4.5 Flood Damage

4.5.1 Flood Damage

The damaged area of Ban Na San occurred in a strip along Chawang river in Tambon Lam Poon, Tambon Na San, Tambon Nam Pu and Tambon Tha Chi. The damage was mainly caused by landslides, river bank erosion, deposited soil on farm land and the town of Ban Na San. It can be described as follows (refer to Appendix G.1).

(1) Flood damage in agriculture

The agricultural land was deposited by the sediment and the total damaged areas are 19,089 rai, out of which 6,957 rai is paddy fields, 2,667 rai rubber trees, and 7,993 rai fruit trees (refer to Table G.1.9, Appendix G).

(2) Flood damage in buildings

The flood damage to public utilities are 85 roads, 44 bridges, 31 schools and 7 temples. The total estimated value of damage to them is amounted to 51.28 million Baht. Moreover, 354 farm houses were completely destroyed and 346 houses were partially damaged (refer to Table G.1.2, Appendix G).

(3) Flood damage in lives

In Ban Na San, 25 people were killed and 317 families became homeless. The homeless people moved to the new resettlement area arranged by the government.

According to the Department of Local Administration, the total value of flood damage in Ban Na San is amounted to 300 million Baht (refer to Table G.1.2, Appendix G).

4.5.2 Rehabilitation Project

RID has planned and completed the flood relief project, titled "Ban Na San Flood Relief Project in Surat Thani Province".

In 1989, RID planned and executed 1) dredging and expanding of 2,400 m of Chawang river (upstream of Ban Na San township) 2) construction of flood protection dike to protect Ban Na San communities. In the following year, a short-cut canal (800 m between route 4009 and railroad) was excavated and earth dikes were constructed. Both the expanded and excavated channel are of the compound cross-section with design drainage capacity of 1,000 m^3/s (refer to Figure 5, E-8, Appendix E). The river land is 160 m and the width of the minor canal bed is 40 m. The berms are

20 m each. Some 8 m wide road on the dike is used for communication. To stabilize river channel, structures such as ground sills, bank revertment were also constructed (refer to Appendix E).

As an extension of flood prevention measures, RID and the Amphoe Office of Ban Na San are cooperating in dredging 4,000 m of the riverbed downstream of the railroad crossing. However, detailed analysis on flood was not conducted for this planning.

To conduct flood prevention measures systematically, the following are required.

1) Flood analysis and examination on river improvement for the upstream area between rehabilitated section by RID and the confluence with Mui river.
2) Dredging the riverbed between route 41 and the mouth of Chawang river (the confluence with Ta Pi river).
3) Detailed study on backwater effects of Ta Pi river including inundation analysis at the mouth of Chawang river.

4.6 Environment

4.6.1 Living Environment

(1) Transportation

Ban Na San has good communication and transportation system. People can travel to and from Surat Thani by railroad using Ban Na San and Pun Pin stations. The province also has a good road system.

(2) Public utility

Electricity	:	Electricity is supplied to every villages by Surat Thani and Ban Na San Electricity Authorities.
Water supply	:	There are three (3) Water Supply Authorities in Ban Na San, which supply separately to each village of Na San, Kaun Suban and Thung Thas.
Telephone	:	Ban Na San Telephone Authority is responsible for telephone service for local and long distant calls in the district.
Post and Telegraph	:	There is one post and telegraph office in the district.

(3) Religion and education

Most of Ban Na San's people believe in Buddha. In Ban Na San, the following schools exist as of 1994.

- Four secondary schools with 137 teachers and 2,739 students
- Three non-formal education schools with 49 teachers and 1,527 students
- Fifty-three elementary schools with 372 teachers and 6,660 students
- Five municipal district schools with 58 teachers and 798 students

(4) Public health

Based on the district's data in 1992, Ban Na San had developed in socio-economic system for public health as follows.

- Government public health services of one hospital with 30 beds, one public health center and eleven public health stations.
- Some private hospitals and clinics.

4.6.2 Natural Environment

(1) Present condition of natural forest

At present, Ban Na San has 211,700 rai of natural forest or 40% of the preservation forest in the Khlong Nam Tuan, Ban Na and Tha Rua, which has been destroyed gradually as farmers cultivate the forest area and plant rubber and orchard plantations. RFD considers to provide substitute area to the farmers. At present, destroyed forest occupies 36,000 rai in preservation forest. Consequently, RFD has authorized Agricultural Land Reform Office to provide 28,100 rai for the farmers and Chulaporn Research Institute, public school and other agencies to rent 7,900 rai. Conservation forest designated as a national park is in Thai Rom Yen, which contains 265,600 rai including nursery area for replanting.

CRI was established at Kaha Wan Sila Dierk San and Thara Wong Arree Villages for relief of flood affected people and area. The activities are the promotion of agro-forestry, handicraft and the construction of recreation park. The forest rehabilitation by replanting trees is one of the activities of CRI.

The sediment deposited area in Ban Na San is not included in the reserved area according to the watershed classification arranged by the National Environment Board (NEB) (refer to Figure K.1.2, Appendix K).

(2) Present condition of ecosystem

- Wildlife

  According to the data collected, four (4) groups of wildlife were recognized in and around the area, which are birds, mammals, amphibians and reptiles.

Birds	: It is reported that there are about 80 species in and around the area.
Mammals	: About nine (9) species including elephant exist in the mountain.
Amphibians	: There is no data. It deems there are 3 to 4 species.
Reptiles	: There is no data. But, there are many snakes.

- Flora

  There are many variety of trees in the forest area, which are Dipterocarpus alatus, Hopea ordorata, Cotylelobius melanexylem and Shonca roxburghii, etc.

- Fish

  There is no data. But, according to the villagers, there are no more than 10 species of fish in the rivers.

There is no valuable ecosystem which requires protection.

CHAPTER 5

GENERAL CONDITIONS OF THE LAN SAKA AREA

CHAPTER 5 GENERAL CONDITIONS OF THE LAN SAKA AREA

5.1 Physical Features

5.1.1 Location, Topography and Geology

Lan Saka area is located in Amphoe Lan Saka of Nakhon Si Thammarat province, 15 km west to Nakhon Si Thammarat city and latitude from 8°22' to 8°27' North and longitude from 99°45' to 99°51' East. The Tha Di river runs from northwest to southeast central of the area. At the southeastern end the area crosses route 4015 road. Western and northern part of the area consist of high steep sloped mountains which is underlain almost by granite. The highest park of the ranges Khao Luang (1,835 m) is west to the area.

Farm land is situated in a narrow valley which was formed at the exit of the Tha Di river from mountains. The terrace and the present fluvial plain of the Tha Di river are distributed in the valley. The fluvial plain changes to a gentle slope at route 4015 road and shifts to an alluvial plain. The debris flow attacked the present fluvial plain but the terrace was saved from the damage (refer to Figure C-3, Appendix C).

5.1.2 Meteorology

(1) Observation station

RID has the following observation stations to record the data of rainfall, water level and discharge around the study area.

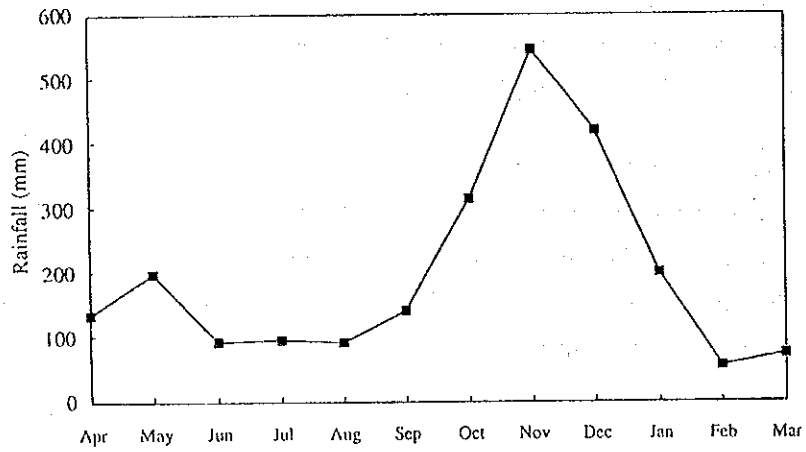
Item	Observation Station (Station No.)	Period	Catchment Area	Location (N.Lat., E. Long.)
Daily Rainfall	Lan Saka (2708)	1968-1992		8-22-08N 99-48-29E
Daily Rainfall	Khlong Sao Thong (2715)	1961-1992		8-20-18N 99-50-03E
Water Level Discharge	Khlong Tha Di (X.55)	1967-1971 1989-1992	105 (km^2)	8-23-53N 99-50-15E

(2) Rainfall

(2)-1 Rainfall pattern

There are two rainfall observation stations around the study area. However, the data of Sao Thong (2715) is more proper for irrigation and drainage planning, because the observation period is longer and topographic condition is more similar to the study area. Monthly average rainfall at Sao Thong (2715) is as follows.

Monthly Average Rainfall (1961-1992)



The figure indicates that the study area has a typical rainfall pattern affected by the Northeast Monsoon. Annual rainfall is 2,370 mm and is 40 percent greater than Ban Na San.

(2)-2 Design rainfall

The design rainfall based on the data of Sao Thong (2715) is shown in the following table. It was determined by Iwai method which is popularly used in Japan.

Unit : mm

Item	Return Period					
	2 years	5 years	10 years	25 years	50 years	100 years
1 Day	152.8	230.3	292.3	382.2	457.3	539.5
2 Days	210.3	316.7	408.8	550.8	675.7	817.7
3 Days	254.4	387.3	498.8	667.5	813.3	977.0

(3) River condition

Tha Di river, flowing through the study area is one of the tributaries of Hua Trut river. The catchment area, length and average river bed slope up to the downstream point in the study area are 105 km^2, 25.1 km and 1/20, respectively. It is very steep.

(4) Flood discharge

In Tha Di river, the discharge is observed by using a stuff gauge, same as in Chawang river. Consequently, real peak discharge might not be observed due to steep slope of the river and short period of run-off duration. Unit hydrograph method is applied to estimate design flood discharge, as described in 4.1.2 (4). The result is shown in the following table (refer to Figure 1-3 and B.2.10~B.2.14, Appendix B).

Flood Discharge of Tha Di River

Unit : m^3/s

Plot	Catchment Area (km^2)	Return Period				
		2 years	5 years	10 years	25 years	50 years
A	71	294	527	757	989	1,184
B	105	339	607	872	1,140	1,364

Note : Refer to Figure 1-3 for the plot location.

5.1.3 Soil and Sediment

(1) Soil

According to the soil distribution including Tha Di river basin, mountainous slope complex soil is the most common residuum and transported soil derived from granite is also distributed.

Before the disaster, the river basin was covered by the soil which originated from granite, which is classified as a Khlong Nok Kratung series. This soil is derived from weathered granite, with deep and well-drained layer. Reaction is strong acid to slightly acidic. It is suited for field crops and perennial trees (refer to Table F.7~F.10 and Figure F.2, Appendix F).

(2) Sediment

Based on the survey results, the depth and features of deposited soil are classified as follows (refer to Figure 1-4).

Class of Depth	Feature	Deposited Condition	
		Area (rai)	Rate (%)
Ⅰ. < 25cm	Depth is moderate plow layer, and sediment is consisted of fine sand or silt.	422	15.3
Ⅱ. 25 ~ 50 cm	Depth is moderate subsoil layer, and sediment is consisted of fine sand or silt.	376	13.6
Ⅲ. 50 ~ 100 cm	Depth is moderate root zone, and sediment is consisted of fine sand or silt.	34	1.2
Ⅳ. > 150 cm	Depth is deep, and sediment is consisted of sand.	900	32.5
Ⅴ. River bed	This contains coarse sand.	1,033	37.4
Total		2,765	100.0

In the above classification, classes Ⅰ and Ⅱ occupy 28.9% of the total sediment deposited area. Classes Ⅲ and Ⅳ are distributed widely, 33.7%.

5.1.4 Land Use

According to the land use condition of Tha Di river basin, the ratio of forest land is larger and farm land is small compared with the Ban Na San. The forest land has mostly tropical evergreen trees including rubber trees (refer to Table F.15 and Figure F.4, Appendix F).

Most of the agricultural land is rubber and mixed orchard. Rubber is planted on the gentle slope in the alluvial deposit. In the foot of the mountain, fruit trees are planted. Sediment deposited areas, however, are not suitable for fruit tree cropping. At present, many crops such as banana, corn and groundnut are planted.

5.2 Socio-Economy

5.2.1 Administration

(1) Division of administration

Amphoe Lan Saka has area of 214,311 rai. The administrative area is divided into 5 sub districts (Tambons) and 35 villages (Mubans).

(2) Rural development plan

According to the fundamental data at village level of NESDB, 9 villages were backward, 24 villages were middle-level and 2 villages were progressive. Backward and second villages are supposed to be developed by the government agencies, based on the rural development plan formulated under the cooperation with the branch offices of the province.

5.2.2 Population and Farm Land Holding

(1) Population and household

According to the Village Survey, the total population is 35,228 as of 1992, and the population density of the amphoe is 172 people/km^2, which is rather dense compared with the province.

The family size per household is estimated at 5.1 people. The sex and the dependency ratio are 95% and 59%, being rather low compared with those of the province, respectively. On the other hand, the occupation of family head is almost all (89%) agriculture. The compulsory education is prevailing as a matter of course, consequently, the percentage of those finishing compulsory education in the age 12 years and over shows 70 which is almost at the same level with the province.

(2) Farm land holding

According to the data of Ministry of Interior (MOI) in the amphoe, the total farm land and total farm household of the amphoe as of 1993 are 117,300 rai and 6,143, respectively. Accordingly, the average farm size per farm household in the amphoe is 19.1 rai, which is rather small compared with 23.0 rai of the province and 27.3 rai of the Ban Na San.

Ninety-five (95)% of the farm households are landed farmers. The average farm size of 19.1 rai is estimated to be mainly comprised of rubber of 10.3 rai, mangosteen of 2.7 rai, rice of 2.3 rai, coconut of 1.9 rai, durian of 1.6 rai, and others of 0.3 rai.

5.3 Agriculture

5.3.1 Agricultural Land Use

Land for fruit trees and tree crops occupy 78% of the farm holding land. Of which, para rubber is dominant, 34,341 rai or 54%, and 6,218 rai or 10% for coconut. Fruit trees occupy 36%, of which 8,979 rai or 14% is mangosteen and 5,306 rai or 8% is durian. The remaining 14% is for rambutan, longkon and others.

Land	Area (rai)	Rate (%)
Fruit tree and tree crops	63,487	77.6
Paddy field	9,699	11.8
Upland crops	1,532	1.9
Vegetable and flower	230	0.3
Housing area	6,847	8.4
Farm holding Total	81,795	100.0

Source : Agricultural Extension Office, Changwat Nakhon Si Thammarat, 1993

5.3.2 Agricultural Production

(1) Crop production

The dominant perennial crop is para rubber with the production of 8,525 ton. It is likely to decrease in future, due to a few un-bearing area and the trend of crop diversification into fruit trees.

The production of durian and mangosteen comes after. It is likely to increase rapidly since there remains many un-bearing area. Production of rambutan is 1,110 ton, and it has been increasing rapidly. However, it has a disadvantage that the harvest season is later than that of the other provinces. Consequently, it is apt to lose the market. Production of longkon tends to increase year by year (refer to Table H-5-2, Appendix H).

Crops	Area			Average yield (kg/rai)	Yearly production (ton/year)
	Planted area (rai)	Harvested area (rai)	Un-bearing fruit (rai)		
Rubber	34,341	34,142	199	249	8,525
Durian	5,306	5,250	56	1,200	6,300
Mangosteen	8,979	5,785	3,194	800	4,628
Rambutan	980	694	287	1,600	1,110
Longkon	343	74	269	750	56
Coconut	6,218	6,218	-	562	3,498
Rice	7,805	7,805	-	420	3,498

Source : Agricultural Extension Office, Amphoe Lan Saka, 1993

(2) Livestock

According to the statistics, the total number of head is lower than in the Ban Na San (refer to Table H-6-5, Appendix H).

Elephant	Horse	Cattle	Buffalo	Pig	Goat	Duck	Chicken	Goose
3	3	3,102	27	2,021	70	563	23,613	62

Source : Livestock Office, Nakhon Si Thammarat, 1993

5.3.3 Marketing

The main agricultural products in Amphoe Lan Saka are rubber, mangosteen, durian, rice, etc., out of which rubber plantation occupies the largest area. However, total production volume and value of fruit trees surpass those of rubber. The amphoe is considered to be the development promotion area of fruit cropping, especially, mangosteen. Accordingly, marketing system of mangosteen is described in the following.

Mangosteen is shipped first to the central market of Nakhon Si Thammarat and then to inside and outside of the province through the central market. The city also has private markets, which are big collecting and distributing centers of agricultural products. The representative example is Hua Hid Market. This market is composed of wholesaler (registration merchant 300 people), middleman (local merchant) and retailer, in which commodities traded are only fruits and vegetables. General consumers can not purchase these commodities in this market. The Market's owner gets a marketing fee from a registrated merchant.

As a marketing route, local merchants purchase these commodities at a farm-gate or fixed places in each village. In this case, the classification of grade for the products is carried out by local merchants. As another one, the farmers manage their own products and directly trade with

wholesalers in Hua Hid Market, in this case, the classification is carried out by farmers themselves.

The grade of mangosteen is classified into three classes. For the first class, they are directly sent to Bangkok and overseas market from Hua Hid Market. Of which, 30% are exported to Taiwan, Hong Kong, Japan, Malaysia, etc.

The amount of exportation has been increasing year by year, and it (including fresh and freezed fruits) was 2,652 ton with 76 million Baht in 1993.

The period that mangosteen could be preserved in a fresh state with high quality is about 15 days. Among the relevant organizations, it is expected to construct a low temperature storage.

5.3.4 Farm Household Economy

According to the Office of Agricultural Economics, the net cash income of an average size farm household in the Amphoe Lan Saka as of 1991 is 42,660 Baht, out of which 13,010 Baht is net farm income. Compared with those of the Amphoe Ban Na San, the cash income and the farm income are less than half. And also, farm household expenditure is 44,096 Baht, less than half of the amphoe. For household expenditures per capita, it is 8,646 Baht.

Crops income occupies 86% of the net farm income, in which 50% comes from rubber. Fruits income also holds 47% (9,331 Baht), differ from Amphoe Ban Na San in where farmers depend on rubber income only. In Lan Saka, livestock income occupies 14%, lower than the province average of 45% (see Table 1-1).

According to the CDD's village survey, the average annual income of farm household is 22,000 Baht for full-time farmers and 33,000 Baht for part-time farmers. The highest is 53,000 Baht (part-time) whereas the lowest is 16,000 Baht (full-time). Compared to Amphoe Ban Na San, income difference between farmers is less, but still significant.

5.3.5 Farming Practices

In Lan Saka, most of the agricultural land is on the hill or the slope and some on the sediment deposited area.

(1) Farming practices on the sediment deposited area

At present, farmers are trying to replant fruit trees in the sediment deposited area. But, they are apt to lose the trees due to flooding. In the lower elevation parts of land, annual crops such as sweet corn, peanut, sweet potato, eggplant and chilli, are grown all year around, except for heavy rainy season in November and December. Cultivation of sweet corn, as an example, is as follows. Sowing is three times, January, April and July, in a year. Growing period is 70 days. Fertilizer is applied at a rate of 25 kg per rai for 15 days after sowing. Weedkiller is also sprayed if necessary.

(2) Farming practices on the hill and the slope

Farmers usually practice mix-cropping of durian, mangosteen, rambutan, lansium, rubber, and coconut, etc in the same area, since the size of their own land is small. Growing of mono-crop is only 10% of the total land. General farming practices are summarized as follows.

- Most farmers do not apply fertilizer to their trees. The reasons are as follows.
  1) The orchard farm is mostly on the hill or slope which makes it difficult to carry fertilizer and apply to the trees.
  2) The cost of fertilizer is high and lacking the knowledge of fertilizers, how and when to apply correctly.
  3) It is difficult to apply it or take care of the trees due to many different crops in the same area.
- Irrigation is not applied generally to the fruit trees.
- Pruning is not a common practice because the tree is too large and tall.
- Insects and disease are the main problems of fruit production, but most of the farmers do not use chemicals. The reasons are lack of knowledge on the use of chemicals, the cost of chemicals is too high, and difficulty applying them in the mixed and tall trees.
- Harvesting ;

  Mangosteen

  Flowering period is from January to February. Fruit is harvested from May to July. It takes about 11-12 weeks from fruit setting until harvesting. It is usually harvested by a bamboo pole (jampa). The picker is usually hired for harvesting.

  Durian

  Local variety is grown and most of the trees are too tall to be harvested in the normal way. Usually the farmers let the ripen durian fall and then pick from ground.

Some of the farmers who plant only rubber now receive financial aid from a rubber replanting program to plant mangosteen. In this case, when mangosteen trees are in full bearing of fruits, the rubber trees are cut down.

Planting system of major crops is as follows.

Crops	Planting system
Rice	30 cm × 30 cm
Rubber	3 m × 7 m
Durian	10 m × 10 m
Mangosteen	10 m × 10 m
Rambutan	10 m × 10 m
Coconut	8 m × 8 m
Lime	4 m × 4 m

Source : Agricultural Extension Office, Lan Saka

5.3.6 Farmer's Organization

Amphoe Lan Saka is an old town and the people have been settled in this area for centuries. Farmers are specialized in the cultivation of fruit trees, in particular mangosteen and durian. Most of the villages in Amphoe Lan Saka are a community of strong solidarity. The farmer's organization may be summarized in the following table.

