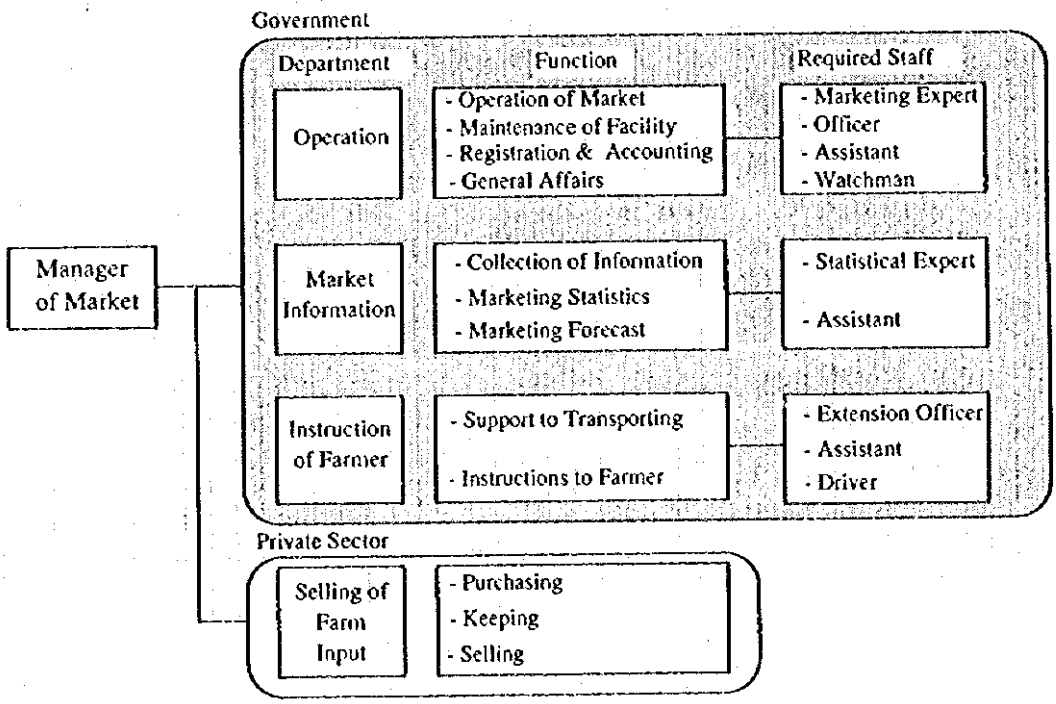
	Facility and Equipment	Purpose
i)	Working space :	collecting and selling products
ii)	Storage :	products and farm inputs
iii)	Loading space:	loading of products
iv)	Parking lot :	for wholesalers
v)	Office space :	for marketing board members and wholesalers

(c) Organization

A marketing board (marketing organization) should also be established for the smooth operation of the market. At the first stage, the marketing board will be composed of government staff (provincial and district trade and agricultural section). Finally however, the farmers organization will fully manage the market in the future.

Subsequently, farmers will also participate in the organization and be trained for the future operation of management technologies. The proposed marketing organization is illustrated on the following chart; the number of staff in each section is presented in the following table.



Position	Number
Director (Manager)	1
Marketing section	4
Information Section	2
Farmers' Organization Section	3

(d) Operation Plan

(i) Operation Plan of Wholesale Market

The market will be held once or twice a week at the first stage, for effective operation. However, it will be operated everyday in the harvest season at the mature stage. Prior to participation, the farmers will register at the market organization with payment of a registration fee. The registration is

effective for a year; hence the buyers who want to participate at this market should register every year. On the other hand, agents or farmers can participate and sell their commodities at the market without limitation.

The related market information such as market price(s) at Vientiane, Savanacket, Ubon, Bangkok, etc. will be supplied at the market for fair trade and price stabilization. In addition, it is also important to provide information about production conditions such as prospected production, etc. to buyers to encourage them to join the market and reduce their risk for investigation.

The operation and maintenance costs of the market are mainly covered by the commission fees calculated on the basis of total sales value. One (1) percent of total sales value is charged to both sellers (farmers) and buyers.

(ii) Farm Input Supply

It is recommended that farm input supply be carried out by the private sector. Although the facilities are planned to be constructed, the operation of this will be done by several private or state companies under the government guidance. The facilities will be rented by companies and rental fees will be charged to the companies. The selling amount and timing will be set through discussions and coordination with APB and the extension office in the district.

(iii) Transportation Support

The organization will have a function of assisting farmers in the transportation of products. The organization rents its truck (about 5 tons); however, the farmers will have to load their produce by themselves. The rental charge of the truck is calculated on the basis of the fuel cost.

(iv) Market Statistics

Through the operation of wholesale market, statistics for price datas, productions, treated amounts, fluctuation of seasons and areas, etc. can be collected for a significant number of years. The data will be useful for the estimation of market forecasts, as well as for the formulation of production plans. Therefore, an expert for statistics will be assigned to the market organization for the constructing of the database.

(v) Estimated Costs and Benefits

The costs and benefits of the wholesale market operation are estimated in the following table. Only the commission fee is calculated in the estimation because it is a main source of benefit.

(000 kip)

Items	Value
1. Commission* (main income)	9,600
2. Total Cost	(7,600)
2-1 Salary	4,200
2-2 O&M	1,080
2-3 Fuel charge	2,160
2.4 Others	160
3. Balance	2,000

Note: * Commission is estimated as 2% of the total annual amount value by the wholesale market.

(e) Training of Local Government Staff

Since the introduction of the wholesale system is a first trial for the entire country, the market staff shall be sufficiently trained, prior to the opening, for smooth operation. The study of operations in other countries is considered the most effective training procedure. The training items to be considered are summarized as follows:

Subject	Trained Items	Trained Country	No. of Person
1. Wholesale System	- Wholesale system - Grading of quality - Pricing system	Japan Thailand	1 or 2
2. Information Management	- Collection and supplying of market information - Market information statistics - Demand forecast	Japan Thailand	1 or 2
3. Support of Farmers	- Farmers' cooperation - Supporting system for shipping	Japan	1 or 2

(f) Other Required Equipment

The following equipment will be required for the operation of the above activities.

Main Required Equipment	Number
Truck of 5 tons capacity	1
Radio communication system	1
Personal computer	1
Printer	1
Generator of 5 kW	1
Industrial-sized scale weighing	1

(2) Establishment of Rice Bank System

The number and capacity of the existing rice mill facilities is insufficient for the increase in future rice production with the implementation of development projects in the Lower Xe Set and Upper Tay-Un. Therefore, the improvement of milling capacity and installation of new rice mill facilities are recommended along with the project implementation. The rice mill facilities would be managed by the existing rice bank system which deals with mutual credit storage, and saving activity based on rice at the village level. The improvement of the rice bank is proposed, to achieve rice processing and marketing, as well as for its banking functions. The improved rice bank would be a prototype of a farmers' cooperative which would be developed in the future.

(a) Proposed Site

Based on the number of villagers, accessibility, ethnic conditions, etc., it is proposed that the rice banks be established in the following villages in the Xe Set and Tay-Un Schemes.

Schemes	Proposed Site	No. of Villages	No. of H.H.	Population
Xe Set	B. Sengvang-gnai	2	187	945
	B. Houakhoua	1	58	290
	B. Sengvang-noi	1	74	454
	B. Khonleng	1	29	179
	B. Natou	1	58	350
Tay-Un	B. Chakamlit	3	108	871

(b) Facility

The main facilities to be installed are summarized as follows:

- milling facility and building
- storage
- drying yard
- offices

(c) Production of Paddies in Priority Areas

The capacity of the facility for the proposed rice bank is decided on the basis of future production. The amount to be handled by the rice bank is estimated as half of the marketed rice from the Lower Xe Set and Upper Tay-Un Schemes. The amount of paddy be produced, marketed and handled by the rice banks in the priority Schemes (Xe Set and Tay-Un) under future with Project conditions is estimated as shown in the following table.

(Unit: ton)

Schemes	Proposed Site	Production	Demand *1	for market	by Rice Bank
Xe Set	B. Sengvang-gnai	2,080	320	1,760	880
	B. Houakhoua	720	100	620	310
	B. Sengvang-noi	920	160	760	380
	B. Khonleng	360	60	300	150
	B. Natou	720	120	600	300
Tay-Un	B. Chakamlit	1,760	260	1,500	750

Remark: Demand is calculated on the basis of the population at 2000

(d) Organization

The organization of rice bank should consist of the beneficiary farmers as an initial step towards farmers' organization. In addition, it should be considered to involve women to the organization for women's development. The proposed staff and required number for the rice bank are presented in the following table.

Position	Number
Managing Director	1
Clerk	1-2
Assistant clerk	0-2
Rice mill operator	1-2
Assistant Operator	0-2
Store keeper	1-2

Note: The required number depends on the size of the Rice Bank

(e) Operation of Rice Bank

(i) Milling charge of rice

The milling charge of paddies is one of the main sources of income for the rice bank. The present milling charge of rice in and around the priority Schemes is about Kip 10-15/kg of rice. Therefore, Kip 15/kg is recommended to be applied.

(ii) Operation cost and balance with income

The operation costs of the rice bank are estimated on the basis of staff salaries, fuel charges of rice mills, etc. The main income will be a milling charge of paddies as shown above. The following table shows the annual gross income and operation costs of rice banks in each proposed site,

(Unit : 000 kip)

Scheme	Sengvang-gnai	Houakhoua	Sengvang-noi	Khonleng	Natou	Chakamlit
1. Gross Income	13,200	4,650	5,700	2,250	4,500	11,250
2. Annual Cost	6,045	2,825	3,070	1,775	2,785	5,720
- Personal expense	3,000	1,680	1,680	1,200	1,680	3,000
- O&M cost	2,875	1,055	1,290	515	1,015	2,555
- Management cost	170	90	100	60	90	165
Balance	7,155	1,825	2,630	475	1,715	5,530

Remark: Excluding the depression cost for facilities

(iii) Marketing of rice

In addition to the above, at a later stage, it is recommended that the rice bank function as an agent to sell rice to the market instead of to farmers. It is proposed that the farmers pay a commission of 2% of the total selling value. Taking into consideration the improvement of quality, the recommendable bank gate price will be a minimum of Kip 300/kg. Based on the assumption, the gross incomes of the banks from the activity of selling rice in each proposed site is expected as follows:

(Unit : 000 kip)

Scheme	Proposed Site	Gross income
Lower Xe Set	B. Sengvang-gnai	3,430
	B. Houakhoua	1,210
	B. Sengvang-noi	1,480
	B. Khonleng	590
	B. Natou	1,170
Upper Tay-Un	B. Chakamlit	2,930

Remark: Marketed price of rice is set up at 300 kip/kg.

4.4.3 Future Agro-economic Conditions

(1) Crop Budgets under With and Without Project Conditions

Crop budgets under without Project conditions is basically not changed from the ones of the present crop budgets. Crop budgets under with Project conditions are estimated based on production costs and values, calculated by financial prices as of 1995. The increment of each crop is summarized as follows:

(Unit : 000 kip)

Crops	Without Project	With Project	Increment
Upland rice	230	0	-230
Coffee	303	1,464	1,161
Tea	149	333	184
Cabbage	684	1,589	905
Lowland rice	311	414	103
Upland crops *	443	449	6

Remark: Upland crops are represented by groundnuts.

(2) Financial Irrigation Benefit

Expected irrigation benefit from the Project is the difference of net return value from crops between future without and with Project conditions. The financial irrigation benefits at full development stage in the priority Scheme areas are summarized as follows:

(Unit : million in Kip, thousand in US $)

	Without Project Condition			With Project Condition			Incremental Benefit	
Crops	Pro.value	Pro.cost	Net Benefit	Pro.value	Pro.cost	Net Benefit	by Kip	by US$
1. Upper Champi	155	15	140	1,130	160	970	830	903
2. Upper Tapoung	0	0	0	185	50	135	135	149
3. Upper Kapheu	230	10	220	1,610	180	1,430	1,200	1,309
4. Lower Xe Set	120	5	115	1,230	340	890	770	839
5. Upper Tay-Un	10	0	10	290	80	210	200	219

(3) Future Farm Household Economy

(a) Future Farm Type

After the implementation of the projects, the present farm types in the each priority Scheme will be changed to the following farm types:

i) Upper Champi and Upper Tapoung

Priority Area	Upper Champi			Upper Tapoung	
Farm Type	Coffee	Coffee+Tea	Coffee+Vege.-1	Coffee+Vege.-2	Coffee+Vege.-3
Irrigated Field	Coffee : 2.7 ha	Coffee : 2.3 ha	Veg-Up.C : 0.3ha	Veg-Up.C : 0.3ha	Veg-Up.C : 0.3ha
(Crop. Pattern)	-	Tea : 0.7 ha	-	-	-
Rainfed fields	-	-	Coffee : 1.5 ha	Coffee : 2.5 ha	Coffee : 2.5 ha
	-	-		Vege. : 0.3 ha	Up. rice : 0.3 ha
No. of H.H.	40 H.H.	186 H.H.	76 H.H.	160 H.H.	26 H.H.

ii) Upper Kapheu and Lower Xe Set

Priority Area	Upper Kapheu	Lower Xe Set	
Farm Type	Coffee+Low. R.	Lowland Rice-1	Lowland Rice-2
Irrigated Field	Coffee : 1.6 ha	Lo.R-Lo.R : 2.5ha	Lo.R-Up.C: 2.5ha
(Crop. Pattern)	Lo.R-Up.C: 0.2ha	-	-
Rainfed fields	-	-	-
No. of H.H.	431 H.H.	80 H.H.	320 H.H.

iii) Upper Tay-Un

Priority Area	Upper Tay-Un			
Farm Type	Lo. R +Coffee-1	Lo. R +Coffee-2	Lowland R-1	Lowland R-2
Irrigated Field	Lo.R-Lo.R : 1.2ha	Lo.R-Up.C: 1.2ha	Lo.R-Up.C: 2.5ha	Lo.R-F : 2.5ha
(Crop. Pattern)	-	-	-	-
Rainfed fields	Coffee : 1.3 ha	Coffee : 0.8 ha	-	-
No. of H.H.	17 H.H.	48 H.H.	29 H.H.	71 H.H.

Remark : Vege. means vegetables, Lo.R means lowland rice, Up.C means upland crop, respectively. Natural increasing of population is taken into consideration in the Upper Kapheu, Lower Xe Set and Upper Tay-Un. In addition, future transmigration is also considered in the Upper Tay-Un Scheme.

The farm types in each Scheme basically follow the present farming type. In fact, the farm type in the Upper Champi Scheme will be not changed. In the Upper Tapoung area, the slash-and-burn cultivation farmers will reduce their fields by 30% because of their future replacement by coffee plantations and operation of permanent irrigated fields along the Project. While, the lowland rice farmer will be drastically increased instead of slash & burn farmers in the Lower Xe Set area and Upper Tay-Un area.

(b) Household Economy of Each Farm Type

The farm budgets for the each farm type are evaluated and the results are summarized as follows:

Priority Area	Upper Champi		Upper Tapoung			Upper Kapheu
Farm Type	Coffee	Coffee+Tea	Coffee +Veg.-1	Coffee +Veg.-2	Coffee +Veg.-3	Coffee +Veg.
1. Gross Farm Income	4,455	4,110	1,520	2,256	1,997	2,888
2. Production Cost	600	594	179	351	276	308
3. Net Income	3,855	3,516	1,341	1,905	1,721	2,580
3.1 Living Expenses *	1,443	1,443	1,075	1,443	1,443	1,443
3.2 Net Reserve	2,412	2,073	267	462	278	1,137

Priority Area	Lower Xe Set		Upper Tay-Un			
Farm Type	Low. R.-1	Low. R.-2	Coffee+Lo. R - 1	Coffee+Lo. R-2	Low. R. 1	Low. R.-2
1. Gross Income	3,000	3,100	1,769	1,690	3,100	1,500
2. Production Cost	1,105	1,030	441	451	925	448
3. Net Income	1,895	2,070	1,328	1,240	2,175	1,052
3.1 Living Expenses *	1,443	1,443	1,075	1,075	1,443	958
3.2 Net Reserve	452	627	253	165	732	95

Remark: *1 O&M cost includes irrigation water charges, domestic water supply, and other maintenance costs.
*2 Living expense is estimated based on the average expenditure of people in urban areas of Laos. (Source: Agricultural Sector Memorandum, IBRD, 1994)
Note: A present farmgate coffee price is applied in this calculation.

The farm budget conditions are different in the each priority areas because of the difference in farm type and size. However, any household could receive a substantial income which is sufficient for annual living expenses and also O&M cost including irrigation water charge, domestic water charge, etc. The farmers' living conditions will especially change dramatically in the Lower Xe Set Scheme. Meanwhile farmers in the Upper Tapoung Scheme are presently at a sufficient level, therefore some of them may not receive substantial benefits from the Project . However, constant benefits from the production resulting from integrated irrigation farming will stabilize their income and avoid risks. It is one of important points from an agro-economical view that even a low economical impact is beneficial for the farmers.

4.5 Socio-economy

4.5.1 Development Concept

The Scheme aims to construct an affluent rural society through achieving a substantial and sustainable improvement in the living conditions of people in the Scheme areas, generating increased agricultural and non-agricultural productions supported by improvements and provisions of the rural infrastructure. To this end, from the implementation stage of the scheme to operation and maintenance of the facilities, a participation with beneficiaries is essential. Among the beneficiaries, the feeling of ownership of the Scheme will be strengthened. Furthermore the objectives of this plan would be realized through activation of rural society by means of community development. Accordingly, the socio-economic development, taken into consideration the participation of beneficiaries to the Scheme, will be proposed. The proposed socio-economic development comprises the participation of beneficiaries and community development.

4.5.2 Participation of Beneficiaries

The most important work in the Scheme is the improvement of the water situations in the areas, through construction of irrigation systems; and the improvement of rural life and society through construction and improvement of the infrastructure (such as community halls, schools, water supplies and roads). This provides an opportunity to build up of a grass roots organizational structure. The following procedures will be proposed for the participation of beneficiaries to effective and sustainable irrigation development and rural development. Concerning irrigation and water supply, the organization of beneficiary groups follows the regulation procedures mentioned in section 4.2.

(1) At the initial construction stage, the village water users' groups for irrigation and domestic water supply (VWUG-Irrigation, and -Domestic Water Supply) and the water users' associations for irrigation and domestic water supply (WUA-Irrigation, and -Domestic Water Supply) will be organized by beneficiaries under the guidance of the provincial and district AFSs.

(2) The groups for irrigation are responsible for the implementation of construction works for tertiary and quaternary canals. Hence, the sub-groups organized by the canal system, will hold discussions and negotiations on the design of the tertiary and quaternary canals in collaboration with the design engineers of the Scheme. They will determine the final design and construction period. On the other hand, the groups for water supply will make the same procedures as the case of irrigation on the final tap place in the village in collaboration with the engineers of the Scheme. All the activities will be done by determination of the groups based on the family unit.

(3) The operation and maintenance including water distribution will be determined by discussions and negotiations on these issues among beneficiaries, in collaboration with engineers and/or technicians in charge of these systems. The water fee required for these works will be set at a reasonable and affordable level among the beneficiaries, resulting from discussions and negotiations based on the function of plot size, the level and number of yields for irrigation, and the consumption of domestic water according to family size.

In order to hasten these procedures smoothly and effectively, a considerable amount of time should be spent by the provincial agricultural and health authorities' staff on the training and extension work for the beneficiaries. On the other hand, rural infrastructure constructed by the Scheme consists of community halls (as the center of activities of rural society), school facilities (for improving the educational environments), water supply (for improving rural life), and road improvement (contributing the regional economy by interlinking areas). From the social development perspective, it is important that the beneficiaries are involved in the implementation of the Scheme and the proposed activities. It is recommended that the

established water users' organizations be engaged as labor units in unskilled work during the implementation stage.

4.5.3 Community Development

It is assumed that the rural infrastructure will become a foundation for the integrated rural development by the effective use of community activities. Community development will be the driving force to accelerate rural development. The objectives of this plan will include the following items:

(i) Improvement of health and hygiene
(ii) Increase in the literacy and educational standards
(iii) Generation of non-farm income
(iv) Positive participation on environmental issues

This development will be carried out gradually taking into consideration the people's concerns for using the provided facilities. Particularly, the people in the Scheme area belong to ethnic groups. Their educational level, is low, and they have traditional customs and cultural backgrounds. Therefore, a development program based on the people's needs will be conducted. As a forum for these activities, the community hall will be used effectively. The proposed programs are as follows:

(1) At the initial development stage, the construction plan and the purpose of the community hall will be explained to village leaders, from the personnel in charge of social development of the provincial and district authorities.

