5. Conceptual Planning of Mine Development

5.1 Mining Area

Open cut mine was planned in the condition that the depth of final floor is 150m below the surface. This depth is a possible mining level, which adjacent open cut mines suggest.

Although the geological structures, correlation of coal seams and coal reserves for mining are still uncertain in detail, whole data at present indicate that three areas (A, B and C) in Ngao basin could be mining candidate areas. Those areas are shown in Figure 5-1.

Key figures such as area, overburden, coal reserves and stripping ratio are shown in Table 5-1. Coal reserves in Table 5-1 are based on the geological assessment of article 2.5.2 in this report.

Table 5-1 Key figures of Area-A, B and C

	Area-A	Area-B	Area-C
Surface Area (㎡)	2,296,000	1,544,000	981,000
Final Bench Are (㎡)	422,000	386,000	78,000
Overburden (1,000m^3)	184,327	135,867	75,882
Coal Reserves (1,000 t)	29,352	15,984	5,313
Stripping Ratio (Bank m^3/t)	6.30	8.50	14.28

Area-A is the most promising area because of the largest coal reserve, the lowest stripping ratio and comparatively low sulfur content.

Therefore, the mining plan was made for Area-A. But, if some limited area with good coal quality is measured in Area-B as a result of further exploration, Area-B also may be able to come up to be hopeful area.

The stripping ratio in Area-A is almost same level to the neighboring coal mines, and

