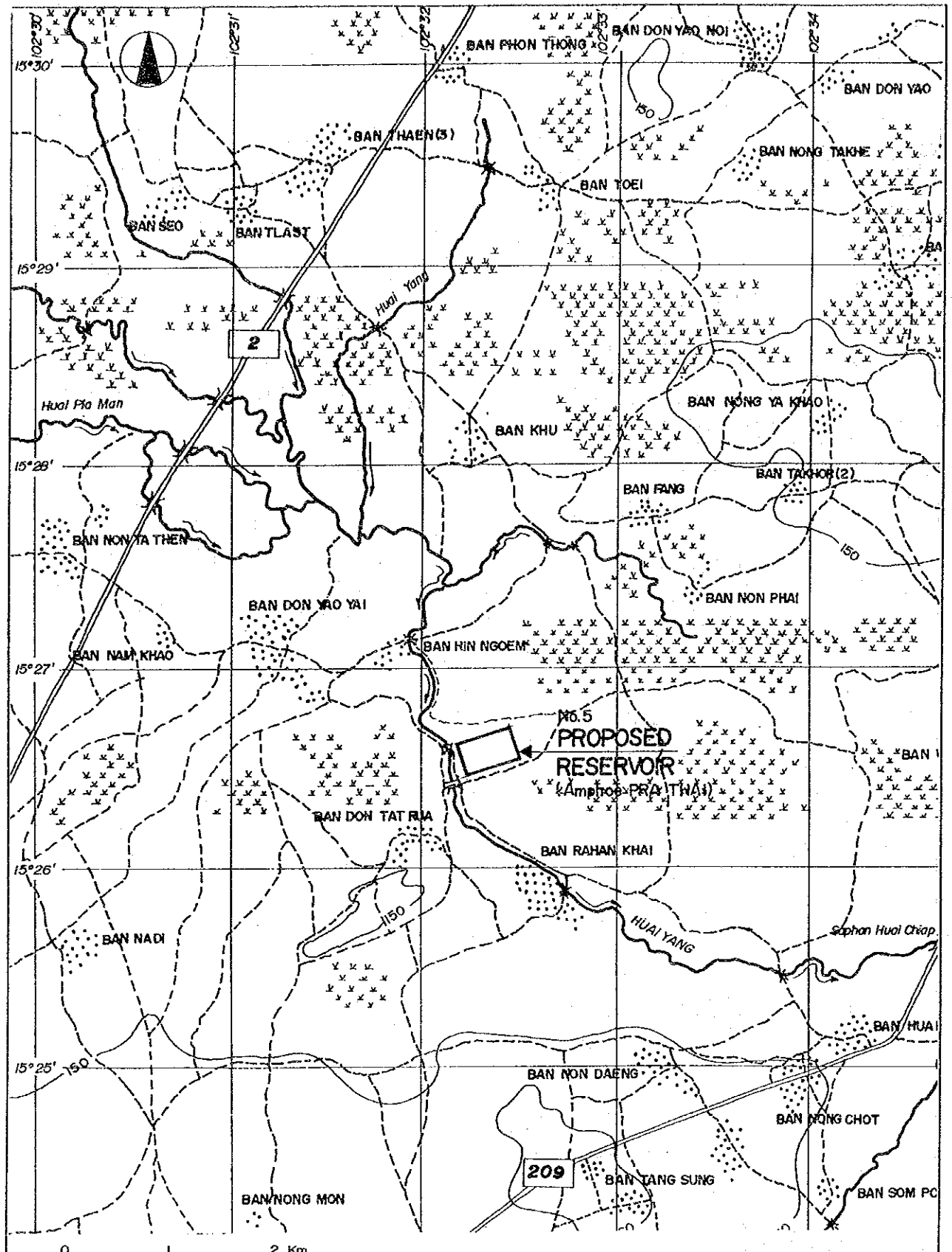


Figure 8 LOCATION OF PROPOSED BAN DON YAO YAI PUMPING RESERVOIR (NR - 5)