No	Type of organization	Number of organization	Number of member	Remark
1	Agricultural Coop. amphoe level	1	579	Established in 1974
2	Agricultural Coop. tambon level	2	351	Established in 1989 and 1992
3	Farmer's group	3	521	
4	Farmers' housewives group	5	na.	
5	Young farmer's group	2	na.	
6	Farmers' group for specific occupation	3	na.	
7	Thrift and credit group	4	2,770	Only Tambon Kam Loan

Source : Amphoe Lan Saka Agricultural Extension Office

There are two agricultural cooperatives at tambon level as follows.

Name	Location	Established (year)	No. of member (household)	Activities
Ban Sai Khing Coop	Tambon Tha Di	1989	163	Credit and supply of agricultural inputs and consumer's goods
Ban Din Doan Coop	Tambon Tha Di	1992	188	----- do -----

Both cooperatives at tambon level do not provide service for marketing of agricultural products. Agricultural cooperatives at amphoe level provide only service on collection of rubber products for the members.

Informal farmer's organizations in Amphoe Lan Saka are rather strong and active, particularly in Tambon Kam Loan. The villagers in the tambon have been organized into four unregistered thrift and credit groups as follows.

Name	Location	No. of member (household)	Operation fund (million Baht)
Ban Kiri Wong	Moo 5	1,376	6.20
Ban Wat Kok	Moo 2	699	3.10
Ban Wat Sa Mo	Moo 4	628	1.80
Ban Wat Chan	Moo 1	67	0.60

In Ban Kiri Wong, besides these groups, the villagers have been organized into three groups to collect agricultural products in the high farmland for the market.

The following are the major problems for future development of farmer's organization in the area.

- Lack of qualified staff
- Insufficient capital or credit
- Lack of strong back-up body at amphoe and/or changwat level

5.3.7 Agricultural Supporting Services

At present there is no commercial bank in Amphoe Lan Saka but BAAC is the only one at the unit level, not branch office level. The agricultural supporting services may be described as follows.

(1) Agricultural credit

a) BAAC is the major source of agricultural credit. In 1993, total operating funds are amounted to 64 million Baht, and the BAAC client farmers are about 50% of total farm household (refer to Table J.3, Appendix J).

b) In 1993, Lan Saka Agricultural Cooperatives provided the operation fund of about 13 million Baht and offered the short term repayment about 65% and medium term repayment 35% of the total.

c) In Tambon Kam Loan, the farmers preferred credit services for short-term through thrift and credit groups which are being carried out by informal farmers organizations in the village.

(2) Fertilizer

Supply of fertilizer is made through the credit-in-kind programs of BAAC, agricultural cooperatives at amphoe and tambon levels and private sectors. In 1994, Agriculture Cooperatives (ACs) Lan Saka, Sai Khing, and Ban Din Doan provided the budget amounted to 0.8 million Baht, 0.06 million Baht and 0.06 million Baht, respectively for supply of fertilizer to the members.

(3) Pesticide

Supply of pesticide is carried out mostly by private sectors. Orchards in this area are an old mixed cultivation of different kind of highly commercial fruit trees. The pesticide requirement is rather low.

(4) Seed

Supply of fruit tree seedlings is carried out by private sectors and farmers themselves.

5.4 Agricultural and Rural Infrastructures

5.4.1 Agricultural Infrastructure

The weir in the downstream of Tha Di river (outside the study area), constructed by RID under medium scale irrigation project (MSIP, 1984-1993, total cost 270 million Baht), is the only major irrigation structure in the watershed of Tha Di river. Due to changes in land use the beneficial area has been reduced to 28,000 rai, of which 10,000 rai are orchard and 18,000 rai paddy.

In the middle and upstream area irrigation is not a common practice. Water is channeled from sources such as waterfalls in higher elevation through small polyvinyl chloride hoses (diameter about 2-6 cm, tapering downstream). Pumping is not a common practice, though some farmers in the downstream areas use them for irrigation.

Except for the natural river system which is also the drainage system for the study area, no prominent drainage facility exists. Flooding occurs during every rainy season. In a normal year, water level in the river rises to about 1-2 m above normal level during flash flood, which comes only a few hours after heavy rain. Flash flood subsides only a couple of hours later. These flash floods cause frequent flooding in the low-lying agricultural land.

5.4.2 Rural Infrastructure

In 1992 RID constructed a small weir in Pong river to extract drinking water for the villagers in Ban Kiri Wong and Ban Wat Samo. Water is distributed through a pipeline system. Water distribution is arbitrated by the water master chosen by the villagers. No measurement is made so far. O&M of the weir is yet to be decided by the village leaders.

The major village road, which runs along the right bank of Ta Di river and leads to Ban Kiri Wong, is a paved road with 6 m width and running speed of about 60 km/hr. The condition of this trunk road is fairly good with occasional pot-holes. The road running parallel to Ta Di river in the left bank is single-lane and unpaved. Like Ban Na San area, road density is small and should be increased when planning land rehabilitation, to ensure smooth and safe agricultural activity.

Electricity supply is available in most of the villages. In most parts of the area tap water system does not exist. Rain water is collected with the roof of the house and is stored mainly for drinking purpose. Shallow wells are used to supplement house chore use. The natural rivers are used for bathing and washing clothes.

5.5 Flood Damage

5.5.1 Flood Damage

Western, northern and north eastern parts of Amphoe Lan Saka consist of high and steep slope mountains. Several mountain streams descend the steep slopes to meet just above Ban Kiri Wong. A series of 4 villages along the banks of Tha Di river in Tambon Kam Loan and 3 villages along the banks of Khao Kaew river in Tambon Khao Kaew suffered the worst of the flood. The flood damage of Amphoe Lan Saka may be described as follows.

(1) Flood damage in agriculture

The total damaged farmland is 11,358 rai of which 2,198 rai is paddy fields, 1,445 rai rubber trees, and 6,157 rai fruit trees (refer to Table G.1.10, Appendix G).

(2) Flood damage in buildings

The flood damage to public utilities is 23 roads, 14 bridges, one (1) government office, 18 schools, 6 village water supply stations and 10 temples. The total value of damage is estimated at about 45.52 million Baht. The total damages to houses are 920 households or 13 % of total households, of which Tambon Khao Kaew was the most severely damaged, with 615 destroyed households (refer to Table G.1.3, Appendix G).

(3) Flood damage to lives

The total number of people who died in Amphoe Lan Saka is 15. In Tambon Kam Loan, Tha Di and Khao Kaew, altogether 86 households had to move into new resettlement areas.

According to the Department of Local Administration, the total value of damage in Amphoe Lan Saka is estimated at about 194 million Baht (refer to Table G.1.3, Appendix G).

5.5.2 Rehabilitation Project

After the flood, RID was designated the responsibility to alleviate flood disaster in the affected area. 1) Ban Kiri Wong Flood Relief and Land Rehabilitation Project in Lan Saka District 1989, and 2) Nakhon Si Thammarat Flood Relief Project in Nakhon Si Thammarat Province are the countermeasures executed in Tha Di river watershed.

Under Ban Kiri Wong Flood Relief Project, RID has executed redredging and expanding Pong river, and short-cutting Ta Ha river. 1) For Ta Ha river, excavation of new channel was implemented after the confluence point of Ta Ha river and Ta Cha river and before the confluence

point of Ta Ha river and Pong river. 2) For Pong river, improvement was implemented between the downstream of the small intake weir and the confluence point of Ta Ha river and Pong river.

The villagers further downstream have requested RID to conduct drainage improvement of Tha Di river (river channel downstream of the improved portion).

5.6 Environment

5.6.1 Living Environment

(1) Transportation

Lan Saka is a well-developed district in communication and transportation.

(2) Public utility

Electricity	:	All areas have electricity supply
Water supply	:	There are six (6) water supply stations which supply separately to each village.
Telephone	:	Lan Saka Telephone Authority is responsible for telephone service for local and long distant calls.
Post and Telegraph	:	There is one post and telegraph office.

(3) Religion and education

Most of Lan Saka's people believe in Buddha. There are 19 temples. Condition of schools in the district as of 1994 are as follows.

- Two elementary schools with 130 teachers and 2,183 students
- Twenty-three secondary schools with 332 teachers and 5,923 students
- One adult education school
- One private kindergarten

(4) Public health

Lan Saka has one government hospital with 30 beds, 5 doctors and 30 nurses. Some private hospitals and clinics also exist in the town.

5.6.2 Natural Environment

(1) Natural forest and national park

Lan Saka has a destroyed forest of 46,000 rai. Farmers are advised to replant at least 5,000 trees per year by RFD. At present, farmers have the right to plant the trees in their own land in the affected area.

The national park called Khao Luang National Park has a land of 14,800 rai to protect the forest and wildlife, as well as to educate people about conservation of forest and to supply recreation area.

The sediment deposited area in Lan Saka is not included in the reserved area according to the watershed classification by the NEB (refer to Figure K.1.3, Appendix K).

(2) Present condition of ecosystem

- Wildlife

  There is no office related to research and management of wildlife in Lan Saka, but there is a wildlife research area situated in Laem Tha Lum Pook district, Amphoe Pak Panuang outside the study area, to protect ecosystem in mangrove forest area. According to the data from the area, wildlife found are 40 species of birds, 5 species of mammals, 10 species of amphibians and 4 to 5 species of reptiles in the province.

- Flora

  There are many variety of trees in the forest area, the same as in the Ban Na San.

- Fish

  There is no data. But, it seems there is no special fish, since fishery ponds are not popular in the area.

There is no valuable ecosystem which requires protection.

CHAPTER 6

BASIC DEVELOPMENT PLAN FOR THE BAN NA SAN AREA

CHAPTER 6 BASIC DEVELOPMENT PLAN FOR THE BAN NA SAN AREA

6.1 Development Approach

6.1.1 Basic Concept and Project Components

In the province, the agricultural sector is the most important part of provincial socio-economy and the GPP share is the highest. The increase in agricultural production, however, is attributed to the extension of rubber plantation through unsuitable land reclamation of forest area. It has led to deterioration of land resources and causes heavy damage to the agricultural land. Therefore, for future agricultural production, farming will have to be practiced through maintaining and conserving natural resources with effective use of limited land, as emphasized in the Seventh National Economics and Social Development Plan. Under such condition, it is a major subject of the province to rehabilitate the flood-affected areas and to conduct the areas to a sustainable agriculture with soil and water conservation.

The main subject for plan formulation is the improvement of the deposited soil including gravel and debris, the preparation of agricultural infrastructure and the establishment of new farming techniques after land rehabilitation. The plan and strategy for soil improvement should be practicable at farmer's level as a part of daily farming, taking account of the ways of soil and water conservation and soil productivity in the process of soil improvement. For infrastructure planning, the way of improvement should be workable with moderate improvement level at an administrative level.

To strengthen measures for conservation of forest areas in the Chawang river basin, present rubber plantation in the mountain and hill should be managed under a basic concept of basin-wide watershed management designed by NEB. In general, structural and agricultural measures are required for soil and water conservation of forest area. In a structural measure, comprehensive survey in forest area has to be conducted for planning, and large scale project with higher investment at national level has to be implemented. In the study, therefore, conservation planning will be putting stress on an agricultural measure.

Based on the above concept, the following project components are proposed through master plan study.

- Improve the low fertile soil in the sediment deposited area for introduction of suitable crops.
- Alleviate the inundation damage by preventing flood intrusion from Chawang river.
- Improve the infrastructural facilities at farm level for soil and water conservation and effective farming.

- Strengthen the present farmer's organizations and supporting services for propagation of farming techniques including soil improvement.

Considering cost-benefit of the project components, much investment will be required for the agricultural production to reach the level before disaster, as compared with other ordinary areas. Therefore, the project will be justified, considering not only agricultural benefits after land rehabilitation, but also the comprehensive prospect of conservation of natural resources.

6.1.2 Land Use and Subdivision of Sediment Deposited Area

(1) Basic concept for land use

Agricultural land use in the sediment deposited area has to be considered together with the possibility of soil improvement. If soil improvement is possible, fruit tree farming could be mainly introduced, from viewpoint of the followings.

- In the province, agricultural development is directed to crop diversification into fruit tree and upland crop farming from mono-culture of rice and para rubber.
- Farm management in the area before and after disaster is based on the rubber and fruit tree plantations.
- Most farmers have a traditional farming techniques for planting fruit trees. They are also positive towards an investment in an irrigation system for cropping.
- The affected area is well-known as a productive area of fruit trees which are consequently marketable and profitable.

(2) Subdivision of the sediment deposited area

The area is subdivided based on the local conditions including soil feature and the present rehabilitation plans/projects (see Figure 1-5).

Upper stream area;

Coarse sand, gravel and debris brought by landslide are deposited in this area. The depth is relatively deep. First priority for land rehabilitation will be given to the soil/soil layer improvement.

Middle stream area;

This area is located along the meander in both sides of the river. The depth is shallower, but the area is apt to suffer from flood. For land rehabilitation, flooding condition will have to be improved.

Down stream area;

This area is located close to the town of Ban Na San. Deposited soil is distributed widely, of which the depth is relatively shallow. At present, rubber and fruit tree farming is practiced as before since the agricultural land was less damaged than the above two areas. In the part of the river, the improvement has been completed. Therefore, land rehabilitation is not so necessary as the upper and middle stream areas.

Based on the above subdivision and consideration, a basic development plan is formulated for the upper and middle stream areas.

6.1.3 Alternative Development Plans

Based on the subdivision of the area and the anticipated project component, the following alternative plans are considered.

Case-1 : Agricultural land is rehabilitated with full scale river improvement to prevent flood intrusion from Chawang river. It is possible to introduce fruit trees to the rehabilitated area, since flood damage will be alleviated by the river improvement.

Case-2 : The river improvement of the case-1 will require much investment and will take long-term implementation period. For preventing flood intrusion, therefore, only embankment is constructed at the necessary locations along the Chawang, as an alleviating measure of flood intrusion. In this case, however, the river remains deposited sandy soil. Inundation condition in the agricultural land will not be alleviated fully due to insufficient flow capacity of the river. Therefore, fruit tree planting in the middle area will be restricted only to the higher elevation parts.

Study results of each case are summarized in the following subsections.

6.2 Land Use

6.2.1 Basic Concept

Land use is planned by taking account of the deposited soil properties, ways of soil/soil layer improvement and alleviating measure of flood, as follows.

Subdivided area	Case-1	Case-2
Upper stream	fruit tree	fruit tree
Middle stream	fruit tree	fruit tree, upland crop, pasture

In the middle stream area of the case-2, fruit tree is planned in higher elevation area. Upland crops may be cropped in the remaining area, taking account of inundation condition. Low lying area near the Chawang will be used as a grass land, since rehabilitation of the low-lying area is not suitable for fruit trees and upland crops due to possible prolonged inundation.

6.2.2 Land Use Area

Land use is planned under the following concepts based on the anticipated inundation and groundwater conditions.

- Possibility of fruit tree planting is dependent on inundation and groundwater. Acceptable inundation condition is different for tree types and tree height. In general, however, duration of inundation is desirable to be less than one (1) day. The inundation condition will be alleviated by river improvement and embankment, to some extent, and flooding period is not so long. But, groundwater will still remain the constraint for planting fruit tree. Groundwater level has to be maintained to be more than 1.0 m below ground surface. Therefore, fruit tree will be introduced in an area under the condition of such groundwater level.
- In the area where groundwater is less than 1.0 m below surface, it is difficult to plant fruit trees. Then, such area will be used as upland crop land except for seasons of heavy rain from viewpoint of flood-affected farmer's economy.
- The area along the Chawang river under prolonged inundation where groundwater is less than 0.6 m below surface and deeply sediment deposited, will be used as grassland. In the areas for upland crops and grass, soil will be improved gradually by continuous supply of organic matter from planted crops.
- Gravel, rock and wood debris are deposited deeply in some parts of the area. Such areas are defined as difficult area for agriculture.
- Based on the above consideration, land use area is estimated by using present topo-map (scale is 1/50,000), distribution map of sediment deposited soil and typical cross section of Chawang river.

Based on the above concepts, land use of each case is planned as follows.

Unit: rai

Area	Present Condition		Plan (case-1)		Plan (case-2)	
	Crop	Area	Crop	Area	Crop	Area
Upper stream area	Waste land	614	Fruit tree	555	Fruit tree	555
			Others*2	59	Others*2	59
	Fruit tree*1	415	Fruit tree	403	Fruit tree	403
			Others*2	12	Others*2	12
Middle stream area	Waste land	1,276	Fruit tree	1,148	Fruit tree	255
			Others*2	128	Upland crop	510
					Grass land	383
					Others*2	128
Total	Waste land	1,890	Fruit tree	2,106	Fruit tree	1,213
	Fruit tree*1	415	Others*2	199	Upland crop	510
					Grass land	383
					Others*2	199
Total		2,305		2,305		2,305

Note *1 : After disaster, trees were planted. But, the growth is poor due to no soil/soil layer improvement. Therefore, improvement will be needed in future.

*2 : This area is designated as public lands, a difficult area for agriculture.

6.3 Agricultural and Rural Infrastructure Improvement

6.3.1 Irrigation Improvement

In and around the area the existing irrigation practice, i.e., pumping water from Chawang river and its tributaries to irrigate fruit trees through a low-head sprinkler system, is reckoned as practical and suitable except for the need for some improvement in small scale water resource, not to mention that sprinkler irrigation is also a functional method to regulate humidity under the canopy during flowering.

According to the result of the irrigation water demand and supply pattern, supply exceeds demand from September through November, and for the other months, especially from January through March, the reverse is true (refer to Figure 1, E-2, Appendix E). A rough estimation shows that the study area is short of irrigation water by about 700 mm per year (refer to Table 1-A, E-1, Appendix E). Since irrigation is crucial for rambutan and durian during the flowering months, which coincides with the critical dry months, stable water supply during dry season has been an acute concern.

To improve water shortage a weir as mentioned in 4.4.1 and a pipeline system are effective to extract water and supply it. The farmers will pump water using their own facility (pumps), and feed it to sprinklers, from the turn-out of the pipeline as they do now from the rivers.

Reckoning these condition the following are outlined as the basic irrigation improvement approach for fruit trees in the restored land.

- Like the existing situation, low head sprinkler system using pumps is introduced.
- Water from the natural streams and farm pond are the only easily available water resource.
- Small intake weir in the natural streams and construction of farm ponds are adopted as the essential measures to stabilize water supply. Water is channeled and stored in farm ponds by pumping and irrigation ditches.

(1) Use of small intake weir

Aside from the intake weir in Mui river, two other intake weirs, one each in Nung river and Ha Nua river, are incorporated to stabilize water supply.

(2) Farm pond construction plan

Small scale farm pond should be constructed to meet the shortage of 700 mm annually, and it will be used about 5 times a year. The scale of the pond is as follows.

Capacity V = (width) 25 m × 25 m × (depth) 2 ~ 3 m = 1,250 ~ 1,875 m^3

6.3.2 Drainage Improvement

In the area, drainage improvement is planned in a two-step approach, (1) on-farm drainage improvement and (2) drainage improvement of Chawang river.

(1) On-farm drainage improvement

From the field survey, it is understood that durian leaves turn yellow or brown after 2-3 days in stagnant water and the trees die after 4-7 days in inundation. Rambutan trees can withstand inundation better, up to 7-15 days. Rubber trees can endure even better in floods. For tree crops drainage requirement is more severe for nursery and young tree, and thus 1/10 probability (exceedence) daily rainfall drained daily is proposed as the drainage requirement at an on-farm level.

Since most of the arable land exist in a belt of 1-2 km wide along the flood plain of Chawang river and its tributaries, on-farm drainage system will be planned in detail in restoration program as below.

- Collecting canal
  Collect drainage water from field plots and drain into drainage canals or directly into Chawang river or tributaries.
- Drainage canal
  Drainage water from the collecting canals flows directly into Chawang river or tributaries.

These drainage plans at the on-farm level are discussed in connection with the farm land conservation plan.

(2) Drainage improvement of Chawang river

Drainage improvement of the Chawang river should be considered separately for the upstream, middle stream and downstream regions, due to the difference in topography, flood phenomena, land use and flood effects on socio-economy (see Figure 1-6).

1) Upstream region (hilly region) drainage improvement
   Rocks, boulders and in some places exposed bedrocks are found in the riverbed and side of the upstream region (elevation > 100 m), implying that there is not much of a need for structures such as drops to reduce velocity, ground sill or mattress (gabion) works to stabilize the riverbed. The riverbed is relatively narrow, deep and with steep banks. Flow is shallow in dry season (10-15 cm was observed in July, 1994). Field observation also showed that water level reaches to about 1-2 m in the rainy season. Except for the river banks at the meanders, bank revertment and spur dike to arrest bank erosion are not necessary. Since there is not much agricultural activity going on in this area, low flow works for irrigation are not important.

   Since appropriate sites with pockets large enough for a large scale sabo dam are limited, construction of a series of debris barriers (small scale sabo dam, check dam) in the upstream region will help to contain debris flow and reduce flood disaster.

2) Middle stream region (alluvial fan) drainage improvement
   Due to the typical geomorphological features, the middle stream region (elevation < 100 m and before the railway crossing) is the "natural sediment reservoir" for Chawang. This is proven by the fact that boulders and rocks brought by the flood in

1988 are confined to the area at and around the confluence of Mui and Chawang rivers.

To protect the settlements along the natural streams and agricultural land from flooding and to rehabilitate the sand deposited arable land, the following two cases are proposed and compared hydraulically (refer to Table 8 and 9, E-11, Appendix E).

Case-1 : Dredging riverbed + dike construction on either or both banks

Case-2 : Dike construction only. Without riverbed dredging

Type	Case-1	Case-2
Riverbed width (m)	30-40	Existing
Cross-section	Compound	Existing
Water depth (m)		
- minor section	1.0	-
- major section	2.8-3.5	-
Profile gradient	1/83-1/670	Existing
Design discharge (m^3/s)	550-1,041	550-1,041
Length (m)	16,543	16,543
O & M road width (m)	4.0	4.0

Hydraulic speculation was based on the boundary conditions of the section improved by RID: compound section, minor bed width 40 m and design discharge 1,041 m^3/s. The results show that the difference in flood level between the two cases is small (refer to Figure 7, E-9, Appendix E). In some locations, flood level of Case-1 is higher than that of Case-2. This could be attributed to the fact the flow sections of Case-1 are much smaller than those of Case-2. From the results, it is anticipated that the middle stream (alluvial fan) of Chawang river has a discharge capacity large enough to accommodate the design flood, provided that dikes are built to contain the flood as speculated in Case-2. Quantity on dike construction is shown in Table 15 and 16, E-14, Table 19 and 20, E-16, Appendix E.