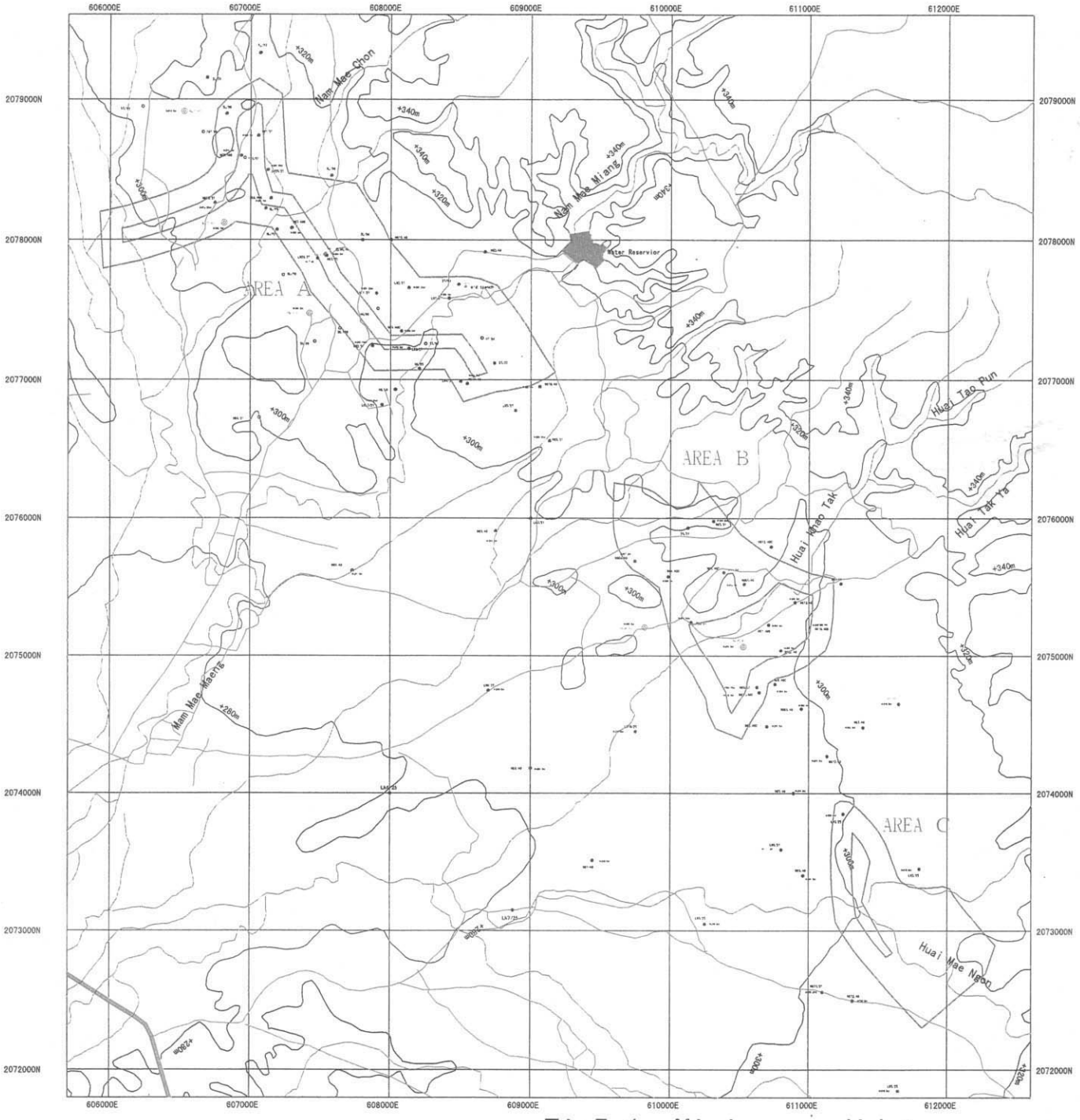

Fig5-1 Mining candidate areas

the coal reserves for mining is comparatively large in Thailand.

In any case, we consider that more detailed exploration about coal seam and coal quality condition are required mainly in Area-A. After that, the most promising area will be selected in Ngao coal basin, and the optimum mining plan will be made.

5.2 Production and Depth of Final Floor

Annual production and final depth of working floor were settled tentatively in 500,000 ton and 150m below the surface respectively.

The inspections were conducted on the five adjacent coal mines in the Study.

Mae Moh mine, the biggest coal mine in Thailand, produced annually around 15 million tons of coal with about 6 bank-m^3/t of average stripping ratio. The final depth of floor is planned at 250m below the surface.

Other four coal mines produce annually around 400,000 to 1,300,000 tons of coal with about 4 to 6.5 bank-m^3/t of average stripping ratio. The final depth of floor is planned at 100m to 220m below the surface in these mines.

5.3 Rock Strength

Compression tests (uni-axial and tri-axial) were conducted on the core samples taken from the drill holes at the depth of around 50 and 100m below the surface, to get information about the workability of heavy machine, stability of bench and dump area, and needs for blasting etc.

The tests were carried out by PBC Engineering Co., Ltd in Thailand with ASTM standard procedures.

In conclusion, these rocks have week property for the impact and stress. Therefore, we consider that the shovels are useful for the excavation of these rocks, and blasting is not necessary. And then, we have to pay attention the stability of bench and dump area.

5.4 Water Control and Dewatering Plan

5.4.1 Surface Water

(1) River

Three creeks, of which width is few meters, flow in the AREA-A. We should take measures to meet the situation, for example shifting of the river flow.

(2) Precipitation

It is relatively less rainfall in northern Thailand. The followings show the precipitation records in these ten years at the neighboring C-Coal Mine and around Chiang Mai by Thailand meteorological agency.

Max Yearly Rainfall : 1,378.1mm (1981)
Max Monthly Rainfall : 394.6mm (July 1981)
Max Mon. Rainfall days : 23days (September 1992)
Max Daily Rainfall : 133.6mm (July 1978)

Yearly rainfall is approximately in range of 900 to 1,400 mm, and less than the average at Bangkok in these 30 years. Then, the yearly rainfall is not so much in Ngao area. And the catchments area for the proposed mining area is relatively narrow.

Following draining measures will be effective.

① To install drain pumps in the reservoir designed in the pit bottom, and pump out gathered water.
② To design more than two benches of different elevation and operate on upper bench in rainy days.

5.4.2 Ground Water

We got information on Permeability test by “falling head method” at water bearing zone in two drill holes (NGJ 1/43, NGJ 4/43).

The permeability showed around the rank of 10^{-6}, which is said to be almost impermeable. And static water level was around 3 to 30m, mainly according to the elevation.

According to this and condition of neighboring coal mine, we need not to be so anxious about the water seepage in pit.

5.5 Operational Criteria

The criteria of operation are as follows.

(1) Production and Bench Depth

- Production : 500,000t/y
- Final depth of floor : 150m below the surface

(2) Bench

- Height : 5m
- Inclination : 55 degree (maximum)
- Road width : 15m
- Road dip : 10 %

(3) High wall

- Bench height : 5m
- Berm width : 2m, and 10m at every 5 steps

(4) Waste dump

- Bench height : 5m
- Bench inclination : 45 degree

- Berm width : 5m
- Overall inclination 30degree

Surface of waste dump will be planted with grass and trees to prevent collapse.