The Study on the Regional Development Plan
for the Lower Northeast and the Upper East Regions
in the Kingdom of Thailand

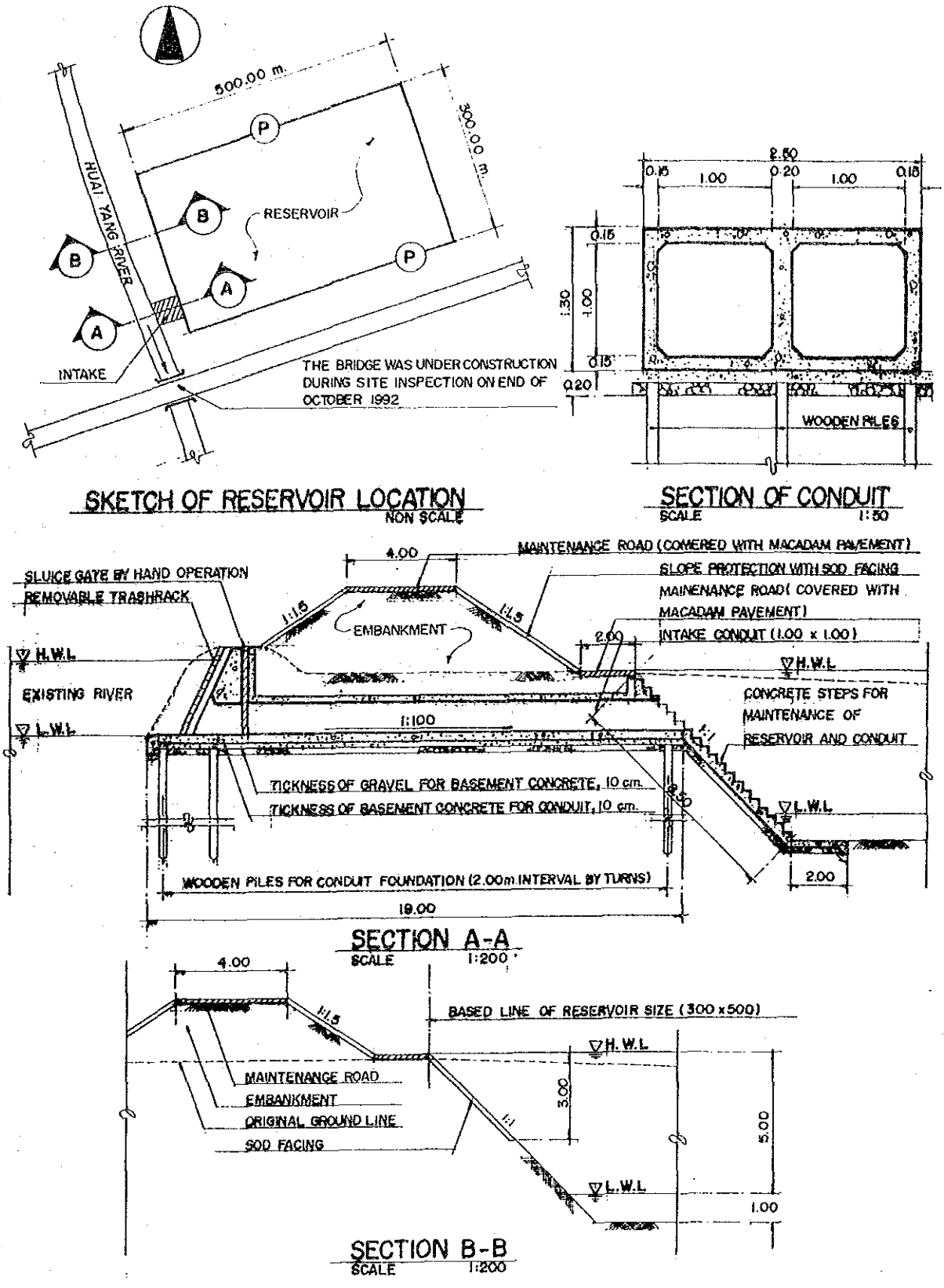


Figure 9 PRELIMINARY DESIGN OF RESERVOIR AND INTAKESON PROPOSED BAN DON YAO YAI PUMPING RESERVOIR

The Study on the Regional Development Plan
for the Lower Northeast and the Upper East Regions
in the Kingdom of Thailand