Short-cutting the meanders in the alluvial fan of Chawang river might help to mitigate flood problems. However, in view of the fact that structures such as railroad crossings, bridges at the major roads (route 41, 4009) and the expanded section completed by RID could likely be the critical sections, and assuming that they cannot be reconstructed, the effects of peak discharge concentration at these structures will have to be studied before proposing any shortcuts.

3) Downstream region (alluvial plain) drainage improvement

Redredging of about 6 km of Chawang river from the railway crossing to route 41 (Asia Highway) is currently under execution by Amphoe Ban Na San, in collaboration with RID. In the downstream area, especially near the confluence of Chawang and Ta Pi, inundation is a yearly phenomena. Therefore, redredging should be accompanied by detail study to ensure proper flood improvement.

6.3.3 Rural Infrastructure Improvement

Route 9012 is the only asphalt-paved road in the middle stream. The condition of this main village road is relatively good, except for the stretch of pot holes downstream of Wat Kan Te Ram. This road requires maintenance works such as patching, surface treatment and overlay. Asphalt pavement is proposed for about 3.3 km of the road on the left dike of Chawang river, which was constructed when improving the riverbed. The road is now used as the village road, linking the settlements in the area to route 4009 and bypassing the township of Ban Na San. The present condition of the road is poor. Traffic volume is expected to increase as the area develops.

Except for the lateral road which branches out from route 9012 and leads to Ban Huai Hun, most of the lateral roads are laterite roads. The present condition of these roads is poor. It is therefore proposed here that these roads should be paved with low cost sediments such as gravel, broken stones and sand (refer to Figure 17, E-24, Appendix E).

6.4 Soil/Soil Layer Improvement

6.4.1 Land Classification for Improvement Plan

Sediment deposited land is classified, by considering depth of deposited soil, soil structure, existence of gravel, mottling and soil texture of top soil. Besides the above, the followings are considered for basic approach of classification.

1) The area is basically rehabilitated for fruit trees and upland crops.
2) Difficulties in improvement depend on the depth of sediment.
3) For soil improvement, physical and chemical properties of soil should be considered.

Based on the above consideration, sediment deposited area is classified into four classes (refer to Table 1-2).

6.4.2 Soil/Soil Layer Improvement Method by Land Classification

(1) Soil improvement measure

The productivity of agricultural land is dependent on physical, chemical, and biological properties of soil. Improvement measures and its effects in Ban Na San are summarized by their properties, as follows.

Soil Improvement Measure	Expected Effect
1. Soil Physical Property	
- Mulching organic material residue	Supply nutrients Improvement soil structure Increase amount of soil water retention
- Growing cover crops	Protect soil erosion Maintain soil structure Increase amount of soil water retention
2. Soil Chemical Property	
- Adding calcareous material	Correct soil acidity
- Continuous input of organic compost	Maintain and increase soil fertility Increase soil buffer action
- Application of slow release fertilizer	Release nutrients Increase crop production
- Soil dressing of clayey soil on farm land .	Increase nutrient holding capacity Increase soil buffer action
3. Soil Biological Property	
- Growing leguminosae crops	Supply nitrogen by nitrogen fixation

(2) Soil layer improvement measure

Soil layer improvement measure is to improve soil structure by means of inputs of suitable soil or improvement materials, plowing of soil and gravel removal.

In the case of shallower deposited depth, class Ⅰ and Ⅱ in Table 1-2, DLD and the farmers have been tried to improve the soil by following ways.

- Input of new suitable soil distributed in and around the deposited area.
- Removal of deposited soil.
- Application of improvement materials at spot of planted seedling.

In the deeper deposited depth, class Ⅲ and Ⅳ, soil layer has to be improved by using machine for planting trees and crops. The improvement measures considered are as follows.

- Removal of gravel : Remove rock, gravel, wood debris for effective cultivation.
- Replacing deposited soil with new good soil : Replace all of the deposited soil in the hole for trees plantation with new good soil.
- Exchange deposited soil with lower original soil.
- Soil dressing on the ground surface without replacement : Place a layer of new clay soil on top of the deposited soil.

The methods of soil and soil layer improvement is shown in Table 1-3.

6.4.3 Improvement Area by Land Use

Based on the alternative land use plans, the improvement area is estimated by land classification, as shown in Table 1-4.

6.5 Farm Land Conservation

6.5.1 Basic Concept

In order to practice sustainable agriculture with soil improvement on the rehabilitated land, some soil and water conservation measures have to be taken at farm level. For planning of structural measure for the area, the followings are required considering the present land conditions.

- Construction of ditch and collecting canals with moderate intervals
- Construction of appurtenant structures such as check and weir for water management and prevention of soil loss
- Construction of farm roads for effective farming and prevention of soil erosion

Improvement level has to be determined by considering future land use, farmer's intention of practicing tree cropping and present land conditions. For the most effective soil and water conservation, realignment of farm plots and land leveling are required. These measures, however, are not practical because of requirements of high investment and farmer's consent. Accordingly, canals and roads will be planned along the present boundary of plots.

6.5.2 Facilities Plan

The facilities are planned based on the land slope, cultivation method and soil properties. The slope of sediment deposited area is estimated at an average of less than three degrees, based on the remote sensing analysis. Therefore, an interval of road and canal is planned as follows.

Facilities	Land slope	
	around 3°	around 1°
Canal intervals		
- Ditch	100m	200m
- Collecting canal	300m	500m
Farm road	along collecting canal	

In junctions of canal and crossing of farm road and canal, small structures such as check and weir are planned for soil and water conservation. Those facilities are introduced evenly for both alternative plans.

6.6 Farming

Fruits, upland crops and pasturage will be introduced in the deposited area, but they are determined by inundation frequency and groundwater level in the fields as mentioned in 6.2.

Fruits will be cultivated in the fields where groundwater level is deeper than 1.0 m, and then the soils and subsoils will be improved not withstanding the depth of deposited soil. Upland crops and vegetables, as well, will be cultivated in lowlands beside the river, there groundwater level is deeper than 0.6 m. While, pasture grasses will be planted in the fields with difficulty of soil and subsoil improvement due to higher groundwater level and higher density of sandy gravel.

6.6.1 Fruit

Vegetative fruits in these areas are rambutan, durian, mangosteen, long kong, saraka and so on, whose cultivation will help to gain stable incomes for farmers. Only for mangosteen and long kong, mixed cultivation with cover trees such as rubber and rambutan are required in their nursery period. The outlines of cultivation methods of major fruit trees are summarized as below:

(1) Rambutan

Planting density needed is 10 m × 10 m or 16 trees per rai. Fertilizer N15:P15:K15 is applied for 0.5 kg per tree in the 1st crop year, 1.0 kg in the 2nd and 1.5 kg in the 3rd. In this manner, fertilizer applied will be 7.5 kg in the 15th year, resulting in increase of 0.5 kg per year. Though the farmers rarely use agricultural chemicals presently, pesticides are applied during occurrence of disease and insect damages. Rambutan fruits ripen at 130 to 160 days after flowering and can be harvested in the 4th year since its planting. Under normal soil condition, the following yields are expected (refer to Table H-8-1, Appendix H).

Year	4	5	6	7	8	9	10
Yield (kg/rai)	115	580	746	1,067	1,213	1,233	1,252

(2) Durian

Planting density is 10 m × 10 m or 16 trees per rai. Fertilizer N15:P15:K15 is applied for 0.5 kg per tree in the 1st to 3rd crop year, 1.0 kg in the 4th year, 1.5 kg in the 5th, 2-3 kg in the 6th. Durian can be harvested in the 5th year and the following yields are expected (refer to Table H-8-2, Appendix H).

Year	5	6	7	8	9	10
Yield (kg/rai)	250	1,000	1,500	2,300	2,500	2,500

Durian ripens at 122 to 130 days after its flowering. Since the root of durian is easy to rot, water management and soil/soil layer improvement have to be considered than the case of rambutan.

(3) Mangosteen

Planting density is 8 m × 8 m / 10 m × 10 m or 25/16 trees per rai. Applied fertilizer is N14:P14:K14, N15:P15:K15 or N16:P16:K16 and applying quantity is 0.5 kg in 1st crop year, 1.0 kg in 2nd, 1.5 kg in 3rd, 2.0 kg in the 4th and 2.0 kg or a little more in the following years. Harvest will start in the 7th crop year and the following yields are expected.

Year	7	8	9	10
Yield (kg/rai)	160	480	960	1,120

Mangosteen fruits ripen 120 days after flowering and covering plant is required between the trees (refer to Table H-8-3, Appendix H).

6.6.2 Upland Crop, Vegetable, and Pasturage

(1) Suitable crops

Upland crops : sweet corn, baby corn, peanut, mungbean, etc.
Vegetables : chilli, watermelon, cucumber, kang kong, ginger, yard long bean, pumpkin, etc.

(2) Farming practice of major upland crops and vegetables

1) Planting density of sweet corn is 70 cm (row width) × 50 cm (intrarow spacing) or 4,226 stocks per rai. Twenty-five (25) to thirty (30) kg/rai of fertilizer N15:P15:K15 as basal dressing and 25 kg/rai of urea as side dressing are applied. The expecting yield is 4,000-8,000 kg. Sweet corn matures at 70 days after seeding and can be harvested four times annually except in disaster-stricken areas (refer to Table H-7-1, Appendix H).

2) Peanut is seeded in May to August and harvested in August to September. The planting density is 50 cm (row width) × 25 cm (intrarow spacing) or 12,800 stocks per rai. Twenty-five (25) to thirty (30) kg/rai of fertilizer N12:P24:K12 are applied as basal dressing. The average yield is 200 kg/rai, but changes yearly (refer to Table H-7-4, Appendix H).

3) Planting density of chilli is 50-70 cm (row width) × 50 cm (intrarow spacing) or 4,000-6,000 setting stocks per rai. Chilli can be cultivated all year round. Harvest is at 80-100 days after seeding. Twenty (20) to twenty-five (25) kg/rai of fertilizer N13:P13:K21 as basal dressing is applied, and then urea is given when flower buds appear. The yield is 200-400 kg/rai in dry weight (refer to Table H-7-6, Appendix H).

4) Planting density of cucumber is 60 cm (row width) × 30 cm (intrarow spacing) or 8,000 stocks. Cucumber can be also cultivated all year round. Harvest is at 1.0 month after seeding and harvesting period is 30 days. Fertilizer N15:P15:K15 as basal and side dressing are applied for 50 kg/rai. The yield is 4,000 kg/rai (refer to Table H-7-10, Appendix H).

(3) Pasturage

The pasture grass will be mix-seeded with gramineous and leguminous plants. Soil in grasslands will be improved gradually. Should the grass be utilized for animal production, the stable manure is applied for fruit and vegetable cultivation.

6.7 Strengthening Program for Farmer's Organization and Agricultural Supporting Services

6.7.1 Strengthening Program for Farmer's Organization

The farmers organizations are important in playing linkage between the farmers and the government agencies. In order to achieve the goals of project, development of capable farmers organization is indispensable and urgent. Considering the present condition on farmer's organization as mentioned in 4.3.6, the followings are the major strengthening program.

- To promote training and development of administration and management capability for members and leaders of the farmer group and executives of ACs, to make these organizations more practicable.
- To promote special program for creation of qualified leaders of farmers and to encourage the present active informal farmers groups to be registered groups.
- To encourage farmers to establish organization of producer groups such as, fruit tree groups, rubber groups and other rural organizations relevant to promotion of crop production, with the technical assistance from the agencies concerned.
- To promote ACs at amphoe and tambon levels to take part in implementation of the government's agricultural supporting programs when ACs could establish proper administrative capability.
- To provide strong back-up body at provincial and/or national levels in supply of inputs to ACs and registered farmers groups with quality assured and reasonable price, and other assistance to the ACs and farmers groups, if necessary, including technical and financial issues.

6.7.2 Agricultural Supporting Services

Agricultural supporting services cover quite broad scopes of activity among which recommendations on use of certified seeds, fertilizers and chemical products are the most essential works which can affect the cost of crop production and farmer's profit to a great extent. The major problems in agricultural production development in the area may be summarized as follows.

- Weakness in technical know-how
- Low crop yield
- Poor physical condition
- Low and/or not uniform quality of product

- Inadequate agricultural credit
- Weakness in marketing skills and lack of marketing information

The proposed project aims at increasing agricultural production together with soil improvement and conservation for stabilizing the farm economy through sustainable utilization of land resources. In order to enable agricultural supporting services to attain objectives as aforementioned, the basic plans dealing with the following measures are deemed as necessary.

a) To provide farmers with consultation services and/or demonstration works on modern cultivation method, use of major farm inputs, selection of cropping pattern, grading of fruit, harvesting, land use and soil improvement/conservation.
b) To assure source of farm inputs with certain quality, reasonable price and in-time supply.
c) To control farm products at a standard grading in order to maintain the quality of products as well as to protect the farmers' marketing profit.
d) To expand lending capacity of BAAC and ACs with low interest rates to cope with future requirement of land rehabilitation and conservation project.
e) To promote marketing business and to provide updated marketing information related to market demand of each type of products.

For an effective implementation and strengthening farmers' organization, project operation should have technical assistance in the form of a technical advisory group to provide technical services for the project unit task force. A technical advisory group should be staffed with subject specialists of different fields such as, horticulture, agricultural extension, soil improvement and conservation, farmer's organization, marketing and agricultural credit. Technical service activities advised by these specialists should be planned as an agricultural supporting project.

Aside from the above mentioned group, local officers in coordination with project unit task force and technical advisory group would work together with the local farmer's groups with respect to their specialized fields.

6.8 Proposed Projects

6.8.1 Project Components

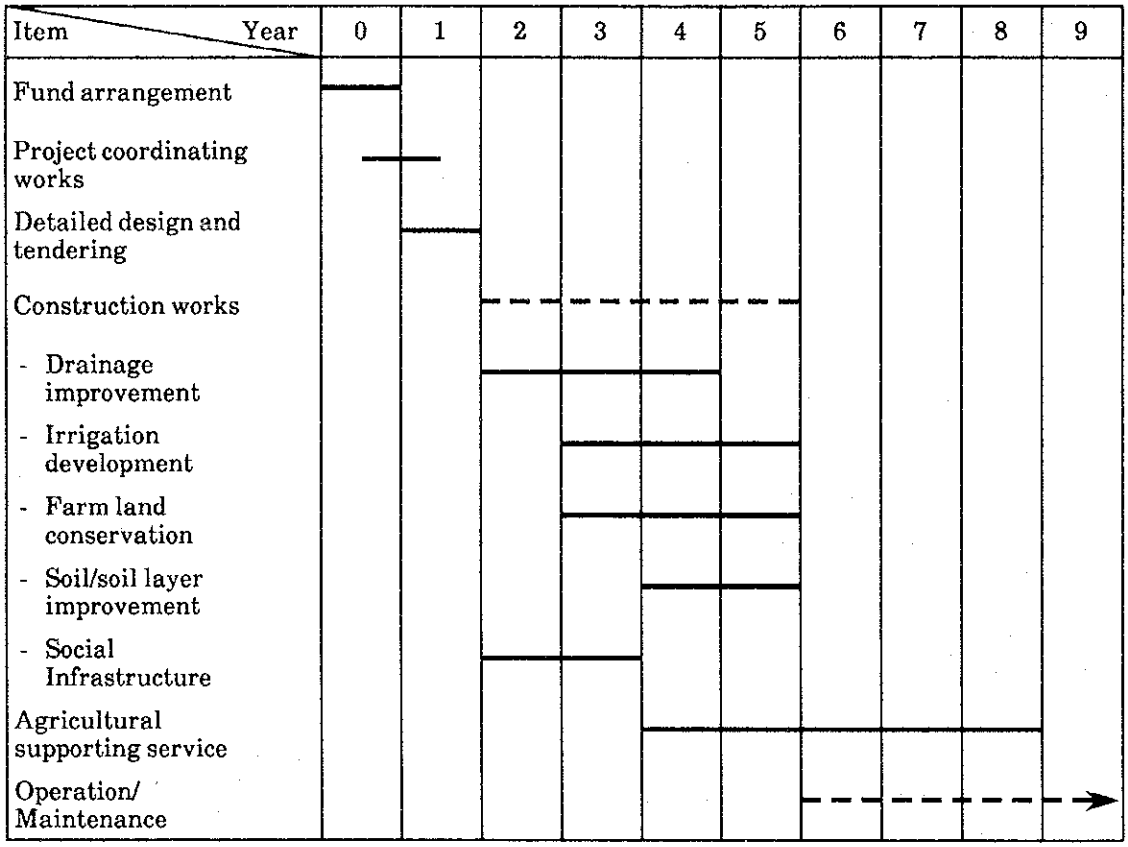
The following projects are proposed based on the above development plans.

Projects	Quantity	Case-1	Case-2
Drainage improvement			
- River improvement	m	16,500	-
- Construction of embankment	m	-	13,900
Irrigation system development	rai	2,106	1,213
Farm land conservation	rai	2,305	1,723
Soil/soil layer improvement	rai	2,106	1,723
Social infrastructural improvement			
- Road improvement	m	10.7	10.7
Agricultural supporting activities	set	1	1

The above projects are implemented under the MOAC. Especially, drainage improvement is done by RID. The others have to be implemented by DLD, DOAE and the other agencies concerned. For smooth implementation, some committees have to be organized under the MOAC, and DLD is assigned as a coordinating agencies.

6.8.2 Project Implementation Program

After completion of the feasibility study, project implementation schedule is planned for the area. First priority of implementation is given to the selected priority project area. Following the priority area, the proposed projects are scheduled for the deposited area. Considering the quantity and characteristics of the projects, typical implementation schedule for each case is considered as follows.



6.9 Environmental Effect

6.9.1 Initial Environmental Examination (IEE)

In the master plan, the following implementation projects are proposed for land rehabilitation and conservation.

- Soil improvement at farm level with replacement, soil dressing and exchange
- Planting fruit trees and other crops with soil improvement
- Introduction and improvement of irrigation system at farm level
- Construction of soil and water conservation facilities at farm level
- Introduction of conservation farming for mountainous/hilly area
- River improvement such as redredging and embankment
- Rehabilitation of the farm road

Environmental impact by the project implementation is summarized in the IEE checklist. It is divided into two categories; social and natural environment (refer to Table K.2.3, Appendix K). Above projects are all small scale construction and the purpose is to rehabilitate the flood affected area and to increase efficiency in utilization of land and water resource. Therefore, the

impact on present social environment of farmers in and around the area is small as seen in the result of IEE.

On the other hand, positive impact such as increase job opportunity for enforcement of the construction, improvement of farmers living standard by agricultural development, activated rural economy, etc. can be found.

A valuable ecosystem to be preserved was not recognized based on the collected data and interviews with villagers living in the area. As a positive impact on natural environment, natural forest can be preserved by land use introduction based on the disaster prevention such as landslides. In addition to that, protection of soil surface by luxuriant growth of cover crops, and improvement of poor soil by increase of organic matter content are other examples for that.

6.9.2 Environmental Conservation Plan

Since encroachment for economic purpose has been recognized in the mountainous area, monitoring activities will be required on mountainous slopes where conservation forests regulated by the watershed classification still remain.

From a long-term view, operation of environmental conservation will decline gradually in proportion to the activated agriculture. As a result, water pollution and impact on newly formed ecosystem may increase. Therefore, establishment of environmental monitoring organization is necessary to observe these natural conditions. This organization also coordinates other related agencies to plan, device and implement environmental protection measures.

6.10 Project Justification

6.10.1 Project Cost

Based on the above proposed projects, the total project cost is estimated approximately as follows.

Unit : 1,000 Baht

Item	Case-1	Case-2
1. Construction cost		
- Drainage infrastructure	71,741	25,669
- Irrigation facilities	102,141	58,830
- Farm land conservation facilities	19,958	16,958
- Soil/Soil-layer improvement	3,765	9,105
- Branch road improvement	637	637
Sub-total	198,242	111,199
2. Detailed survey and design services	19,824	11,119
3. Agricultural supporting activities	7,500	7,500
Total (1-3)	225,566	129,818
4. Physical contingency (10% of 1-3)	22,556	12,981
Total (1-4)	248,122	142,799
5. Price escalation	12,406	7,139
Grand total	260,528	149,938

Note : Price escalation is assumed at 5.0%.

6.10.2 Economic Analysis

Economic analysis is examined from financial viewpoint, based on the estimated cost and agricultural benefit of proposed projects. The analysis is carried out by each alternative plan, considering the following cases of project implementation.

Project-1 ; The analysis is done by considering all project costs.

Project-2 ; The project cost is estimated except for the construction costs of drainage infrastructure and branch road improvement. The analysis is done by considering this estimated cost.

The result by cost benefit ratio (B/C ratio) is as follows.

Cost Benefit Ratio (B/C Ratio)

Case	Project	Discount rate (%)		
		4	6	9
Case-1 (River improvement)	Project-1	0.6	0.4	0.2
	Project-2	1.0	0.6	0.3
Case-2 (Embankment)	Project-1	1.0	0.7	0.4
	Project-2	1.3	0.9	0.5

The result shows that non quantitative effects such as disaster reconstruction or farm land conservation have to be considered, in addition to the quantitative agricultural benefit, for overall project justification.