(2) The training seminars on rural community development will be held regularly for village leaders including leaders of existing village groups, under the sponsorship of the provincial and district authorities' social development units and the Lao Women's Union. Through the training, village leaders will recognize the importance of community development.

(3) This hall will be managed and operated autonomously by the villagers themselves and will have a role as the core of village community activities for rural society development. On this account, explanations will be given to the village leaders and the objectives of the hall will be expressed to all the villagers, without exception, by opening a village meeting.

(4) In order to effectively and smoothly manage and operate the hall, a community executive board will be established, comprising representatives of the village administration, elders, women and youth groups, village agricultural association, both water users' groups for irrigation and water supply, and health volunteers. The chairman of the board will take responsibility for the management and operation of the community hall; and a secretary, an accountant and a manager will be assigned.

(5) Community activities will be carried out with the participation of all the villagers at the community hall as the center of the activities. The relevant authorities to these activities such as from the health, education, and agricultural services, will provide cooperation. Furthermore, active volunteer work will be encouraged through these activities.

(6) Operation funds will be collected from each group, and rental fees for the facilities will be collected when used. The collected fees will fill a deficit.

With the aim to activate the rural community and improve rural life, programs which could make practical use of the community hall are proposed as follows:

(1) Health and Hygiene Programs

Owing to easily obtainable clean water from the water supply system, the health and hygiene program which deal with such issues as environmental cleanliness, the handling of drinking water, hygienic cooking, etc., will be arranged and implemented in collaboration with the LWU, the provincial health services, and NGOs. Implementing this program will help realize a healthy family life, and thereby increase working capabilities.

(2) Adult Education Programs

In order to accelerate the literacy rate, which will bring affluence to the local society, and raise the social status of women and increase their educational opportunities, adult education programs will be arranged and implemented in cooperation with the provincial education services and the LWU. Particularly, the improvement of literacy will be encouraged to improve the living conditions and facilitate communication with the outside world.

(3) Rural Handicraft Programs

The people in the rural area have a traditional handicraft and weaving techniques. A program will be arranged in an attempt to develop these traditional crafts. This will give an opportunity to introduce their precious culture to the world and help preserve their art to succeeding generations. This program will be implemented with the support of the LWU. It seems that this could produce additional income and contribute to the family economy.

(4) Environmental Programs

This program encourages a good rural environment by the reduction of slash-and-burn cultivation, and through reforestation and forest preservation. This will be arranged and implemented in collaboration with the provincial and district AFSs. Through raising the awareness for an environmental problem among the people, the base of rural society will be strengthened.

Besides, the activities of the proposed women's extension staff will be centered on vegetable gardening, pig and poultry raising, and home economics. The extension staff will promote the improvement program of domestic life in cooperation with volunteers of the village women's group and/or the LWU's staff.

4.5.4 Women's Participation to Social Development

Rural society in the Scheme area consists mainly of ethnic groups. The women's participation to the social activities is limited. However, it can be observed that its situation is different among ethnic sub-groups due to cultural backgrounds. Under the circumstances, the involvement of women to the Scheme and operation of irrigation facilities and water supply, will be considered. It will contribute in the long term to enhance awareness of the women's role in irrigation and water supply. The improvement in the social status of rural women will be promoted through incentives in community participation. In addition, the provision of clean water by the constructed water supply system will greatly contribute to the welfare of women and girls by reduction of home tasks such as water fetching. It also improves their health. As a result, participation in social activities and improvement in literacy may be obtained without difficulty. The women's decision-making role in the family and community may also be enhanced from supplementary income obtained from additional working hours. It is expected that women's participation in social activities will go a long way towards improving rural society in the Scheme area.

4.6 Agricultural Infrastructures

4.6.1 Irrigation Canal Layout

Irrigation canal networks generally consist of head race, main canal, secondary and tertiary canal. Concrete block lining is made from head race to secondary canals. Head race and the main canal are basically laid out in a vertical direction against contour lines. Secondary canals are laid out to branch off from the main canal, and generally follow topographical contour lines. Tertiary irrigation block is basically demarcated about 30 ha. These canal layouts are shown in Figures 2.11 to 2.15.

(1) Upper Champi Scheme

Irrigation water is off-taken by concrete diversion weir and supplied to the left bank area of the H. Champi. Diversion weir has a height of 9.5 m and a width of 43 m. The irrigation area is 730 ha, and the crops to be irrigated are vegetables, upland crops and coffee.

Irrigation canal networks consist of a main trapezoidal and secondary canals of approximately 41 km in total length, an impounding pond with an active storage capacity of about 105,000 m^3, farm ponds and related structures. Canal lining with a concrete block of about 23 km is planned in the main, secondary, and tertiary irrigation canals networks. Inspection and farm roads networks of about 21 km in total are planed to be paved with gravel. In line with the agriculture extension development program, a highland vegetable trial and demonstration station of about 50 ha is planned to be constructed in the area.

(2) Upper Tapoung Scheme

Irrigation water is off-taken at the outlet of the existing pond of Tapoung river by concrete diversion weir with a height of 7.5 m and a width of 38 m. Irrigation area extends over upland field of 80 ha which extends at the left bank of the river. Main crops are vegetables and upland crops. Storage capacity of the existing pond is increased by about 240,000 m^3. In the canal and drainage networks, main and secondary irrigation canals are planned to be laid out about 2.4 km in total length. Canal lining with concrete block is also planned, to provide about 3 km for main and secondary canals. Inspection and farm roads are proposed to be constructed at about 5 km with gravel pavement.

(3) Upper Kapheu Scheme

Water resource for irrigation development is the Kapheu river, and concrete diversion weir is planned to be constructed at about 1.5 km upstream from B. Sixiangmai village. Height of weir is 3.5 m and width is 14 m. Irrigation water is conveyed to an area of 1,000 ha by main canal networks of about 14 km. Main canal networks consist of main and secondary canals, 4 impounding ponds with total effective capacities of about 395,000 m^3 and related structures. Concrete block canal lining is planned, to provide about 21 km for main canal networks and tertiary canal. Main crops to be irrigated are coffee, upland crops and wet season paddies. Farm road network including inspection road of canals is laid out about 15 km with gravel pavement.

(4) Lower Xe Set Scheme

Irrigation water is off-taken at about 2 km downstream from Xe Set power station by concrete diversion weir with a height of 11.5 m and a width of 75 m and regulated by stored pond water which is laid out just downstream from the diversion weir in order to deal with the released discharge from the Xe Set hydro-power station. Irrigation area extends over 1,000 ha, and main crops are paddies and upland crops. Canal networks consist of main and secondary canals lined with concrete block, farm ponds and related structures. The length of the main canal networks and tertiary canal is about 21 km. Road networks including an inspection road are to provided, about 26 km with a gravel pavement.

(5) Upper Tay-Un Scheme

Two (2) small impounding ponds are constructed at the Tay-Un and the Thon river basins. Irrigation water diverted from both the H. Tay-Un and H. Thon is conveyed to the irrigation area of approximately 330 ha by main canal networks and tertiary canal of about 11 km in total length through the said ponds. A regulation pond is planned to be constructed along the main canal stretching from the H. Tay-Un river. An effective storage capacity of the regulation pond is about 65,000 m^3. Irrigation areas are 330 ha of paddies in wet season and about 190 ha of upland crops in the dry season. Concrete lining of about 7 km is provided in the main to tertiary canals. Farm road networks of about 5 km including inspection roads are planned with a gravel pavement.

4.6.2 Canal Lining

According to the results of soil investigation, soils in majority of all the Scheme areas are Dystric Nitosols derived from basaltic rock. It has an erosive characteristic against rainfall. Therefore, in designing the canal system, a thin concrete block lining of aggregates obtained from basaltic gravel, is adopted to save seepage loss in irrigation canals, facilitate maintenance work for the farmers. Canal lining is made in the main, secondary, and tertiary canals. The total length of the canal lining is about 75 km.

4.6.3 Drainage Requirement

Drainage requirement for the priority development Schemes is estimated by using rainfall data for the past ten (10) years from 1986 to 1995. Drainage water requirement for paddy and upland fields is estimated on a different assumption. For the paddy field, drainage requirement with a probability of once in 5-years is estimated to evacuate the surplus rain water with the drainage period of 3 days. For the upland fields, a rational formula is applied. Drainage periods of four (4) hours for vegetables and one (1) day for other upland crops are considered. Estimated results are as follows;

Priority Scheme	Probable Daily	Paddy Field	Upland Field	
Area	Rainfall (mm/day)	q (lit./sec/ha)	r_t (mm/hr)	q (lit./sec/ha)
Upper Champi	272.1	10.5	27.8	38.6
Upper Tapoung	272.1	10.5	27.8	38.6
Upper Kapheu	186.0	7.2	7.8	10.8
Lower Xe Set	186.0	7.2	7.8	10.8
Upper Tay-Un	86.0	3.3	3.6	5.0

4.6.4 Drainage Canal Layout

Main drains are laid out in river courses and/or existing drains as much as possible. If the drain length is somewhat long, the main drain is connected with rivers and/or other drainage systems located nearby; in order to divide a heavy discharge and protect soil erosion along the drain. A tertiary drain is provided in each tertiary irrigation block. A secondary drain is basically laid out to follow a topographical contour line. The total length of the main drain system is about 12 km. General Layouts of main drains in the each Scheme are shown in Figures 2.11 to 2.15.

4.6.5 Operation and Maintenance Plan

Operation and maintenance plans of irrigation facilities are made in the following four points;

(i) Construction and provision of O&M facilities

(ii) Establishment of an O&M organization
(iii) Irrigation operation
(iv) Maintenance schedule

(1) Construction and Provision of O&M Facilities

Discharge measurement of irrigation water is needed, to carry out sufficient and successful water operation in the entire irrigation areas. The measuring structures are provided immediately downstream from all the intake gates, farm ponds, turn out and division boxes. The type of measuring structure is designed as a broad crested weir for the main canal system to provide a gauging staff for the tertiary canal system.

Furthermore, some of the facilities for irrigation operation and maintenance works that are being planned are: (i) a radio system for irrigation operation, (ii) vehicles (including motorcycles) for transportation, operation, monitoring and maintenance works, (iii) maintenance equipment for irrigation facilities which will be sustained by Government agencies and (iv) an O&M work office and gate keeper house.

(2) O&M Organization

Water users' association and village water users' groups are proposed to be established as an O&M organization. The organization will conduct the following five main activities and functions, in consultation and cooperation with other governmental agencies, such as the district agricultural services, provincial agricultural authorities and the Ministry of Agriculture and Forestry.

(i) Operation of irrigation water supply,
(ii) Maintenance works,
(iii) Establishment of irrigation schedule,
(iv) Monitoring work, and
(v) Collection of water charge

The maintenance works are divided into two (2) categories, (i) maintenance works on the main canal system, from the diversion structure at water resources to the secondary canal and (ii) those of tertiary and on-farm canal systems. The government agencies such as the provincial agriculture authorities and the Ministry of Agriculture and Forestry are responsible for maintenance works on the main canal system; the water users' association and village water users' group for tertiary and the on-farm canal system. Maintenance works are scheduled to be carried out periodically and in emergency cases.

(3) Irrigation Operation

Irrigation is scheduled to conduct for 24 hours of paddy, and for 12 hours of upland crops and coffee during the peak irrigation requirement period. As for irrigation of upland crops and coffee, a farm pond is provided at head section of secondary canal in order to control water supply in the command area.

Furthermore, the irrigation of coffee aims to control its flowering to fruiting stages and indirectly to control labor requirement in the harvest period. To reach these goals, the rotation of irrigation is scheduled for about 3 months from the end of December to the beginning of March.

(4) Maintenance Schedule

Maintenance of irrigation and drainage facilities is categorized by periodical and emergency works. Ordinary maintenance works are: the repair of gates at diversion weirs, the disposal of sediment in settling basins, the cleaning of earth-filled dams, impounding ponds, farm ponds, and canal section linings. These works are scheduled periodically before planting the crops.

4.6.6 Soil Conservation Plan

Soil conservation in crop lands is a comprehensive subject, involving not only physical work for erosion control; but also soil fertility management and soil-water-plant relationships, which in combination lead to sustained high crop yields. Methods of soil conservation can be grouped into (i) civil engineering and (ii) agronomic technology.

In practice, the above two methods cannot be separated and one complements the other. Both methods apply at different stages in the life of a crop depending upon local conditions. This section however, discusses the engineering methods that may need to be adopted over a land gradient of about 2%. Basically, two (2) methodologies are proposed as (i) farm (contour) bund and (ii) boulder drop structure in the main drains for the priority Schemes. Farm bund is designed to be laid out in a horizontal direction to topographic contour line, so as not to lose too much top soils. The bund may be strengthened by planting shrubs or trees on the upper side; and repeated cultivation of soils will bring about a terrace effect after some years.

Where the gradient is steeper, a contour drain system is provided as secondary and tertiary drains to eliminate surface runoff and reduce transportation of soils. In line with the provision of a contour drain system, a boulder drop structure is provided in main drains which has a vertical direction against topographic contour lines. A boulder drop structure aims to improve the gradient of a main drain and sustain its allowable maximum velocity.

4.7 Rural Infrastructures

Table 2.2 summarizes the proposed rural infrastructure development plan including rural roads, water supplies, primary schools and village community halls. Details are described in the following sections.

4.7.1 District and Village Roads

(1) Development Plan

It is proposed that district and village roads with a total length of 34.6 km be rehabilitated as a model in improving the district/village road network in the future, taking into account the function of these roads. The proposed roads will be of all-weather type. These roads will have side ditches with sufficient capacity to allow drainage on either side; and an appropriate number of cross drains to avoid rainfall damage to roads. The proposed roads to be rehabilitated are summarized as follows:

Priority Area	Road section (village to village)	District road (km)	Village road (km)
1. Upper Champi		-	-
2. Upper Tapoung	Pakxong to B.Xetapoung	12.9	-
3. Upper Kapheu	Road No.20 to B.Sixiangmai	9.3	-
	B.Sixiangmai to B.Phouak-gnai	-	1.8
	B.Phouk-noi to B.Phouk-gnai	-	1.9
4. Lower Xe Set	Road No.20 to Xe Set power station	3.2	-
	Road No.20 to B.Natou	-	3.8
5. Upper Tay-Un	Road No.16 to B.Chakamlit	-	1.7
(Total)		25.4	9.2

(2) Design

The Lao standard Class-V and Class-VI of MCTPC (*) are applied designing the cross sections of proposed district and village roads. As for the pavement method, a penetration macadam for district roads and gravel pavement for village roads are proposed, considering the heavy rainfall in the area and poor maintenance work.

Proposed road	District road	Village road
Pavement	Penetration macadam	Gravel
Pavement width = carriage way (m)	4.5	3.5
Shoulder (m)	3.0 (1.5 m x 2)	2.5 (1.25 m x 2)
Total width (m)	7.5	6.0

Note: (*) MCTPC = Ministry of Communication, Transportation, Post and Construction

Side drains with sufficient capacity are indispensable for the drainage of excess water from the road surface. Protection work of side drains, such as linings by stone masonry, will be proposed in the steep longitudinal section to prevent soil erosion .

In addition to side drains, cross drains are required according to the topography. The pipe culvert type having a minimum diameter of 0.6 m will be utilized for this purpose. This is necessary considering maintenance, particularly desilting. For large cross drains, two sets of 0.6 m culverts or more, as required, will be utilized.

The proposed road improvement is summarized in Table 2.3 and typical cross sections of proposed district and village roads are shown in Figure 2.16.

4.7.2 Domestic Water Supply

(1) Development Plan

On the basis of field survey results of topographical conditions and water availability, the following nine (9) water supply systems are proposed, covering a total of 25 villages.

Model Scheme area	Water supply system	Water source	Covering villages
(1) Upper Champi	One (1) gravity flow piped water system	Champi river	8
(2) Upper Tapoung	Two (2) water systems with electric pump	Kapheu /Tapoung river	3
(3) Upper Kapheu	One (1) gravity flow piped water system	Kapheu river	5
(4) Lower Xe Set	One (1) gravity flow piped water system	Xe Set river	6
(5) Upper Tay-Un	Four (4) water systems with electric pump	Thon/Tit river	3, (*)
(Total)	9 systems		25 villages

Note: (*) For B.Chakam-mai, two (2) systems are required because the village comprising two (2) groups, is located at two points.

(2) Distribution System

(a) Upper Champi Scheme

A gravity flow piped water system is proposed in this area. This system will cover eight (8) villages with a total of 828 households and 4,731 people. Water from H.Champi will be taken through an intake facility, which will also be used for irrigation purposes. The demand of water is estimated at 5.41 lit./sec. The water is diverted to a sand filter tank and

then introduced to transmission pipe lines, covering all the villages. Eight (8) distribution tanks will be installed for better distribution in each village. Each distribution tank has a capacity of a half day's water supply. From each distribution tank, main and branch pipe lines are networked in the village areas. A total length of 35,410 m of trunk/main pipelines (GI pipe) and 4,280 m of branch pipe lines (PVC pipe) are required for distribution of water. Communal tap stands with washing basin will be installed along the distribution lines at the rate of one to five (5) households, totaling 138 taps in this area.

Since there are existing gravity flow water supply systems in B.Lak40 and B.Lak38, water supply to these existing distribution tanks and some supplemental distribution facilities are proposed for both villages.

The transmission pipe line of the Upper Champi Scheme is illustrated in Figure 2.17.

(b) Other Priority Schemes

The design of water supply systems for other priority Scheme areas such as Upper Tapoung, Upper Kapheu, Lower Xe Set and Upper Tay-Un is made based on the same concept as that for the Upper Champi area. The proposed transmission pipe lines for these four (4) Schemes are shown in Figures 2.18 to 2.21 and details are described in ANNEX-VII.

The proposed water supply systems in five (5) priority Scheme areas are summarized in Table 2.4.

(3) Operation and Maintenance

(a) Policy

In the proposed water supply program, two (2) water supply systems, namely "gravity flow piped system" and "water system with electric pump" will be constructed. Since each proposed gravity flow system will cover 5 to 8 villages, well organized operation and maintenance (O/M) is strongly required for fair distribution of water. The proposed water system with electric pump will cover one (1) or two (2) villages. However, well organized O/M is also required because of the importance of effective pump operation.

Unless there is proper maintenance, the water supply system will deteriorate and eventually become unworkable within a few years. The only possible solution is that the village people maintain the system themselves. The responsibility of maintenance must be felt by them. However, it is unrealistic to expect the community to take over all the maintenance duties as it is still difficult for village people to repair even a minor fault without a skilled technician, necessary tools and spares. It is therefore proposed that maintenance be a shared responsibility of the government and the community, with the government providing reliable technical support.

(b) Village Water Users' Group for Water Supply (VWUG-Water Supply)

It is proposed that every village community establish a "Village Water User's Group for water supply (VWUG-Water Supply)". The VWUG-Water Supply is responsible for the operation and maintenance of water supply facilities. The VWUG-Water Supply is formed after the prospective members are fully informed about their duties and responsibilities in the group. In the formation process, community members will be assisted by the provincial health service. The VWUG-Water Supply is managed by a committee of members (COM). The members of the committee will be elected by the general assembly of the members.

(c) Water Users' Association for Water Supply (WUA-Water Supply)

Since most proposed water supply systems cover more than two (2) villages, cooperation with relevant VWUGs-Water Supply is very important for the fair distribution of water. For this purpose, it is proposed that a Water Users' Association for water supply

(WUA-Water Supply) be established for each water system. The WUA-Water Supply is managed by the board of heads (BOH). The BOH will comprise of representatives of respective VWUG-Water Supplies, basically its leaders.

(d) Technical Support by the Provincial Health Service

The role of the provincial health service is to: monitor the condition of the water system, encourage and motivate the community to carry out maintenance work, ensure the availability of spares, and carry out major repairs beyond the capacity of the community.

For this purpose, it is proposed that the provincial health service set up a maintenance organization with an appropriate budget and full-time staff. A mobile maintenance team will be appointed to carry out periodical preventive maintenance according to a specified schedule and curative maintenance upon request from the village. The maintenance technicians will be selected from among the experienced field technicians or provided with a quick training after recruitment.

4.7.3 Primary Schools

(1) Development Plan

A more complete education is essential for raising the living standards of people. Improvement of school facilities will be one of the main supporting measures for this purpose. It is proposed that the existing primary schools be improved and new primary schools be constructed in the villages, where none exist at the present.

The proposed primary schools to be renovated or newly constructed are summarized as follows:

Priority area	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un	(Total)
No. of village	8	3	5	6	3	25
Class-III primary school	3	2	3	5	2	15
Class-V primary school	4	1	1	0	0	6
(Total)	7	3	4	5	2	21

(2) Design

The proposed class-III primary school has three (3) class rooms and one (1) teachers' and school administrative room, which consists of a slate sheet roof brick masonry walls and concrete floors. Slate sheet roofing is emphasized to provide more comfortable conditions for the students particularly in the hot season. One room will have a floor area of 42 m^2 (6m x 7m) and is large enough to accommodate 45 students based on the provincial standard.