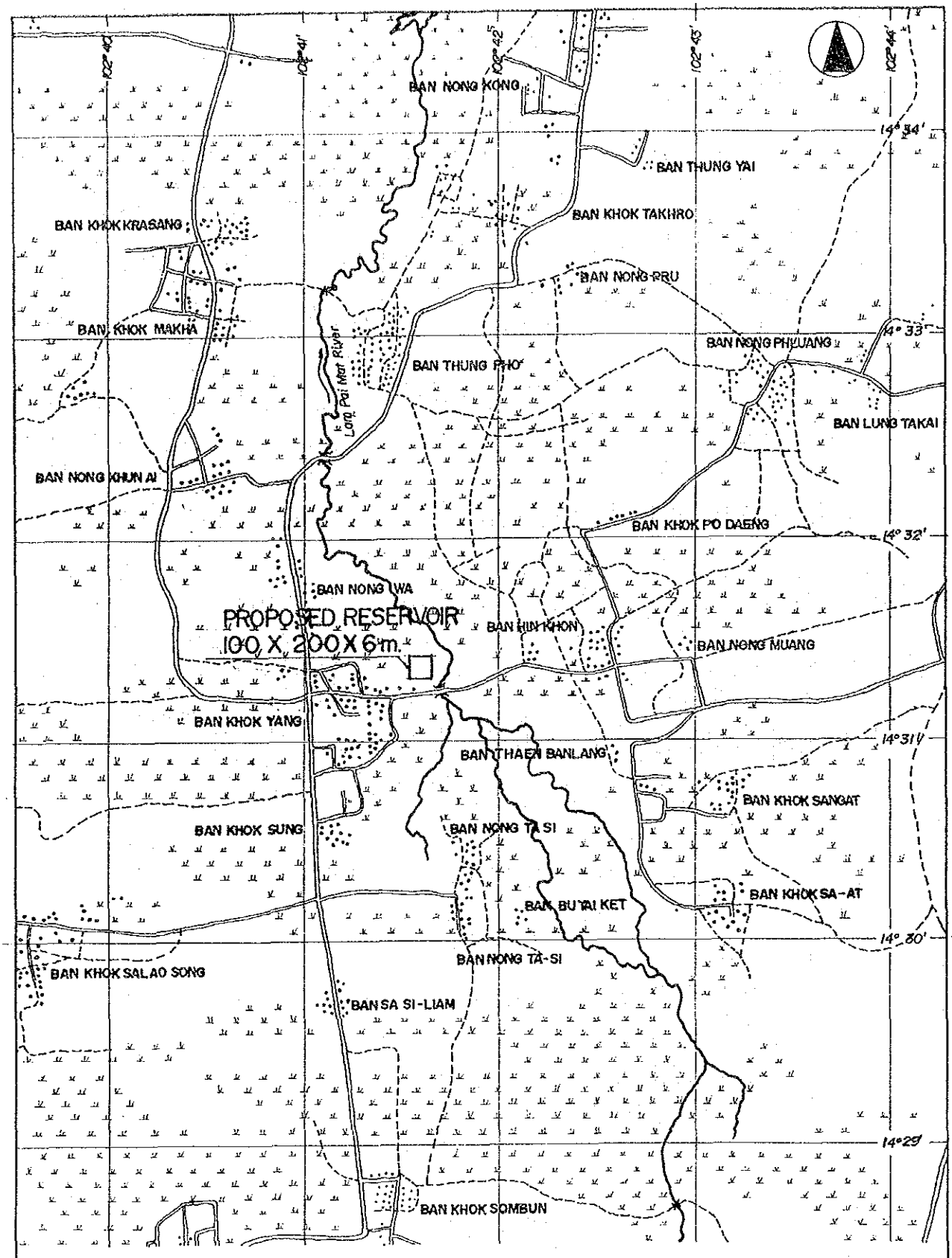


Figure 10 LOCATION OF PROPOSED BAN KHOK YANG PUMPING RESERVOIR (BU-1)