6.10.3 Overall Evaluation

The results of economic analysis show that the economic rate of return is low, implying that the project is less feasible from the economical point of view. However, since this project is in line with the natural resources conservation policy of the Agricultural Development Plan, which is one of the pillars of the 5th National Economic and Social Development plan, it is very important that this project is implemented to ensure sustainable agriculture by restoring the devastated farmland and conserving natural resources. Furthermore, systematic restoration and effective and sustainable farming on the sand deposited land will discourage the farmers from practicing extensive and uncontrolled farming by encroaching the natural forest which have been the major causes of landslide and landslip on the mountainous slopes. This is very important since it will help to control and prevent further deterioration of the natural forest and restoration of environment.

Two alternative development plans, based on drainage improvement approach, have been studied and compared. The economic rate of return for case-2 (with embankment construction only) is better than that of case-1 (with embankment construction and dredging). Case-1 involves large scale dredging and embankment construction and entails long construction period and high implementation cost and long and will mainly be executed by RID.

Also, since the farmers, by their own resource, have started restoring some of the farmlands where sand deposition is shallow, it is necessary that agricultural supporting service, especially on soil and soil layer improvement, be provided to them as soon as possible.

Therefore, based on the above considerations, case-2 is recommended as the method for restoration and conservation.

CHAPTER 7

BASIC DEVELOPMENT PLAN FOR THE LAN SAKA AREA

CHAPTER 7 BASIC DEVELOPMENT PLAN FOR THE LAN SAKA AREA

7.1 Development Approach

7.1.1 Basic Concept and Project Components

In the province, agricultural sector is the most important part of the provincial socio-economy, same as the Surat Thani Province. It is a major subject to rehabilitate the affected areas and to restore the agricultural activities again to increase agricultural production.

The main subject for plan formulation is the improvement of low fertile deposited soil, the establishment of new farming techniques, the alleviation of flooding condition in the agricultural land caused by insufficient flow capacity of Tha Di river and the provision of infrastructural facilities for soil and water conservation. Development plan and strategy should be practicable at farmer's and administrative levels.

For conservation and management of the forest area in Tha Di river basin, present rubber and fruit tree planting area in the mountain should be managed under a basic concept of basin-wide watershed management designated by the NEB. In order to formulate a suitable conservation measures for the forest, a comprehensive survey has to be conducted. Consequently, a costly, large-scaled project at national level will have to be implemented. Development plan in the study, therefore, will be formulated putting stress on the sediment deposited area along the Tha Di river.

Based on the above concept, the following project components will be proposed through master plan formulation.

- Alleviate the flood damage in the agricultural land by preventing flood intrusion from Tha Di river.
- Improve the low fertile soil deposited on the land for planting some crops.
- Improve the infrastructural facilities at farm level for soil and water conservation and effective farming.
- Strengthen the present farmer's organization and supporting services through training and propagation of farming techniques including soil/soil layer improvement.

A lot of input will be required to raise agricultural output with land rehabilitation to a certain level. The project, therefore, will be justified, considering not only agricultural benefits but also comprehensive prospect of conservation of natural resources.

7.1.2 Land Use and Subdivision of Sediment Deposited Area

(1) Basic concept for land use

Agricultural land use in the sediment deposited area has to be considered together with improvement of soil and inundation conditions. If the improvement is possible, fruit tree farming is mainly introduced, from viewpoint of the followings.

- Taking account of agriculture in and around areas, farm management is based on the rubber and fruit tree croppings which are a main source of income for farmers.
- Lan Saka is well-known as the most productive amphoe of mangosteen in the province, where deems delicate climate condition is suitable for mangosteen production. Most farmers have a traditional technique for farming fruit trees.
- Fruits have a high marketability since the area is located close to the town of Nakhon Si Thammarat.
- Promotion of fruit tree cropping into the affected area would diminish cropping on mountainous, steep slopes. Consequently, deterioration of natural forest environment could be arrested.

(2) Subdivision of the sediment deposited area

The sediment deposited area is subdivided into the following three by considering topographic condition and present rehabilitation projects/plans (refer to Figure 1-7).

Upper stream area;

This area is located at the junction of Tha Di and Pong river. It was one of the most damaged areas where most of the houses and agricultural land had been denuded. After disaster, restoration projects such as reconstruction of houses, public facilities and river improvement, had been implemented by the agencies concerned. Almost all of the projects had been completed. Consequently, the necessity of land rehabilitation is low compared with the other areas.

Middle stream area;

The deposited area is located along Tha Di river. The depth of sediment is deep, from 100 to 150 cm, except for some parts. For agricultural land rehabilitation, the main subject is the alleviation of flood problems.

Down stream area;

This area is located on both sides of the meanders of the river. The depth of deposited soil is shallow. In the area, mixed farming of various fruit trees, upland crops and vegetables is

practiced at present. The area is apt to suffer from flooding due to insufficient flow capacity caused by the risen river bed of Tha Di.

Based on the above subdivision and consideration, basic development plan will be formulated putting stress on the middle and down stream areas.

7.1.3 Alternative Development Plans

Based on the subdivision of the area and the development purpose, the following alternative plans are considered.

Case-1 ; Full scale improvement of Tha Di river including redredging and construction of embankment, will be implemented to alleviate flood damage. Fruit tree cropping will be introduced in the middle and down stream areas, since the present inundation problem is expected to be alleviated by the river improvement.

Case-2 ; The river improvement of the case-1 will require a large investment and a long-term implementation period. Also, the improvement plan/project has to be examined taking account of a comprehensive drainage system of Tha Di river designed by the RID. In order to cope with severe flooding, in this case, embankments will be constructed at necessary locations in the river, as an alternative measure. However, the river remains deposited sandy soil and insufficient flow capacity, which will restrict fruit tree planting.

Study results of each case are summarized in the following sections.

7.2 Land Use

7.2.1 Basic Concept

Land use planning is formulated as follows, by taking account of flooding and topographic conditions.

Anticipated inundation damage	Land classification (elevation)	Land use
Small	High	Fruit tree
Medium	Medium	Fruit tree with raising bed
Large	Low	Upland crops (except for heavy rainy season)

Degree of flood damage is dependent on the improvement level of drainage facilities. In the area, raising bed is constructed for planting fruit trees, which is effective to mitigate inundation damage on root system during rainy season. The height is considered to be about 0.5 m, based on planting density and construction cost.

7.2.2 Land Use Area

In the planning, land use area is estimated based on the concept of land use plan, same as in Ban Na San. Land use of each case is planned as follows.

Unit: rai

Area	Present Condition*1		Plan*2		
	Crop	Area	Crop	Case-1	Case-2
Middle stream area	Fruit tree/ Upland crops/ Waste land	764	Fruit tree-1	535	229
			Fruit tree-2	130	283
			Upland crops	76	229
			Others*3	23	23
Down stream area	Fruit tree/ Upland crops/ Waste land	643	Fruit tree-1	624	386
			Fruit tree-2	-	129
			Upland crops	-	109
			Others*3	19	19
Total area	Fruit tree/ Upland crops/ Waste land	1,407	Fruit tree-1	1,159	615
			Fruit tree-2	130	412
			Upland crops	76	338
			Others*3	42	42
Total		1,407		1,407	1,407

Note - Fruit tree-1 is applied in less damaged, higher elevation area and fruit tree-2 is planted on raising bed.

*1 ;Except for river bed

*2 ; Area is assumed based on the field survey and present topo-map (1:50,000), since it is impossible to classify the elevation for planning.

*3 ; includes the area of public facilities

7.3 Agricultural and Rural Infrastructure Improvement

7.3.1 Irrigation Development

Irrigation is not a common practice in Lan Saka. Except for some PVC hoses which are used to conduct water from sources such as waterfalls in the higher elevation, no major irrigation facility exists in the area. Irrigation should be promoted, especially in the restored area, since it helps to increase and stabilize yield potential and to ensure good quality harvest.

Like Ban Na San district, water demand is relatively constant throughout the year, while supply is subject to seasonal rainfall fluctuation (refer to Figure 2, E-2, Appendix E). Supply exceeds demand in October through December and for the other months, especially in February, March, and June through August, supplies fall below demand. Storing water in small scale farm ponds or pumping water from wells are practical and economical means. A rough estimation shows that the study area is in short of irrigation water by about 270 mm per year (refer to Table 1-8, E-1, Appendix E). Small scale farm pond can store water to tide over a month or two during dry season. The ponds should be filled up about 5 times to meet the shortage.

$$V = 15\ m \times 15\ m \times 2\text{-}3\ m = 450\text{-}675\ m^3$$

7.3.2 Drainage Improvement

(1) On-farm drainage improvement

Like Ban Na San district, it is determined by the drainage requirement of young orchard trees, and thus 1/10 probability (exceedence) daily rainfall drained daily is proposed as the drainage requirement at on-farm level.

Since the arable land lies in a belt of a few hundred meters in width along both banks of Tha Di and is relatively flat, the following drainage system is proposed.

- A catch drain is planned along the village road on both banks to catch surface runoff from the hill slopes. Water intercepted by these catch drains drained directly, through drainage canal into the Tha Di river.
- A dike is planned along the Tha Di to prevent flood intrusion
- At the on-farm level, drainage water from the field is drained by collecting drains which flows directly into the Tha Di river.

(2) Drainage improvement of the Tha Di river

Drainage improvement of Tha Di river should be considered separately for the upstream, middle stream and downstream regions, due to the difference in topography, flood phenomena, land use and flood effects on socio-economy (refer to Figure 1-8).

1) Upstream region drainage improvement

The riverbed and banks of the upstream region (elevation > 100 m) are rocky, implying that there is not much need for structures such as drops, ground sills or mattress (gabion) works to stabilize the riverbed. The riverbed is relatively narrow, deep and has steep banks. Flow is very shallow in the dry season. Except for the river banks at the meanders, bank revertment and spur dike to arrest bank erosion are not necessary.

Construction of a large scale sabo dam (check dam) in the upstream region, as proposed by Short-term Japanese Experts in 1989, is an ideal method to mitigate debris flow and flood disaster. However, since appropriate sites with pockets large enough for the construction of a large scale sabo dam are limited, construction of a series of small debris barriers will help to contain debris flow and reduce possible flood disasters.

2) Middle stream region drainage improvement

Due to the typical geomorphological features (cone-shape valley), the middle stream region (elevation < 100m) is the natural sediment reservoir for the Tha Di river. This is proven by the fact that most of the sedimentation occurred at the upstream of route 4015. To protect the villages and agricultural land from flooding and to rehabilitate and conserve the sand deposited arable land, the following two cases, as proposed in 7.1, are compared hydraulically (refer to Table 10 and 11, E-12, Appendix E).

Case-1 : Dedredging and Expanding riverbed and dike construction.
Case-2 : Dike construction only. Without riverbed improvement.

Type	Case-1	Case-2
Riverbed width (m)	160-80	Existing
Cross-section	Simple	Existing
Water depth (m)	3.1-4.0	2.5-8.1
Profile gradient	1/250-1/1,200	Existing
Design discharge (m^3/s)	1,184-1,364	1,184-1,364
Length (m)	15,000	15,000
O & M road width (m)	4.0	4.0

Hydraulic speculation was based on the boundary conditions of the upstream section improved by RID: simple section, bed width 80 m (refer to Figure 6, E-8, Appendix E). The results show that the difference in flood level between the two cases is large; in about 8,000 m of the lower reach flood level of case-1 is much lower than that of case-2, indicating the possible advantage of riverbed improvement (refer to Figure 8, E-9, Appendix E). However, riverbed improvement entails the following problems.

- Large volume of cut work (river bed) is required.
- Structures such as railroad crossing, bridges in the downstream region and in the township of Nakhon Si Thammarat could likely be the critical sections of the larger deluge resulting from riverbed improvement in this area..

Short-cutting the meanders of Tha Di river might help to mitigate flood problem in this region. However, like in Case-1, crossing structures further downstream could become the critical sections and there is the danger of increasing flood damage in the downstream region and township of Nakhon Si Thammarat. Therefore a short-cut is only feasible on condition that the drainage capacity of these crossing structures and downstream channels of the Tha Di are improved.
Quantities on dike construction is shown in Table 17 and 18, E-15, Table 21 and 22, E-17, Appendix E.

3) Downstream region drainage improvement
Under the flood relief program, RID is currently implementing the drainage improvement of the 5 effluences of Tha Di river. Drainage will improve after completion of the improvement project. This will help to reduce the inundation problem of the downstream region, which is currently subject to days of flooding in almost every rainy season. Also, completion of this project is a prerequisite when considering short-cuts in the middle stream region.

7.3.3 Rural Infrastructure Improvement

The major road on the right bank, paved with asphalt and concrete after the 1988 flood, is a "two-lane" road. The condition of the road is relatively good. Patching works are necessary to fill up the occasional potholes. The stretch of road, about 1.7 km, in the upstream region of Ban Kiri Wong, should be paved with asphalt to ensure stable and easy access (refer to Figure 18, E-25, Appendix E).

The condition of the village road on the left bank, which is a single-lane road, is poor. It is paved with low cost sediment pavement for some portions. Since many villages are located along

this road and most of its length is unaffected by flooding, it is proposed that the whole length of this village road, about 6 km or at least up to Ban Kiri Wong, should be paved with asphalt. However, raising the road by filling-up the ground is necessary when the height of the road surface at depressions is low and subject to occasional flooding. Since it is a single-lane road, passing places are necessary to ensure safe and smooth traffic. The lateral road at Ban Na Bot, about 500 m, should be expanded and the alignment be improved.

7.4 Soil/Soil Layer Improvement

7.4.1 Land Classification for Improvement Plan

Sediment deposited land is classified into four parts, same as the Ban Na San, by considering depth of deposited soil, soil structure, existence of gravel, mottling and soil texture of top soil. Besides the above, the following is considered for basic approach of classification.

1) The area is mainly rehabilitated for fruit trees.
2) Difficulties in improvement depend on the depth of sediment.
3) For soil improvement, physical and chemical properties of soil should be considered.

The basis of soil and depth for each class is shown in Table 1-5.

7.4.2 Soil/Soil Layer Improvement Method by Land Classification

(1) Soil improvement measure

Considering physical, chemical, and biological properties of soil, improvement measures applied in this area is same as in Ban Na San (refer to 6.4.2).

(2) Soil layer improvement measure

Soil layer improvement measure is same as in Ban Na San. In the case of shallower deposited depth, class Ⅰ and Ⅱ, the farmers have tried to improve the soil by removing deposited soil. In the deeper deposited depth, class Ⅲ and Ⅳ, soil layer has to be improved by the following methods.

- Replacing deposited soil with new good soil.
- Exchange deposited soil with lower original soil.
- Soil dressing on the ground surface without replacement.

These measures have to be taken concurrently with making raising bed.

The methods of soil and soil layer improvement of (1) and (2) in each class is shown in Table 1-6.

7.4.3 Improvement Area by Land Use

Based on the alternative land use plans, improvement area is estimated by land classification, as shown in Table 1-7.

7.5 Farm Land Conservation

7.5.1 Basic Concept

In order to practice sustainable agriculture with soil improvement on the rehabilitated land, the soil and water conservation measures have to be taken at farm level. In the area, taking account of topography, irrigation/drainage and farming, the following facilities are constructed.

- Ditch and collecting canals for smooth drainage and prevention of soil erosion.
- Raising bed for alleviation of inundation damage.
- Appurtenant structures such as check and weir for soil and water conservation.
- Farm road for effective farming.

Those facilities are installed, taking account of the present boundary of farm plots and land use plans.

7.5.2 Facilities Plan

The facilities are planned based on the land slope, cultivation method and soil properties. The slope of the sediment deposited area is estimated averagely at of less than three degrees, based on the remote sensing analysis. Therefore, an interval for road and canal is planned as follows.

Facilities	Land slope	
	around 3°	around 1°
Canal intervals		
- Ditch	100m	200m
- Collecting canal	300m	500m
Farm road	Along collecting canal	

In the junction of canal and crossing of farm road and canal, small structures such as check and weir are planned for soil and water conservation. Raising bed is also planned at 4.0 m wide, 0.5 m high and an intervals of 9.0 m as the same planting density as in the higher elevation area without bed. Those facilities are introduced evenly for both alternative plans.

7.6 Farming

Though the sediment deposited soils are composed of fine and coarse sand, soil/subsoil can be improved by means of plowing or tilling because the subsoils consist of silt loam and silt cray loam. However, organic matters should be provided due to lack of basic constituent.

Fruit cultivation will be introduced in the higher areas with more than 1.0 m depth of groundwater level. In the medium areas, high ridge cultivation will be proposed to keep the groundwater depth with above 1.0 m, and fruit trees could be planted. Cultivation of upland crops and vegetables in low areas, which is easily affected by inundation, are introduced in January to September except the rainy season during October to December.

7.6.1 Fruit

The kind of vegetative trees are mangosteen, durian, long kong, banana, young coconut, mango and betel nut, considering marketability and profitability. Mangosteen and long kong need shading crops such as rubber, rambutan, banana, bamboo, etc. Cultivation and management methods of major fruits are mentioned in 6.6, so only long kong described here as other fruits.

Planting density of long kong is 8 m × 8 m or 25 trees per rai. Fertilizer N15:P15:K15 is applied for 0.2 kg per tree in the 1st crop year, 0.5 kg in the 2nd, 1 kg in the 3rd, 2 kg in the 4-5th, 3 kg in the 6-7th. For the following years, applying fertilizer will increase at 1 kg per year. The harvest will start in the 8th year and the yields are expected as follows:

Year	8	9	10-11	12-13
Yield (kg/rai)	250	500	750	1,250

7.6.2 Upland Crop and Vegetable

(1) Suitable crops

As well as Ban Na San, sweet corn, chilli and so on are proposed (refer to 6.6.2).

(2) Farming practices of major upland crops and vegetables

The crops, except for sweet corn, peanut, chilli and cucumber mentioned in 6.6.2, are described below. Each crop is designated a cropping period between January and September.

1) Cultivating period of mungbean is from May to June for seeding and from July to August for harvesting. The planing density is 50 cm (row width) × 50 cm (intrarow spacing) or 12,800 to 38,400 stocks per rai. Fertilizer N12:P24:K12 is applied for 25-30 kg/rai. The average yield is 80 kg/rai (refer to Table H-7-3, Appendix H).

2) Cultivating period of baby corn is from early February to middle September for seeding and in mid March to late October for harvesting. Harvest is at 40-45 days after seeding. Planting density is 50 cm (row width) × 50 cm (intrarow spacing) or 6,400 to 12,800 stocks per rai. Fertilizer N15:P15:K15 as basal dressing is applied for 25-30 kg/rai, and urea as side dressing will be applied for 25 kg/rai. The yield is about 1,000kg/rai (refer to Table H-7-2, Appendix H).

3) Yard long bean is cultivated all year except for periods with heavy rain. Harvest is at 60-90 days after seeding. Planting density is 80 cm (row width) × 40 cm (intrarow spacing) or 5,000 stocks per rai. Fertilizer N15:P15:K15 as basal dressing is applied for 50 kg/rai. The average yield is about 3,000 kg/rai (refer to Table H-7-11, Appendix H).

7.7 Strengthening Program for Farmer's Organization and Agricultural Supporting Service

7.7.1 Strengthening Program for Farmer's Organization

Agricultural Cooperatives at amphoe level and two ACs at tambon level are the major registered farmers organizations in Amphoe Lan Saka. The major activities of ACs are short-term credit and supply of farm inputs. Some of the major constraints for further development regarding farmer's organization may be summarized as follows.

- Weakness in cooperative discipline and extension
- Lack of qualified staff
- Inadequate agricultural credit
- Lack of strong back-up body for strengthening organization

In order to solve the above problems, the following programs are required.

- To implement campaign for strengthening the present organization
- To promote training services for increasing proper knowledge on administration and management of the organization
- To supply soil and soil improvement input with reasonable price
- To encourage the present active informal farmers groups to be registered groups
- To encourage the present organization to join the project

7.7.2 Agricultural Supporting Services

In effort to strengthen supporting services in this area, emphasis should be given to technical know-how on changing traditional cultivation methods into modern cultivation technology together with soil improvement/conservation. The problems in supporting services are weak in technical know-how, poor soil condition, agricultural credit, etc, same as in Ban Na San. The basic plans consist of the following issues.

a) To provide farmers with consultation services and/or demonstration works on modern cultivation methods such as soil improvement/conservation and pest control.

b) To supply proper farm inputs

c) To control farm products for marketing

d) To expand lending capacity with low interest rate for the future implementation of rehabilitation and conservation project by farmers.

e) To promote marketing business and to provide updated marketing information related to market demand of each type of products.

For an effective implementation, project operation should have a technical advisory group to provide technical services for a project unit task force and local farmer's groups, same as Ban Na San.

7.8 Proposed Projects

7.8.1 Project Components

The following projects are proposed based on the above development plans.

Projects	Quantity	Case-1	Case-2
Drainage improvement			
- River improvement	m	15,000	-
- Construction of embankment	m	-	28,800
- Construction of drainage canal	m	8,500	8,500
Irrigation system development	rai	1,289	1,027
Farm land conservation	rai	1,407	1,407
Soil/soil layer improvement	rai	1,407	1,407
Social infrastructural improvement			
- Road improvement	km	5.4	5.4
Agricultural supporting activities	set	1.0	1.0

The above projects are implemented under the committees organized under the leadership of MOAC. Drainage improvement is done by RID. The others have to be implemented by DLD, DOAE and the other agencies concerned. DLD is assigned as a coordinating agency.

7.8.2 Project Implementation Program

Project implementation schedule is programmed for the area. First priority is given to the selected priority project area. After completion of the priority area, the proposed projects are extended to other sediment deposited areas. Considering the quantity and characteristics of the

proposed projects, implementation schedule is considered to be the same as in the Ban Na San, as described in 6.8.2.

7.9 Environmental Effect

7.9.1 Initial Environmental Examination (IEE)

In the master plan, the following implementation projects are proposed for land rehabilitation and conservation.