The proposed class-V primary school has five (5) class rooms and one (1) teachers' and school administrative room. One room for the class-V school will have a floor area of 56 m^2 (7m x 8m), which is large enough to accommodate 55 students.

Each room will be equipped with the required number of desks, chairs and blackboard. The rooms will be linked with each other with a terraced passage way at the front side. All the proposed schools will have a water supply facility and toilets.

The proposed class-III and class-V primary schools are illustrated in Figure 2.22.

4.7.4 Village Community Halls

(1) Development Plan

A well organized village community and coordination among the communities are indispensable for raising the people's living standards and for the future development of rural areas. The village community halls will provide different village organizations with facilities to conduct their meetings, such as:

- Management of village administration
- Operation and maintenance of irrigation facilities
- Operation and maintenance of water supply facilities
- Extension of agricultural technology
- Enlightenment of rural health and sanitation; and
- Adult education

A village community hall is proposed to be newly constructed in each village of the priority Scheme areas. It is proposed that one village in each Scheme be the focal point and play a coordinating role of the whole area.

(2) Design

Three (3) types of village community halls are proposed based on the number of households in the village. They are type-A, -B and -C with floor areas of 168 m^2, 252 m^2 and 336 m^2, respectively. The coordinating center will be of the C-type.

The type-A village community hall has three (3) rooms, with a slate sheet roof, brick masonry walls, and a concrete floor. One room with a floor area of 42 m^2 (7m x 6m) will be used as the village administrative room. The other two (2) rooms will be used as meeting rooms, and will have floor areas of 42 m^2 (7m x 6m) and 84 m^2 (14m x 6m), respectively.

The type-B village community hall also has three (3) rooms, which consists of the same materials as that of type-A. One room with a floor area of 42 m^2 (7m x 6m) will be a village administrative room. The other two (2) rooms will be used as meeting rooms, and have floor areas of 84 m^2 (14m x 6m) and 126 m^2 (14m x 9m), respectively.

The type-C village community hall has four (4) rooms, which consists of the same materials as that of type-A and -B. One room with a floor area of 42 m^2 (7m x 6m) will be a village administrative room. The other three (3) rooms will be used as meeting rooms, with a floor areas of 42 m^2 (7m x 6m), 84 m^2 (14m x 6m) and 168 m^2 (14m x 12m), respectively.

Each room will be equipped with the required number of desks, chairs, bookcase and blackboards. The rooms will be linked to each other with a terraced passage way at the front side. It is proposed that each village community hall be equipped with a radio communication facility. This facility will be used for the following purposes:

- Operation and maintenance activities for irrigation facilities
- Operation and maintenance activities for water supply facilities
- Communication among the villages

The distribution of village community halls is summarized below and is also shown in Figure 2.23.

Priority Scheme	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un	(Total)
No. of villages	8	3	5	6	3	25
Proposed village community halls						
type-A (3 rooms, 168 m²)	4	1	3	5	2	15
type-B (3 rooms, 252 m²)	3	1	1	0	1	6
type-C (4 rooms, 336 m²)	1	1	1	1	0	4

4.7.5 Micro-hydropower Generation

In the master plan, a micro-hydropower plant in the Upper Kapheu area is listed as a potential development. However, considering economical view points from recent information, it is proposed that the micro-hydropower development in the Upper Kapheu area be excluded from the feasibility study of the proposed priority Scheme.

Among the total five (5) villages in the Upper Kapheu priority Scheme area, three (3) villages of B. Ong-gnai, B. On-noi and B. Phouak-noi will be electrified by 1997 based on the PGI project in Salavan province. In addition, the other two (2) villages of B. SiXiangmai and B. Phouak-gnai can be electrified with an additional transmission lines of 2.5 km for each village.

Table 2.6 summarizes the proposed rural infrastructure development plan including rural roads, water supplies, primary schools and village community halls.

4.8 Highland Vegetable Trial and Demonstration Station

As mentioned in section 4.2.8, a highland vegetable trial and demonstration station will be established. The following projects are proposed to be carried out.

(i) Construction of unadministrative office, laboratory, training room, workshop, storage and dormitory;
(ii) Provision of water resources, and irrigation and drainage facilities;
(iii) Supply of farm machinery; and
(iv) Layout of trial and demonstration fields.

The details of these proposed items are summarized below.

(1) Construction of buildings:

(a)	Main building with administrative office, study rooms, training room:	1 unit
(b)	Tea laboratory with pilot plant for its processing:	1 unit
(c)	Dormitory and dining room:	1 unit
(d)	Garage for farm machinery with workshop:	1 unit
(e)	Garage for vehicles:	1 unit
(f)	Farm administrative building with storages and room for laborers:	1 unit
(g)	Green house:	1 unit
(h)	Net houses:	5 units
(i)	Manure house:	1 unit
(j)	Cowshed:	1 unit
(k)	Pump room:	1 unit
(l)	Water tanks:	2 units
(m)	Quarters for staff:	10 units

(2) Construction of irrigation and drainage facilities:

(a)	Preparation of trial and demonstration fields:	39.0	ha
(b)	Irrigation equipment: sprinkler	4.0	ha
	drip	2.0	ha
	hydrant and pipeline	5.0	ha

(3) Supply of farm machinery and vehicles:

(a)	Tractors with attachments:	3	units
(b)	Tillers:	5	units
(c)	Light weight tillers:	3	units
(d)	4WD wagon-type vehicle:	1	unit
(e)	4WD pick-up:	1	unit
(f)	4 ton truck:	1	unit
(g)	Motorcycles:	5	units

(4) Supply of research and extension materials, and equipment:

(a)	Laboratory and observatory equipment:	1
(b)	Pilot plant for tea processing:	1
(c)	Audio-visual equipment for extension works:	1

(5) Supply of office equipment:

(a)	Personal computer with printer:	
(b)	Copy machine:	1
(c)	Generator and air-conditioner:	1
(d)	Kitchenware and equipment:	1

4.9 Marketing Facilities

4.9.1 Wholesale Market in Pakxong

(1) Basic Assumption

Size and space of the proposed wholesale market is estimated on the basis of the following assumptions and also construction criteria of Japan (ST Procedure, Ministry of Agriculture and Forestry, Japan)

[Assumption]

i) If the priority areas such as Upper Champi and Upper Tapoung are developed and the effective extension works are implemented in the next five years, the total vegetable production in a season is estimated to be 3,000 tons in maximum; of which about 60% will be traded through the wholesale market. The amount is estimated to be about 1,800 tons.

ii) On the other hand, about 15% of the total production from other villages surrounding the priority Schemes, such as Xe Pian and Tonset, will also be shipped to the wholesale market. Since it is estimated to be about 650 tons a season, the total amount to be traded in the wholesale market will be about 2,450 tons a season.

iii) In case the working days in a harvest season are 60 days, the treated amount per working day is estimated at about 40 tons.

[Criteria]

i) The suitable amount to be treated in 1 m^2 is 40 kg.

ii) The aisle space is about 20% of the trading space.

(2) Proposed Size and Facility

Taking the above situation into consideration, the general plan of the proposed wholesale market is set up as Fig. 2.24 and summarized as follows:

Items	Specification	No
Working spaces	30 x 20 m of concrete floor, platform type about 80 cm higher than the loading space, steel frame with shade.	2
Warehouse	100 m² of concrete type	1
Loading spaces	along the working space, 30 x 10 m of asphalt pavement	4
Parking lot	800 m² of gravel pavement	1
Building for office spaces	100 m² for marketing organization	1
	40 m² for shop selling farm inputs	1
	6 rooms of 3 x 4 m for buyers	2

4.9.2 Rice Bank in the Lower Xe Set and Upper Tay-Un

(1) Basic Assumption and Capacity of Rice Mill

The required milling capacity and number of mills are estimated on the basis of the following assumption and also the availability of rice mills in the local or Thai market.

i) Annual operation days for rice mills are estimated to be 120-200 days. The daily working hours are 6 hours per day.
ii) The amount of paddies traded through the rice bank is assumed to be about 50% of total marketed productions.
iii) The capacity of the rice mill which will be set up is 500 kg/hour of output, taking into consideration the future increase of the product.

The required rice mill capacity and number of rice mills in each proposed site are summarized as follows:

Scheme	Proposed Site	milled rice (ton/year)	Number of Mills
Lower Xe Set	B. Sengvang-gnai	880	1
	B. Houakhoua	310	1
	B. Sengvang-noi	380	1
	B. Khonleng	150	1
	B. Natou	300	1
Upper Tay-Un	B. Chakamlit	750	1

(2) Storage and Drying Yard

Storage is inevitable for the original function of the bank and for temporary storing of marketable paddies. The drying yard will be used for further drying of the paddies and sorting out mixtures (as stone, etc.). The capacity and specification of storages and dry yard spaces are estimated on the basis of the following assumption.

i) The maximum amount of stored paddy is estimated on the rainy season paddy and the paddy to be marketed is deducted from it.
ii) Storing duration from collecting to selling is basically set up as one (1) month.
iii) Size of storage is estimated as 1.5-2.0 tons/m² and 1.2 times for open spaces.
iv) Storage type to be installed is a concrete type.
v) The yard is used only for temporary (additional) drying and sorting of rice.
vi) About 20% of paddy brought by the farmers are assumed to be dried at the yard.

vii) The yard is set up as a concrete floor, and may be used for other purposes, such as volleyball and tennis, etc.

The storage floor spaces for the proposed sites are shown as follows:

(unit : m^2)

Scheme	Proposed Site	Storage Space	Drying Yard Space
Lower Xe Set	B. Sengvang-gnai	250	200
	B. Houakhoua	150	200
	B. Sengvang-noi	150	200
	B. Khonleng	100	200
	B. Natou	150	200
Upper Tay-Un	B. Chakamlit	250	200

(3) Office

The office building required for the bank should have enough space for routine work of managing the bank by clerk, accountant, etc. The required floor space is about 50 m^2.

4.10 Organizations of Agricultural Support Services, Rural Community and O&M Works

In order to intensify rural communication and O&M works for all the Schemes, 6 organizations are proposed. These organizations coincide with the governmental agencies concerned and non governmental organizations (NGO) in conducting all the activities and functions of agricultural support services, the rural community and O&M works for the scheme facilities, as shown in Figures 2.25 and 2.26.

The proposed organizations are a farmers' association, water users' associations, a community hall, association, a wholesale marketing board and that of the highland vegetable trial and demonstration station. The water users' association is divided into two (2) associations for irrigation and domestic water supply.

Governmental agencies concerned are district agricultural and forestry services, provincial agriculture and forestry services, health services and education services, ministries of agriculture and forestry, education and health. APB also plays an important role in the scheme as a public financing institution.

Out of the 6 proposed organizations, the agricultural association, water users' associations and the community hall association are set up voluntarily with the aggressive participation of villagers. The main activities are of agricultural promotion and extension, credit and mutual aid. These are in close cooperation with the water user's association, provincial and district authorities concerned, the women's union, APB and NGO, concerning agricultural extension, credit, water management and mutual aid such as the rice bank and mutual fund. Beneficiaries of the agricultural association make up a part of the beneficiaries of the water users' association. Both water users' associations for irrigation and domestic water supply carry out activities of water management, operation and maintenance of each facility, in collaboration with the provincial and district AFSs (for irrigation), the provincial and district health services (for domestic water supply), and the women's union (for both activities). The community hall association conducts the activities of rural community to improve the quality of life. The activities work in close cooperation with the provincial and district authorities concerned, the women's union and NGOs, with respect to the improvement in literacy, health and hygiene, and home economics.

On the other hand, the wholesale marketing board managed by the provincial and district authorities of agriculture and/or trade, mainly conducts the activities of marketing and

distribution of vegetables produced in the scheme and the plateau. The activities are worked together with agricultural associations concerning collection, shipping, and marketing. The highland vegetable trial and demonstration station operated by the agricultural and forestry services of Champasak province mainly carries out extension activities for vegetable production, and development of appropriate cultivation techniques for vegetables, in collaboration with MAF's Department of Agriculture and Extension and Hatdockeo research station. The activities include on-farm training for farmers and extension staff concerning appropriate cultivation techniques of vegetables and pest control.

4.11 Development Features

Development facilities in this Study are broadly divided into two (2) categories, (i) development facilities of the 5 priority development Scheme areas and (ii) supporting development facilities for the 5 priority development Schemes.

The development facilities of the 5 Schemes are agricultural and rural infrastructures. The agricultural infrastructures to be developed are the irrigation and drainage development facilities, including small scale impounding ponds. Through the accomplishment of the 5 Schemes, irrigation is achieved in approximately 3,100 ha. Production of commercially profitable crops such as vegetables, coffee and tea, and staple food such as upland crops and rice can be expected to increase drastically. The main facilities of the 5 Schemes are of concrete weirs at four sites, small scale impounding ponds at eight sites, main and secondary canals of about 66 km and a main drainage system of about 12 km.

Rural infrastructures to be development are a domestic water supply system, village roads, school and a village community hall. Beneficiaries of these rural infrastructure developments are estimated to be about 12,000 people of 25 villages. Infrastructure development consists of a domestic water supply system of 85 km, improved and new village roads of about 35 km, 25 primary schools and 25 village community halls.

The supporting development facilities are a highland vegetable trial and demonstration station, a vegetable wholesale marketing facility, post-harvest facilities (rice bank) and extension facilities.

A highland vegetable trial and demonstration station is to be constructed in the irrigation block of the Upper Champi Scheme area. The station area is 50 ha. A vegetable wholesale marketing facility is provided in Pakxong town to influence vegetable trading in and around the Scheme areas. Post-harvest facilities are also provided in 5 villages of the Lower Xe Set Scheme area and one (1) village of the Upper Tay-Un Scheme area through the establishment of a rice bank.

The detailed features of scheme facilities are shown in Tables 2.7 (1/8) to 2.7 (8/8), and the general layout of the facilities are illustrated in Figures 2.27 to 2.31.

5. ENVIRONMENTAL ASSESSMENT

5.1 Environmental Assessment of Agricultural and Rural Development

Land use planning, the first step in sustainable land management, will take considerable time to be used as a planning tool under present conditions of human resource development in the project areas. Hence, it is not a recommendation that can be immediately implemented. Nevertheless it is important to make a beginning. It can be gradually developed depending on available resources.

Environmental impact assessment is another very useful tool in resource management. An attempt to predict environmental impacts at an early stage of a proposed development can be a beginning that will set in motion a thought process into what adverse impacts may arise. These can include social impacts (people who might be affected), economic impacts (financial losses that might occur directly or indirectly) and ecological impacts (environmental effects). Hence it is important to assess the adverse and beneficial impacts.

5.2 Environmental Management

Environmental management concerns the attainment of sustainable growth using appropriate policies and incentives. However, translation of policy to success in the field often falls far short of expectations in the Lao PDR due to a number of reasons. While some are of a technical nature, many are institutional. These include institutional weaknesses, farmer doubts about new technology, market imbalances, population pressure, and resource tenure arrangements.

Village communities are at the present time, called upon to play increasingly important roles in the management of their own resources. But the most fundamental resource management challenge is commercialization and the growing competition with incompatible patterns of resource exploitation. These however, need resolution at national level. The conservation aspects discussed below are common to all Schemes. An exception perhaps is the cabbage cultivation in the Upper Tapoung.

5.2.1 Soil and Water Conservation

Soil and water conservation constitutes an important area of resource management methodologies can be broadly grouped into two; agronomic methods and mechanical or engineering methods. Usually a combination of methods is the likely choice, as different stages of crop growth and different physical conditions require different approaches.

Lowlands being alluvial plains and usually cultivated in paddy, are not so much erosion-prone. The bunds that are an essential part of lowland paddy, are generally an insurance against soil movement unless during floods. Lowland paddy is the proposed crop for the Upper Tay-Un where the topography is flat to one of mild gradients. Upland soils have a diverse occurrence -- undulating, as in Xe Set to steep slopes as in parts of the Upper Champi and Upper Kapheu -- and when opened up are exposed to erosion.

(1) Mechanical Measures

On mild gradients , as a precautionary measure, certain soil conservation measures are proposed as in the Upper Tapoung Scheme. A priority is that all land preparation be done on the contour, as this will encourage the formation of terraces after some years of cultivation. To achieve this objective, the creation of low contour bunds is proposed at intervals of about 10-20 m, while at the same time, provision should be made for the diversion of excess rainfall through interception and diversion ditches as cabbage like most other vegetables require good drainage. In the alternative, if soil improvement is also considered, contour bunds can be strengthened by planting hedgerows of leguminous shrubs.

For upland crops that are grown on gradients upto 30 per cent or more, soil conservation measures will take a different perspective. Such lands are found in the Upper Champi and Upper Kapheu Schemes. The drains will be at shorter intervals and if runoff is a problem, the drains will have a mild slope. In this way, water can be led into a natural drainage way and removed at non-erosive velocities.

In the Lower Xe Set, where gradients are mild, contour bunds at intervals depending on crops grown will also be used on the same basis as above. In the Upper Champi and Upper Kapheu, where slopes are steeper, bunds will be at still closer intervals and may be combined with drains at a mild grade to remove excess water if field conditions so demand. Mechanical measures must be supplemented by agronomic methods.

(2) Cultural Measures

In an immature plantation, at the time of establishment, a minimal soil cover will be present. The exposed soil will therefore be susceptible to erosion. A way of minimizing soil loss will be by establishing a leguminous cover crop even before planting the coffee. This acts as a live mulch. The concept of cover cropping has been successful in plantation agriculture of rubber, coconut and oil palm. Some tropical varieties of cover crops are *Pueraria, Desmodium, Centrosema* and *Psophocarpus*. Most leguminous cover crops grow profusely and produce a large volume of leaf and herbaceous stem which contribute very substantial amounts of organic matter under tropical farming systems. There are also many other benefits of cover crops that contribute to improving the physical, biological and chemical properties of soils. Some of these are improving nitrogen, lowering soil temperature, buffering pH and preventing weed growth.

It has often been said that the coffee yield in the Bolovens has suffered from moisture stress. While this is correct, it is also quite clear that coffee lands are not being properly maintained in an agronomic sense. This means that there is also a nutrient loss along with a soil loss where erosion is the main issue. The question is whether the yield decline can be arrested by improving management. This means: improving infiltration and reducing runoff; improving soil organic matter; improving shade level; improving tree management; improving soil nutrient status; and using varieties of coffee appropriate to each agro-climatic zone and restricting planting to frost-free areas.

Often shrubs are used to effect soil conservation by planting as hedges on the contour. Plants such as *Sesbania* spp., *Crotalaria* spp., *Albizzia* sp. and *Flemingia congesta* are also leguminous. The lopping of these shrubs can also be used as green manure and as thatch. for mulching. Strip cropping is another possible practice, where strips of grass on the contour alternate with vegetable beds.

(3) Mulching

Mulching is a practice that has a large range of benefits in crop production. It has certain disadvantages too, such as difficulty in obtaining large quantities of materials and the attraction to termites. These however, can be overcome and the advantages of mulching outweigh the disadvantages.

Live mulching is possible in a number of crops. For example, Nigerian work has shown that the yield of maize was higher in live mulch plots than in bare tilled or untilled plots. Weed growth was eight times more in tilled unweeded plots than in the live mulch plots of *Desmodium* and *Psophocarpus*. Another very significant observation had been the high incidence of earthworms in the live mulch plots than in the unmulched plots. Very desirable farming characteristics indeed.

(4) Alley Cropping

Alley cropping or avenue cropping is another method of soil conservation that can be successfully adopted on land of all gradients. The soil is held in place by avenues of deep-rooted tree species planted on the contour at convenient intervals. Some useful tree species are *Leucaena, Gliricidia, Albizzia* and *Calliandra*. Leguminous species will have the added benefit of nitrogen supply. At the beginning of the season, trees are lopped and the lopping are used to mulch the inter-row space. Woody portions can be used for firewood.

Crops are grown in the space between the avenues. The addition of nitrogen and other nutrients to the crops will take place through the mulched lopping; released when the mulch decays. The avenues of trees also act as windbreaks and bring about favorable microclimatic effects on crops. The slope may finally assume a terraced shape after some years of cultivation.

(5) Cover Crops

Cultivated plots, where particularly widely spaced crops, such as maize, tobacco, groundnut, coffee, tea and fruit trees are grown, are very susceptible to erosion soon after crop establishment as the soil is exposed to rain. This drawback can to a great extent be minimized in some crops such as coffee and fruits by growing cover crops or by adopting mixed cropping.

(6) Tillage

Tillage in tropical agriculture is another factor that can have a degrading effect on soils when carried out at extreme soil moisture levels, and hence on productivity. Ploughing and cultivating during extremes of soil moisture bring about destruction of soil structure. These should be addressed in future research programs.