The Study on the Regional Development Plan
for the Lower Northeast and the Upper East Regions
in the Kingdom of Thailand

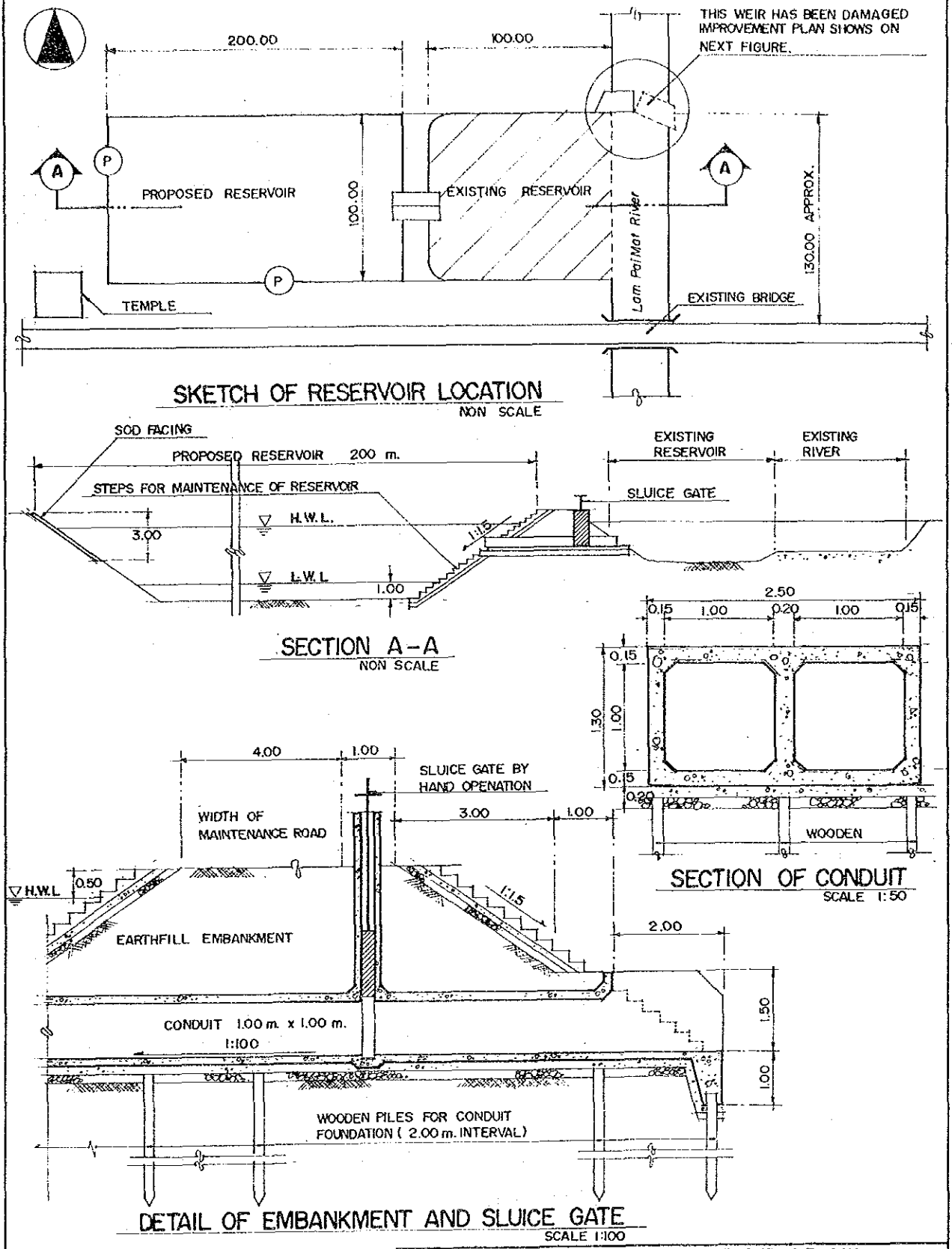
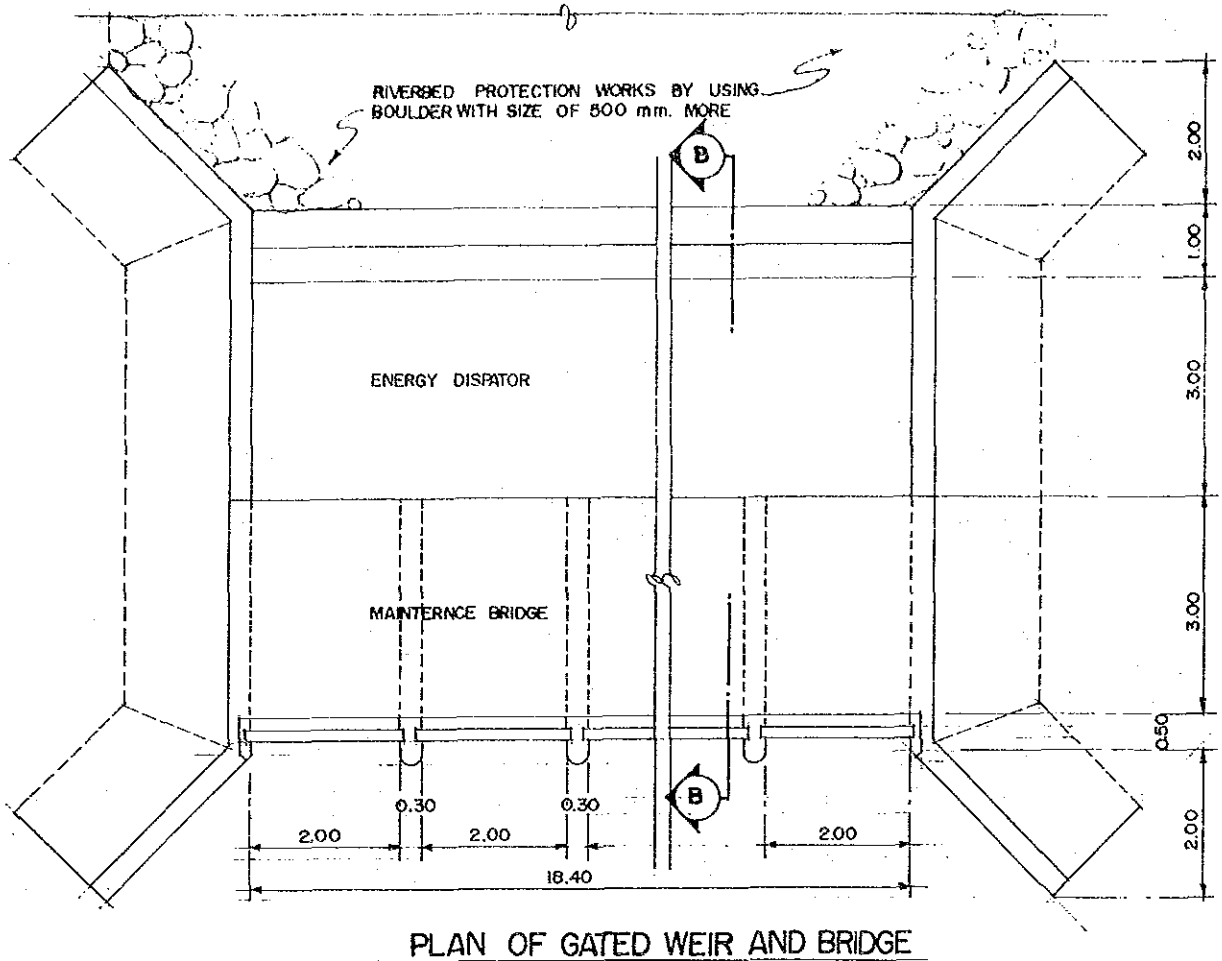