5.6 Coal Production Cost

5.6.1 Production System

Generally, a coal company in Thailand entrusts a contractor with direct production activities under a contract agreement.

The contractor bears the responsibility for mining and transporting of coal at the designated place, stripping, disposal of waste materials, workshop works, and bench maintenance. Then, the contractor holds also the responsibility for preparing equipments and spare parts as well as manpower, relating to coal production and waste disposal.

On the other hand, the company designs mining plan, maintains safety at works, controls coal quality, protects environment and keeps friendly relations with local people.

5.6.2. Presumed Condition for Production

- Mining Area : Area-A
- Annual Production : 500,000 ton
- Term of Operation : 20 years
- Minable Reserves Required: 10,000,000 ton
- Average Stripping Ratio : 6.30 Bank m^3／ton-coal
- Coal Preparation : Jig System

5.6.3 Production Cost

Production cost was roughly estimated, based on the investigation data on coal mine, which is located around Lampang city. In case that the cost in Thailand is not clear, it was estimated referring the data in Japan, in consideration of economic index in Thailand.

As a result, the production cost was estimated 315 Bahts/t, which was almost same to that of coal mines around Lampang city.

The breaking down is as the followings.

(1) Mining: 192.0 B/t-coal

(Contractor Fee)

・Coal (28 B/t) : 28 B/t

・Waste (26B/t): 164 B/t(26B/m^3×6.3 m^3 /t＝164 B/t)

(2) Fuel 2.5 B/t

(3) Electricity 2.5 B/t

(4) Water 0.7 B/t

(5) Running of Jig Plant 20.0 B/t

(6) Administration 26.8 B/t

(7) Investment 30.9 B/t

Land、Office、Residence、Jig Plant、Water Pump & Pipe、Weighing Machine、Stationery and Fixture、Road Pavement、Shift of River Flow

(8) Royalty 20.0 B/t

(9) Others 19.6 B/t

Total cost of clean coal (1)～(9) 315.0 B/t

5.7 Quality and Use of Products

5.7.1 Quality of Products

Based on the present data by eleven (11) drillings, the average quality of raw coal in Area-A is estimated as the following table 5-6. This raw coal includes the rock bands less than 30 cm in thickness.

The quality of products is mentioned about two cases. One is the case only by conventional coal preparation (jig plant), and another is that by the upgrading technique (Low temperature dry distillation process: SGI process) in addition to the former process.

(1) Case by conventional coal preparation

The average Sulfur content in Area-A is 4.27 % (A.R). But, according to the Figure 3-3 (Iso-value contour map on total Sulfur contents), relatively low Sulfur content area (less than 3 %, A.R) is seemed to spread over some range in Area-A. Then, we expect to make clear about 10 million tons of low Sulfur coal reserves (around 3 %, A.R) in the definite area of Area-A by further exploration. Furthermore, it is considered to remove high Sulfur of thin coal seam in order to keep the low Sulfur content.

We consider that the heating value of coal products can be kept 3,600 kcal/kg (A.R) using selective mining method and washery plant.

(2) Case by Conventional Coal Preparation and Upgrading Technique

By further exploration, we expect to measure about 10 million tons of coal reserves in the definite area of Area-A, where the quality of clean coal is almost same to the bulk sample. In this case, we will be able to get the following products by applying SGI process to the clean coal.

Table 5-2 Quality of Raw Coal and Products

Area	Sample	Analysis Basis	Mo. (%)	Ash (%)	Total S (%)	Form of Sulfur		H.V. (kcal/kg)	S/H.V. (per 1000kcal)
						Pyrite	Others		
Area -A	Raw Coal (Ave.)	A.R	30.0	29.0	4.27			2,520	
		Dry	0.0	41.4	6.10	41%	59%	3,495	1.75
	Clean Coal (Asumed)	A.R	30.0	18.0	＜3.0			3,600	
	Bulk Sample	A.R	30.0	13.0	4.27			3,780	
		Dry	0.0	18.6	6.10	41%	59%	5,400	1.13
	Upgraded Coal	A.R	5.0	25.9	3.42			5,800	
		Dry	0.0	27.3	3.60	0%		6,100	0.59

- Solid Product (Yield: 50 %) : H.V; 5,800 kcal/kg, S; 3.42 (A.R)
- Liquid Product (Yield: 10 %): H.V; 8,100 kcal/kg, S; 4.5 (A.R)
- Sulfur content equivalent to the heating value of domestic coal (4,500 kcal/kg):

  $3.42 \times (4,500 \div 5,800) = 2.65$ % (A.R)

And then, if we can get the Sulfur content of clean coal less than 5 % (D.B), we will keep the Sulfur content of the upgraded coal less than 3 % (A.R).