(7) Incentive Subsidy

As an incentive to have the soil resource conserved, it is proposed that the government considers granting of a soil and water conservation subsidy to coffee farmers to provide measures for erosion control on their farms. Coffee is selected because it is presently an export crop and shows promise of being so in the future also. Therefore, the land on which coffee grows should be carefully conserved, so that benefits of the world trade will continue to come to the Lao farmers. For example, newly established coffee just planted on flat land or mild gradients, will benefit with cover crops but mature coffee under shade will not have luxuriant covers and will require some mechanical measures also.

5.2.2 Sustainable Agriculture

(1) Plant Nutrient Supply

The maintenance of soil fertility in cropped land, often by the addition of supplemental plant nutrients in the form of fertilizers and manure, are basic requirements of present day agriculture, expected to produce food and other products in sufficient quantities to keep pace with growing populations. Manure are available in rural areas from livestock and plant parts, often in large quantities, but not put to good use. Productivity is reported to be on the decline in the Boloven Plateau and ways and means are urgently needed to remedy the situation.

With extensive commercial livestock rearing by almost all households, it should be possible to bring about management systems that allow for collection of unutilized waste for farm use. This possibility should be examined in the demonstration farms.

The use of green manure is a method of organically supplying plant nutrients to both lowland and upland agriculture. Large amounts can be obtained from outside the farms. Farm boundaries can also be utilized to grow green manure trees.

Rice straw is another organic source of nutrients, being particularly a good source of carbon, nitrogen, potassium and silicon. It can be used in the rice cropping systems. In a long-term experiment on a Sri Lankan farmer's field, straw applied treatments receiving about 30 kg N/ha less than the normal recommended dosage, and no potassium fertilizer, have given equivalent or higher grain yields than treatments receiving the full dose of inorganic fertilizer. Straw under Sri Lankan conditions has around 0.6 per cent nitrogen and 1.6 per cent potassium.

(2) Integrated Farming Systems

The integration of crop and livestock farming systems is an ideal situation to be maintained in tropical agriculture. Animal waste provides large amounts of plant nutrients. Urine contains as much as 50 per cent of the value of the waste containing as much as two-thirds of the nitrogen and four-fifths of the potassium. If livestock management can be made systematic with proper housing, almost all the waste can be collected in a suitable form and used in the fields. A cemented or well rammed earthen floor will prevent too much losses of nutrients. Bedding of paddy straw or grass will absorb much of the urine and when mixed with the dung can be used in composting. In the alternative, the waste can be directly led into a composting pit some distance away from the housing every 3-4 days.

Similarly, if poultry is reared on the deep litter system, the litter can be used in the field about once every 12-18 months. Fresh poultry litter may contain over 3 per cent nitrogen and 2 per cent potassium and many trace elements.

(3) Multipurpose Trees and Shrubs

There are many opportunities of growing trees and shrubs of utility value. Tree crop culture also fits in well with land rehabilitation programs. Many ecological benefits can also be expected. When grown on paddy field bunds and on boundary fences, trees and shrubs will provide regular lopping for green manuring and mulching. A steady supply of round poles, sticks, fodder, firewood and timber are other benefits that are possible.

(4) Agrochemical Use

As the problem of agrochemical use is one of toxic pesticides in cabbage cultivation in the Upper Tapoung, two recommendations are made: firstly, extension staff should educate themselves and then train farmers in correct pesticide use; of the dangers to themselves and to the community, including those who consume the harvested produce. Since most rural people depend on the natural waterbodies for domestic water supply, the community in a larger area can be affected if water sources get polluted. Secondly, government should enforce pesticide regulations if legislation has been already enacted. Illegal entry can also be checked at the point of sale, usually the retail store.

Water anaylsis of suspected aquatic bodies is suggested, eg. H. Tapoung below the drainage basin where cabbage is grown. This is not locally possible but some mechanism may have to be worked out with the Mekong Commission as only its work program, possesses the capability to undertake testing for pesticides.

If conclusively proved, strict controls are recommended and a program to be implemented as follows: (a) conduct a short training for extension staff, including village level workers, (b) survey farmers using the banned chemicals and confiscate stocks, (c) undertake an education program for the farmers of the affected drainage basin, (d) identify dealers having the chemicals and confiscate stocks, (e) safely dispose confiscated stocks, and (f) survey border points into the country and educate customs staff on correct identification procedure and follow up action.

At this point of time, it does seem possible to recommend integrated pest management (IPM) as a management requirement as the institutional capacity cannot cope with the demands of the subject. However, the immense possibilities of IPM are recorded here for

likely adoption at a future date. IPM can be defined as "a system that relies on a variety of approaches for controlling pests, including physical, biological, genetic and cultural methods as well as pesticides. It relies on the concept of an economic threshold of pest population density or crop damage, below which the cost to control a pest is greater than the benefit of doing so. In agriculture IPM components include efforts to breed crops resistant to pests and diseases, use of cover crops for weed control, timing of planting, crop rotation, and introduction of predators and parasites."

An IPM program can reduce pesticide use, cost of production, health hazards to humans and animals and promote multiplication of natural predators and parasites. Pest resistance can occur from the repeated use of chemicals in high doses when pests initially acquire tolerance levels. Pests then become resistant and can withstand very high doses. Control using a single or group of pesticides become impossible and still more toxic chemicals are then used. The vicious cycle continues.

(5) Control of Slash-and-burn Cultivation

One of the objectives of providing irrigation water is to encourage settled farming systems and discourage shifting cultivation. Hence the potential land for shifting cultivation in all Schemes is being converted into arable land. The total areas is estimated at 2,560 ha within the priority Scheme areas. Beside, about 630 ha in the homer Xe Set Scheme area, 320 ha in the Upper Tapoung Scheme area would be used for other than slash-and-burn cultivation such as reforestation and coffee plantation. Apart from shifting cultivation, these land categories are used by people for grazing their cattle and also to obtain firewood and minor forest produce.

5.2.3 Catchments

It is proposed that each catchment be studied during the implementation phase to determine the intensity of human use and degradation. Hence the study will be socioe conomic as well as ecological. Some components for a socioeconomic and resources survey are as follows:

socio economic survey
- demographic data;
- occupational data;
- degree of dependence on the land and its resources;

resources survey
- types, extent and quality of natural vegetation;
- nature and extent of gallery forest;
- types, extent and quality of planted forests;
- species of wildlife and diversity;
- subsistence/commercial dependence on non-timber forest produce;
- agricultural activities, including shifting cultivation;
- other resources, eg. minerals, cultural and aesthetic;
- hydro-meteorological data; and,
- boundary identification and marking.

It is proposed that all catchments be maintained in as good a conserved state as possible depending on the level of current human use. Catchment management plans should be prepared on the basis of the survey results.

(1) River Bank Protected Areas

As an interim urgent measure it is proposed that both banks of all rivers and streams in the Project areas be declared protected to an agreed distance from each bank. This can vary according to the width of the river or stream. The banks of the H.Tapoung and H.Tay-Un

and H.Thon do not naturally support forest vegetation. These have a vegetation of grasses. A large part of the headwaters of the H. Xe Set lie in the flat Pakxong wetlands. These should be preserved in the same state as the original natural vegetation.

The following steps are proposed in a simple model:

i. decide on the river /stream and area of bank, and the width of each reservation to be allocated to each family;
ii. involve a suitable number of families on a pilot basis;
iii. determine the range of species to be grown;
iv. prepare contractual agreement;
v. provide free plants and advice;
vi. permit some intercropping with food plants during the first few years, depending on gradient, and with proper advice on cultivation practices;
vii. utilize the concept of mulching as much as possible;
viii. use contour drains where gradients require such;
ix. enlist support of district forestry services to raise required plants; and,
x. provide food aid and free fertilizer to participants as incentives if the project can be linked to a donor, may be even a private voluntary organization (PVO).

(2) Pakxong Wetlands

The importance of the Pakxong wetland to the project lies in it forming the larger part of the Xe Set catchment; actually the headwaters. Besides, the wetland is the nursery for all the rivers that have beginnings in the Boloven Plateau. This is a natural system -- an intricate system of grasslands, hills, springs, ponds and lakes -- all feeding the southern hydrological network.

In the Master Plan Study, the recommendation has been made for the conservation of this entire area above the 1,200 m contour -- an area of over 400 km^2. This same recommendation is made for the Xe Set and Tapoung catchments as well. In the latter case the area is only 4 km^2 and all of it lies in the Pakxong wetlands. However, there are many human activities taking place including large scale land concessions. Hence it may not be possible to have total protection without human activity. A number of low hills are present in the plain. It is recommended that all these hills be reforested as they are an integral part of the wetland landscape.

5.2.4 Forests

There is only limited opportunity for forest conservation. In the Upper Tapoung, there is very little forest, being less than 10 per cent and the largest extent of 30 per cent is in the Lower Xe Set. Actually these areas are made up of small fragmented patches of varying quality. As the bush land is to be converted into agriculture, there is no land available for reforestation. However, in the Lower Xe Set there is a substantial area made up of soils and land forms not quite suitable for agriculture and this land area, although found in scattered extents, can be converted into forms of forestry. Therefore, at least for ecological reasons, these remaining forest patches should be protected and preserved.

Village administrations should also make it a point to make a meaningful contribution to the national tree planting day by undertaking projects to increase the amount of tree cover in each village. It is not possible at this stage to specify exact land areas or identify specific locations for this work. There are many abandoned areas in a village that can be used for this purpose. Planting for firewood need is another useful long-term planning exercise.

While all larger watercourses bordering and flowing through the schemes require protection of the river bank and its legal status as a protected area, the following require reforestation of the gallery forest:

- H. Champi partly on the left bank;
- H. Kaphen on the right bank and H. Houn on the left bank; and,
- H. Xe Set on the right bank and H. Lanan on the left bank;
- H. Tapoung, H.Tay-Un and H.Thon do not flow through natural forest vegetation.

Lower Xe Set has a large area of discontinuous land, amounting to 633 ha in land capability class III. These soils which are basaltic and District Nitosols, have severe limitations in crop growth, thereby restricting the possible range of crops and also requiring special conservation practices if agriculture is to be practiced. Similar land classes are found in other scheme areas also, but in lesser extents. There is also land class IV, in other scheme areas, which has even more limitations than land class III, and therefore further limits crop production. It is recommended that these lands be put into forestry. Some of it can be in commercial timber production on a participatory basis, and also part set aside for firewood production. Management can be under the direction of one of the village forestry schemes.

5.2.5 Wildlife

In the absence of extensive forest habitats, wildlife does not have much chance to get established. Hence, diversity of wildlife is low, being only the smaller types. Besides, with much land opened up for cultivation, the presence of wildlife will be a problem to successful cultivation. Even at present with scattered forest patches, wild boar cause a fair amount of crop damage. Only the smaller animal species can have a chance to survive. Some bird species, including migrants will use the wetland habitats, particularly around Pakxong. The small weirs across the rivers will not cause serious impacts to fish movement upstream as river morphology does not anyway permit such movement. Fishing in the rivers is not a substantial economic activity.

5.2.6 Water Quality

On the basis of available water quality data from the Phase III Study, surface river flow in the rivers tested, are without major drawbacks. Proposals have been made in the discussion on Sustainable Agriculture in section 5.2.2 (4), in relation to agrochemical use and possible residues in aquatic systems. It is not expected that fertilizer will in the near future be used to such extents that excesses will cause eutrophication. However, a monitoring program can give indications of changing water quality.

Parameters to be concerned about in a future monitoring program are plant nutrient levels -- nitrogen and phosphorus, pesticide levels and surveys of fish in rivers and regulation ponds to determine beneficial species in respect to feeding on mosquito larvae.

5.2.7 Environmental Health

Components of a malaria management plan will involve local communities and may include the following:

- preliminary survey of vector distribution;
- vector control by chemical and biological means;
- preliminary clinical survey of suspected people;
- treatment of carriers;
- survey for vector introduction;
- proper design of irrigation network;

- correct water transfer;
- involvement of water users' associations;
- routine spraying; and,
- community education.

Communicable diseases such as gastrointestinal diseases are caused by contaminated food and water, and unsanitary conditions. Such diseases may be grouped as follows: Water-borne (cholera and typhoid), water-washed (diarrhea and eye problems), water-based (worm infestations), water-related (malaria) and water-dispersed (some amebic diseases). These can be controlled by the provision of potable water and sanitary disposal of sewage and waste. Tuberculosis control lies in good housing and sanitation and effective treatment of carriers.

5.2.8 Mitigation of Construction Impacts

Construction work during project implementation in each Scheme will consist of regulation pond(s), dam(s), intake weir(s), access roads, canals, buildings, roads, water tanks and pipelines. The larger earthwork will be in the construction of regulation ponds, intake weirs, roads and canals. These activities will generate localized environmental problems through the necessity for borrow areas, earth transport, vehicle movement and concentration of construction workers. The associated problems will be dust, noise, oil pollution from machinery, sedimentation, and creation of depressions in which water collects where the malaria mosquito can breed.

Work may generally be confined to the dry season as working during rains is difficult. Dust on the roads passing through villages can be minimized by a fine spray of water using a bowser attachment. Damage caused to roads during construction should be repaired without delay by the contractors. Keeping machinery in good working order will keep noise levels down.

Then a series of degrading sequences take place over time. Two of these are, the eroding processes; and mosquito breeding in pits and the spread of malaria. As far as possible, areas should be restored at least to the point where degradation can be minimized. A series of actions can be taken towards restoration, one of which could be fish culture if soil conditions permit.

On completion of excavation, the exposed surface should be leveled off to eliminate pits that might otherwise collect water and allow mosquito breeding. Erosion of this area should not cause sedimentation of nearby fields if there are any. A quick growing creeper such as *Pueraria* can be grown although it may be somewhat difficult to have it established. The creeper is leguminous and spreads rapidly.

5.2.9 Institutional Aspects

There is no separate institution for environmental affairs. As almost all development activity concerns the soil, water and natural vegetation, forestry, agriculture and irrigation institutions have to focus attention on environmental protection and management.

5.2.10 Monitoring

As environmental changes relating to natural resources are good indicators of resource quality, regular monitoring will be a useful management tool. Monitoring can be done during both construction and operation phases of a project. It provides a means of assessing the effectiveness of mitigating measures if any have been adopted and is a mechanism that allows management to be advised about changing trends in environmental quality.

For the present time, it is recommended that only limited water quality analysis be carried out in view of the baseline data available from the field studies already conducted and the logistic difficulties encountered. Conductivity, suspended solids, nitrate and nitrite nitrogen, phosphate, and iron analysis can be carried out on an annual basis. As more land is being brought under cultivation and better practices like increased fertilization is recommended, it will be useful to be aware of the movement of plant nutrients, mainly nitrogen and phosphorous as eutrophication of waterbodies is a possibility. To the range of parameters, pesticide analysis in the H. Tapoung basin should be added and has to be done with the assistance of the Mekong Commission.

6. ESTIMATION OF CONSTRUCTION COSTS

6.1 Basic Conditions of Cost Estimation

Construction costs are estimated at the price level of December 1995 taking into consideration the increase in costs of labor, construction materials and equipment, the current price estimation method, tender method, local contractors' work capacities, etc.

In the Study, construction costs are estimated with the conditions of the international competitive bidding (ICB), and on the following conditions and assumptions.

i) Proportion between local and foreign currencies are assumed as: local portion: foreign portion = 3:7. Local portions of costs consists of labor costs, material costs of timber, gravel, sand and stone, and the remaining covered by foreign costs.
ii) Construction materials are assumed to be transported from Pakxe to the respective Scheme sites, and the transportation costs are estimated broadly to be divided into five price steps, area by area.
iii) The working ratio and work capabilities of equipment are estimated based on the present prevailing conditions in the Study area.
iv) Land acquisition costs are estimated as US$5.0/ha, based on the present land concession fee in the Study area.
v) Physical contingency is assumed as 10% of the direct construction costs.
vi) Overheads and profits of contractors are assumed as 15% of the direct construction costs.
vii) Engineering costs are assumed as 10% of the sum of the direct construction cost and physical contingency.
viii) Exchange rate is applied as follows; US$1.0 = Kip 920.

6.2 Construction Cost of Each Scheme

6.2.1 Construction Cost

Direct construction cost of each Scheme is summarized below. Total construction costs, including physical contingencies, administration and engineering costs are estimated at about US$39.7 million for the 5 Schemes. The detailed costs are shown in Table 2.7.

Construction Costs of the Five Schemes

(US$ 1,000)

Description	F.C	L.C	Total
1 Direct Construction Cost	21,021	9,009	30,030
2 Land Acquisition		14	14
3 Engineering Services	2,102	900	3,002
4 Purchasing Cost of O&M Equipment	960		960
5 Highland Vegetable Trial & Demonstration Station	1,320	304	1,624
6 Marketing Facilities	777	205	982
7 Physical Contingencies	2,102	900	3,002
Grand Total	28,282	11,332	39,614

The cost of the each Scheme is shown below:

Construction Cost of the Upper Champi Schemes

(US$ 1,000)

Description	F.C	L.C	Total
1 Agricultural & Rural Infrastructure Direct Construction Cost	4,456	1,911	6,367
2 Land Acquisition	0	4	4
3 Engineering Services	446	191	637
4 Purchasing Cost of O&M Equipment	168	72	240
5 Physical Contingencies	446	191	637
Grand Total	5,516	2,369	7,885

Construction Cost of the Upper Tapoung Schemes

(US$ 1,000)

Description	F.C	L.C	Total
1 Agricultural & Rural Infrastructure Direct Construction Cost	2,108	904	3,012
2 Land Acquisition	12	5	17
3 Engineering Services	211	90	301
4 Purchasing Cost of O&M Equipment	48	0	48
5 Physical Contingencies	211	90	301
Grand Total	2,590	1,089	3,679

Construction Cost of the Upper Kapheu Schemes

(US$ 1,000)

Description	F.C	L.C	Total
1 Agricultural & Rural Infrastructure Direct Construction Cost	4,332	1,858	6,190
2 Land Acquisition	0	4	4
3 Engineering Services	433	186	619
4 Purchasing Cost of O&M Equipment	288	0	288
5 Physical Contingencies	433	186	619
Grand Total	5,486	2,234	7,720

Construction Cost of the Lower Xe Set Schemes

(US$ 1,000)

Description	F.C	L.C	Total
1 Agricultural & Rural Infrastructure Direct Construction Cost	7,962	3,414	11,376
2 Land Acquisition	0	4	4
3 Engineering Services	796	341	1,138
4 Purchasing Cost of O&M Equipment	288	0	288
5 Physical Contingencies	796	341	1,138
Grand Total	9,842	4,101	13,943

Construction Cost of the Upper Tay - Un Schemes

(US$ 1,000)

Description	F.C	L.C	Total
1 Agricultural & Rural Infrastructure Direct Construction Cost	2,158	927	3,085
2 Land Acquisition	0	1	1
3 Engineering Services	216	93	309
4 Purchasing Cost of O&M Equipment	96	0	96
5 Physical Contingencies	216	93	309
Grand Total	2,686	1,114	3,800

6.2.2 O&M Cost

O&M costs consist of administration expenses and maintenance costs for irrigation and domestic water supply facilities. The administrative expenses estimated at US$34,000 an year is based on the structural conditions of the O&M offices. The cost mainly consists of the salaries of O&M staff, operation costs such as fuel cost of vehicles and equipment and office expenses. On the other hand, maintenance cost of the facilities is estimated to assume 1% of the direct construction cost. Total O&M cost is estimated at about US$257,000/a year.

6.2.3 Replacement Cost

O&M equipment is estimated at US$280 million based on the quantities of construction facilities in each Scheme. Other equipments such as a vehicle, a motor cycle and a radio system, etc. are selected for the operation of the O&M office. The purchasing cost of these O&M equipment are estimated at US$960,000.

6.3 Cost of Highland Vegetable Trial and Demonstration Station

The highland vegetable trial and demonstration station has extension facilities as described in section 4.8 of the report. The construction cost including the cost of laboratory equipment is estimated at US$1,624,000. The costs of these facilities and equipment are broadly divided into two (2) groups, (i) buildings and irrigation and drainage facilities, and (ii) procurement of farm machinery, vehicles, extension materials and office equipment. Construction costs of buildings and irrigation and drainage facilities are estimated at about US$1,050,000, and the procurement costs of machinery, equipment, etc. are estimated at about US$574,000.

6.4 Cost of Marketing Facilities

Marketing facilities are planned to provide a wholesale market and rice banks. The costs are also for the construction of buildings, a parking lot and loading spaces, and for the procurement of rice mill equipments. Total construction costs including purchasing costs of the rice mill, etc. are estimated at US$982,000. The construction costs are estimated at US$327,000 for wholesale marketing facilities and US$655,000 for rice banks. The purchasing cost of each rice mill is estimated at about US$39,817 for the 6 proposed villages.