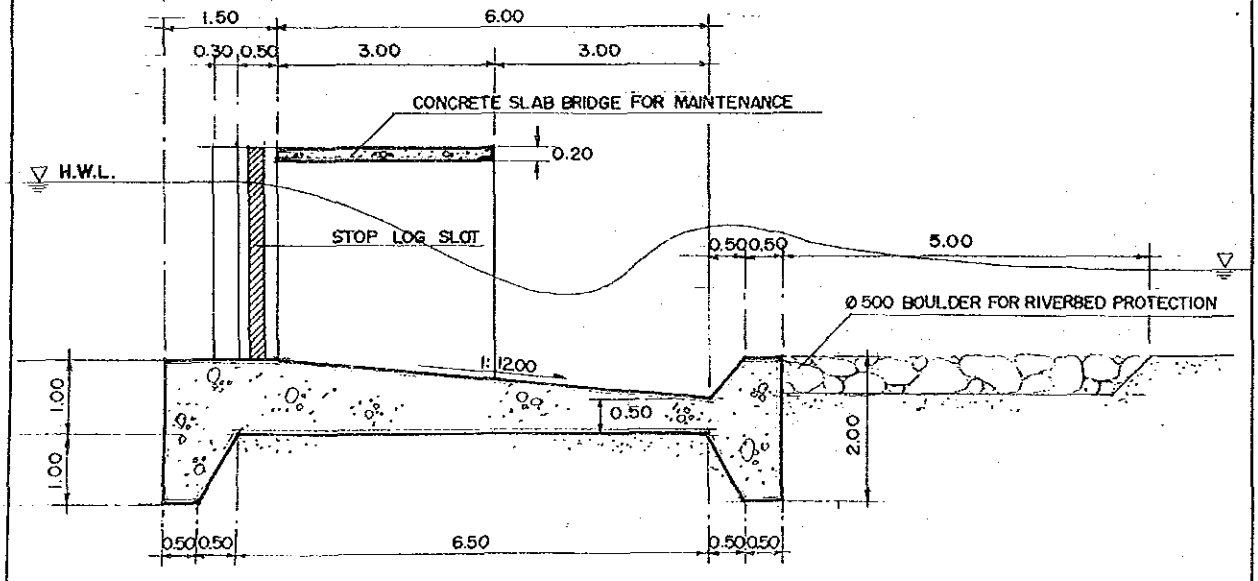
Figure II PRELIMINARY DESIGN OF RESERVOIR AND PROPOSED BAN KHOK YANG PUMPING RESERVOIR

The Study on the Regional Development Plan
for the Lower Northeast and the Upper East Regions
in the Kingdom of Thailand



PLAN OF GATED WEIR AND BRIDGE

SCALE 1:100



SECTION B-B

SCALE 1:100

Figure 12 PRELIMINARY DESIGN OF WEIR IMPROVENMENT

The Study on the Regional Development Plan
for the Lower Northeast and the Upper East Regions
in the Kingdom of Thailand