- Soil improvement at farm level with replacement, soil dressing and exchange, and making raising bed
- Planting fruit trees and upland crops
- Introduction of irrigation system at farm level
- Construction of soil and water conservation facilities such as drainage canal
- Promotion of farming improvement for mountainous/hilly area
- River improvement such as redredging and embankment
- Rehabilitation of the farm road

Environmental impact by the project implementation is summarized in the IEE checklist same as the Ban Na San (refer to Table K.2.4, Appendix K). The results show that the above projects are for rehabilitation and improvement of the flood affected area and resumption of farming at deposited farm land, and the impact on social and living conditions of villager and natural environment is small.

7.9.2 Environmental Conservation Plan

In case of overall riverbed improvement with redredging of Tha Di, the implementation of improvement in the study area before completion of Nakhon Si Thammarat Flood Relief Project by RID may cause some damage such as increase of run-off volume and time lag of peak discharge to the down stream area. Even though the above implementation would be completed, sediment from upstream of Tha Di has to be removed periodically.

At present, rubber and fruit trees are planted on the mountainous area of Tha Di river basin. Preservation agriculture on slopes and forest conservation in accordance with the watershed management should be introduced and extended to prevent disaster such as land slides in this area. On slopes where conservation forests still remain, monitoring activities will be required to prevent encroachment and improve land use condition. From viewpoint of

preservation of natural environment in forest, the land should be conserved through regrading forest area and granting land title to related farmers.

It is therefore, required to establish an organization which aims at environmental monitoring and management, and to perform continuously for environmental conservation.

7.10 Project Justification

7.10.1 Project Cost

Based on the above proposed projects, the total project cost is estimated approximately as follows.

Unit: 1,000 Baht

Item	Case-1	Case-2
1. Construction Cost		
- Drainage infrastructure	331,572	116,429
- Irrigation facilities	43,955	35,020
- Farm land conservation facilities	17,179	25,132
- Soil/Soil-layer improvement	3,554	4,628
- Branch road improvement	1,262	1,262
Sub-total	397,522	182,471
2. Detailed survey and design services	39,752	18,247
3. Agricultural supporting activities	7,500	7,500
Total (1-3)	444,774	208,218
4. Physical Contingency (10% of 1-3)	44,477	20,821
Total (1-4)	489,251	229,039
5. Price escalation	24,462	11,451
Grand total	513,713	240,490

Note : Price escalation is assumed at 5.0%.

7.10.2 Economic Analysis

The analysis is carried out by each alternative plan, considering the following cases of project implementation, same as in the Ban Na San.

Project-1 ; This includes all proposed projects in section 7.8.1. The analysis is done by considering all the cost.

Project-2 ; The project cost is estimated except for the construction cost of drainage infrastructure and branch road improvement. The analysis is done by considering the estimated cost.

The result is as follows.

Cost Benefit Ratio (B/C Ratio)

Case	Project	Discount rate (%)		
		4	6	9
Case-1 (river improvement)	Project-1	0.5	0.3	0.2
	Project-2	2.7	1.8	1.0
Case-2 (Embankment)	Project-1	0.7	0.4	0.2
	Project-2	1.8	1.2	0.6

Considering the above results, non quantitative effects characterized as a disaster reconstruction or farm land conservation have to be considered for overall project justification.

7.10.3. Overall Evaluation

Like in Ban Na San the feasibility of the project in Lan Saka is low. However, since it is in line with the policy of national development and in response to the immediate demands of the society for restoring the flood devastated farmland, it will reactivate proper farming on the devastated farmland and conserve natural environment, and will bring abundant social benefits.

Two alternative development plans have been compared. For case-1 channel improvement works in the downstream area of Tha Di river is prerequisite to any improvement work in the upstream area. So far no definite plan has been formulated by RID. Like in Ban Na San area, the economic feasibility of case-2 is higher.

Based on the above considerations and the urgency for restoration, case-2 is recommended as the method for restoration and conservation.

CHAPTER 8

SELECTION OF PRIORITY PROJECT AREAS

CHAPTER 8 SELECTION OF PRIORITY PROJECT AREAS

8.1 Basic Approach for Selection and Selection Criteria

8.1.1 Basic Approach

The study aims at developing suitable rehabilitation and conservation methods to restore the devastated agricultural areas. Master plans for such areas are formulated in the study, based on the development potential and constraints. Rehabilitation works, however, will face many difficulties in financial and technical aspects.

It is more effective and practical for land rehabilitation to select priority areas for rehabilitation works and to develop suitable restoration plans and to implement them as an initiator. In the study, therefore, the areas are selected for feasibility study.

Under such considerations, the master plan study areas are divided into various areas, taking account of deposited soil properties and present land use. Then, priority areas are selected from the subdivided areas, based on the following selection criteria.

8.1.2 Selection Criteria

(1) Soil condition

Most of the difficulty in restoration of land is the deposited soils with low fertility. In some parts of the areas with shallower deposited depth, the farmers have tried to replant fruit trees. But, the results have not been obtained yet. Since soil improvement technique practiced in the selected priority areas should be applicable to the other similar deposited area, the following area is selected.

- Area in which soil improvement is required for agricultural use
- Area in which the properties and depth of deposited soil are representative in the damaged areas.

According to the field survey, the areas with shallower deposited depth are distributed extensively, and soil layer improvement in these areas were already performed by exchanging deposited soil with lower original soil or by the other techniques. Therefore, the area in which the proposed improvement techniques in this study could be applied and these techniques will be able to develop to the other areas, this should be selected as a priority area.

(2) Social condition

Priority areas play an important role as an initiator for land rehabilitation and conservation in the deposited soil areas. In the selected areas, therefore, various activities will be carried out at both administrative and farmer's levels, putting stress on soil improvement. Their results may be expected to give immediate effects on farming practices and strong impacts on farmer organization. Therefore, priority area is selected from the following.

- An area in which social demand for agricultural use is strong
- An area in which farmer's intention of rehabilitating their farm land is strong
- An area in which access is easy for a demonstrative effect

(3) Environmental effect

For implementation in the selected priority areas, social and natural environmental impact should be small. Then, the area is selected from the following.

- Area in which significant negative changes on social harmony and individual well-being are not introduced directly by the project
- Area which is not in the preservation zone delineated by RFD

(4) Scale of project implementation

A rehabilitation project will be implemented in close cooperation with the agencies concerned. Then, DLD shall act as the coordinating agency, responsible for soil/soil layer improvement. Therefore, the following area is selected.

- Area for which implementation programs anticipated will be suitable for DLD's financial limitation and implementing capability

8.2 Subdivision of the Study Areas

8.2.1 Ban Na San

The area is divided into five parts, based on the present land use, agricultural conditions, distribution of deposited soil, and river conditions (shown in Appendix A-3).

(1) B-1 area : This area is located at the foot of a mountain in the upper basin of Chawang. Most of the farmers intend to practice horticulture again. They have tried

independently to plant fruit trees with soil improvement and sprinkler irrigation on low-interest loans from BAAC.

(2) B-2 area : This is an area at the junction of Chawang and tributaries of Hang Hin, Nong and Ngon. Agriculture is not active at present due to the constant threat of flood because of the deposited sediment on the riverbed, in spite of shallower deposited soil on the farm land.

(3) B-3 area : This area is located meanderingly along the Chawang, in a strip of 100 to 500 m wide. The river remains deposited with sandy soil. Most of the land remains abandoned.

(4) B-4 area : This area is located close to the town of Ban Na San. River improvement with embankment and protection works had been completed by RID. Agriculture is being practiced as before, since after the disaster land rehabilitation has been carried out by farmers.

(5) B-5 area : This area is located in the down stream of Chawang. In this area, residential and agricultural land uses are mixed together. It has been restored independently by the farmer. Most areas are used for rubber and fruit tree plantations.

8.2.2 Lan Saka

The area is divided into three parts, as follows (shown in Appendix A-3).

(1) L-1 area : This area is located between Tha Di and Pong rivers in the upper basin. After the disaster, residential houses and public facilities were rebuilt and river improvement was also carried out. After completion of improvement, living conditions became a moderate level.

(2) L-2 area : The deposited area is located along Tha Di river, about 4 km long and 200 to 800 m wide, and had suffered great loss. Agricultural land remains deposited sandy soil. The depth is from 100 cm to 150 cm. Despite such deposited soil, farmers intend to restore the agriculture.

(3) L-3 area : This area is situated on both sides of the meanders of Tha Di with narrow and long shape. Deposited silt soil is distributed along the river, from 25 to 50 cm in depth. Agricultural land has been rehabilitated independently by

the farmers. But, drainage of Tha Di remains poor because the bed of river is rising and the flow capacity is becoming small.

8.3 Selection of Priority Project Areas

Subdivided areas were examined based on the each selection criteria. As a result, the following two areas were selected as priority development areas (shown in Appendix A-3).

- Ban Na San : B-1 area, A = 1,329 rai
- Lan Saka : L-2 area, A = 850 rai

PART 1

TABLES AND FIGURES

Table 1-2 Land Classification for Sediment Deposited Area (Ban Na San)

Class	Horizon	Depth (cm)	Structure	Gravel (%)	Mottling	Soil texture
I	Deposit	0 - 25	Massive	Non	Non	Coarse sand
		0 - 50	Massive	Non	Non	Fine sand, Silty loam, Silty clay loam
	Buried A	10 - 30	Blocky	Non	Present/Non	Sandy clay loam, Silty clay loam
II	Deposit	25 - 50	Massive	5 - 20	Non	Coarse sand
		50 -100	Massive	Non	Non	Fine sand, Silty loam
	Buried A	10 - 25	Massive	Non	Present/Non	Coarse sand, Silty clay loam
III	Deposit	50 -150	Massive	20 - 50<	Non	Coarse sand
		100 -150	Massive	Non	Non	Fine sand, silty loam
	Buried A	7 - 10	Massive	5 - 10	Present	Sandy loam, Silty clay loam
IV	Deposit	Not survey				
	Buried A	Not survey				

Table 1-3 Soil/Soil Layer Improvement Method (Ban Na San)

Class	Land Use	Soil Improvement Method	Soil Layer Improvement Method
I	Orchard	- Input of compost or barnyard manure - Add chemical fertilizer - Grow soil cover crops	- Soil mixing with lower original soil
	Upland crop/ grassland	- Input of compost or barnyard manure - Add chemical fertilizer - Mulch organic material residuum	- Soil mixing with lower original soil
II	Orchard	- Input of compost or barnyard manure - Add chemical fertilizer - Grow soil cover crops	- Remove out gravels - Exchange deposited soil with lower original soil
	Upland crop/ grassland	- Input of compost or barnyard manure - Add chemical fertilizer - Mulch organic material residuum	- Remove out gravels - Soil dressing on farm land
III	Orchard	- Input of compost or barnyard manure - Add chemical fertilizer - Grow soil cover crops	- Replacement deposited soil with new good soil
	Upland crop/ grassland	- Input of compost or barnyard manure - Add chemical fertilizer - Mulch organic material residuum	- Remove out gravels - Soil dressing on farm land
IV	Orchard	- Input of compost or barnyard manure - Add chemical fertilizer - Grow soil cover crops	- Replacement deposited soil with new good soil
	Upland crop/ grassland	- Input of compost or barnyard manure - Add chemical fertilizer - Mulch organic material residuum	- Remove out gravels - Soil dressing on farm land

Table 1-4 Soil/Soil Layer Improvement Area by Land Use Plan (Ban Na San)

Land Use	Class	Improvement Method	Depth of Improved Soil (cm)	Improved Area(rai) Case 1	Improved Area(rai) Case 2
Orchard	I	- Input of organic and inorganic materials	25	1,045	1,045
		- Soil mixing with lower original soil	50	1,045	1,045
	II	- Input of organic and inorganic materials	25	593	100
		- Remove out gravels	50	593	100
		- Exchange deposited soil with lower original soil	50	593	100
	III	- Input of organic and inorganic materials	25	468	68
		- Replacement deposited soil with new good soil	100	468	68
	IV	- Input of organic and inorganic materials	25	—	—
		- Replacement deposited soil with new good soil	100	—	—
Upland crop/ grassland	I	- Input of organic and inorganic materials	25	—	—
		- Soil mixing with lower original soil	25	—	—
	II	- Input of organic and inorganic materials	25	—	493
		- Remove out gravels	25	—	493
		- Soil dressing on farm land	25	—	493
	III	- Input of organic and inorganic materials	25	—	400
		- Remove out gravels	25	—	400
		- Soil dressing on farm land	25	—	400
	IV	- Input of organic and inorganic materials	25	—	—
		- Remove out gravels	25	—	—
		- Soil dressing on farm land	25	—	—

Table 1-5 Land Classification for Sediment Deposited Area (Lan Saka)

Class	Horizon	Depth (cm)	Structure	Gravel (%)	Mottling	Soil texture
I	Deposit	0 - 25	Massive	Non	Non	Fine sand
		0 - 50	Massive	Non	Non	Silty loam
	Buried A	16 - 39	Blocky	Non	Non	Silty loam
II	Deposit	25 - 50	Massive	5 - 10	Non	Coarse sand
		50 -100	Massive	Non	Non	Fine sand, Silty loam
	Buried A	17 - 20	Blocky	Non	Non	Sandy clay loam
III	Deposit	50 -150	Massive	Non	Non	Coarse sand
		100 -150	Massive	Non	Non	Fine sand, silty loam
	Buried A	8 - 27	Massive	Non	Present/Non	Sandy loam, Fine sand, Silty loam
IV	Deposit	Not survey				
	Buried A	Not survey				

Table 1-6 Soil/Soil Layer Improvement Method (Lan Saka)

Class	Land Use	Soil Improvement Method	Soil Layer Improvement Method
I	Orchard	- Input of compost or barnyard manure - Add chemical fertilizer - Grow soil cover crops	- Soil mixing with lower original soil
	Upland crop	- Input of compost or barnyard manure - Add chemical fertilizer - Mulch organic material residuum	- Soil mixing with lower original soil
II	Orchard	- Input of compost or barnyard manure - Add chemical fertilizer - Grow soil cover crops	- Exchange deposited soil with lower original soil
	Upland crop	- Input of compost or barnyard manure - Add chemical fertilizer - Mulch organic material residuum	- Soil dressing on farm land
III	Orchard	- Input of compost or barnyard manure - Add chemical fertilizer - Grow soil cover crops	- Replacement deposited soil with new good soil
	Upland crop	- Input of compost or barnyard manure - Add chemical fertilizer - Mulch organic material residuum	- Soil dressing on farm land
IV	Orchard	- Input of compost or barnyard manure - Add chemical fertilizer - Grow soil cover crops	- Replacement deposited soil with new good soil
	Upland crop	- Input of compost or barnyard manure - Add chemical fertilizer - Mulch organic material residuum	- Soil dressing on farm land

Table 1-7 Soil/Soil Layer Improvement Area by Land Use Plan (Lan Saka)

Land Use	Class	Improvement Method	Depth of Improved Soil (cm)	Improved Area(rai) Case 1	Improved Area(rai) Case 2
Orchard	I	- Input of organic and inorganic materials	25	422	422
		- Soil mixing with lower original soil	50	422	422
	II	- Input of organic and inorganic materials	25	280	280
		- Exchange deposited soil with lower original soil	50	280	280
	III	- Input of organic and inorganic materials	25	20	20
		- Exchange deposited soil with lower original soil	100	20	20
	IV	- Input of organic and inorganic materials	25	567	305
		- Exchange deposited soil with lower original soil	100	567	305
Upland crop	I	- Input of organic and inorganic materials	25	—	—
		- Soil mixing with lower original soil	25	—	—
	II	- Input of organic and inorganic materials	25	—	—
		- Soil dressing on farm land	25	—	—
	III	- Input of organic and inorganic materials	25	—	—
		- Soil dressing on farm land	25	—	—
	IV	- Input of organic and inorganic materials	25	76	338
		- Soil dressing on farm land	25	76	338

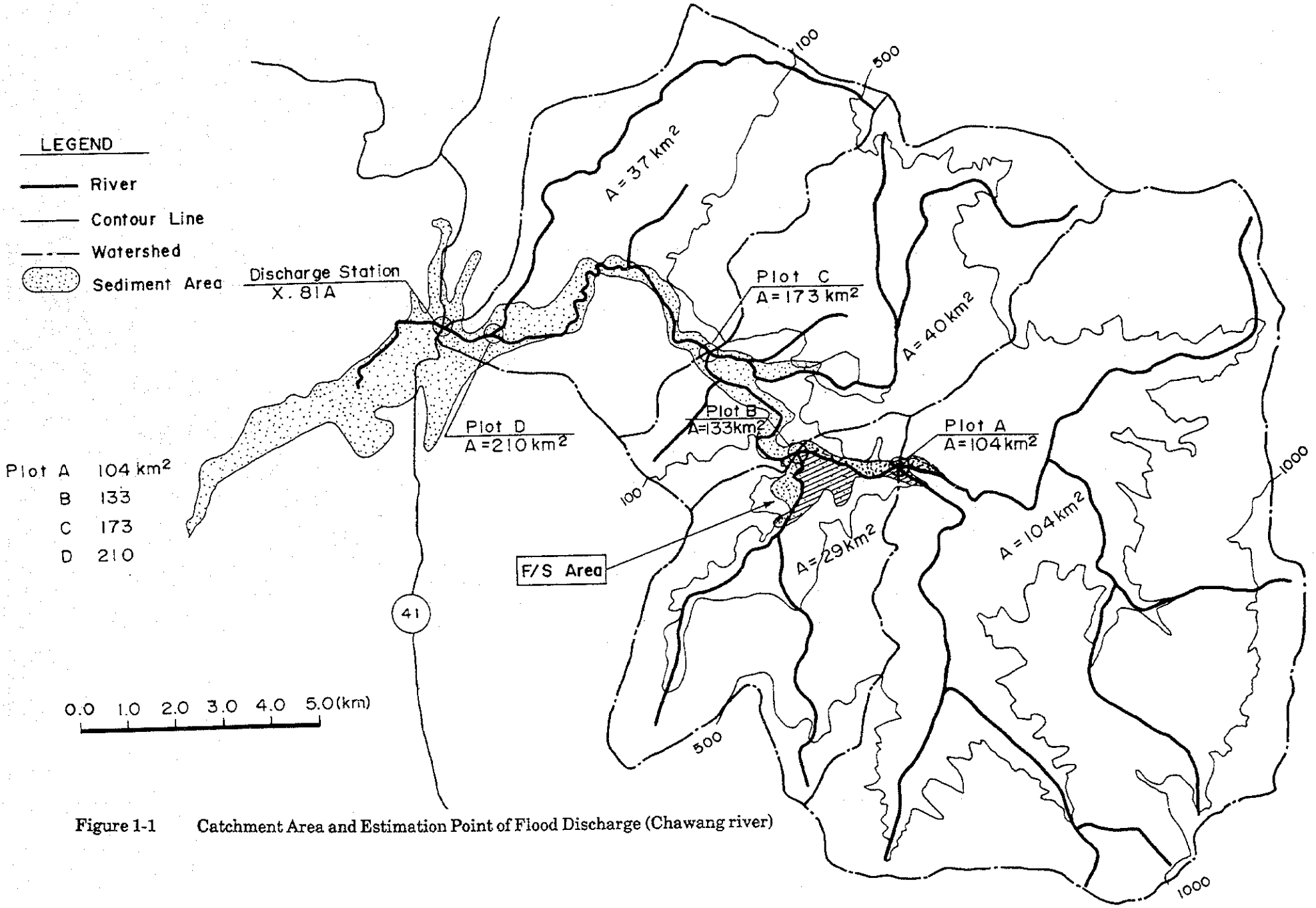


Figure 1-1 Catchment Area and Estimation Point of Flood Discharge (Chawang river)

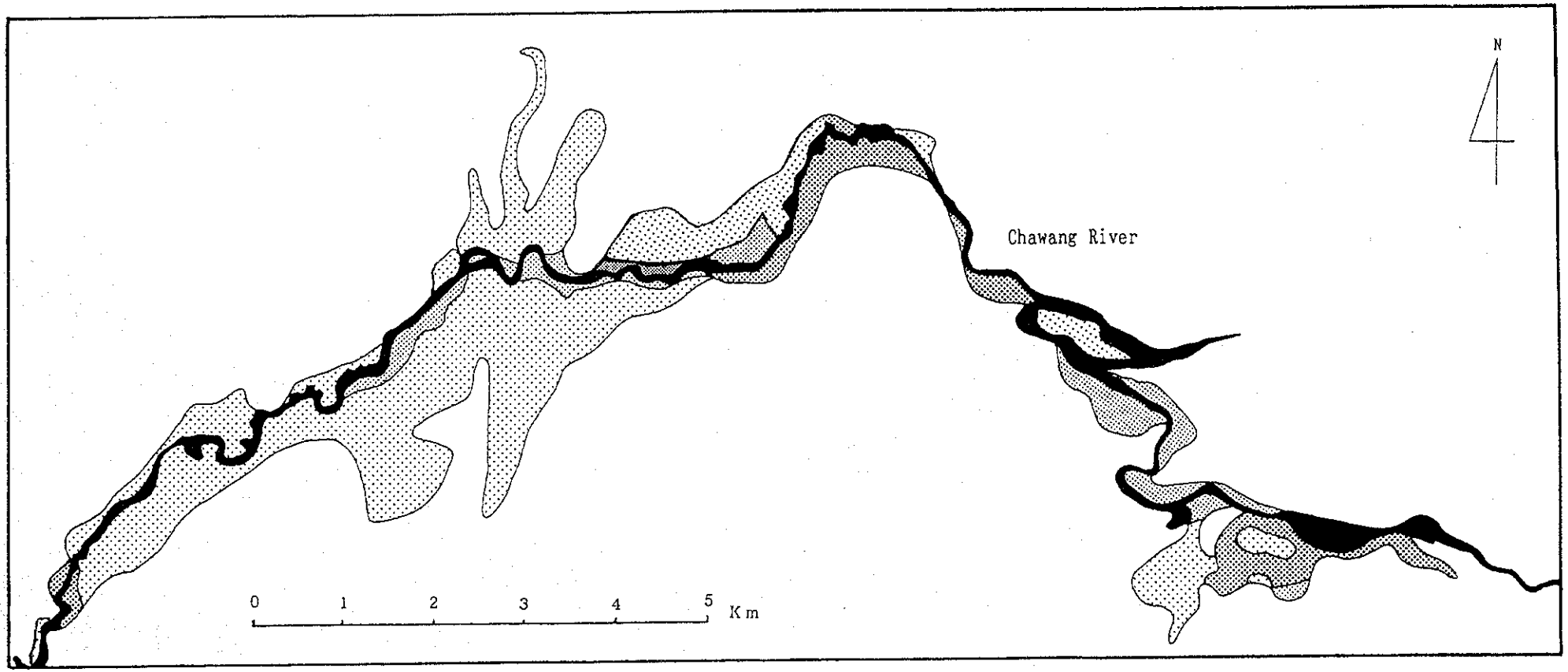


Figure 1-2 Sediment Deposit Map of Chawang River Basin (Tha Di river)