5.7.2 Use

The Sulfur content of coal products is estimated around 3 % in both cases as above mentioned. Therefore, the main user for the coal product in Ngao is supposed to be cement industry.

6. Environmental Surveys

The object of this survey (Phase 1) is to collect the data on the environmental policies and the understanding of the present natural and social condition of the Ngao city and the proposed mining area, and to point out the environmental issue relating the mining activities.

6.1 National Policy for Mining Industry and Environment Preservation

6.1.1 Environmental Preservation Policy Affecting the Development of Mining Industry

Since the middle of 1980's, the Thai government has adopted a "green" policy to preserve the country's diminishing forests and increase forestland. This policy has unintentionally affected the development of mining industry as it leads to land use conflict. Since May 1985, watershed classification has been declared for all over the country for preservation of water source area and stipulation of appropriate land use. Moreover, under the Seventh National Economic and Social Development Plan, forest preservation policy has been employed. As a result, 40% of the country's area is targeted to be forest reserves.

6.1.2 Environmental Policy for Mining Industry

Under the Ministry of Industry, the Department of Mineral Resources (DMR) is responsible for mineral resources exploration and development, administration of mining activities, enforcement of minerals law and mine pollution control. DMR has currently proclaimed some policies to restrain environmental deterioration caused by mining industry and to integrate conservation and development schemes.

Theses policies are as follows:

(a) Environmental Impact Assessment (EIA)

(b) Public Participation

(c) Beneficial Return to Host Communities

(d) Performance and Assurance Bonds

(e) Bank Guarantee

The Environment Division of DMR is responsible for the implementation of these policies.

6.1.3 Mining Laws and Regulations

(1) The Mineral Act

The Mineral Act, B.E. 2510 (1967) provides the legal framework permitting the orderly and progressive exploration and exploitation of mineral resources.

(2) The Enhancement and Conservation of National Environmental Quality Act

The environmental act having the most significance on the mining industry is the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992). This Act was promulgated on 4th June 1992 and effectively repealed the Environmental Quality Act, B.E. 2518 (1979). The 1992 Act further clarified and improved the environmental process and replaced the Office of National Environmental Board (ONEB) with three new organizations;

(a) The Office of Environmental Policy and Planning (OEPP)

OEPP is responsible for the preparation, review and approval of environmental documents for a range of specified project categories.

(b) The Pollution Control Department (PCD)

PCD is responsible for regulating standards of pollutant levels and investigating environmental violations.

(c) The Department of Environmental Quality Promotion (DEQP)

DEQP is responsible for providing environmental information and assisting point source discharges with advise on technical expertise concerning pollution control.

This 1992 Act covers four main issues relating to mining activities. They are specified as follows:

(a) New proposed mining projects of any size and type must submit EIA reports to the OEPP for approval before implementation.

(b) Mining activities must follow forthcoming and predetermined environmental standards such as the standards for surface water quality, industrial effluent quality and ambient air quality.

(c) The OEPP authorized to designate any natural area as an environmentally protected area or conservation area, which is prohibited for economic utilization including mining.

(d) The Act established an environmental fund for investment in operation of pollution control and waste treatment systems as well as waste disposal facility. This fund can be another source of finance for miners, particularly small to medium size mines, to borrow for improvement of their environmental works.

6.1.4 Environmental Impact Assessment (EIA)

The EIA has been adopted as a tool for managing the environment in relation to mineral resources development since July 1981. It contains a procedure of environmental planning and management. For mining industry, the EIA is part of a prerequisite in the process of granting a mining lease. A proposed mining project of any size and type must submit EIA report prepared by a competent company, which has been registered with the OEPP. Under the Enhancement and

Conservation of National Environmental Quality Act 1992, the EIA reports are reviewed and approved by the OEPP under the consideration of the Expert Committee which is appointed by the National Environmental Board (NEB).