7. IMPLEMENTATION PROGRAM

7.1 Implementation Program

7.1.1 Construction Works

Construction of civil works in each Scheme is broadly divided into four (4) categories. These are agricultural and rural infrastructures, highland vegetable trial and demonstration station of agricultural extension facility and marketing facilities. Civil works of agricultural infrastructure is further divided into main irrigation and drainage facilities and on-farm development facilities as shown below.

(i) Main Irrigation and Drainage Facilities

- Diversion weir/dam and reservoir and intake structures
- Main and secondary canals with related structures
- Regulation/farm ponds
- Main and secondary drains and related structures
- Inspection/farm roads

The number of diversion weirs, dams and farm ponds, and the length of main and secondary canals are shown in the table of salient features of each Scheme. Earth work of main and secondary canals in each Scheme is estimated at about 550 m^3 to 3,700 m^3 as excavation and 630 m^3 to 14,500 m^3 as embankment. Block concrete linings are estimated as 260 m^3 to 5,700 m^3. As for the concrete work of related structures, it is estimated as 7,100 m^3 to 45,400 m^3. Excavation works of main and secondary drains are estimated as 490 m^3 to 16,500 m^3.

(ii) On-farm Development Facilities

- Tertiary and field canals with related structures
- Tertiary and field drains with related structures
- Farm road to be provided along the tertiary canal
- Farm bund to be provided along topographic contour lines
- Land clearing and leveling for paddy field

Canal density of on-farm development is basically estimated as 20 m/ha at the tertiary canal level. Earth works of the canal in each Scheme are estimated at about 150 m^3 to 1,800 m^3 as excavation and about 640 m^3 to 8,000 m^3 as embankment. Excavation works of tertiary drain are estimated as 360 m^3 to 4,500 m^3.

(iii) Rural Infrastructure

- Village roads
- Domestic water supplies
- Communication halls
- Schools

Road lengths of both penetration macadam pavement and gravel pavement in each Scheme vary from 0.0 km to 13.0 km. As for domestic water supplies, the numbers of distribution tanks, filter tanks, communal taps are shown in the summary tables of each Scheme. The total lengths of pipe installations are estimated as 0.8 km to 39.7 km. Two (2) types of schools, class-III and class-V primary schools are required with floor areas of 168 m^2 and 336 m^2, respectively. The numbers of primary schools vary from two (2) to seven (7). Three (3) types of village community halls are proposed with floor areas of 168 m^2, 252 m^2 and 336 m^2, respectively. Some Schemes will have a minimum of three (3) community halls while the maximum number will be eight (8) in one of the Schemes.

(iv) Agricultural Extension Facilities

- Highland vegetable trial and demonstration station

An office, quarters, a dormitory and a research laboratory of six timber buildings are planned. The area is estimated as 2,500 m^2, and land consolidation is planned in the trial and demonstration farm of 50 ha.

(v) Marketing Facilities

- Wholesale marketing facilities
- Rice bank facilities

Building areas of offices are estimated as 510 m^2, and the asphalt pavement area for loading space, parking lot, etc. is estimated as 120 m^2.

7.1.2 Construction Time Schedule

Construction is scheduled to take place for over five years on the assumption of international competitive tender of contractors and consultants, mechanized construction method and phasing of construction stage. The schedule is shown in Figure 2.32. Construction of irrigation and drainage facilities are scheduled to take place for a maximum of 2 years; and the construction period of rural infrastructure for a maximum of 20 months. Construction period of the highland vegetable trial and demonstration station and marketing facilities are respectively 11 months and 7 months. The temporary work of diversion weirs and dams will be executed, thereby half closing or diverting river courses.

7.2 Organization of the Project Implementation

An organization, namely the Boloven Agricultural and Rural Development Authority is proposed to implement the construction work of the five priority Schemes. After which all the facilities will be handed over to the provincial government concerned. After the construction, the authority is concluded and the responsibility of O&M works is also handed over to the provincial government.

The authority will consist of three (3) departments. These are the treasury, construction and extension departments, and are managed by a committee headed by the director of the authority. Representatives of farmers' associations and water users' associations will act as for the management as committee members and will participate in the discussions and decisions of the authority. Figures 2.33 shows the organization chart of the authority.

7.3 Participatory Planing and Management of Beneficiaries Farmers

Each Scheme is implemented in consultation with village leaders and/or beneficiaries and the local government agencies concerned, to take into consideration the beneficiaries' opinions. Development of rural community is also consulted through the public consultation during the implementation. The public consultation is conducted and managed by the Boloven agricultural and rural development authority.

The public consultation aims to have the beneficiaries understand the development concept and the plan, to promote their voluntary participation to the Scheme implementation, and increase communication on the development between them and the government.

The public consultation has been conducted during this Study, and furthermore, continued during the detailed designing of the implementation as shown in Figures 2.34 to 2.35. Targets of the public consultation is broadly divided into two (2) groups, (i) beneficiaries including the village leader and (ii) local agencies concerned including village chiefs. Training programs on the implementation of on-farm development and agricultural and rural extensions are also conducted for beneficiaries and the local government after public consultation.

8. PROJECT IMPACT AND EVALUATION

8.1 Project Impacts

8.1.1 Agricultural Impacts

The following agricultural impacts can be expected in the future.

(1) Upper Champi Scheme

- Substantial increase of coffee and tea production. The expected amount is 750 tons and 120 tons, respectively, five times the present production of coffee and three times the present production of tea.
- Highland vegetables and some upland crops are newly introduced and produced. The expected productions are 2,200 tons and 330 tons, respectively.
- The project works as well as the stabilized increase in production (by the modernized farming system supported by improved agricultural services) would bring a high demonstration effect to the adjacent areas.
- The estimated area for control of the slash-and-burn cultivation is about 240 ha.

(2) Upper Tapoung Scheme

- The present grassland, most of which is utilized for an agricultural purpose, will be converted to a new agricultural land and produce 1,600 tons and 240 tons of vegetables and upland crops, respectively.
- The cabbage area which is outside the Scheme area, and cultivated under the slash-and-burn cultivation system will be reduced drastically.
- The area will be the nuclear model scheme for the extension of the permanent cropping system, with the development of highland vegetables under the modernized farming system.
- The area converted from the slash-and-burn cultivation to the permanent cropping system is estimated as 100 ha. Moreover, outside the area, about 320 ha of a slash-and-burn lands would be converted to coffee and other permanent systems.

(3) Upper Kapheu Scheme

- About 700 ha of land composed of bush, upland rice and secondary forests, which are mostly under the slash-and-burn cultivation system at present, will be converted to permanent cropping fields for coffee and lowland rice.
- The project works as well as the stabilized increase in production by the modernized farming system (supported by improved agricultural services) would bring a high demonstration effect to the adjacent areas.
- The expected crop production is 1,350 tons or 8 times of that of the present. About 400 tons of lowland rice will be newly produced.
- The area converted from the slash-and-burn system is estimated as 680 ha.

(4) Lower Xe Set Scheme

- The expected increments of crop productions are 4,500 tons of paddies and 1,500 tons of upland crops under the stabilized farming system with irrigation development.
- More than 1,000 ha of bushlands, grasslands, secondary forests and upland rice fields under the slash-and-burn system will be converted to a permanent cropping field.
- The project works as well as the stabilized increase in production (especially by the lowland rice fields) would be a high demonstration effect to the adjacent areas, and improve the staple food supply as well.
- The area converted from slash-and-burn system is estimated as 1,150 ha. Besides, outside the area, about 630 ha would be used for reforestation.

(5) Upper Tay-Un Scheme

- The project works as well as the stabilized increase in production (especially by the lowland rice fields) would be a high demonstration effect to the adjacent areas, improve the staple food supply as well.
- The newly opened lowland rice fields would be distributed to the farmers who have none at present. Moreover some immigrants would be provided with some of the new lowland rice fields as well.
- About 390 ha of slash-and-burn area would be converted to the permanent cropping system.

8.1.2 Rural Development Impact

Agricultural development will achieve its target through direct measures for increasing production and indirect ones for improving the rural infrastructure and living conditions. It will be an integrated balanced agricultural development. Improvement to the rural infracture can be recognized in various forms, some of which are described below:

(1) Road Improvement

Good transportation facilities, particularly a well functioned road network encourages farmers to expand and improve farming and crop diversification, as well as marketing of farm inputs and outputs. Improved roads will also contribute largely to people's socio-economic activities.

(2) Water Supply Development

Provision of rural water supply will ease the burden of women and children, who now have to fetch water from streams or rivers. Good water also means better health. In addition, the water supply facilities in such public facilities as clinics, schools and markets will contribute to their better functions.

(3) Primary School Improvement

Rehabilitated schools will give better conditions to both teachers and school children. Those schools will encourage the children to go to school more often and continuously, resulting in increasing literacy rate of children.

(4) Village Community Hall

The hall can be used for several purposes such as cooperative work, agricultural extension services, farmers' training, health care services, meetings, social education to adult people, entertainment, etc. Therefore, it will contribute largely to rural life improvement and help benefit the social status of women as well.

8.1.3 Social Development Impact

(1) The Increase and Stabilization of Farm Income

Farmers have to live upon limited as well as unstable agriculture output due to inefficient farming practices such as slash-and-burn farming and rainfed farming. The farmers' income will be increased and stabilized considerably after implementing of the Projects, because of the increase and stabilization in crop production and improvement of the marketing system. The increase and stabilization of the net farm income will provide motivation to improve the living standards of farmers as well as in rural economic development.

(2) Improvement of Rural Life and Correction of Living Differentials

The direct improvement in the living and health conditions in the Study areas, will be expected by the programs of rural water supply systems for supplying clean and safe water for villagers. In addition, it is expected that the community development will stimulate literacy, public health, nutrition and housekeeping. This in turn will progress and stabilize rural living conditions. The improvement of living conditions translates into a rise in the social status of women, which can be expected to contribute to rural socio-economy. These circumstances will promote better rural living conditions, expanding the living differentials within the areas, as well as to that of the urban areas.

(3) Expansion of Women's Activity

In addition, the women's activities will be improved and expanded through community development, establishment of a water supply system and clinics, improvement of roads, and a rice bank. By incorporating women into the project activities such as a rice bank operation, women can be members of village association which operate the village activities. Through these activities, women will gain a knowledge and also power to manage their lives.

(4) The Increase in Employment Opportunity

The project implementation will increase employment opportunity in the each priority area in terms of farm laborers and construction workers. In addition, enhancement of marketing activities will also generate the employment in related sectors.

8.1.4 Environmental Impact

The project is designed to improve the living standard of the people in the five priority areas, made up of 26 villages. Project benefits are as described in the preceding sections. From a review of proposals, the project is seen to implement a range of benefits. The adverse impacts are few and of a temporary nature only. The living standard of rural people, are being enhanced by attention to the physical environment through implementing a series of conservation actions designed to enhance productivity, eliminate pollution and, among others, make the production processes sustainable.

It would also be relevant to consider the "no project" option, i.e. the situation that would arise if the project is not implemented. The people of the project areas live in poverty. Their livelihood is closely linked to what can be obtained from nature, to sustain them through a subsistence form of living. Often, when weather is unfavorable, people are short of food and water and life becomes increasingly difficult. This leads people to shifting cultivation; growing paddy and other upland crops. In a situation such as this, depletion of natural resources will continue until these become exhausted. If the project proposals are in any way not to be implemented, the people will continue to live the way they are used to. In the long-term, more resources will get degraded and be turned into unproductive land or deforested land for example. The population will increase and will face more and more health-related problems under continuing poor nutrition levels. Education will stagnate at present levels and there will be a general degeneration of the quality of life.

Project impacts are qualitatively assessed and mitigation measures are proposed for those likely to be of an adverse nature which are grouped into low, medium and high impact classes. Some adverse impacts will be caused during the construction phase and relevant mitigation measures are discussed in section 3.8. These are assessed as having a medium impact as they are of a temporary nature. Pesticides used in cabbage cultivation are some of the extremely toxic kinds and it is suspected that water in the Upper Tapoung area may be contaminated. The following table is an assessment of the impacts of the project on the environment. In view of the large number of anticipated beneficial impacts, it is concluded that the project will not cause any harm to the environment.

Issue and Activities	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un
1. Environmental Issues					
(1) Wildlife	N	N	N	N	N
(2) Forest	B	B	B	B	B
(3) Water quality	N	*	N	N	N
(4) Health	B	B	B	B	B
(5) Living condition	B	B	B	B	B
(6) Human resources	B	B	B	B	B
2. Project Activities					
(1) Construction	M	M	M	M	M
(2) Land Use	B	B	B	B	B
(3) Improved farming system	B	B	B	B	B
(4) Institution aspect	B	B	B	B	B
(5) Monitoring	B	B	B	B	B
(6) Environmental Planning	B	B	B	B	B

Remarks: Key to impact assessment is indicated as follows:
H: High adverse impact, M: Medium adverse impact, L: Low adverse impact,
N: No adverse impact, B: Beneficial impact, *: To be assessed

8.2 Economic Evaluation

8.2.1 Basic Assumption

The economic justification was carried out on the basis of Economic Internal Rate of Return (EIRR), calculated based on the estimated project costs and incremental project benefits. The justification was carried out for the whole and each proposed Projects. Major assumptions for the estimation of EIRR are summarized below:

i) The economic useful life of each Scheme is 50 years.
ii) All prices are based on December 1995 prices in kip.
iii) The exchange rate of US$1.00 = Kip 920 as of average during November to December, 1995 is applied.
iv) A standard conversion factor (SCF) of 0.99 is applied to domestic cost elements such as transportation, handling and processing for estimation of economic value.
v) The transfer payment such as tax, duty, subsidy and interest are excluded.
vi) Economic prices of farm inputs and tradable farm produce (coffee, tea, rice, soybeans, groundnuts and maize) are estimated on the basis of IBRD projection of world market prices for 2005 in constant 1995 term. Economic prices of other non-tradable farm output and farm inputs are set at same financial prices.
vii) The part of unskilled labor is converted to the economic value applying the conversion factor of 0.46.

8.2.2 Economic Benefit

The following benefits are expected from the implementation of the project, however, only direct benefits accrued from the agricultural development was counted in the conservative estimate of the EIRR.

- Irrigation development (Coffee, Vegetables, Paddies, and Upland crops)
- Improvement of existing farm roads
- Rural water supplies
- Improvement of Public services

- Establishment of Vegetable trial farms
- Establishment of Wholesale markets

The incremental economic irrigation benefits of the each Scheme were estimated on net economic production values under future conditions without and with the Project as shown below:

(Unit: Thousand US$)

Items	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un
1. Without Project	35	0	64	118	8
2. With Project	583	187	590	1,028	248
3. Incremental Benefit (2-1)	548	187	484	910	239

It is estimated that the build-up period to achieve full benefit is five (5) years after the completion of physical works.

8.2.3 Economic Cost

In this evaluation, the cost for rural roads, water supplies, community halls, schools, and agricultural and marketing support facilities were excluded from project costs, since the benefits from them were not included as direct project benefits. Consequently, the economic cost is calculated based on financial project costs excluding the transfer payment and price contingencies, which are for irrigation development. The economic costs of the each project are summarized as follows:

Items	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un	Whole Project
1. Project Cost	5,883	1,497	6,000	11,804	3,093	28,277
2. Annual O&M Cost	52	21	45	102	32	252
3. Replacement Cost	1,398	654	1,384	1,492	770	5,698

8.2.4 Economic Evaluation

Based on economic costs and benefits, EIRR was calculated for the economic evaluation of each and overall Schemes. The results of the estimations are shown in Table 2.7 and summarized as follows:

Items	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un	Whole Scheme
EIRR	7.3%	10.2%	6.9%	6.3%	6.1%	6.9%

8.2.5 Sensitivity Analysis

In order to evaluate the soundness of each and overall Schemes to possible changes in future economic conditions, a sensitivity analysis was made as shown below:

Items	Upper Champi	Upper Tapoung	Upper Kapheu	Lower Xe Set	Upper Tay-Un	Whole 5 Schemes
1. Base Case	7.3%	10.2%	6.9%	6.3%	6.1%	6.9%
2. Construction cost 10% up	6.5%	9.2%	6.2%	5.6%	5.3%	6.1%
3. Benefit 10% down	6.4%	9.1%	6.1%	5.5%	5.2%	6.0%
4. Project cost 10% down	8.2%	11.5%	7.8%	7.2%	7.0%	7.8%
5. Benefit 10% up	8.1%	11.4%	7.7%	7.1%	6.9%	7.7%
6. Case 3 and 4	5.7%	8.1%	5.4%	4.8%	4.5%	5.3%

8.3 Financial Evaluation

8.3.1 Future Farm Budget

In order to evaluate the Scheme from the financial aspect of farmers, a farm budget analysis on different types of farming are made under project conditions. In this evaluation, farm budgets are calculated by using a future coffee price of 670 kip, prospected by IBRD. The results of the estimation are presented in Table 2.8 and summarized as follows:

Priority Area	Upper Champi		Upper Tapoung			Upper Kapheu
Farm Type	Coffee	Coffee+Tea	Coffee +Veg.-1	Coffee +Veg.-2	Coffee +Veg.-3	Coffee +Veg.
1. Gross Farm Income	2,714	2,627	1,256	1,815	1,556	1,856
2. Production Cost	600	594	179	351	276	308
3. Net Income	2,113	2,033	1,077	1,464	1,280	1,548
3.1 Living Expenses *	1,443	1,443	958	1,075	1,075	1,443
3.2 Net Reserve	670	590	119	390	206	105

Priority Area	Lower Xe Set		Upper Tay-Un			
Farm Type	Low. R.-1	Low. R.-2	Coffee+Lo.R -1	Coffee+Lo.R -2	Low. R. 1	Low. R.-2
1. Gross Farm Income	3,000	3,100	1,640	1,611	3,100	1,500
2. Production Cost	1,105	1,030	441	451	925	448
3. Net Income	1,895	2,070	1,199	1,160	2,175	1,052
3.1 Living Expenses *	1,443	1,443	1,075	1,075	1,443	958
3.2 Net Reserve	452	627	125	86	732	95

Remark: * Living expenses are estimated from the average national and urban expenditures.
(Source: Agricultural Sector Memorandum, IBRD, 1994)

Through the above estimation, the following agro-economical impacts are identified.

(1) Upper Champi

- Although the income will fairly fluctuate by coffee prices, the farm income will increase to more than 2.5 million kip.
- They can attain the average living standard of the urban area.
- Net reserve will be over 0.5 million kip.

(2) Upper Tapoung

- The farm income will be more than 1.0 million kip.
- In fact, farm income of some farmers are considerably high at present, however, they can continue to stabilize their life.
- They can attain the average living standard of the urban area.

- They can reduce their farm work in a year by changing their farming style from shifting cultivation to permanent farming.
- Net reserve may be over 0.1 million kip.

(3) Upper Kapheu

- The farm income will be more than 1.8 million kip.
- They can attain the average living standard of the urban area.
- Net reserve may be over 0.1 million kip

(4) Lower Xe Set

- Farm income will increase to 3.0 million kip.
- Living conditions will also be drastically improved, they can attain the average living standard of the urban area.
- Net reserve may be over 0.5 million kip

(5) Upper Tay-Un

- Farm income will increase to 1.5 to 3.0 million kip
- Living conditions of the present farmers will also be drastically improved.
- They can attain the average living standard of the urban area.
- While new immigrants from the other area can have one cropping field of paddy, they will get the stable income of 1.5 million kip.

8.3.2 Capacity to Pay

After the implementation of the projects, the operation and maintenance costs of irrigation and drainage facilities, on-farm facilities, and rural infrastructure facilities are shouldered by the beneficiary farmers. O&M costs for the main system will be recovered from the water charges while O&M costs for the on-farm facilities will be met in the form of labor.

According to a government regulation, the farmers benefited by irrigation in the Schemes will have to pay water charges at kip 0.45 per one cubic meter. In this case, the water charges of each typical farmer are estimated at about kip 1,000 to 20,000 annually, which are equivalent to 0.1 to 10% of net reserve. Therefore, they will have enough capacity to pay the charges.

On the other hand, the Government also maintains that the annual O&M costs of irrigation facilities should be shouldered by the beneficiaries. However, most farmers in the entire country have hardly paid the costs. Therefore the Department of Irrigation suggested to the government that the farmers' duty be 30% of the O&M costs. In case that farmers have to shoulder 30% of annual O&M costs, they would pay the charges as shown below:

(Unit: Thousand Kip)

Priority Area	Upper Champi		Upper Tapoung			Upper Kapheu
Farm Type	Coffee	Coffee+Tea	Coffee +Veg.-1	Coffee +Veg.-2	Coffee +Veg.-3	Coffee +Veg.
Net reserve	670	590	119	390	206	105
O&M cost	65	65	23	23	23	30

(Unit: Thousand Kip)

Priority Area	Lower Xe Set			Upper Tay-Un		
Farm Type	Low. R.-1	Low. R.-2	Coffee+ Lo.R - 1	Coffee+ Lo.R-2	Low. R. 1	Low. R.-2
Net reserve	452	627	125	86	732	95
O&M cost	72	72	54	54	54	54

Except for the Upper Tay-Un area, farmers can easily shoulder the O&M costs. These are estimated at about 10 to 30% of net reserve for the four (4) Schemes. Even in the Upper Tay-Un Scheme, the charge will be 7 to 60% of net reserve. Since this net reserve results from high consumption of living expenses, it is considered that they have enough capacity to pay the O&M charges.