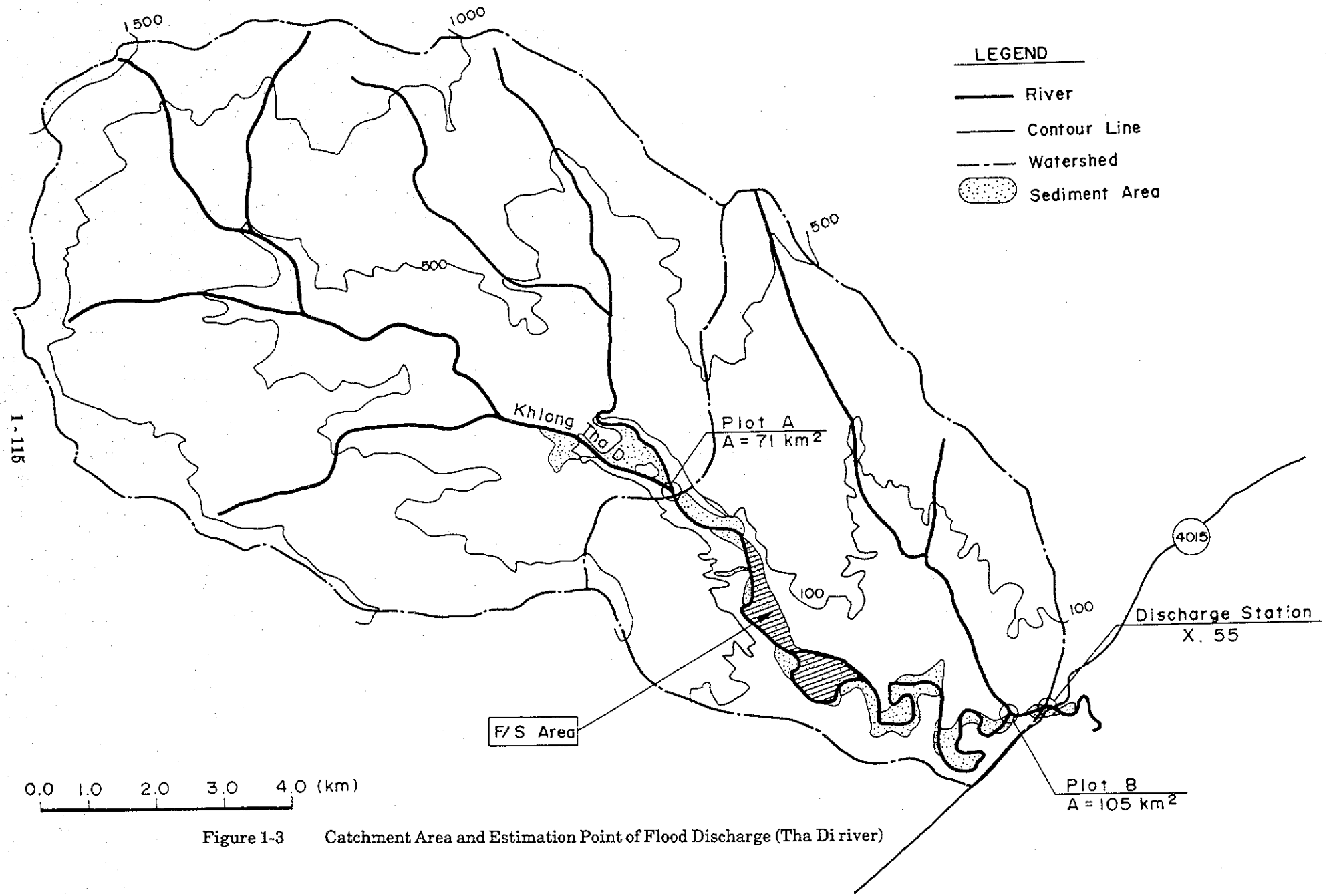
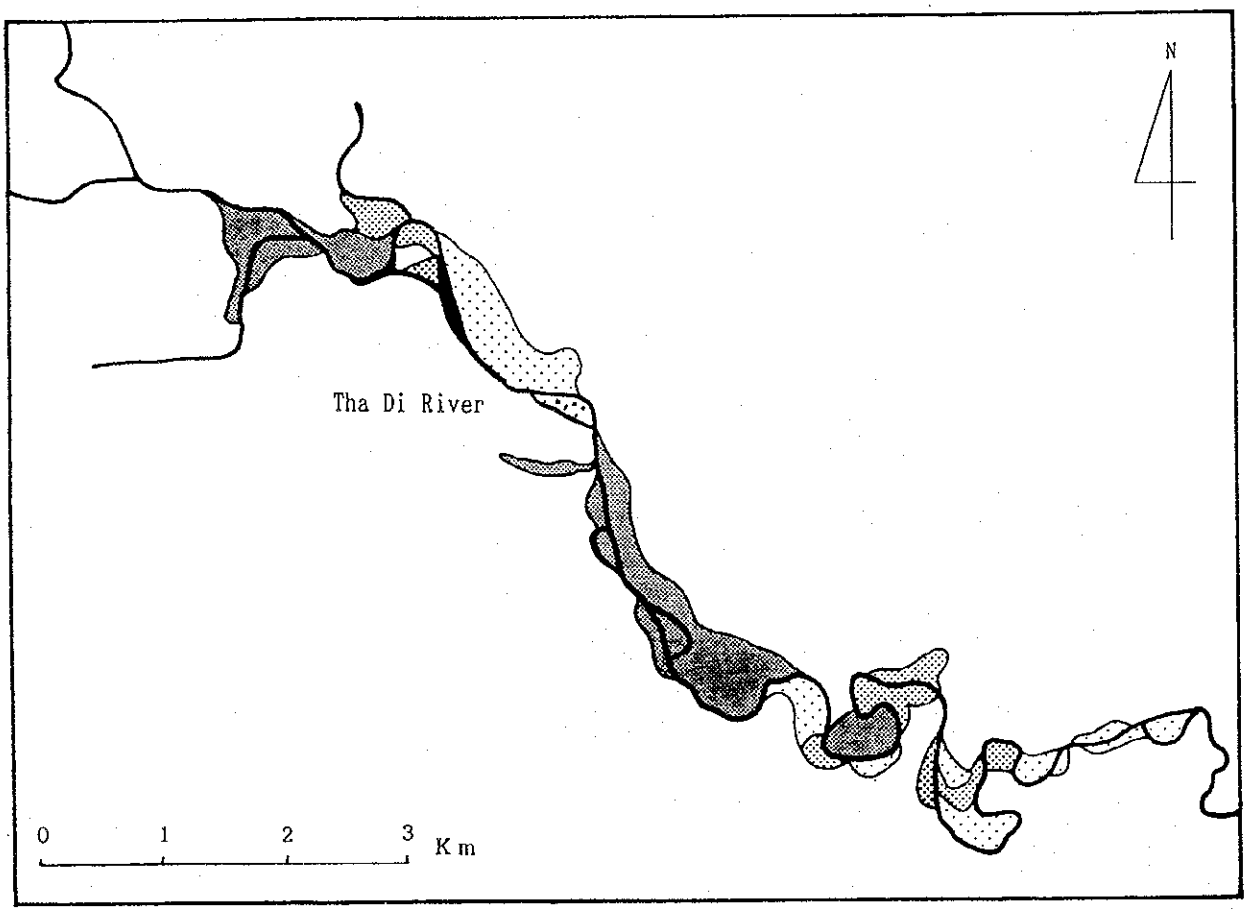


Figure 1-3 Catchment Area and Estimation Point of Flood Discharge (Tha Di river)



Unit of Sediment Depth(cm)	
1. < 25	
2. 25-50	
3. 50-150	
4. > 150	
5. River bed	

Figure 1-4 Sediment Deposit Map of Tha Di River Basin

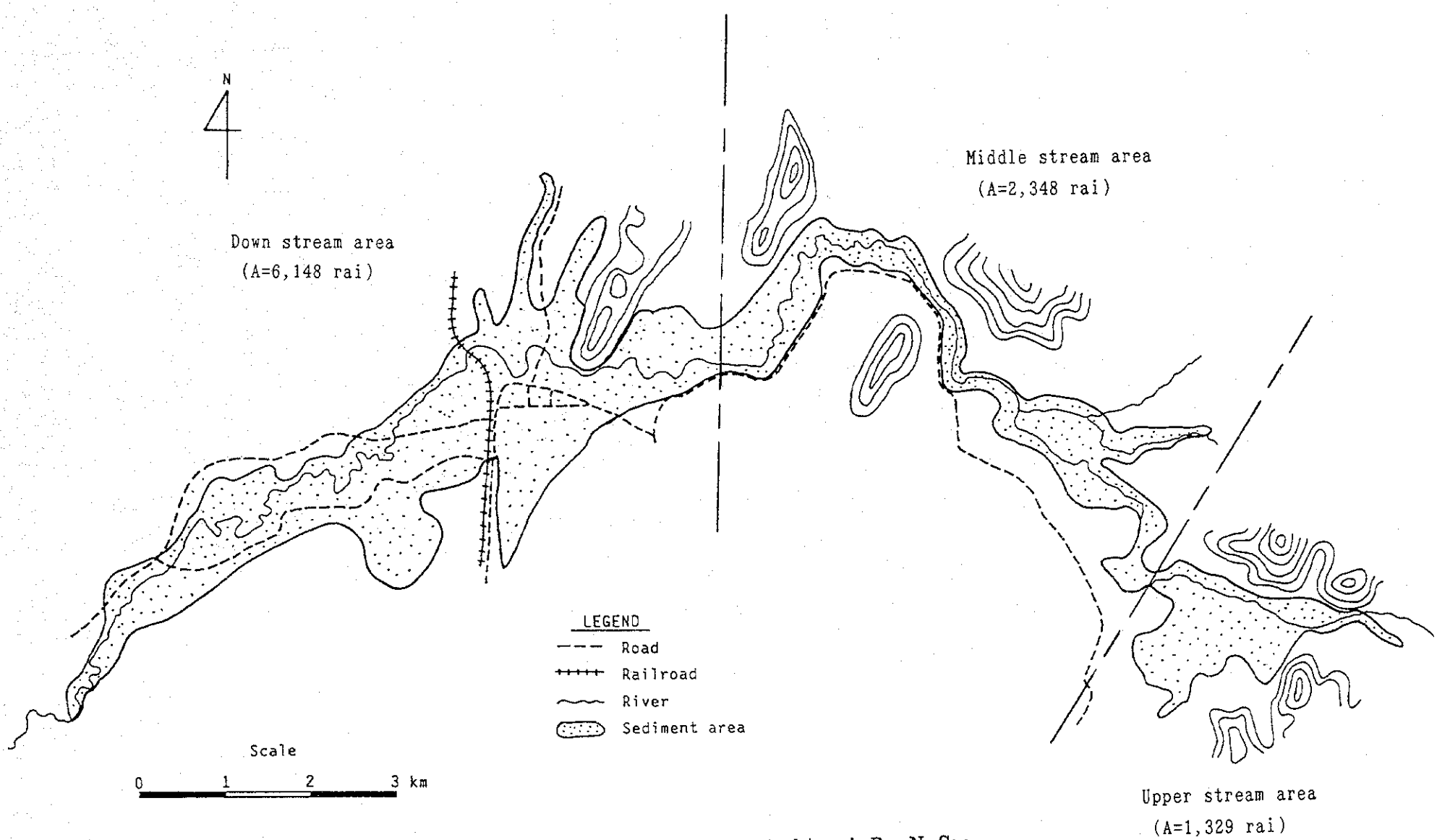


Figure 1-5 Subdivision of Sediment Deposited Area in Ban Na San

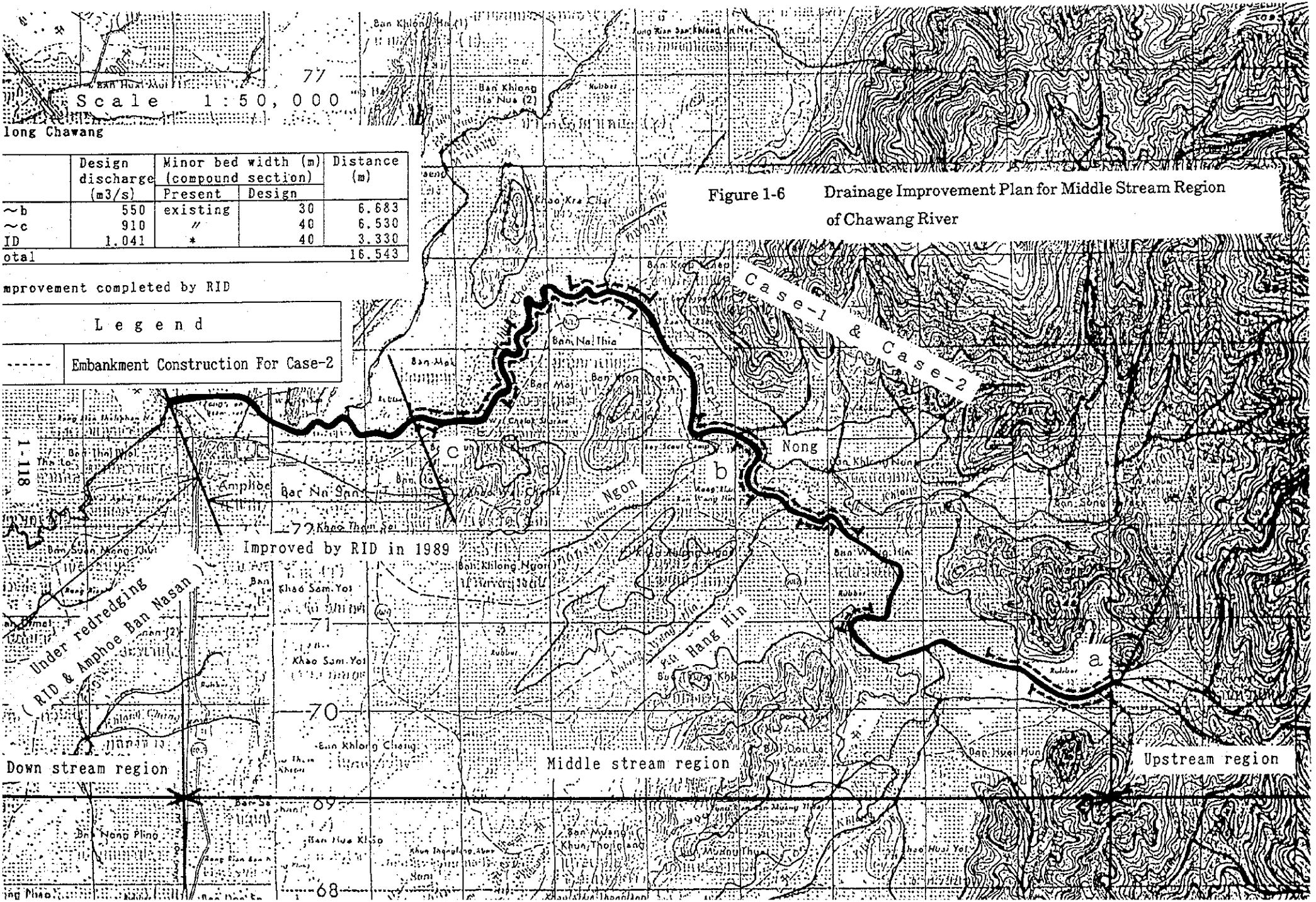


Figure 1-6 Drainage Improvement Plan for Middle Stream Region of Chawang River

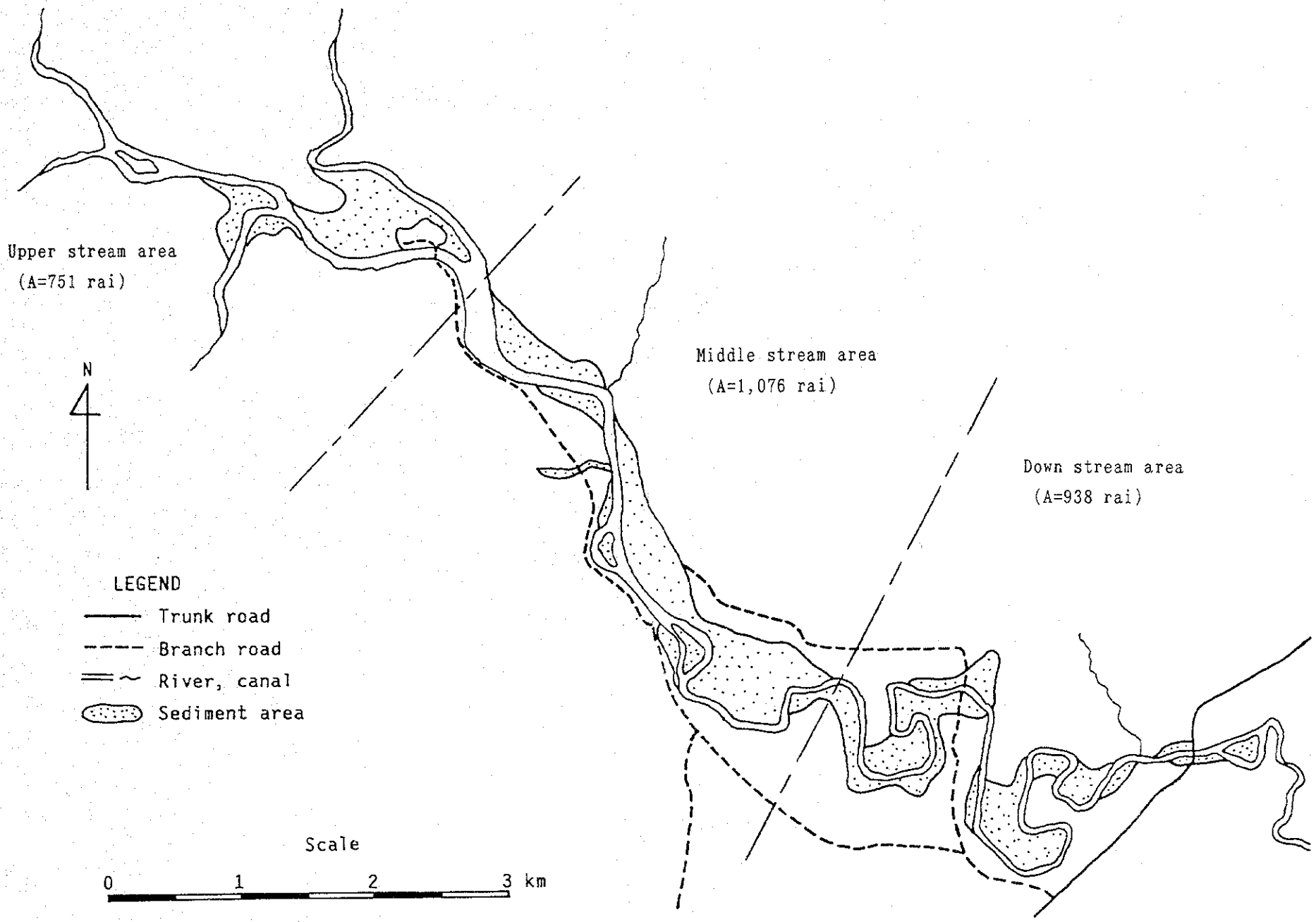


Figure 1-7 Subdivision of Sediment Deposited Area in Lan Saka

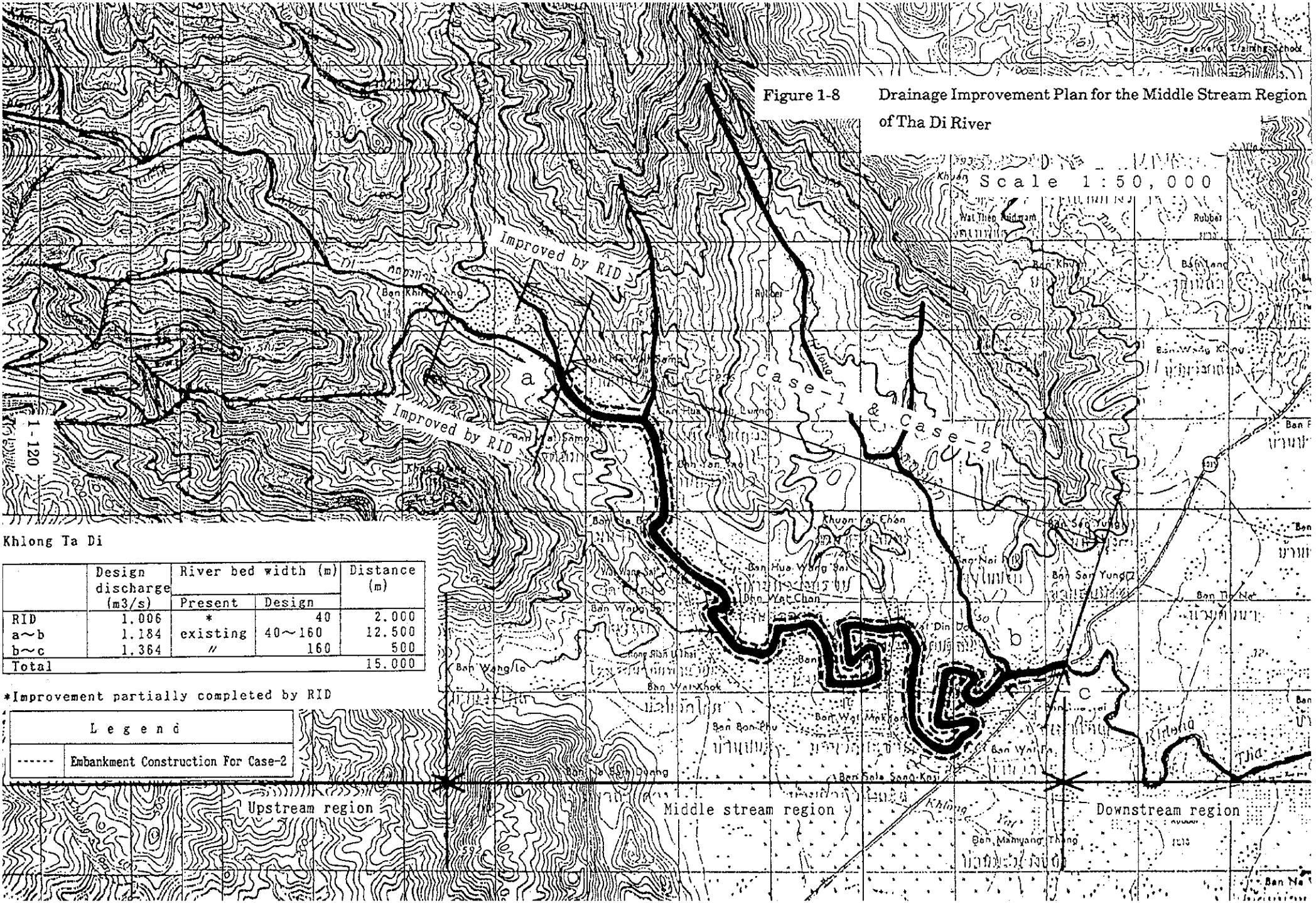


Figure 1-8 Drainage Improvement Plan for the Middle Stream Region of Tha Di River