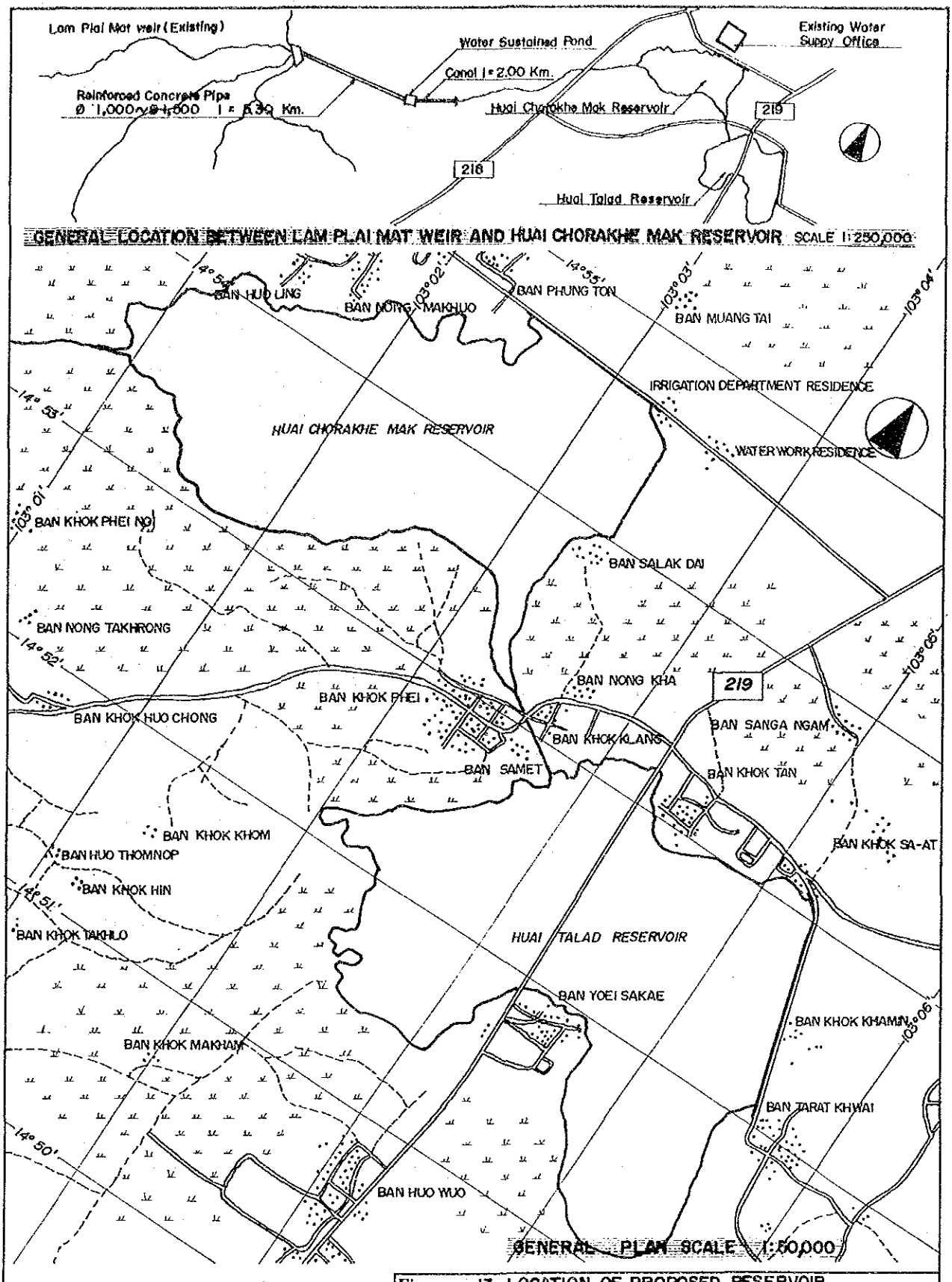


Figure 13 LOCATION OF PROPOSED RESERVOIR EXCAVATION (HUAI CHORAKHE MAK RESERVOIR) (BU – 2)

The Study on the Regional Development Plan for the Lower Northeast and the Upper East Regions in the Kingdom of Thailand