Presently the water charge in the Laongam area is at kip 100 per cubic meter. In case that it is applied to the projects, the anticipated water charge of an average household is about kip 15,000. Therefore, it could be considered as a small portion among the net reserves.

8.4 Project Justification

Based on the results of economic and financial evaluations for the proposed Schemes, the Project is justified as summarized below:

a) Economic Internal Rate of Return (EIRR) is 6.1 to 10.2% on each priority Scheme and 6.9% on the entire five Schemes. The Project is economically viable in view of the national economy.

b) The farm economy will be drastically increased and also stabilized compared with the without project condition. From the financial point of view, the large benefit will be born to the beneficiary farmers after project implementation.

c) About 2,600 ha of slash-and-burn fields in all the Schemes will be shifted to farm lands, and about 920 ha of slash-and-burn fields around the priority Schemes are assumed to be changed to permanent forests or coffee plantations. Consequently, about 3,500 ha of slash-and-burn fields will be reduced by the implementation of the projects.

d) It is easily expected that the dissemination and expansion effect to the surrounding areas will be born from the implemented projects, which will functioned as the core projects. The following effects can be considered;

- reduction of slash-and-burn cultivation
- improvement of the farming practices
- improvement of living conditions and rural life
- improvement of the marketing systems

e) It is estimated that the farmers have a capacity to pay the O&M charges when the duty is 30% of the total O&M costs of the main system.

9. RECOMMENDATION

(1) The Study area covering about 654,000 ha is blessed with natural resources; fertile soils and ample rainfall. Out of the total, suitable land for agricultural development is estimated at about 135,000 ha in net, of which approximately 55,000 ha of irrigable land extend scatteringly over the Study area. Irrigation area of 55,000 ha is divided into 36,000 ha of gravity system and about 19,000 ha of pump up system.

(2) Based on the overall development plan studied, it is proposed that the stage wised development (namely, short, middle and long terms) of the entire development of 135,000 ha is practical and attractive, from the view point of the development scale and implementation ability of farmers concerned and the Government. Out of 135,000 ha ,about 36,000 ha of gravity irrigation schemes were selected as the model development; taking into account the development suitability for several farming systems, model function for smooth extension and efficient dissemination of agricultural practices to surrounding and similar areas.

(3) In order to implement the model development in the area smoothly and sustainably, it is further proposed that some representative schemes (in appropriate scale) be urgently developed among the model development areas. In line with the effective agricultural extension, demonstration for rural development, and the typical farming system from the climate and soil conditions, five (5) priority Schemes, namely, Upper Champi, Upper Tapoung, Upper Kapheu, Lower Xe Set and Upper Tay-Un Schemes, have been selected for the feasibility study.

(4) After careful field investigation and study was carried out for the priority development schemes, the development plan was justified as technically feasible, economically viable, and will improve the lives and communities of the areas. The early implementation of priority schemes are strongly recommended, in order to establish a core base for further development and to demonstrate a suitable and self-reliant development.

(5) The proposed integrated agricultural and rural development plan includes various development components which require widely ranging technologies in soft and hard-ware, such as: increase in agricultural productivity, development of agricultural and rural infrastructures, improvement support services for rural life of the people concerned, and agricultural and social support services. It is suggested that the Ministry of Agriculture and Forestry (MOAF) organize a coordination system in cooperation with the relevant agencies concerned for the efficient implementation of the projects. For this purpose an organization of a Boloven Agricultural and Rural Development Authority, supported by the Provincial AFSs, Ministries of Health and Education and CTPC, and Farmers' and Water Users' Associations, is recommended to be established. Moreover, autonomous water users' associations for both irrigation and domestic water supplies are proposed to be established for proper water distribution and O&M of the facilities. The extension services for agriculture and rural life improvement would be implemented by strengthening provincial and district AFSs in line with the polices of NIERP.

(6) The primary intention of the O&M project is to sustain the development, and encourage operation and maintenance of facilities/programs by the beneficiaries themselves. In order to attain these objectives, it is indispensable to include the beneficiaries in the planning and implementation of the project. Furthermore to facilitate participation, it is suggested that planning, design and construction of on-

farm facilities be carried out by farmers with engineering and financial assistance by the Government.

(7) Both the beneficiaries of irrigation and domestic water supplies do not have technical skills and knowledge as of yet. After completion of the schemes, the administrative authorities will hand over both facilities to the group/associations for operation and maintenance, with legal procedures. Thus, it is recommended that the relevant authorities be required to provide intensive guidance and assistance to both water users' associations of irrigation and domestic water for the operation and maintenance of these facilities.

(8) As verified in the financial analysis, the economic situation of the beneficiary farmers will be greatly improved when full development is achieved. However, estimated O&M costs would be rather high for small farmers to pay, particularly in the Lower Xe Set area. Accordingly, it is recommended that the Government assist the association on O&M works, especially in engineering aspects, so as to reduce the annual water charge dues.

(9) The highland vegetable trial and demonstration station proposed is essential for the promotion and extension of vegetable production, by providing farmers with adequate methods for stabilized production and by the distribution of improved seeds. Besides, the station would conduct research on tea cultivation and its processing for the purpose of upgrading the quality of the products. The proposed station will be operated under the AFSs of Champasak province in collaboration with DAE of MAF.

(10) It is strongly recommended that training opportunities be provided for the government staff, selected water users and leading farmers to establish agricultural, irrigation and water users' associations, in order to successfully implement the proposed schemes for their sustainable development and improved rural life.

Tables

Table 2.1 Monthly Mean Discharge (1/2)

H.Champi (tak 47)
Basin Area 16 km2

UNIT : m3/sec

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
1986	0.351	0.213	0.143	0.147	0.451	0.665	1.032	1.403	1.436	1.150	0.868	0.585	0.704
1987	0.334	0.209	0.134	0.195	0.341	0.691	1.116	1.553	1.380	1.150	0.813	0.506	0.702
1988	0.322	0.239	0.182	0.265	0.413	0.735	0.693	1.196	0.999	0.975	0.726	0.448	0.600
1989	0.267	0.161	0.103	0.180	0.471	0.726	0.929	1.179	1.205	1.018	0.803	0.530	0.631
1990	0.306	0.189	0.128	0.111	0.288	0.531	0.702	1.071	1.389	1.178	0.870	0.550	0.609
1991	0.331	0.209	0.135	0.130	0.379	0.614	1.209	2.164	1.912	1.512	1.015	0.649	0.856
1992	0.410	0.272	0.175	0.139	0.177	0.636	1.146	1.517	1.401	1.116	0.760	0.480	0.686
1993	0.306	0.189	0.113	0.115	0.230	0.511	0.612	1.153	1.144	0.863	0.613	0.400	0.504
1994	0.237	0.157	0.235	0.353	0.543	0.764	1.517	1.796	1.726	1.412	0.951	0.701	0.867
1995	0.389	0.255	0.181	0.227	0.362	0.425	0.776	0.943	0.978	0.792	0.574	0.368	0.523
AVERAGE	0.323	0.209	0.153	0.185	0.365	0.611	0.973	1.398	1.357	1.117	0.802	0.522	0.668

H.Champi (tak 43)
Basin Area 36 km2

UNIT : m3/sec

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
1986	0.751	0.478	0.322	0.330	1.015	1.496	2.323	3.157	3.231	2.588	1.998	1.316	1.584
1987	0.751	0.471	0.301	0.445	0.767	1.554	2.511	3.495	3.106	2.588	1.830	1.140	1.580
1988	0.724	0.539	0.409	0.597	0.928	1.654	1.559	2.692	2.249	2.194	1.634	1.008	1.349
1989	0.601	0.363	0.232	0.405	1.059	1.633	2.089	2.654	2.712	2.290	1.806	1.193	1.420
1990	0.688	0.425	0.288	0.250	0.648	1.195	1.579	2.410	3.125	2.650	1.957	1.237	1.371
1991	0.744	0.470	0.304	0.292	0.853	1.404	2.719	4.870	4.303	3.402	2.283	1.461	1.925
1992	0.921	0.611	0.393	0.313	0.398	1.431	2.578	3.412	3.152	2.510	1.710	1.080	1.542
1993	0.688	0.426	0.255	0.258	0.517	0.701	1.377	2.594	2.573	1.942	1.380	0.900	1.134
1994	0.533	0.353	0.535	0.795	1.221	1.719	3.413	4.041	3.882	3.178	2.162	1.577	1.951
1995	0.876	0.575	0.414	0.510	0.814	0.956	1.746	2.122	2.201	1.782	1.293	0.828	1.176
AVERAGE	0.728	0.471	0.345	0.420	0.822	1.374	2.189	3.145	3.053	2.513	1.805	1.174	1.503

H. Tapoung
Basin Area 4 km2

UNIT : m3/sec

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
1986	0.083	0.053	0.036	0.037	0.113	0.166	0.258	0.351	0.359	0.288	0.222	0.146	0.176
1987	0.083	0.052	0.033	0.049	0.085	0.173	0.279	0.388	0.345	0.288	0.203	0.127	0.176
1988	0.080	0.060	0.045	0.066	0.103	0.184	0.173	0.299	0.250	0.244	0.182	0.112	0.150
1989	0.067	0.040	0.026	0.045	0.118	0.181	0.232	0.295	0.301	0.254	0.201	0.133	0.158
1990	0.076	0.047	0.032	0.028	0.072	0.133	0.175	0.268	0.347	0.294	0.217	0.137	0.152
1991	0.083	0.052	0.034	0.032	0.095	0.156	0.302	0.541	0.478	0.378	0.254	0.162	0.214
1992	0.102	0.068	0.044	0.035	0.044	0.159	0.286	0.379	0.350	0.279	0.190	0.120	0.171
1993	0.076	0.047	0.028	0.029	0.057	0.078	0.153	0.288	0.286	0.216	0.153	0.100	0.126
1994	0.059	0.039	0.059	0.088	0.136	0.191	0.379	0.449	0.431	0.353	0.240	0.175	0.217
1995	0.092	0.064	0.046	0.057	0.090	0.106	0.194	0.236	0.245	0.198	0.144	0.092	0.131
AVERAGE	0.081	0.052	0.038	0.047	0.091	0.153	0.243	0.349	0.339	0.279	0.201	0.130	0.167

H.Kapheu
Basin Area 24 km2

UNIT : m3/sec

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
1986	0.459	0.288	0.187	0.184	0.576	0.877	1.369	1.870	1.936	1.553	1.157	0.779	0.940
1987	0.459	0.284	0.177	0.251	0.439	0.899	1.480	2.069	1.864	1.554	1.090	0.671	0.936
1988	0.420	0.307	0.232	0.329	0.531	0.970	0.917	1.589	1.341	1.303	0.973	0.591	0.792
1989	0.369	0.219	0.136	0.211	0.628	0.982	1.224	1.557	1.537	1.323	1.023	0.656	0.822
1990	0.459	0.284	0.192	0.166	0.432	0.796	1.053	1.606	2.083	1.767	1.304	0.825	0.914
1991	0.405	0.245	0.148	0.126	0.406	0.719	1.479	2.684	2.447	1.999	1.353	0.854	1.072
1992	0.557	0.366	0.228	0.175	0.228	0.801	1.470	1.958	1.872	1.516	1.030	0.639	0.907
1993	0.400	0.242	0.138	0.123	0.262	0.380	0.739	1.394	1.505	1.152	0.798	0.506	0.637
1994	0.309	0.196	0.243	0.396	0.643	0.945	1.851	2.211	2.167	1.801	1.217	0.862	1.070
1995	0.501	0.321	0.218	0.237	0.398	0.516	0.945	1.190	1.274	1.053	0.754	0.467	0.656
AVERAGE	0.434	0.275	0.190	0.220	0.451	0.789	1.253	1.817	1.803	1.502	1.074	0.655	0.875

H.Thong
Basin Area 8 km2

UNIT : m3/sec

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
1986	0.124	0.099	0.079	0.075	0.185	0.290	0.432	0.587	0.615	0.437	0.297	0.162	0.282
1987	0.124	0.098	0.077	0.097	0.147	0.270	0.488	0.602	0.601	0.437	0.246	0.140	0.277
1988	0.116	0.099	0.085	0.115	0.182	0.323	0.279	0.499	0.407	0.374	0.240	0.127	0.237
1989	0.099	0.076	0.058	0.070	0.211	0.332	0.345	0.487	0.451	0.356	0.233	0.128	0.237
1990	0.098	0.074	0.059	0.051	0.116	0.202	0.298	0.391	0.544	0.459	0.272	0.131	0.225
1991	0.098	0.078	0.127	0.151	0.107	0.167	0.202	0.345	0.347	0.319	0.265	0.246	0.206
1992	0.112	0.091	0.076	0.073	0.095	0.127	0.175	0.258	0.324	0.297	0.194	0.130	0.163
1993	0.091	0.061	0.050	0.047	0.091	0.172	0.221	0.252	0.366	0.353	0.290	0.250	0.186
1994	0.098	0.074	0.055	0.052	0.063	0.161	0.281	0.387	0.443	0.336	0.154	0.095	0.183
1995	0.071	0.049	0.030	0.019	0.103	0.145	0.274	0.261	0.247	0.176	0.087	0.053	0.126
AVERAGE	0.102	0.080	0.070	0.075	0.130	0.219	0.300	0.407	0.434	0.354	0.230	0.146	0.212

Table 2.1 Monthly Mean Discharge (2/2)

H.Tay-Ua
Basin Area 31 km2

UNIT : m3/sec

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
1986	0.303	0.238	0.187	0.177	0.447	0.719	1.081	1.476	1.552	1.099	0.741	0.401	0.702
1987	0.303	0.236	0.183	0.231	0.355	0.669	1.226	1.519	1.524	1.100	0.611	0.348	0.692
1988	0.280	0.238	0.203	0.275	0.445	0.801	0.690	1.241	1.014	0.933	0.591	0.311	0.585
1989	0.239	0.178	0.134	0.152	0.546	0.887	0.859	1.193	1.028	0.832	0.490	0.285	0.569
1990	0.210	0.151	0.125	0.102	0.274	0.471	0.722	0.913	1.243	1.086	0.636	0.299	0.519
1991	0.244	0.189	0.168	0.179	0.192	0.359	0.591	1.050	1.123	1.037	0.744	0.489	0.532
1992	0.277	0.239	0.194	0.166	0.232	0.384	0.672	0.995	1.087	0.909	0.534	0.309	0.501
1993	0.235	0.177	0.139	0.118	0.196	0.374	0.478	0.612	0.997	0.847	0.570	0.387	0.427
1994	0.210	0.151	0.107	0.100	0.177	0.428	0.754	0.993	1.098	0.843	0.383	0.233	0.456
1995	0.163	0.109	0.062	0.030	0.166	0.292	0.576	0.615	0.672	0.507	0.238	0.130	0.297
AVERAGE	0.245	0.191	0.152	0.153	0.303	0.538	0.765	1.061	1.134	0.919	0.554	0.319	0.528

Xe Set
Basin Area 413 km2

UNIT : m3/sec

YEAR	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	AVERAGE
1986	4.342	3.093	2.359	2.932	13.452	20.907	33.838	42.477	43.245	28.347	17.592	7.621	18.184
1987	4.700	3.356	2.375	5.227	10.117	19.994	36.460	43.495	43.119	28.616	13.797	6.265	18.126
1988	4.617	4.055	3.263	6.720	12.652	23.616	19.351	36.227	27.757	25.135	14.233	5.747	15.281
1989	4.165	2.908	2.067	3.950	16.249	25.600	24.947	35.910	30.890	22.948	13.289	5.907	15.736
1990	3.856	2.608	2.177	1.748	8.159	15.253	21.775	27.903	39.424	31.124	16.314	6.118	14.705
1991	4.186	3.174	3.036	3.145	6.090	11.257	32.820	41.872	41.718	37.298	17.599	9.791	17.668
1992	3.790	3.406	2.415	2.335	4.350	15.746	30.036	45.900	34.843	21.523	10.355	5.820	15.043
1993	4.020	2.972	2.540	2.562	6.087	5.680	14.550	26.724	34.571	17.182	7.985	4.616	10.791
1994	3.089	2.331	2.030	5.268	11.050	15.650	29.721	30.923	36.667	19.854	9.506	5.851	14.331
1995	3.952	2.872	2.370	2.290	5.561	5.850	13.036	21.574	25.043	17.586	9.378	5.226	9.562
AVERAGE	4.072	3.077	2.463	3.618	9.377	15.955	25.453	35.301	35.728	24.964	13.005	6.298	14.943

Table 2.2 Proposed Rural Infrastructure Development Plan

	Priority Development Scheme	Target villages	No. of target villages (no.)	Households in 1996 (no.)	Population in 1996 (no.)	Water supply system: Gravity flow piped water system	Water supply system: Water system with electric pump	Rural road improvement: Penetration macadam (km)	Rural road improvement: Gravel pavement (km)	Rural road improvement: Box culvert (no.)	Rural road improvement: Pipe culvert (no.)	Primary school: Class-III ,1/ (no.)	Primary school: Class-V ,2/ (no.)	Village community hall: type-A ,3/ (no.)	Village community hall: type-B ,4/ (no.)	Village community hall: type-C ,5/ (no.)
(1)	Upper Champi	Lak 33		61	347							1	0	1	0	0
		Lak 35		121	674							0	1	0	1	0
		Lak 36		80	476							1	0	1	0	0
		Lak 38		71	431							1	0	1	0	0
		Lak 40		144	837							0	1	0	1	0
		Lak 42		56	263							0	0	1	0	0
		Lak 43		206	1,146							0	1	0	1	0
		Lak 45		89	557							0	1	0	0	1
			8	828	4,731	1	0	0.0	0.0	0	0	3	4	4	3	1
(2)	Upper Tapoung	Phoulangkeo		45	283							1	0	1	0	0
		Houaisan		116	666							0	1	0	0	1
		Xetapung		101	529							1	0	0	1	0
			3	262	1,478	0	2	12.9	0.0	0	26	2	1	1	1	1
(3)	Upper Kapheu	Phouak-noi		83	453							1	0	1	0	0
		Sixiangmai		49	265							1	0	1	0	0
		On-noi		97	490							0	0	0	0	1
		Phouak-gnai		133	731							1	0	0	1	0
		On-gnai		94	454							0	1	1	0	0
			5	456	2,393	1	0	9.3	3.7	1	26	3	1	3	1	1
(4)	Lower Xe Set	Natteu		32	149							1	0	1	0	0
		Sengvang-gnai		135	796							1	0	0	0	1
		Houakhoua		58	290							0	0	1	0	0
		Sengvang-noi		74	454							1	0	1	0	0
		Khonleng		29	179							1	0	1	0	0
		Natou		58	350							1	0	1	0	0
			6	386	2,218	1	0	3.2	3.8	1	14	5	0	5	0	1
(5)	Upper Tayun	Chakamlit		20	160							1	0	0	1	0
		Khamkok		50	470							1	0	1	0	0
		Chakam-mai		38	241							0	0	1	0	0
			3	108	871	0	4	0.0	1.7	2	3	2	0	2	1	0
	(total)		25	2,040	11,691	3	6	25.4	9.2	4	69	15	6	15	6	4

Note : 1/ comprising four (4) rooms, with a total floor area of 168 m2
2/ comprising six (6) rooms, with a total floor area of 336 m2
3/ applied to the village with less than 100 of households, with a total floor area of 168 m2
4/ applied to the village with more than 100 of households, with a total floor area of 252 m2
5/ applied to the village, which is proposed to be a center of each scheme area, with a total floor area of 336 m2

Table 2.3 Proposed Road Improvement Plan

Scheme	Road section (village)	to	(village)	Penetration macadam pavement (km)	Gravel pavement (km)	Pipe culvert (nos.)	Box culvert (nos.)
(1) Champi							
	(sub-toatal)			0	0	0	0
(2) Tapoung							
(2)-1	Pakxong	-	B.Xetapung	12.9	0	26	0
	(sub-toatal)			12.9	0	26	0
(3) Kapheu							
(3)-1	Road No.20	-	B.Sixiangmai	9.3	0	19	0
(3)-2	B.Sixiangmai	-	B.Phouak-gnai	0	1.8	4	1
(3)-3	B.Phouak-noi	-	B.Phouak-gnai	0	1.9	4	0
	(sub-toatal)			9.3	3.7	27	1
(4) Xeset							
(4)-1	Road No.20	-	Xeset power station	3.2	0	6	0
(4)-2	Road No.20	-	B. Natou	0	3.8	8	1
	(sub-toatal)			3.2	3.8	14	1
(5) Tay-Un							
(5)-1	Road No.16	-	B. Chakamlit	0	1.7	3	2
	(sub-toatal)			0	1.7	3	2
	(Total)			25.4	9.2	70	4