	Design discharge (m3/s)	River bed width (m)		Distance (m)
		Present	Design	
RID	1.006	*	40	2.000
a～b	1.184	existing	40～160	12.500
b～c	1.364	〃	160	500
Total				15.000

*Improvement partially completed by RID

PART 2

FEASIBILITY STUDY FOR THE AGRICULTURAL LAND REHABILITATION AND CONSERVATION PROJECT IN THE PRIORITY PROJECT AREAS

CHAPTER 1

PRESENT CONDITIONS OF THE BAN NA SAN F/S STUDY AREA

PART 2 FEASIBILITY STUDY FOR THE AGRICULTURAL LAND REHABILITATION AND CONSERVATION PROJECT IN THE PRIORITY PROJECT AREAS

CHAPTER 1 PRESENT CONDITIONS OF THE BAN NA SAN F/S STUDY AREA

1.1 Physical Features

1.1.1 Location

The F/S area is located on the river terrace and present fluvial plain of the Chawang river which are distributed on the south-east end of the Ban Na San area, extends the left bank of the Chawang river covering an area of 730 rai. This area was damaged seriously by debris flow of the 1988 disaster and at present the major part has been underlain by thick debris flow sediment. The area is bordered north and east by the Chawang river, south by small stream of the Thoe river and hill area, and east by the Thuat river and its right bank hill.

1.1.2 Topography, Geology and Groundwater

(1) Topography and geology

The river terrace and fluvial plain distributed widely at the area can be classified to five topographic types 1) River Terrace, 2) Buried River Terrace, 3) Fluvial Plain covered by thick deposit, 4) Swampy Place, 5) Present River Channel (refer to Figure 2-1). Surrounding these plains underlain by quaternary sediments, there are hills and mountains underlain by paleozoic rocks such as limestone and slate. The elevation of the area ranges from 109 to 78 m.

The River Terrace is widely distributed in the southern part and near the Chawang river on the small scale, and is extended with 2 to 4 m in height small cliff to the Fluvial plain, and covered by old rambutan trees (about more than 15 years old) which have been saved from the damage of the disaster. It is overlain by pleistocene sediments such as sand and gravel whose color is grey at almost part and brown at western part.

The Buried River Terrace is distributed continuously to the River Terrace and is overlain by sediment deposited soil of less than 50 cm thick. Thus, it is supposed that there were slightly higher terrace in comparison with fluvial plain before which was overlain by the sediment (refer to Figure C-5, Appendix C).

The Fluvial Plain is distributed along the Chawang river and central part of the F/S area, which is overlain by the sediment of more than 100 cm, partly more than 150 cm thick.

The Swampy Place is distributed on the west end of the F/S area.

The Present River Channel is distributed along the Chawang river making up continuous low cliff of about 1.0 m high to the Fluvial plain. After the disaster, the river bed is falling yearly.

(2) Groundwater

There are some wells on the River Terrace in the area for farmers' domestic use. The diameter of wells is from 90 cm to 1.0 m, the depth is from 5.0 to 6.5 m and groundwater level usually occurs from 3.0 to 4.0 m below the surface (list of wells is shown in Table C-1, Appendix C). Based on the results of a pumping test, the transmissibility is estimated 6 to 7 cm^2/sec. (refer to Table C-2 and Figures C-4.1 to 4.3, Appendix C). Judging from the test, due to the fact of the small capacity of aquifer of river terrace deposits and the deep groundwater level, the availability of groundwater development for irrigation use is estimated small.

In the F/S area many small ponds for irrigation use were excavated. The size is about 10 × 10 m and the depth is about 3 m. The irrigation water is reserved in it. The groundwater surface is deeper than the bottom of the pond. Leakage from the pond is supposed little because of small permeability of the terrace deposit.

1.1.3 Hydrometeorology

(1) River condition

Four rivers drain in the F/S area. Chawang river forms the northern boundary of the area and flows from east to west. Mui river is one of the tributaries of Chawang river and joins Chawang river at the most easterly point of the area. Thuat river also joins Chawang river west of the area and flows from south to north. Thoe river flows south of the area, which is one of the tributaries of Thuat river.

The catchment area and the length of Chawang river at the most downstream point of the F/S area (Part 1, Figure 1-1, Plot B) are respectively 133 km^2 and 16.5 km, and the average slope of river bed is very steep, approximately 1/100 in the area.

(2) Flood and drainage discharges

a) Flood discharge of Chawang river and Mui river

Flood discharges at selected points of Chawang river are estimated by the unit hydrograph method as mentioned in paragraph 4.1.2 in Part 1. Flood discharge of Mui river is calculated from the specific flood discharge of Chawang (refer to Table B.3.1 and Figure B.3.7, Appendix B).

b) Flood discharge of Thuat river and Thoe river

For the design flood discharge of Thuat river, the unit hydrograph method is adopted similarly to the case of Chawang river. Also the flood discharge of Thoe river is calculated from the specific discharge of Thuat river because they are included in the same watershed (refer to Figure B.3.2~B.3.7, Appendix B).

Flood Discharge and Specific Flood Discharge of Thuat River

Return Period	2 years	5 years	10 years	25 years	50 years
Flood Discharge (m^3/s)	54	75	112	130	143
Specific Discharge ($m^3/s/km^2$)	2.030	2.820	4.210	4.887	5.376

c) Design drainage discharge in the F/S area

For the design drainage discharge, a 1/10 exceedance probable daily rainfall is used from the viewpoint of drainage requirement for a young tree. Design drainage discharge by using the Rational Formula is determined as follows (refer to Table B.3.2, Appendix B).

Design Drainage Discharge

Return Period	2 years	5 years	10 years	25 years	50 years
Design Drainage Discharge ($m^3/s/km^2$)	0.497	0.688	1.024	1.193	1.311

Details on flood discharge and design drainage discharge are shown in Appendix B.3.

1.1.4 Soil and Sediment

(1) Soil

Before the disaster, the F/S area has been covered by alluvial soil classified as Ruso and Tha Khun series in Thailand. The soil exists with deep layer and well-drained condition. Surface soil is brown sandy loam or loam, and subsoil is silty clay loam. Reaction is generally acidic. It is a suitable soil for a cropping of fruit tree and vegetable.

After the disaster, the area is covered by sediment deposited soil.

(2) Sediment

Based on the soil survey, sediment deposited soil is classified as follows (refer to Figure 2-2).

Class	Depth of sediment	Feature of deposited soil	Distribution	
			Area (rai)	Share (%)
I	No	-	48.31	7.4
II	<25cm	It is in moderate plow layer, consisted of coarse sand.	65.31	10.0
III	25~50cm	It is in moderate subsoil layer, consisted of coarse sand.	130.94	20.1
IV	50~100cm	It is in moderate root zone, consisted of coarse sand, fine sand and silt	82.06	12.6
V	100~150cm	It is not in moderate root zone, consisted of coarse sand, fine sand and silt	28.63	4.4
VI	>150cm	It is very deep, consisted of sand and gravel	297.20	45.5
Total			652.45	100.0

Note : The area except for the river/canal, road and test field are estimated based on the distribution map (Figure 2-2).

According to the above classification, classes I and V occupy a small area, 11.8% of the whole area. Classes II, III, and IV occupy 10.0%, 20.1% and 12.6%, respectively. On the other hand, Class VI has a wide distribution, 45.5% of the total.

(3) Properties of deposited soil

According to the soil analysis, properties of the deposited soil are summarized as follows (refer to Table F.17~F.20 and Figure F.5, Appendix F).

1) Deposited soil is derived from weathered granite, consisted of gravel or coarse sand including many quartz and micas.

2) Soil texture is classified into sand including gravels, composed of very coarse and coarse sand fraction. Hydraulic conductivity is very high and water holding capacity is very small (see Figure 2-3 and Table 2-1).

3) Soil fertility is very low, according to the standard of chemical fertility in Thailand as follows.

Item	Rating of the value		Evaluation for the area
1. CEC (me/100g)	- High	more than 20	Low
	- Moderately high	15 - 20	
	- Medium	10 - 15	
	- Moderately low	5 - 10	
	- Low	less than 5	
2. Organic Matter (weight %)	- High	more than 3.5	Low
	- Moderately high	2.5 - 3.5	
	- Medium	1.5 - 2.5	
	- Moderately low	1.0 - 1.5	
	- Low	less than 1.0	
3. Base Saturation (%)	- High	more than 75	Low to Medium
	- Medium	35 - 75	
	- Low	less than 35	
4. Available Phosphorus (ppm.of P_2O_5)	- High	more than 57	Low to Medium
	- Moderately high	34 - 57	
	- Medium	23 - 34	
	- Moderately low	14 - 23	
	- Low	less than 14	

Source: Benchmark soils of Thailand, DLD in THAILAND and SMSS in USA (1987)
Note: Chemical properties of the soil are shown in Table 2-1.

The deposited soil is characterized as poor physical and chemical conditions for agricultural use, due to the low soil fertility and the low nutrient holding capacity.

1.1.5 Land Use

The land use in the area is as follows.

Land use		Area (rai)	Share (%)
1. Agricultural land		411.47	56.4
Orchard land	(Rambutan)	346.85	47.5
"	(Durian)	56.12	7.7
"	(Cashew nut)	8.50	1.2
2. Waste land		240.98	33.0
Sand land		110.09	15.1
Grass land		94.96	13.0
Marsh		35.93	4.9
3. Others		77.25	10.6
River/Canal		60.84	8.3
Road		10.81	1.5
Test field		5.60	0.8
Total		729.70 (116.75 ha)	100.0

Note : Each area is estimated according to the geographical map prepared by the study team.

Sediment deposited area is generally classified into the orchard land where fruit trees were planted after the disaster and the waste land. Most of the fruit trees have not reached a bearing level yet.

1.2 Socio-Economic Conditions

1.2.1 Administration

(1) Division of administration

The F/S area is located in Muban 4 of Tambon Perm Poon Sap. The muban 4 is located in south-western border part of the tambon and covers 7,460 rai.

(2) Applicability to rural development plan

According to the result of the survey at village level which were carried out in 1990 by NESDB for the Seventh National Economic and Social Development Plan, the muban 4 has been ranked as second level, which is supposed to be developed by provincial rural development plan.

1.2.2 Population and Farm Land Holding

(1) Population and household

According to the Fundamental Data of Village Level Survey carried out, every two years by the Community Development Department (CDD) of Ministry of Interior (MOI), the population of the muban 4 is 899 as of 1994, out of which 432 are male and 467 are female. The population density is 76 people/km^2, which is rather high compared with 62 of the tambon. A number of household is 212, accordingly, the family size per one household is 4.2 people. The sex ratio and dependency ratio are 93% and 56%. The both ratios are rather low compared with those of the tambon (96%, 74%). On the other hand, the number of farm households is 203 and occupies 96% of total household, that is almost all the farm household. Compulsory education is prevailing, consequently, the percentage of those who finished compulsory education in the age 12 years and above is 84. Accordingly, there is no illiterate in the muban.

(2) Farm land holding

According to the above mentioned survey, the farm land of the muban as of 1994 is 5,830 rai, of which ownership is composed by farmers of 100% owned land. Generally, many farmers have their own land not only the inside but the outside of the living muban. So that, for the average farm size per farm household in the area, it is rather nearer to the actual situation to adopt that of the tambon. Accordingly, it is 43.3 rai. On the other hand, the number of farm only occupation farmer is 189 or 93% with average household income of 58,000 Baht per year, and farm and others occupation farmers 14 or 7% with 65,000 Baht. The fruit farmers are 122 or 60% of the total farmers, which have average planting area of 10.0 rai and get average income of 58,000 Baht per year. Para rubber farmers are 97 or 48%, out of which 58 (60% of the para rubber farmers) are farmers with planting area of under 16 rai, 33 (34%) are from 16 to 50 rai and 6 (6%) are 50 rai and over.

1.2.3 Farm Household Economy

The farmer's economic survey was conducted to understand farmer's socio-economic conditions in the area. Twenty (20) households or 10% of the total farm households were interviewed as a sample, taking account of the followings.

- This study aims at formulation of the land rehabilitation and conservation plan on the sediment deposited area. Therefore, farm household which has covered with sediment by the disaster should be selected.

- Since some of the farmers in this area go outside the area to work, farm household which has farm land in the area should be selected.

According to the results, farm households were classified into three sizes; large, medium and small. The average farmer's economy of each size is as follows.

Table 2-2 Farm Household Economy (Ban Na San)

Item	Large Size Farmer (50 rai and over)	Medium Size Farmer (30~50 rai)	Small Size Farmer (under 30 rai)
1) Farm Net Income (Baht)	102,008	65,925	39,276
Rambutan	21,480	6,495	1,358
Durian	-19,937	20,943	-
Mangosteen	-	-	-
Juck fruits	-	-	-
Other fruit, etc.	-	-	-
Rubber	99,915	37,787	37,418
Baby corn and Other Vegetables	-	-	-
Livestock	550	700	500
2) Non-farm Net Income (Baht)	-	50,000	20,000
3) Farm Household Net Income (Baht)	102,008	115,925	59,276
4) Direct Tax, etc. (Baht)	-	30,000	-
5) Disposable Income (Baht)	102,008	85,925	59,276
6) Household Expenditures (Baht)	102,550	83,900	65,980
7) Farm Household Surplus (Baht)	-542	2,025	-6,704
8) Per Capita (Baht)			
(1) Farm Net Income	17,001	10,988	9,819
(2) Farm Household Net Income	17,001	19,321	14,819
(3) Farm Household Expenditures	17,092	13,983	16,489
9) Farm Labour Input Quantities (man/day)			
(1) per year	1,044	395	483
(2) per rai	18	10	19
10) Family Farm Labour			
(1) Input Quantities (man/day)			
(a) per year	660	387	288
(b) per rai	11	10	11
(2) Labour Reward (Baht)			
(a) per man per year	22,156	18,597	16,623
(b) per man per day	134	144	115
11) Farm Net Income Ratio (%)	50	37	39
12) Farm Household Cash Net Income (Baht)	123,668	127,195	63,339

The rubber occupies the most of farm income, whereas, its planted area is less than half of the whole planted area of each size farmer. It seems to be due to the lower ratio of bearing fruit area to the whole fruit area. The farm household expenditures are fairly high, accordingly, farm household economic surplus is in the red or narrowly in the black.

Compared with the average farm household cash net income (92,756 Baht) of Amphoe Ban Na San by the Office of Agriculture Economy, MOAC, that of the large farmer is 123,668 Baht, of the medium farmer 127,195 Baht and the small farmer 63,339 Baht.

The low ratio of the bearing fruit trees has been caused by the disaster. Accordingly, when these trees will be favorably grown and reach the bearing stage, with the agricultural land rehabilitation and conservation project, etc., the farm net income and the farm household net income will be substantially improved and increase in the near future.

1.3 Agriculture

1.3.1 Agricultural Land Use

According to the land use survey in 1.1.5, this area contains orchard land, waste land, canals, and roads. Rambutan, durian, and cashew nut are planted in the orchard land. This orchard land has two types of trees; trees planted before the 1988 flood and possible to bear fruits, and trees planted after the disaster and still immature. The systematic cultivation of vegetables and upland crops is not practiced. Some parts of the waste land could be improved to the agricultural land by soil/soil layer improvement. The present area which could be used as the agricultural land in the future is shown in the following table.

Agricultural Land Use in the F/S area

Type of Land Use	Area (rai)	Ratio (%)	
1. Cultivated land	411.47	63.0	100.0
- Young rambutan	261.16	40.0	63.5
- Old rambutan	85.69	13.1	20.8
- Young durian	55.07	8.4	13.4
- Old durian	1.05	0.2	0.3
- Cashew nut	8.50	1.3	2.0
2. Waste land	240.98	37.0	100.0
- Sand land	110.09	16.9	45.7
- Grass land	94.96	14.6	39.4
- Marsh	35.93	5.5	14.9
Total Agricultural land	652.45	100.0	

Note : - Young tree is defined as a tree that has not reached a bearing level.
- The area for each land use is calculated by the geographical survey.

1.3.2 Farming Practice

The traditional farming at no damaged orchard area has been practicing as mentioned in 4.3.5, PART 1. The planted fruit trees after the disaster are still young and have not reached a bearing level, and those growing levels vary. The planting methods of these trees were as follows.

(1) Planted directly on deposited soil.
(2) Planted directly on deposited soil and after one year brought new soil from outside and laid around tree at 6.0 cm deep.
(3) Dug the hole at 1.0 × 1.0 m and 1.0 m deep brought new soil from outside and planted.
(4) Dug the hole at 2.0 × 2.0 m and 1.0 m deep by heavy machine and filled in with new soil and planted.

From observation of the growth of trees, it is indicated that the (1) has poorest growth, (2) has better growth. For (3), the trees are in normal growth, whereas the (4) trees are in good and vigorous growth.

Based on the above observation, the condition is classified into the following four groups, from viewpoint of the growing.

(1) Poor : The growth is poor, in need of full improvement.

(2) Fair : The growth is fair, but in need of improvement.

(3) Normal : The growth is normal, but in need of some improvements.

(4) Good : The growth is good, no need for improvement.

The area of each growth condition is summarized as follows (refer to Figure 2-4).

The Area by Each Growth Condition of the Fruit Trees

Unit: rai (%)

Fruit tree	Poor	Fair	Normal	Good	Total
Y.R.	60.08	171.30	11.73	18.05	261.16
	(14.6)	(65.6)	(4.5)	(6.9)	(100)
O.R.	-	-	85.69	-	85.69
			(100)		(100)
Y.D.	-	11.95	43.12	-	55.07
		(21.7)	(78.3)		(100)
O.D.	-	-	-	1.05	1.05
				(100)	(100)
C.N.	-	-	8.50	-	8.50
			(100)		(100)
Total	60.08 (23.0)	183.25 (44.5)	149.04 (36.2)	19.10 (4.7)	411.47 (100)

Note: Y.R. = Young rambutan
O.R. = Old rambutan
Y.D. = Young durian
O.D. = Old durian
C.N. = Cashew nut

According to the above table, around 68% of the fruit trees need some farming improvements including soil improvement. For young rambutan, 80% of the planted trees need soil improvement.

Any upland crop and vegetable is not cropped in the area, except for very few sweet potato, chili and egg plant planted around the house, for home consumption. Most farmers have no knowledge of upland crop and vegetable cultivation.

In order to improve the present farming practice and to introduce new farming techniques and soil/soil layer improvement, some supporting service activities will be needed in future. The test field constructed by the JICA Study Team is effective for carrying out various farming activities.

1.3.3 Farmer's Organization

The farmers in this area practice farming under the agricultural organizations in Ban Na San district as mentioned in 4.3.6, part 1. The active organizations or groups can be summarized as follows.

(1) Lam Poon Orchard Farmer's Group

It was reported that this farmer's group has been established since 1974. All members are rambutan growers, and most farmers in the F/S area are the members of this group. The objective of this group is only rambutan collection to merchants in Bangkok. The merchants will inform the daily price of rambutan to the members for their consideration, and provide transportation from the collecting place in Lam Poon to Bangkok. The classification of grade for rambutan is carried out by members themselves.

In 1994 the total value of rambutan through this group accounted for about 10 million Baht. However, the accounting management is rather weak, because this Farmer's Group does not have an accounting system. The merchants in Bangkok will pay directly to individual members. Then, this Farmer's Group and Department of Cooperative Auditing can not conduct annual auditing.

This group is a single purpose farmer's organization and the activities are carried out only during rambutan harvesting season.