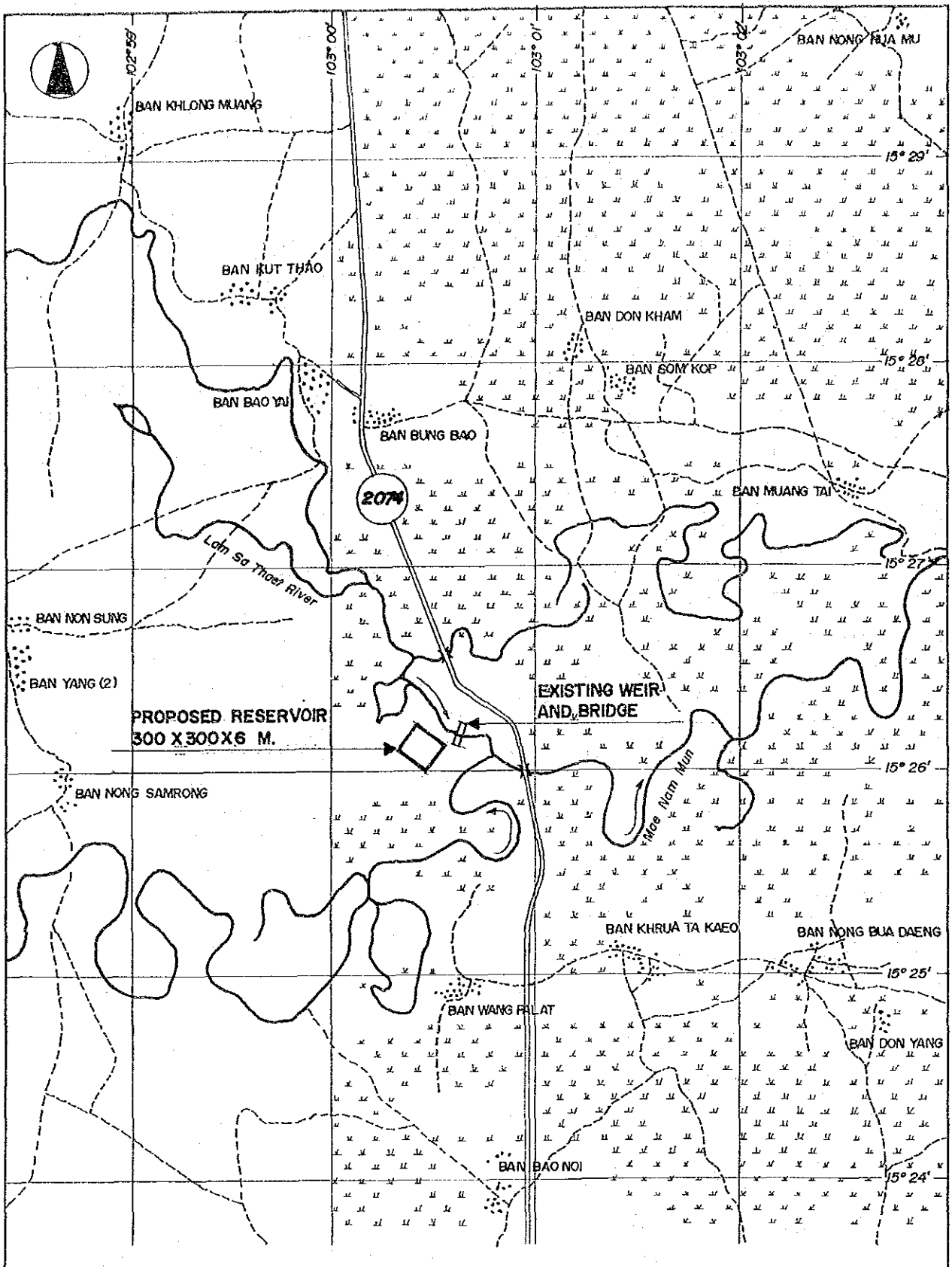


Figure 14 LOCATION OF PROPOSED BAN YANG PUMPING RESERVOIR (BU - 3)

The Study on the Regional Development Plan
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in the Kingdom of Thailand