6.1.5 Environmental Policy and its problems

The Environmental Division of DME is pointing out the following issues as real problems occurred at present;

(a) A lack of a land utilization plan for development of mineral resources

(b) Private mining sectors don't spend sufficient money to the environmental protection due to shortages of company's funds except the Electricity Generating Authority of Thailand (EGAT)

(c) The relationship among each government offices is not arranged well because of their own different policies.

(d) Development study is not enough due to the insufficient ability on mine development planning and technology.

(e) Management on an environmental protection from mining is not enough level.

Therefore, the Environmental Division of DME has concluded that the close collaboration upon integrated planning and management between the government and private sector is urgently acquired to achieve the nation's goal, and that policies and legislation regarding planning and management of natural resources utilization and conservation in harmonious manner is certainly important for the country's future to obtain its sustainable development and national prosperity.

6.2 Present condition of Amphoe Ngao (Ngao city)

Amphoe Ngao is one of 13 cities (Amphoe) in the Lampang Province, with area of

1,815 km^2 (60 km from north to south and 30km from west to east). It is located 83 km northeast of Lampang town. Town area and farming villages are located in a basin (the Ngao Basin) surrounded by mountains of the 1,000m class. A mountain area occupies 73% of Amphoe Ngao, and a flat area is 22% and rivers and ponds are 5%.

A lot of small streams are running from the mountain ranges around the basin and join the Ngao River flowing at the center of the Ngao basin from north to south. The drainage system in the Ngao basin is divided into two drainage systems; the Ngao main stream system and the Hua river system. Moreover, the drainage system of the Ngao main stream is also divided into two sub-systems; the northwest area and the southeast area. The surveyed area is located in the southeast area of the Ngao main stream drainage system (Figure 6-1).

Amphoe Ngao is politically divided into ten (10) districts, and consists of seventy-three (73) villages. A population of Amphoe Ngao is 61,346 (1999) and its households are 15,532. An average population and households per a village is 840 and 212 respectively.

A main industry in Ngao is agriculture and products are rice, corn, garlic, oranges, vegetables, and cotton. Flat area along the Ngao River and its tributaries are used for rice farming due to good water condition. Some areas are raised two crops a year.

6.3 Present condition around the Proposed Mining Area

The proposed mining area is located in the eastern part of the Ngao basin, 12 km northeast of the town of Ngao. This area is the gentle hill regions in a fringe area of the basin and bounded on the east and northeast by mountains consist of basement rocks. Several tributaries flow from the mountains to the center of the basin and join the Ngao River. In this area, there are two drainage systems (Drainage

systems A and B) (Figure 6-2).

The flat area between the exploration area and the Ngao town, within 10 km from the Ngao town, is utilized to a large-scale rice farming. In the hilly area including the exploration area, the irrigated area is used as a rice field and other area is utilized to the small-scale farming field of corn, cotton, upland rice and oranges (Photo 6-1). There is an irrigation dam (a earth-fill-type dam) to the northeast of the exploration area and irrigation channels are cut toward the rice field (Photo 6-2, 6-3). Some of them are running in the proposed mining area and must be changed their routes in the case of an open cut mining (Photo 6-4).

Watershed Classification in this area is shown in Figure 6-3. This area belongs to Class-4 or Class-5 in which mining activities can be processed (the development of the mine in Class-1A is needed the approval of the cabinet.). As shown in Figure 6-4, mountainous area is classified as the forest preservation under the Forest Act. However, almost of the proposed mining area is classified as commercial forest in which economic and agricultural activities can be processed under individual permission.

The proposed mining area is located in Ban Haeng district, of which population and households were reported 7,055 peoples and 1,729 families in 1999. Ban Haeng district consists of ten villages and its main industry is agriculture (Photo 6-5). According to the current mining plan, the proposed mining area is planned more than 1.5 km apart from the Ban Haeng Nua village. However, the environmental study and monitoring on noise and water pollution occurred from the mining activities will be conducted. One cultivating village of mountainous tribe exists near the planned pit so that the village may be considered to move if the development activities affect it.