(2) Thrift and Credit Group

In general, BAAC is the major source of agricultural credit in Muban 4, Perm Poon Sap, or 59% of the total household are members of BAAC. Aside from BAAC, ACs and commercial banks, the Thrift and Credit Group in Muban 4, Perm Poon Sap have been established many years ago. They are an informal farmer's organization aiming at credit services and thrift for the members. Most farmers in this village or about 80% of the total households are its members.

Regular members have to deposit money 100 Baht per member every month. The Thrift and Credit Group will provide lending activities to the members and in case of emergency or urgent need of funding, the members can also borrow without interest. The management of this farmer's group have been conducted through a selected committee. The basic data of the group may be summarized as follows (as of 1995).

Operation fund as of January, 1995	=	200,000 Baht
Normal interest rate	=	2% /month
Interest rate for overdue repayment	=	5% /month

Term of repayment	=	short term
Maximum lending amount	=	three times of accumulated deposit
Maximum borrowing amount	=	4,000 Baht/member
Term of repayment for borrowing	=	3 months

Generally speaking, the activities of this group have been implemented successfully.

1.3.4 Agricultural Supporting Services

Present status of agricultural supporting services in different activities can be summarized as follows.

(1) Agricultural credit

(1)-1 About 59% and 24% of total household are financed by BAAC and Commercial Bank respectively as mentioned in 1.3.3.

(1)-2 After the disaster, 43 farmers in the area are financed by BAAC for replanting of rambutan and durian under the technical assistance of BAAC, DOA, DOAE and DLD. It is a special long term credit service with 9% interest rate and 20 years of repayment period.

(1)-3 BAAC can provide maximum short term credit up to 50,000 Baht per client farmer, with interest rate 11.5% per year. Most farmers are looking for low interest rate for improvement of farmland which it should be lower than the standard rates.

(2) Fertilizers and chemical products

Supply of fertilizer and pesticide are carried mostly by private sector in Amphoe Ban Na San. BAAC's members can get services through the credit-in-kind programs of BAAC, mostly fertilizer, pesticide and hubicide. At present, there is no quality control service to assure source of farm inputs with certain quality.

(3) Seedling and seed

Supply of fruit seedling and seed is carried out by private sector and farmers themselves particularly, rambutan.

(4) Consultation and extension services

The farmers in Ban Na San are rather active in orchard farming. After the disaster, farmland was covered by sediment. Most farmers need consultation and extension services on cultivation method, use of fertilizer and chemical and soil improvement method.

(5) Marketing information

At present, the updated marketing information related to market demand and price of each type of product are not available in and around the area.

1.4 Agricultural and Rural Infrastructures

1.4.1 Irrigation and Drainage Facility

In the F/S area low-head sprinklers have been used to irrigate fruit trees (see 4.4.1, PART 1). Small pumps (mostly 5HP) are used to lift water from sources such as Chawang river, the tributaries and tanks/farm ponds constructed by farmers.

After the disaster, DLD constructed a small scale fixed weir to extract water from Mui river, a tributary of Chawang river, and the appurtenant conveyance structure to improve water supply. The fixed weir (3-46-26N, 99-27-44E, Moo 7 Ban Huay Hun, design year 1/25, watershed 2 km^2, design discharge 25 m^3/s) is 30 m long. Water diversion is regulated by a manual operated gate. The diverted water is conveyed by an existing open channel (about 1 m wide, 0.7 - 1.5 m deep, 1,600 m long) in the upper area and by a free flow pipeline in the middle and downstream areas. The pipeline is 950 m long with a branch line of 485 m at 800 m, forming a 'L-shape' arborescent system. The ends of the pipeline discharge into Thoe river and Thuat river.

The farmers along the pipeline pump water from the open channel or the turn-outs located at every 100 m of the pipeline to irrigate their orchards. Water pumped from these sources is feeded directly to the individual farm household sprinkler network. Farm ponds (sizes between 10 m $\times$ 5 m $\times$ 2 m to 24 m $\times$ 20 m $\times$ 3 m) have traditionally been used, especially by the farmers in the lower end of the F/S area, to irrigate the fruit trees (see Figure 2-5). Farmers using these ponds seldom take water from the pipeline, probably due to difficult access. Since the ponds seldom dry up in normal drought year, they are the major reliable source of irrigation water during the dry months.

Systematic irrigation system such as irrigation block does not exist. Generally, irrigation is conducted on farm household basis. The farmers are not organized into users' groups or cooperatives for the purpose of proper water use, O & M or water fee collection.

In January and February of 1995, quite a large percentage of water diverted was observed to flow pass the pipeline into the outlets/wasteway, unutilized. Proper use of the water in the pipeline should be arbitrated so that more farmers can have access to the water. Farmers can utilize water from this pipeline.

Except for the natural river system, no major drainage canal is observed in the F/S area. Drainage capacity of these natural channels is much reduced due to deposition brought by the flood. The surface of farmland in the middle area has been raised by sand deposition and is less prone to flooding now. The strip of sand deposited land in the flood plain of Chawang river is subject to frequent flooding and remained unreclaimed. The conveyance canal, open canal and pipeline by DLD, also function as drainage canal in the rainy seasons. On-farm drainage is seldom practiced.

Except for the box culvert across Thoe river, simple pipe crossing structures are commonly used to drain water under the roads. Some of these pipe crossings are in bad conditions and must be improved.

1.4.2 Agricultural and Rural Infrastructure

The lateral road branching from the main road and leading to the F/S area is a 3-4 m wide low cost sediment paved road. It is used as village and farm road and is well maintained.

Roads in the F/S area is unpaved and have width of about 2 m. Road density is small and should be increased when planning land rehabilitation.

Electricity supply is available even to the most remote house in the F/S area. No tap water system exists in the area. Rain water is collected with the roof of houses and is stored mainly for drinking purpose. Shallow wells are used to supplement for drinking water and house chore use. The natural rivers are also utilized for bathing and washing clothes. Farmers living along the irrigation pipeline mentioned in 1.4.1. also use the water from the pipeline for their living, especially in the dry months when some of the shallow wells dry up. Sewerage or sewage disposal does not exist in the F/S area. Most of the sanitary flushing toilets are located outside the main farm house.

CHAPTER 2

PRESENT CONDITIONS OF THE LAN SAKA F/S STUDY AREA

CHAPTER 2 PRESENT CONDITIONS OF THE LAN SAKA F/S STUDY AREA

2.1 Physical Features

2.1.1 Location

The F/S area is located in south-east part of the Lan Saka area, and extends left bank of Tha Di river and bordered by hills in the upper stream, by river terrace in the east side and by the Tha Di river in the west side. The sands which were formed during the flood and has been surrounded by branch streams of Tha Di river, is included in the area. The area was damaged seriously by debris flow and major part have been overlain by thick sediment. Sediment deposited area is 723 rai.

2.1.2 Topography, Geology and Groundwater

(1) Topography and Geology

The fluvial plain distributed widely in the F/S area can be classified into three topographic types, 1) Present Natural Levee, 2) Older Natural Levee, and 3) Swampy Place (see Figure 2-6).

The fluvial plain is bordered by the River Terrace and by the hill in upper stream. The hill is underlain by deeply weathered granite. The River Terrace was saved from the damage because the terrace is from 2 to 5 meters higher than the fluvial plain. The River Terrace deposit presumed pleistocene is composed of gravel, sand and silt, and soil is formed on the top of this.

A contour map of the basement of the debris flow (surface of buried old soil) was made based on the soil survey. On the basis of the above map, it is supposed that the old soil was distributed in the F/S area before the disaster and contour map shows a continuous mound along the Tha Di river from upper stream to down stream forming a natural levee, which is named The Older Natural Levee (refer to Figure C-6, Appendix C). The Old Natural Levee was eroded by flood and was overlain by the debris flow. So it is suggested to call this topographic unit the Present Natural Levee. The Present Natural Levee is underlain by sand and gravel brought by the flood. The deposit ranges from more than 1.5 m to less than 30 cm thick.

The Older Natural Levee is distributed in upper stream of the area long and slenderly. It is supposed that because of the mound of Older Natural Levee the debris flow was interrupted to flow into so many swampy places. The Older Natural Levee was overlain by the sediment, less than 50 cm thick in the upper stream area and less than 100 cm thick in the sands of the down stream.

The Swampy Place is widely distributed between the Older Natural Levee and the River Terrace in the upper stream area, and a big swamp exists in the middle of the area.

(2) Groundwater

There are many wells in the area for farmers domestic use. The groundwater level occurs about 2.0 m below the surface in the Old Natural Levee, 1.0 meter in the Swampy Place, 2.5 meters in the Present Natural Levee, and about 4.0 meters in the River Terrace. The groundwater has a little smell and impurity in some wells under the influence of sediments (Table C-1, Appendix C).

According to the results of a pumping test, transmissibility of two wells are estimated 166 cm^2/sec. and 72 cm^2/sec (refer to Table C-2, Figures C-4.4 and C-4.5, Appendix C). If the aquifer is extended enough horizontally and vertically, it is possible to develop groundwater for irrigation use in the Present Natural Levee area, but it is necessary to consider the interference to the wells by lowering water level as a result from pumping.

2.1.3 Hydrometeorology

(1) River condition

Tha Di river forms the western boundary of the F/S area, flowing from north to south. This river divides into two at some point inside the area, and the two rivers join again at the most downstream point of the area. The river width is narrow and the cross section is small, and the route changes whenever flood water comes, which is not stable.

The catchment area and the length of Tha Di river at the most downstream point of the area are respectively 82.8 km^2, 16.8 km, and the average slope of the river bed is approximately 1/400 in the area, which is relatively steep.

(2) Flood and drainage discharges

(2)-1 Flood discharge of Tha Di river

As the flood discharges at selected points of Tha Di river is mentioned in 5.1.2, PART 1, the discharge at points in the area is calculated from flood specific discharge (refer to Table B.4.1 and Figure B.4.1, Appendix B).

(2)-2 Design drainage discharge in the F/S area

For the design discharge, it is calculated with the same method as the Ban Na San area. The design drainage discharge is determined by using the Rational Formula based on the 1/10 exceeded probable daily rainfall for a young tree (refer to Table B.4.2, Appendix B).

Design Drainage Discharge

Return Period	2 years	5 years	10 years	25 years	50 years
Design Drainage Discharge ($m^3/s/km^2$)	1.131	2.027	2.909	3.804	4.552

(3) Flood disaster in November, 1994

Heavy rainfalls caused by the Northeast Monsoon occurred from 17 November, 1994. Up to 600 mm were recorded in 10 days rainfall, causing water depth of the Tha Di river to increase and a peak to occur on 25 November. According to the water depth observations by RID, the maximum depth was 6.40m. This corresponded to a discharge of 630 m^3/s, which is closed to the 5 years return period from the viewpoint of the calculated flood discharge. This flood caused damages of the raised bed in the test field and abutments of the bridge.

One day amount of rainfall on 25 November and 2 days amount on 24 and 25 recorded respectively 133, and 260 mm. These rainfall amounts correspond to approximately the 2 years return period. However relatively big flood occurred because the runoff was at a peak when the concentrated heavy rainfall occurred.

2.1.4 Soil and Sediment

(1) Soil

Before the disaster, the F/S area has been covered by the soil classified as a Khlong Nok Kratung series in Thailand. This soil has deep and well-drained layer. Surface soil is brown coarse sandy loam, and subsoil is also brown coarse sandy clay loam. Reaction is from strong acid to slightly acidic. It is suited for field crops and perennial trees.

After the disaster, the area is covered by sediment deposited soil consisted of weathered granite.

(2) Sediment

Based on the soil survey, the deposited soil is classified into the followings, same as the Ban Na San (refer to Figure 2-7).

Class	Depth of sediment	Feature of deposited soil	Distribution	
			Area (rai)	Share (%)
I	No	-	125.78	22.2
II	<25cm	It is in moderate plow layer, consisted of fine sand silty loam	60.31	10.6
III	25~50cm	It is in moderate subsoil layer, consisted of fine sand and silty loam	38.75	6.8
IV	50~100cm	It is in moderate root zone, consisted of coarse sand, fine sand and silt loam	104.22	18.4
V	100~150cm	It is not in moderate root zone, consisted of coarse, fine sand and silty loam	14.53	2.6
VI	>150cm	It is very deep, consisted of sand	222.97	39.4
Total			566.56	100.0

Note : The area except for the river/canal, marsh, temple and test field are estimated based on the distribution map (Figure 2-7).

According to the above classification, classes III and V occupy a small area, 9.4% and Class I , 22.2%. On the other hand, Class VI has a wide distribution, 39.4%.

(3) Soil properties of deposited sediment

Physical and chemical properties of the deposited soil are summarized as follows (refer to Table F.22~F.25 and Figure F.6, Appendix F).

1) Soil is derived from weathered granite, consisted of fine sand including many quartz and micas.

2) Soil texture is classified mainly into sand and silt, or clay contents are very low within the all deposited horizons. The feature of sand fraction is mainly fine sand (0.5mm >). (see Figure 2-8). The soil composition is greater different from the Ban Na San in which coarse sand (2.0~0.5mm) is the main fraction.

3) Based on the standard in Thailand, chemical fertility of the soil is evaluated as follows.

Item	Rating of the value		Evaluation for the area
1. CEC (me/100g)	- High	more than 20	Low to Moderately low
	- Moderately high	15 - 20	
	- Medium	10 - 15	
	- Moderately low	5 - 10	
	- Low	less than 5	
2. Organic Matter (weight %)	- High	more than 3.5	Low to Medium
	- Moderately high	2.5 - 3.5	
	- Medium	1.5 - 2.5	
	- Moderately low	1.0 - 1.5	
	- Low	less than 1.0	
3. Base Saturation (%)	- High	more than 75	Medium to High
	- Medium	35 - 75	
	- Low	less than 35	
4. Available Phosphorus (ppm of P_2O_5)	- High	more than 57	Medium to Moderately high
	- Moderately high	34 - 57	
	- Medium	23 - 34	
	- Moderately low	14 - 23	
	- Low	less than 14	

Source: Benchmark soils of Thailand, DLD (1987).
Note: Chemical properties of the soil are shown in Table 2-3.

The level of soil fertility and nutrient holding capacity varies from low to high.

(4) Comparison of deposited soils in Ban Na San and Lan Saka

Compared with the physico-chemical properties of the deposited soil in the both areas, in physical property, particle composition is different. In Ban Na San, coarse sand is the main fraction. Lan Saka has high content of fine sand. In chemical property, the potentialities of soil fertility in Lan Saka are higher than those of Ban Na San.

Item	Ban Na San		Lan Saka	
	Range of data	Average	Range of data	Average
Coarse Sand (2.0 - 0.5 mm) content (%)	7.3 - 87.5	52.4	0.1 - 1.2	0.7
Medium Sand (0.5 - 0.25 mm) content (%)	7.8 - 26.6	14.1	2.9 - 46.7	27.6
Fine Sand (0.25 - 0.05 mm) content (%)	2.7 - 64.2	24.9	37.8 - 72.3	59.5
pH (H_2O)	4.8 - 5.7	5.2	4.5 - 5.8	5.3
Electric Conductivity (ds /m)	0.05 - 0.15	0.09	0.07 - 0.35	0.18
Total Carbon (%)	0.04 - 0.56	0.26	0.12 - 1.70	0.47
Total Nitrogen (%)	0.00 - 0.05	0.03	0.01 - 0.12	0.04
Cation Exchange Capacity (me/100g)	1.5 - 5.6	3.5	2.8 - 7.0	4.4
Degree of Base Saturation (%)	21 - 26	42	39 - 94	57
Available Phosphorus (ppm)	13.8 - 29.6	21.2	28.0 - 45.9	34.2
Available Potassium (ppm)	23.0 - 58.0	44.8	32.0 - 270	88.0

2.1.5 Land Use

The land use in the area is as follows.

Land use	Area (rai)	Share (%)
1. Agricultural land	510.70	70.7
Orchard land	510.70	70.7
2. Waste land	61.74	8.5
Swamp	27.03	3.7
Grassland	24.40	3.4
Marsh	10.31	1.4
3. Others	150.69	20.8
River/Canal	125.94	17.4
Road	21.15	2.9
Temple	0.16	-
Test field	3.44	0.5
Total	723.13	100.0

Note : Each area was estimated according to the geographical map prepared by the Study Team.

Most of the area is occupied by the orchard with mixed fruit trees plantation.

2.2 Socio-Economic Conditions

2.2.1 Administration

(1) Division of administration

The F/S area is located in Wat Chan and Yan Yao villages of Tambon Kam Loan. Both villages cover 6,840 rai, out of which the Wat Chan village is 2,340 rai and Yan Yao village is 4,500 rai. They are located in south-eastern border part of the tambon as neighboring villages.

(2) Applicability to rural development plan

According to the survey of NESDB, both villages have been ranked as second level, which is supposed to be developed by the provincial rural development plan.

2.2.2 Population and Farm Land Holding

(1) Population and household

According to the same survey, the population of the F/S area is 1,455 as of 1992, out of which Wat Chan village is 487 or 33% and Yan Yao village is 968 or 67%. The population density is 241people/km^2, which is rather high compared with 233 of the tambon. The number of households is 288, accordingly the family size per household is 5.1 persons. The population is composed of 717 male and 738 female, accordingly sex ratio is 97%. The dependency ratio is 135%, which means that working population is very few in the villages. On the other hand, the number of farm households is 268 or 93% of total household. The percentage of those who finished compulsory education in the age 12 years and above is 63, and relatively in low level. Especially, 46% in Wat Chan village.

(2) Farm land holding

According to the same survey, the farm holding land of the villages as of 1992 is 6,228 rai, out of which Wat Chan village is 2,228 rai and Yan Yao village is 4,000 rai. The ownership of these farm land is composed by farmers of 99% owned land. There are four (4) farm households in Wat Chan village which rent farm land. The average farm size per farm household in the F/S area is estimated based on the same method as in Ban Na San, as a result, it is 11.8 rai on the tambon basis. On the other hand, the number of farm only occupation farmers is merely four (4) in Wat Chan village, and the remaining farmers, that is, 99% of total farmers are farm and others occupation farmers.

2.2.3 Farm Household Economy

Farmers' socio-economic survey was carried out, same as in Ban Na San. Twenty (20) households or 10% of the total households in the two villages were interviewed as a sample. The average farmer's economy of three sizes is as follows.

Table 2-4 Farm Household Economy (Lan Saka)

Item	Large Size Farmer (15 rai and over)	Medium Size Farmer (5~15 rai)	Small Size Farmer (under 5 rai)
1) Farm Net Income (Baht)	56,533	31,279	12,544
Rambutan	-325	-	-243
Durian	8,825	-	-
Mangosteen	26,825	14,828	-396
Juck fruits	-	-	-
Other fruit, etc.	-	3,653	7,354
Rubber	21,208	12,798	-
Baby corn and Other Vegetables	-	-	5,829
Livestock	-	-	-
2) Non-farm Net Income (Baht)	-	18,000	27,000
3) Farm Household Net Income (Baht)	56,533	49,279	39,544
4) Direct Tax, etc. (Baht)	30	2,000	-
5) Disposable Income (Baht)	56,503	47,279	39,544
6) Household Expenditures (Baht)	31,520	30,300	19,100
7) Farm Household Surplus (Baht)	24,983	16,979	20,444
8) Per Capita (Baht)			
(1) Farm Net Income	11,307	6,256	2,509
(2) Farm Household Net Income	11,307	9,856	7,909
(3) Farm Household Expenditures	6,304	6,060	3,802
9) Farm Labour Input Quantities (man/day)			
(1) per year	208	124	111
(2) per rai	13	15	40
10) Family Farm Labour			
(1) Input Quantities (man/day)			
(a) per year	208	124	111
(b) per rai	13	15	40
(2) Labour Reward (Baht)			
(a) per man per year	18,060	10,160	4,060
(b) per man per day	261	241	110
11) Farm Net Income Ratio (%)	88	90	89
12) Farm Household Cash Net Income (Baht)	60,802	48,497	39,196

The rubber in the average farm net income occupies 34%. Whereas, the mix planted fruit trees mainly composed of the mangosteen occupy relatively a large part of those incomes. Farm net income and farm household net income are relatively low compared with the Ban Na San area. However, farm household surplus has risen with the share of 30-50% of the farm household net income by cutting down household expenditures. The farm net income ratio is 90%, that is, it shows to input few agricultural materials, etc. It is due to the following situation, that is, most of the fruit in the area has been produced in the mountainous/hilly land, and the fruit field in low land is of few, with unbearing fruit trees of which are newly planted after the disaster. Consequently family farm labour rewards per man per day exceeds twice of farm labour wages per day, however, that of the small farmers is an equality, due to a lot of labour requirements for vegetable cultivation (triple cropping).

Compared with the farm household cash net income in Amphoe Lam Saka (42,660 Baht), by the OAE, MOAC, farm household cash net income of large and medium size farmers is greater.

2.3 Agriculture

2.3.1 Agricultural Land Use

Based on the land use survey in 2.1.5, agricultural land is divided into the cultivated and waste lands. In the cultivated land, mixed cropping with mangosteen, rambutan, banana and coconut, etc., are practiced. Besides such fruit trees, sweet corn, sweet potato, peanut, chili, eggplant, cucumber and watermelon, etc. are also cropped as the intercrops. Waste land is consisted of swamp, grass land and depression. Present agricultural land use is shown in the following table.

Agricultural Land Use in Lan Saka F/S Area

Land Use	Area (rai)	Percentage (%)
Agricultural Use Land	572.44	100.0
1. Cultivated land	510.70	89.2
- Mixed Orchards	510.70	89.2
2. Waste land	61.74	10.8
- Swamp	27.03	4.7
- Grass	24.40	4.3
- Depression	10.31	1.8

Note : Each area is estimated on the topo-map (1/5,000).
Present land use boundary is delineated by the Study Team.