Table 2.4 Proposed Water Supply System Development Plan

Water Supply System	Target villages	No. of target villages	Households in 1996	Population in 1996	Population in 2010	Demand of water (lit./sec)	Proposed Facilities: Water source	Transmission/ main pipe, 1/ (m)	Branch pipe, 2/ (m)	Filter tank (no.)	Distribution tank (ground level) (no.)	Distribution tank (ground level) (no.), 3/	Elevated tank	Communal tap (no.)	Communal tap (no.), 4/	Pumping facility (no.)
(1) Gravity Flow Piped Water System, Upper Champi	Lak 33 Lak 35 Lak 36 Lak 38 Lak 40 Lak 42 Lak 43 Lak 45	8	828	4,731	5,990	5.41	H. Champi	35,860	4,280	1	8	0	0	138	0	0
(2) Water System with electric pump, Upper Tapung No.1	Phoulangkeo	1	45	283	358	0.32 (1.29), 5/	H. Kapheu	1,010	90	1	1	0	0	9	0	1
(3) Water System with electric pump, Upper Tapung No.2	Houansan Xetapung	2	217	1,195	1,513	1.36 (5.46), 5/	H. Tapung	7,450	1,030	1	1	0	1	43	0	2 6/
(4) Gravity Flow Piped Water System, Upper Kapheu	Phouak-noi Sixiangmai On-noi Phouak-gnai On-gnai	5	456	2,393	3,926	3.54	H. Kapheu	14,300	3,620	1	5	0	0	92	0	0
(5) Gravity Flow Piped Water System, Lower Xeset	Naueu Sengvang-gnai Houakhoua Sengvang-noi Khonleng Naimu	6	386	2,218	3,221	2.91	Xeset	14,660	1,940	2	3	3	0	54	20	0
(6) Water System with electric pump, Upper Tayun No.1	Chakamlit	1	20	160	232	0.21 (0.84), 5/	H. Thon	100	0	1	0	1	0	0	5	1
(7) Water System with electric pump, Upper Tayun No.2	Khamkok	1	50	470	682	0.62 (2.46), 5/	H. Tit	150	0	1	0	1	0	0	10	1
(8) Water System with electric pump, Upper Tayun No.3	Chakam-mai (1) 7/	0.5	20	118	171	0.15 (0.63), 5/	H. Tit	200	0	1	0	1	0	0	5	1
(9) Water System with electric pump, Upper Tayun No.4	Chakam-mai (2) 7/	0.5	18	123	179	0.16 (0.63), 5/	H. Tit	300	0	1	0	1	0	0	5	1
(Grand total)		25	2,040	11,691	16,272	14.68		74,030	10,960	10	18	7	1	336	45	7

Note : 1/ transmission / distribution main pipe (GI pipe), including an intake pipe from a water source
2/ distribution branch pipe (PVC pipe)
3/ with a washing basin and communal tapstands
4/ installed directly to the distribution tank
5/ a half day's consumption with a 3 hours pump operation
6/ including pumping to an elevated tank
7/ for B.Chakam-mai, two (2) sytems are required because the villge comprising two (2) groups, is located at two points.

Table 2.5 (1/8) Summary of the Schemes -Upper Champi-

General Description		
Scheme Name	Upper Champi	
Location and Altitude	Paksong District, Champasak Province (El. 900 to 1,200 m)	
No. of Target Villages	8 villages	
Village Name	Lak33, Lak35, Lak36, Lak38, Lak40, Lak42, Lak43, Lak45	
Households	828 households	
Population	4,731	

Development Plan			
Item	Description	Quantity	Remarks
(1) Agricultural Supporting Service			
- Extension Facility	Meeting room in village community hall(Lak 45)	1	
(2) Irrigation and Drainage Facilities			
- Water sources	H.Champi		
- Proposed cropping pattern and Irrigation area (net)	Coffee : 620 ha, Upland Crops - Vegetables : 110 ha	730 ha	
- Diversion weir	Concrete diversion weir, Width = 43.0 m	1 place	
- Earthfill dam	V = 34,000 m3	1 no.	
- Reservoir	Effective storage capacity = 105,000 m3		
- Design discharge		0.117 m3/sec.	
- Main irrigation canals	Concrete lining canal, 2 canals	4.7 km	
- Secondary irrigation canals	Concrete lining canal, 3 canals	13.0 km	
- Secondary drainage canals	Earth canal, 8 canals	3.0 km	
- Farm road	Effective width = 3.0m, Gravel pavement	21.2 km	
- Farm ponds	Cut and embankment pond	43 places	
(3) Rural Infrastructure Facilities			
- Water supply system :	Gravity flow piped water system	1 system	
Water source	Houay Champi		
Water demand		5.41 lit./sec	
Transmission / Distribution main pipe (GI Pipe)		35,860 m	
Distribution branch pipe (PVC Pipe)		4,280 m	
Filter tank		1 no.	
Distribution tank		8 nos.	
Communal tap		138 nos.	
- Village road :	Penetration macadam pavement	none	
	Gravel pavement	none	
- School :	Class-III primary school (4 rooms, 168 m2)	3 nos.	
	Class-V primary school (6rooms, 336 m2)	4 nos.	
- Village community hall :	Type-A (3rooms, 168 m2)	4 nos.	
	Type-B (3rooms, 252 m2)	3 nos.	
	Type-C (4rooms, 336m2)	1 no.	

Table 2.5 (2/8) Summary of the Schemes -Upper Tapoung-

General Description	
Scheme Name	Upper Tapoung
Location and Altitude	Pakxong District, Champasak Province (EL 900 to 1,300 m)
No. of Target Villages	3 villages
Village Name	Phoulangkeo, Houaisan, Xetapung
Households	262 households
Population	1,478

Development Plan			
Item	Description	Quantity	Remarks
(1) Agricultural Supporting Service			
- Extension Facility	Meeting room in village community hall(Houaisan)	1	
-			
(2) Irrigation and Drainage Facilities			
- Water sources	H.Tapoung		
- Proposed cropping pattern and Irrigation area (net)	Upland Crop - Vegetable : 80 ha	80 ha	
- Diversion weir	Concrete diversion weir. Width = 38.0 m	1 place	
- Reservoir	Effective storage capacity = 240,000 m3		
- Design discharge		0.063 m3/sec.	
- Main irrigation canals	Concrete lining canal, 1 canal	1.6 km	
- Secondary irrigation canals	Concrete lining canal, 1 canal	0.8 km	
- Secondary drainage canals	Earth canal, 1 canal	0.2 km	
- Farm roads	Effective width = 3.0m, Gravel pavement	5.3 km	
- Farm ponds	Cut and embankment pond	5 places	
(3) Rural Infrastructure Facilities			
- Water supply system :	Water system with electric pump	2 systems	
Water source	Houay Kapheu and Houay Tapung		
Water demand		1.68 lit/sec	
Pumping intake pipe / Transmission / Distribution main pipe (GI Pipe)		8,460 m	
Distribution branch pipe (PVC Pipe)		1,120 m	
Filter tank		2 nos.	
Distribution tank		2 no.	
Elevated tank		1 no.	
Communal tap		52 nos.	
Electric pump		3 nos.	
- Village Road :	Penetration macadam pavement	12.9 km	
	Gravel pavement	none	
- School :	Class-III primary school (4 rooms, 168 m2)	2 nos.	
	Class-V primary school (6 rooms, 336 m2)	1 no.	
- Village community hall :	Type-A (3 rooms, 168 m2)	1 no.	
	Type-B (3 rooms, 252 m2)	1 no.	
	Type-C (4 rooms, 336 m2)	1 no.	

Table 2.5 (3/8) Summary of the Schemes -Upper Kapheu-

General Description	
Scheme Name	Upper Kapheu
Location and Altitude	Laongam District, Salavan Province (EL 600 to 800m)
No. of Target Villages	5 villages
Village Name	Phouak-noi, Sixiangmai, On-noi, Phouak-gnai, On-gnai
Households	456 households
Population	2,393

Development Plan			
Item	Description	Quantity	Remarks
(1) Agricultural Supporting Service			
- Extension Facility	Meeting room in village community hall(On-noi)	1	
(2) Irrigation and Drainage Facilities			
- Water sources	H.Kapheu		
- Proposed cropping pattern and Irrigation area (net)	Coffee : 900 ha, Paddy - Upland Crops : 100 ha	1,000 ha	
- Diversion weir	Concrete diversion weir, Width = 14.0 m	1 place	
- Earthfill dam	V1 = 20,000 m3, V2 = 16,000 m3, V3 = 18,000 m3, V4 = 18,000 m3	4 nos.	
- Reservoir	Dam No.1: Effective storage capacity = 137,000 m3		
	Dam No.2: Effective storage capacity = 64,000 m3		
	Dam No.3: Effective storage capacity = 52,000 m3		
	Dam No.4: Effective storage capacity = 142,000 m3		
- Design discharge		0.272 m3/sec.	
- Main irrigation canals	Concrete lining canal, 2 canals	2.2 km	
- Secondary irrigation canals	Concrete lining canal, 3 canals	11.8 km	
- Secondary drainage canals	Earth canal, 6 canals	1.1 km	
- Farm roads	Effective width = 3.0m,Gravel pavement	15.3 km	
- Farm roads	Cut and embankment pond	35 places	
(3) Rural Infrastructure Facilities			
- Water supply system :	Gravity flow piped water system	1 system	
Water demand		3.54 lit./sec	
Water source	Houay Kapheu		
Transmission / Distribution main pipe (GI Pipe)		14,300 m	
Distribution branch pipe (PVC Pipe)		3,620 m	
Filter tank		1 no.	
Distribution tank		5 nos.	
Communal tap		92 nos.	
- Village Road :	Penetration macadam pavement	9.3 km	
	Gravel pavement	3.7 km	
- School :	Class-III primary school (4 rooms, 168 m2)	3 nos.	
	Class-V primary school(6 rooms, 336 m2)	1 no.	
- Village community hall :	Type-A (3 rooms, 168 m2)	3 nos.	
	Type-B (3 rooms, 252 m2)	1 no.	
	Type-C (4 rooms, 336 m2)	1 no.	

Table 2.5 (4/8) Summary of the Schemes -Lower Xe Set-

General Description	
Scheme Name	Lower Xe Set
Location and Altitude	Salavan District, Salavan Province (EL. 300 to 400m)
No. of Target Villages	6 villages
Village Name	Natteu, Sengvang-gnai, Houakhoua, Sengvang-noi, Khonleng, Natou
Households	386 households
Population	2,309

Development Plan

Item	Description	Quantity	Remarks
(1) Agricultural Supporting Service			
- Extension Facility	Meeting room in village community hall(Sengvang-gnai)	1	
- Post-harvest Facility(Rice Bank)	Equipped with prost-harvest facility of rice (drying yard, rice mill, paddy and rice storage, etc.):		
	(Natteu, Houakoua)	1	
	(Sengvang-gnai)	1	
	(Sengvang-noi)	1	
	(Khonleng)	1	
	(Natou)	1	
(2) Irrigation and Drainage Facilities			
- Water sources	H Xeset		
- Proposed cropping pattern and Irrigation area (net)	Paddy - Paddy : 200 ha, Paddy - Upland Crops : 800 ha	1,000 ha	
- Diversion Weir	Concrete diversion weir, Width = 75.0 m	1 place	
- Regulation pond		1 place	
- Design discharge		9.030 m3/sec.	
- Main irrigation canals	Concrete lining canal, 3 canals	3.6 km	
- Secondary irrigation canals	Concrete lining canal, 5 canals	11.0 km	
- Secondary drainage canals	Earth canal, 4 canals	7.6 km	
- Farm roads	Effective width = 3.0 m, Gravel pavement	26.0 km	
- Farm ponds	Cut and embankment pond	35 places	
(3) Rural Infrastructure Facilities			
- Water supply system	Gravity flow piped water system	1 system	
Water source	Xe Set		
Water demand		2.91 lit./sec	
Transmission / Distribution main pipe (GI Pipe)		14,660 m	
Distribution branch pipe (PVC Pipe)		1,940 m	
Filter tank		2 nos.	
Distribution tank		6 nos.	
Communal tap		74 nos.	
- Village Road	Penetration macadam pavement	3.2 km	
	Gravel pavement	3.8 km	
- School	Class-III primary school (4 rooms, 168 m2)	5 nos.	
	Class-V primary school (6 rooms, 336 m2)	none	
- Village community hall	Type-A (3 rooms, 168 m2)	5 nos.	
	Type-B (3 rooms, 252 m2)	none	
	Type-C (4 rooms, 336 m2)	1 no.	

Table 2.5 (5/8) Summary of the Schemes - Upper Tay Un -

General Description	
Scheme Name	Upper Tay-Un
Location and Altitude	Thateng District, Sekong Province (El. 500 to 600m)
No. of Target Villages	3 villages
Village Name	Chakamlit, Khamkok, Chakam-mai
Households	108 households
Population	871

Development Plan

Item	Description	Quantity	Remarks
(1) Agricultural Supporting Service			
- Extension Facility	Meeting room in village community hall(Chakamlit)	1	
- Post-harvest Facility(Rice Bank)	Equipped with prost-harvest facilty of rice (drying yard, rice mill, paddy and rice storage, etc.):		
(2) Irrigation and Drainage Facilities			
- Water sources	H.Tay-un, and H.Thon		
- Proposed cropping pattern and Irrigation area (net	Paddy - Paddy : 70 ha, Paddy - Upland Crops : 80 ha		
	Rainy Season Paddy : 180 ha	330 ha	
- Diversion weir	H.Tay-Un, Dam No.1 Earthfill dam	1 place	
	H.Thon, Dam No.2 Earthfill dam	1 place	
	Dam No.3 Earthfill dam	1 place	
- Earthfill dam	V1 = 21,000 m3, V2 = 49,000 m3, V3 = 10,000 m3	3 nos.	
- Reservoir	Effective storage capacity = - m3		
	Effective storage capacity = 158,000 m3		
	Effective storage capacity = 65,000 m3		
- Regulation pond		1 place	
- Design discharge	Dam No.1	0.489 m3/sec.	
	Dam No.2	0.382 m3/sec.	
- Main irrigation canals	Concrete lining canal, 2 canals	2.5 km	
- Secondary irrigation canals	Concrete lining canal, 3 canals	2.3 km	
- Secondary drainage canals	Earth canal, 1 canal	0.1 km	
- Inspection roads	Effective width = 3.0 m, Gravel pavement	5.0 km	
(3) Rural Infrastructure Facilities			
- Water supply system	Water system with electric pump	4 systems	
Water source	Houay Thon and Houay Tit		
Water demand		1.14 lit./sec	
Pumping intake pipe		750 m	
Filter tank		4 nos.	
Distribution tank		4 nos.	
Communal tap		25 nos.	
Electric pump		4 nos.	
- Village Road :	Penetration macadam pavement	none	
	Gravel pavement	1.7 km	
- School	Class-III primary school (4 rooms, 168 m2)	2 nos.	
	Class-V primary school (6 rooms, 336 m2)	none	
- Village community hall	Type-A (3 rooms, 168 m2)	2 nos.	
	Type-B (3 rooms, 252 m2)	1 no.	
	Type-C (4 rooms, 336 m2)	none	

Table 2.5 (6/8) Summary of the Schemes - Vegetable Wholesale Marketing Facilities -

General Description	
Scheme Name	Establishment of Vegetable Wholesale Marketing Facility
Location and Altitude	Center of Pakxong Town
No. of Target Villages	Whole villages of vegetable production area around Pakxong in Boloven Plateau

Development Plan			
Item	Description	Quantity	Remarks
Wholesale market facility		1	
- Working space	30 x 20 m of Concrete floor and plat form type about 80 cm higher	2	
- Storage	100m2 of concrete type	1	
- Loading space	along the working space, 30 x 10m of asphaltic pavement	4	
- Packing space	800m2 of gravel pavement	1	
- Office space	100m2 for marketing organization including conference room	1	
	40m2 for selling shop of farm inputs	1	
	6 rooms of 3 x 4m for buyers	2	
- Transportation	5ton -truck	1	
- Communication equipment	Radio communication system, facsimile machine (in Pakse)	1 set	
- Computer, Printer, Other office equipment		1 set	

Table 2.5 (7/8) Summary of the Schemes - Highland Vegetable Trial and Demonstration Station -

General Description	
Scheme Name	Establishment of Highland Vegetable Trial and Demonstration Station
Location and Altitude	Ban Lak 45, 1200 m
No. of Target Villages	Whole villages of vegetable production area around Pakxong in Boloven Plateau

Development Plan			
Item	Description	Quantity	Remarks
Highland Vegetable Trial and Demonstration Station	Introduction, trial and demonstration of cultivation techniques of highland vegetables, trials for processing of tea, extension through training of officers and farmers	50 ha	
- Trial Farm			
- Office space			
- Office equipment			
- Storage			
- Farm machinery, equipment and tools			
- Simple Laboratory with equipment			

Table 2.5 (8/8) Summary of the Schemes - Agricultural Extension Services -

General Description	
Scheme Name	Strengthening of Agricultural Extension Services
Location and Altitude	Pakxong District, Salavan District, Laongam District and Thateng District
No. of Target Villages	

Development Plan			
Item	Description	Quantity	Remarks
Agricultural Extension Services			4 Districts
- Office Equipment	Supply of copy machine,	4 No.	
- Extension materials and equipment	Audio visual aid and materials, training equipment	LS	
- Transportation	2WD-pickups, mortar cycles	LS	
- Office & Storage	Establishment of office space in provincial office		

Table 2.6 The Project Cost

Unit: US$

	Description	Foreign Currency	Local Currency	Total
1	Construction Cost			
	(1) Preparatory Work	240,000	103,000	343,000
	(2) Upper Champi Scheme			
	a) Agricultural Development Works	2,830,000	1,213,000	4,043,000
	b) Rural Infrastructure Works	1,186,000	509,000	1,695,000
	(Sub-Total)	4,016,000	1,722,000	5,738,000
	(3) Upper Tapoung Scheme			
	a) Agricultural Development Works	798,000	342,000	1,140,000
	b) Rural Infrastructure Works	1,249,000	536,000	1,785,000
	(Sub-Total)	2,047,000	878,000	2,925,000
	(4) Upper Kapheu Scheme			
	a) Agricultural Development Works	2,604,000	1,116,000	3,720,000
	b) Rural Infrastructure Works	1,085,000	465,000	1,550,000
	(Sub-Total)	3,689,000	1,581,000	5,270,000
	(5) Lower Xe Set Scheme			
	a) Agricultural Development Works	6,157,000	2,639,000	8,796,000
	b) Rural Infrastructure Works	1,005,000	432,000	1,437,000
	(Sub-Total)	7,163,000	3,070,000	10,233,000
	(6) Upper Tay-Un Scheme			
	a) Agricultural Development Works	1,526,000	655,000	2,181,000
	b) Rural Infrastructure Works	379,000	163,000	542,000
	(Sub-Total)	1,906,000	817,000	2,723,000
	Total [(1) to (6)]	19,062,000	8,170,000	27,232,000
2	On-farm Development Cost			
	(1) Upper Champi Scheme	380,000	163,000	543,000
	(2) Upper Tapoung Scheme	49,000	21,000	70,000
	(3) Upper Kapheu Scheme	571,000	246,000	817,000
	(4) Lower Xe Set Scheme	728,000	312,000	1,040,000
	(5) Upper Tay-Un Scheme	229,000	99,000	328,000
	Total	1,957,000	841,000	2,798,000
3	Sub-Total (1 - 2)	21,021,000	9,009,000	30,030,000
4	Land Acquisition and Compensation		14,000	14,000
5	Engineering and Administration cost (3x10%)	2,102,000	900,000	3,002,000
6	O & M Equipment	960,000		960,000
7	Highland Vegetable Trial ans Demonstration Station	1,320,000	304,000	1,624,000
8	Marketing facilities	777,000	205,000	982,000
9	Physical Contingencies (3x10%)	2,102,000	900,000	3,002,000
10	Gramd Total	28,282,000	11,332,000	39,614,000

Table 2.7 Economic Cost and Benefit Stream of Project (1/2)