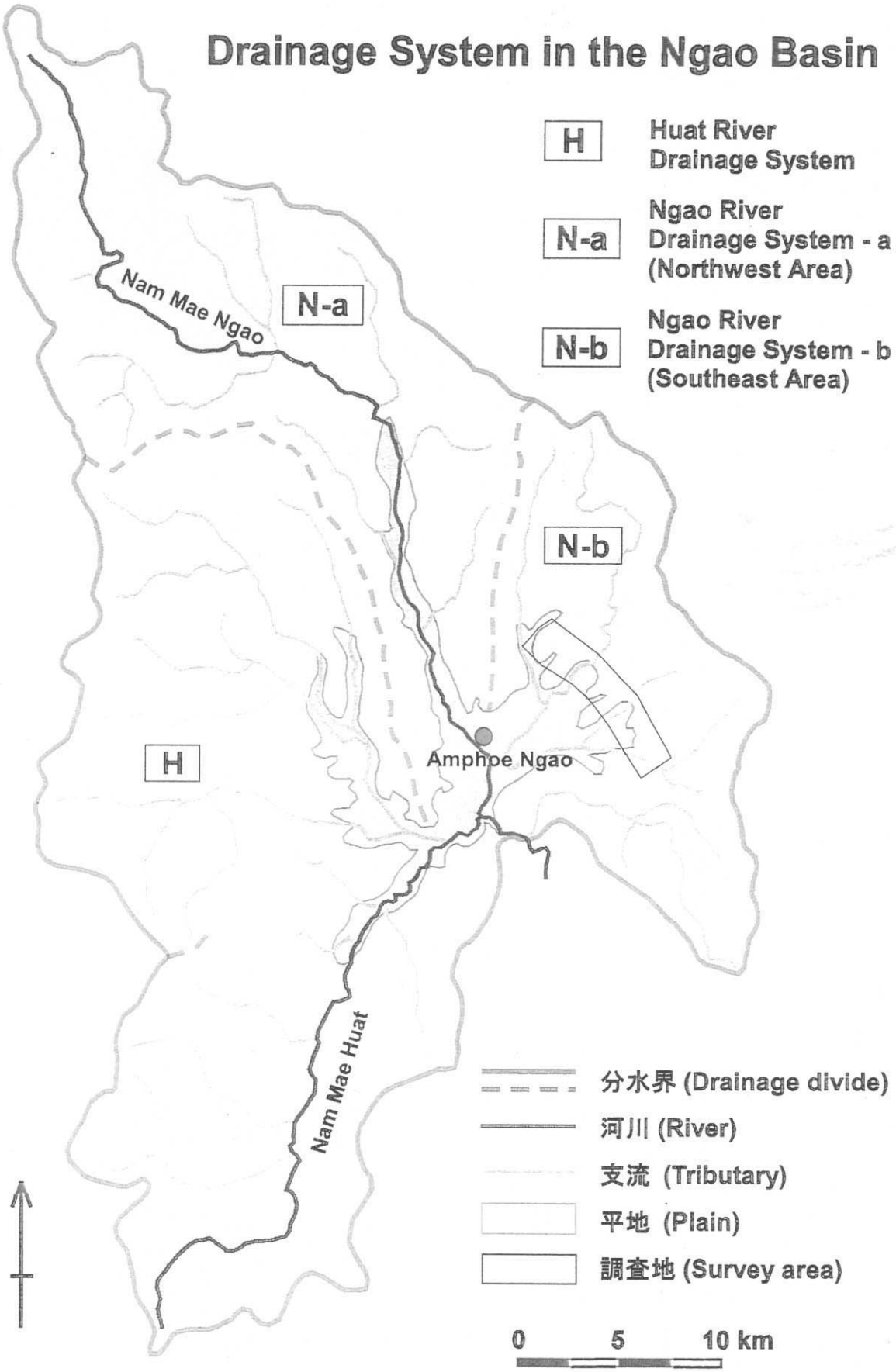
Drainage System in the Ngao Basin
H
Huat River
Drainage System
N-a
Ngao River
Drainage System - a
(Northwest Area)
N-b
Ngao River
Drainage System - b
(Southeast Area)
Nam Mae Ngao
N-a
N-b
H
Amphoe Ngao
Nam Mae Huat
分水界 (Drainage divide)
河川 (River)
支流 (Tributary)
平地 (Plain)
調査地 (Survey area)
0
5
10 km

Figure6－1

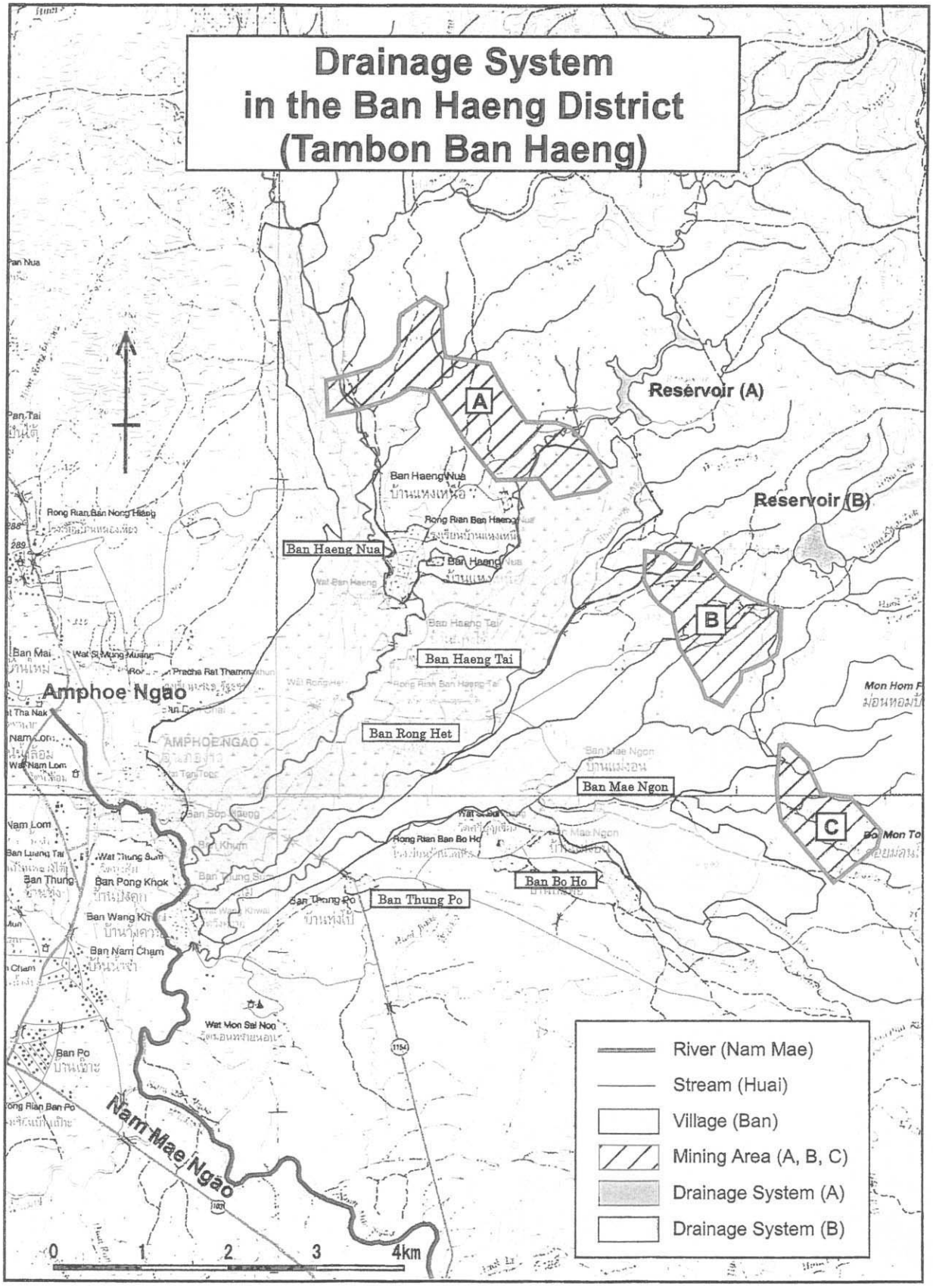
Drainage System
in the Ban Haeng District
(Tambon Ban Haeng)
A
B
C
Reservoir (A)
Reservoir (B)
Ban Haeng Nua
Ban Haeng Tai
Ban Rong Het
Ban Mae Ngon
Ban Bo Ho
Ban Thung Po
Amphoe Ngao
Nam Mae Ngao
River (Nam Mae)
Stream (Huai)
Village (Ban)
Mining Area (A, B, C)
Drainage System (A)
Drainage System (B)
0 1 2 3 4km

Figure6－2