(1) Upper Chamo (Unit : '000 US$)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	1,258	0		1,258	0	-1,258
2	3,674	0		3,674	110	-3,564
3	898	0		898	110	-789
4	52	0		52	219	167
5		0		0	329	329
6		0		0	438	438
7		7		7	548	541
8		15		15	548	533
9		22		22	548	526
10		30		30	548	518
11		37		37	548	511
12		45		45	548	503
13		52		52	548	496
14		52		52	548	496
15		52		52	548	496
16		52		52	548	496
17		52		52	548	496
18		52		52	548	496
19		52		52	548	496
20		52		52	548	496
21		52		52	548	496
22		52		52	548	496
23		52	262	314	548	234
24		52		52	548	496
25		52		52	548	496
26		52		52	548	496
27		52		52	548	496
28		52	437	489	548	59
29		52		52	548	496
30		52		52	548	496
31		52		52	548	496
32		52		52	548	496
33		52		52	548	496
34		52		52	548	496
35		52		52	548	496
36		52		52	548	496
37		52		52	548	496
38		52		52	548	496
39		52		52	548	496
40		52		52	548	496
41		52		52	548	496
42		52		52	548	496
43		52	262	314	548	234
44		52		52	548	496
45		52		52	548	496
46		52		52	548	496
47		52		52	548	496
48		52		52	548	496
49		52		52	548	496
50		52		52	548	496
51		52		52	548	496
52		52		52	548	496
53		52	437	489	548	59
54		52		52	548	496
	5,881	2,334	1,399	9,614	27,519	17,891
	7.4%					

(2) Upper Tropng (Unit : '000 US$)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	316	0		316	0	-316
2	1,092	0		1,092	37	-1,055
3	79	0		79	56	-23
4	10	0		10	112	102
5		0		0	187	187
6		0		0	187	187
7		3		3	187	186
8		6		6	187	181
9		9		9	187	178
10		12		12	187	175
11		15		15	187	172
12		18		18	187	169
13		21		21	187	166
14		21		21	187	166
15		21		21	187	166
16		21		21	187	166
17		21		21	187	166
18		21		21	187	166
19		21		21	187	166
20		21		21	187	166
21		21		21	187	166
22		21	218	239	187	-52
23		21		21	187	166
24		21		21	187	166
25		21		21	187	166
26		21		21	187	166
27		21	109	130	187	57
28		21		21	187	166
29		21		21	187	166
30		21		21	187	166
31		21		21	187	166
32		21		21	187	166
33		21		21	187	166
34		21		21	187	166
35		21		21	187	166
36		21		21	187	166
37		21		21	187	166
38		21		21	187	166
39		21		21	187	166
40		21		21	187	166
41		21		21	187	166
42		21	218	239	187	-52
43		21		21	187	166
44		21		21	187	166
45		21		21	187	166
46		21		21	187	166
47		21		21	187	166
48		21		21	187	166
49		21		21	187	166
50		21		21	187	166
51		21		21	187	166
52		21	109	130	187	57
53		21		21	187	166
54		21		21	187	166
	1,497	969	654	3,101	9,556	6,455
	10.2%					

(3) Upper Kapheu (Unit : '000 US$)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	1,298	0		1,298	0	-1,298
2	2,673	0		2,673	53	-2,621
3	1,966	0		1,966	105	-1,861
4	63	0		63	210	148
5		0		0	316	316
6		0		0	421	421
7		6		6	526	520
8		13		13	526	513
9		19		19	526	507
10		26		26	526	500
11		32		32	526	494
12		39		39	526	487
13		45		45	526	481
14		45		45	526	481
15		45		45	526	481
16		45		45	526	481
17		45		45	526	481
18		45		45	526	481
19		45		45	526	481
20		45		45	526	481
21		45		45	526	481
22		45		45	526	481
23		45	236	281	526	245
24		45		45	526	481
25		45		45	526	481
26		45		45	526	481
27		45		45	526	481
28		45	456	501	526	25
29		45		45	526	481
30		45		45	526	481
31		45		45	526	481
32		45		45	526	481
33		45		45	526	481
34		45		45	526	481
35		45		45	526	481
36		45		45	526	481
37		45		45	526	481
38		45		45	526	481
39		45		45	526	481
40		45		45	526	481
41		45		45	526	481
42		45		45	526	481
43		45	236	281	526	245
44		45		45	526	481
45		45		45	526	481
46		45		45	526	481
47		45		45	526	481
48		45		45	526	481
49		45		45	526	481
50		45		45	526	481
51		45		45	526	481
52		45		45	526	481
53		45	456	501	526	25
54		45		45	526	481
	6,000	2,023	1,384	9,407	26,353	16,946
	6.9%					

(4) Lower Xe Set (Unit : '000 US$)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	304	0		304	0	-304
2	2,344	0		2,344	0	-2,344
3	5,861	0		5,861	182	-5,679
4	3,294	0		3,294	273	-3,021
5		0		0	546	546
6		0		0	910	910
7		0		0	910	910
8		15		15	910	895
9		29		29	910	881
10		44		44	910	866
11		58		58	910	852
12		73		73	910	837
13		88		88	910	822
14		102		102	910	808
15		102		102	910	808
16		102		102	910	808
17		102		102	910	808
18		102		102	910	808
19		102		102	910	808
20		102		102	910	808
21		102		102	910	808
22		102		102	910	808
23		102	244	346	910	564
24		102		102	910	808
25		102		102	910	808
26		102		102	910	808
27		102		102	910	808
28		102	502	604	910	306
29		102		102	910	808
30		102		102	910	808
31		102		102	910	808
32		102		102	910	808
33		102		102	910	808
34		102		102	910	808
35		102		102	910	808
36		102		102	910	808
37		102		102	910	808
38		102		102	910	808
39		102		102	910	808
40		102		102	910	808
41		102		102	910	808
42		102		102	910	808
43		102	244	346	910	564
44		102		102	910	808
45		102		102	910	808
46		102		102	910	808
47		102		102	910	808
48		102		102	910	808
49		102		102	910	808
50		102		102	910	808
51		102		102	910	808
52		102		102	910	808
53		102	502	604	910	306
54		102		102	910	808
	11,804	4,497	1,492	17,793	45,591	27,798
	9.1%					

(5) Upper Tuy-Un (Unit : '000 US$)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	651	0		651	0	-651
2	1,987	0		1,987	48	-1,939
3	433	0		433	72	-362
4	21	0		21	143	122
5		0		0	239	239
6		0		0	239	239
7		5		5	239	234
8		9		9	239	230
9		14		14	239	225
10		18		18	239	221
11		23		23	239	216
12		27		27	239	212
13		32		32	239	207
14		32		32	239	207
15		32		32	239	207
16		32		32	239	207
17		32		32	239	207
18		32		32	239	207
19		32		32	239	207
20		32		32	239	207
21		32		32	239	207
22		32		32	239	207
23		32	218	250	239	-11
24		32		32	239	207
25		32		32	239	207
26		32		32	239	207
27		32		32	239	207
28		32	167	199	239	40
29		32		32	239	207
30		32		32	239	207
31		32		32	239	207
32		32		32	239	207
33		32		32	239	207
34		32		32	239	207
35		32		32	239	207
36		32		32	239	207
37		32		32	239	207
38		32		32	239	207
39		32		32	239	207
40		32		32	239	207
41		32		32	239	207
42		32		32	239	207
43		32	218	250	239	-11
44		32		32	239	207
45		32		32	239	207
46		32		32	239	207
47		32		32	239	207
48		32		32	239	207
49		32		32	239	207
50		32		32	239	207
51		32		32	239	207
52		32		32	239	207
53		32	167	199	239	40
54		32		32	239	207
	3,093	1,441	770	5,304	12,213	6,909
	6.1%					

Table 2.7 Economic Cost and Benefit Stram of Project (2/2)

(6) Whole 5 Schemes (Unit:US$1000)

Year	Cost				Irrigation Benefit	Balance
	Construction	O & M	Replacement	Total		
1	2,821			2,821		-2,821
2	7,105			7,105	138	-6,968
3	8,708			8,708	343	-8,365
4	6,202			6,202	758	-5,445
5	3,441			3,441	1,234	-2,207
6		3		3	1,722	1,719
7		17		17	2,300	2,283
8		38		38	2,410	2,372
9		74		74	2,410	2,336
10		111		111	2,410	2,299
11		147		147	2,410	2,263
12		183		183	2,410	2,227
13		216		216	2,410	2,194
14		238		238	2,410	2,172
15		252		252	2,410	2,158
16		252		252	2,410	2,158
17		252		252	2,410	2,158
18		252		252	2,410	2,158
19		252		252	2,410	2,158
20		252		252	2,410	2,158
21		252		252	2,410	2,158
22		252	218	470	2,410	1,940
23		252	454	706	2,410	1,704
24		252	262	514	2,410	1,896
25		252	244	496	2,410	1,914
26		252		252	2,410	2,158
27		252	109	361	2,410	2,049
28		252	623	875	2,410	1,535
29		252	437	689	2,410	1,721
30		252	502	754	2,410	1,656
31		252		252	2,410	2,158
32		252		252	2,410	2,158
33		252		252	2,410	2,158
34		252		252	2,410	2,158
35		252		252	2,410	2,158
36		252		252	2,410	2,158
37		252		252	2,410	2,158
38		252		252	2,410	2,158
39		252		252	2,410	2,158
40		252		252	2,410	2,158
41		252		252	2,410	2,158
42		252	218	470	2,410	1,940
43		252	454	706	2,410	1,704
44		252	262	514	2,410	1,896
45		252	244	496	2,410	1,914
46		252		252	2,410	2,158
47		252		252	2,410	2,158
48		252		252	2,410	2,158
49		252		252	2,410	2,158
50		252		252	2,410	2,158
51		252		252	2,410	2,158
52		252	109	361	2,410	2,049
53		252	623	875	2,410	1,535
54		252	437	689	2,410	1,721
55		252		252	2,410	2,158
	28,277	11,368	5,196	44,841	122,174	77,333

EIRR = 6.9%

Table 2.8 Future Farm Budget of Each Farm Type

Priority Area	Upper Champi		Upper Tapoung			Upper Kapheu
Farm Type	Coffee	Coffee+Tea	Coffee+Vegetables	Coffee+Vegetables	Coffee+Vegetables	Coffee+Vegetables
Irrigated Field	Coffee : 2.3 ha	Coffee : 2.3 ha	Vege.- Up.C : 0.3 ha	Vege.-Up.C : 0.3 ha	Vege.-Up.C : 0.3 ha	Coffee : 1.6 ha
(Cropping Pattern)	- -	Tea : 1 ha	- -	- -	- -	Low.R.-Up.C : 0 ha
Non-irrigated fields	- -	- -	Coffee 2 ha	Coffee 3 ha	Coffee 3 ha	
	- -	- -		Vegetables 0 ha	Upland rice 0 ha	
No. of Household	40 HH.	186 HH.	76 HH.	160 HH.	26 HH.	431 HH.
1. Gross Income	(2,714)	(2,627)	(1,256)	(1,815)	(1,556)	(1,856)
1-1 Farm Income	2,714	2,627	1,256	1,815	1,556	1,856
1-2 Non-farm Income	0	0	0	0	0	0
2. Production Cost	600	594	179	351	276	308
3. Net Income	2,113	2,033	1,077	1,464	1,280	1,548
4. Living Expenses	(1,443)	(1,443)	(958)	(1,075)	(1,075)	(1,443)
4-1 Food Items	820	820	623	623	623	820
4-2 Non-food Items	623	623	335	452	452	623
5. Net Reserve	670	590	119	390	206	105

Remarks : Future living expense level is classified into three type as satisfy, average in national level, and average in rural level, based on the data from Agricultural Sector Memorandum Report (IBRD, 1994)
Futre coffee price is applied for the estimation.

Priority Area	Lower Xe Set		Upper Tay-Ua			
Farm Type	Lowland Rie	Lowland Rie	Coffee+Lowland R	Coffee+Lowland R	Lowland R	Lowland R
Irrigated Field	Low.R.-Low.R : 2.5 ha	Low.R.-Up.C. : 2.5 ha	Low.R.-Low.R : 1.2 ha	Low.R.-Up.C. 1.2 ha	Low.R.-Up.C. 2.5 ha	Low.R.-Fallow : 2.5 ha
(Cropping Pattern)	- -		- -	- -	- -	- -
Non-irrigated fields	- -	- -	Coffee 1.3 ha	Coffee 0.8 ha	- - ha	- - ha
	- -	- -			- - ha	- - ha
No. of Household	80 HH.	320 HH.	17 HH.	48 HH.	29 HH.	71 HH.
1. Gross Income	(3,000)	(3,100)	(1,640)	(1,611)	(3,100)	(1,500)
1-1 Farm Income	3,000	3,100	1,640	1,611	3,100	1,500
1-2 Non-farm Income	0	0	0	0	0	0
2. Production Cost	1,105	1,030	441	451	925	448
3. Net Income	1,895	2,070	1,199	1,160	2,175	1,052
4. Living Expenses	(1,443)	(1,443)	(1,075)	(1,075)	(1,443)	(958)
4-1 Food Items	820	820	623	623	820	623
4-2 Non-food Items	623	623	452	452	623	335
5. Net Reserve	452	627	125	86	732	95

Remarks : Future living expense level is classified into three type as satisfy, average in national level, and average in rural level, based on the data from Agricultural Sector Memorandum Report (IBRD, 1994)
Futre coffee price is applied for the estimation.

Figures

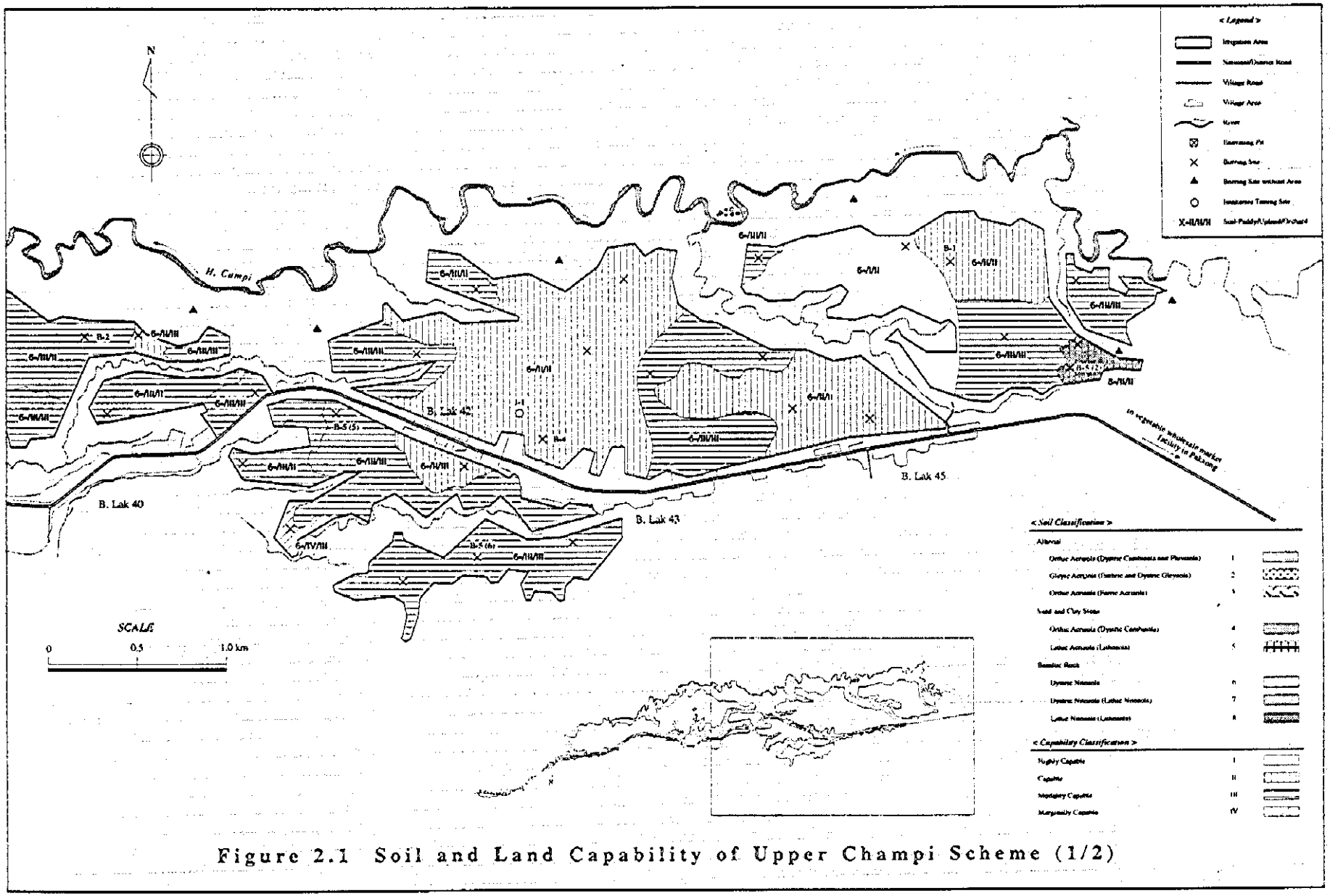


Figure 2.1 Soil and Land Capability of Upper Champi Scheme (1/2)

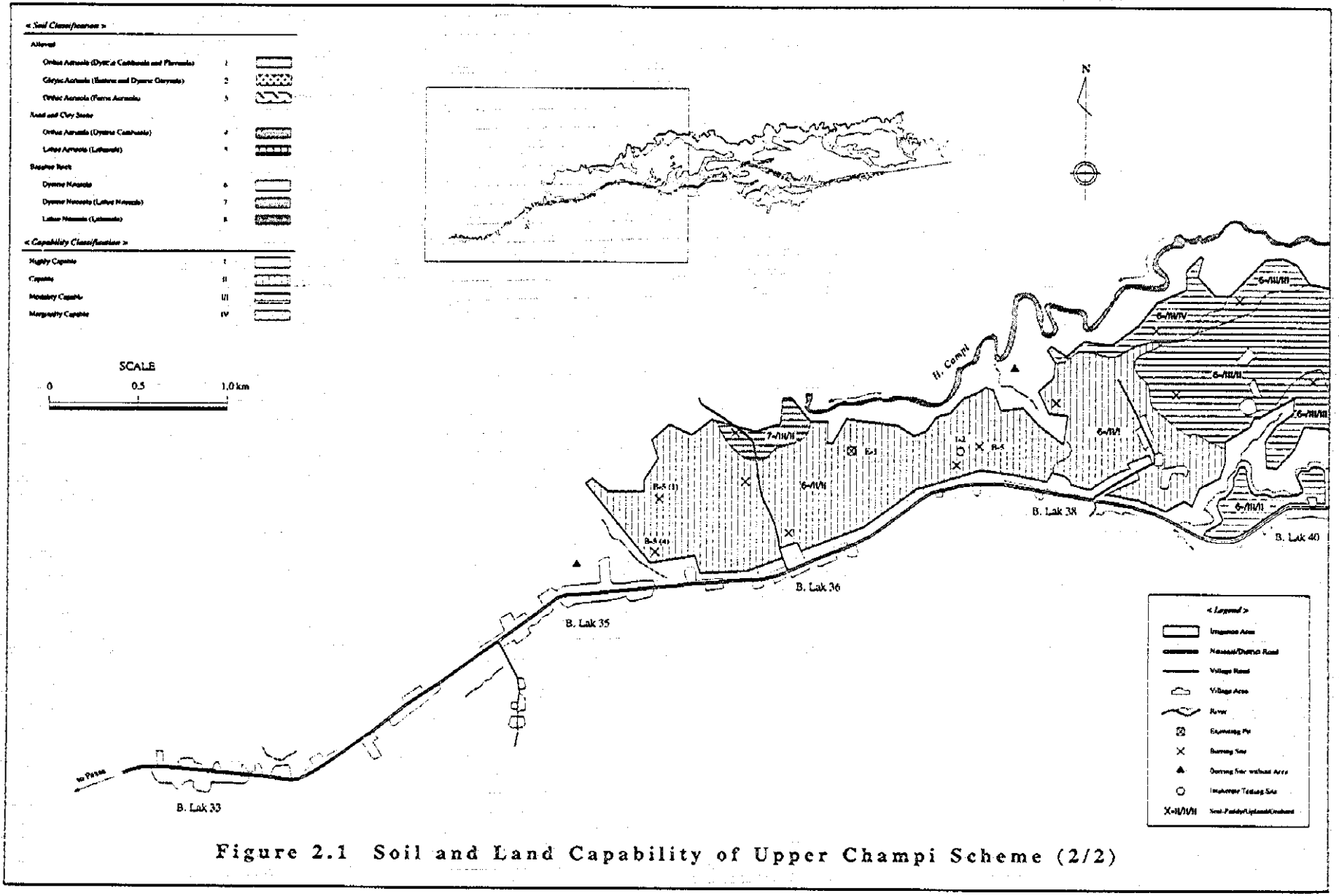


Figure 2.1 Soil and Land Capability of Upper Champi Scheme (2/2)

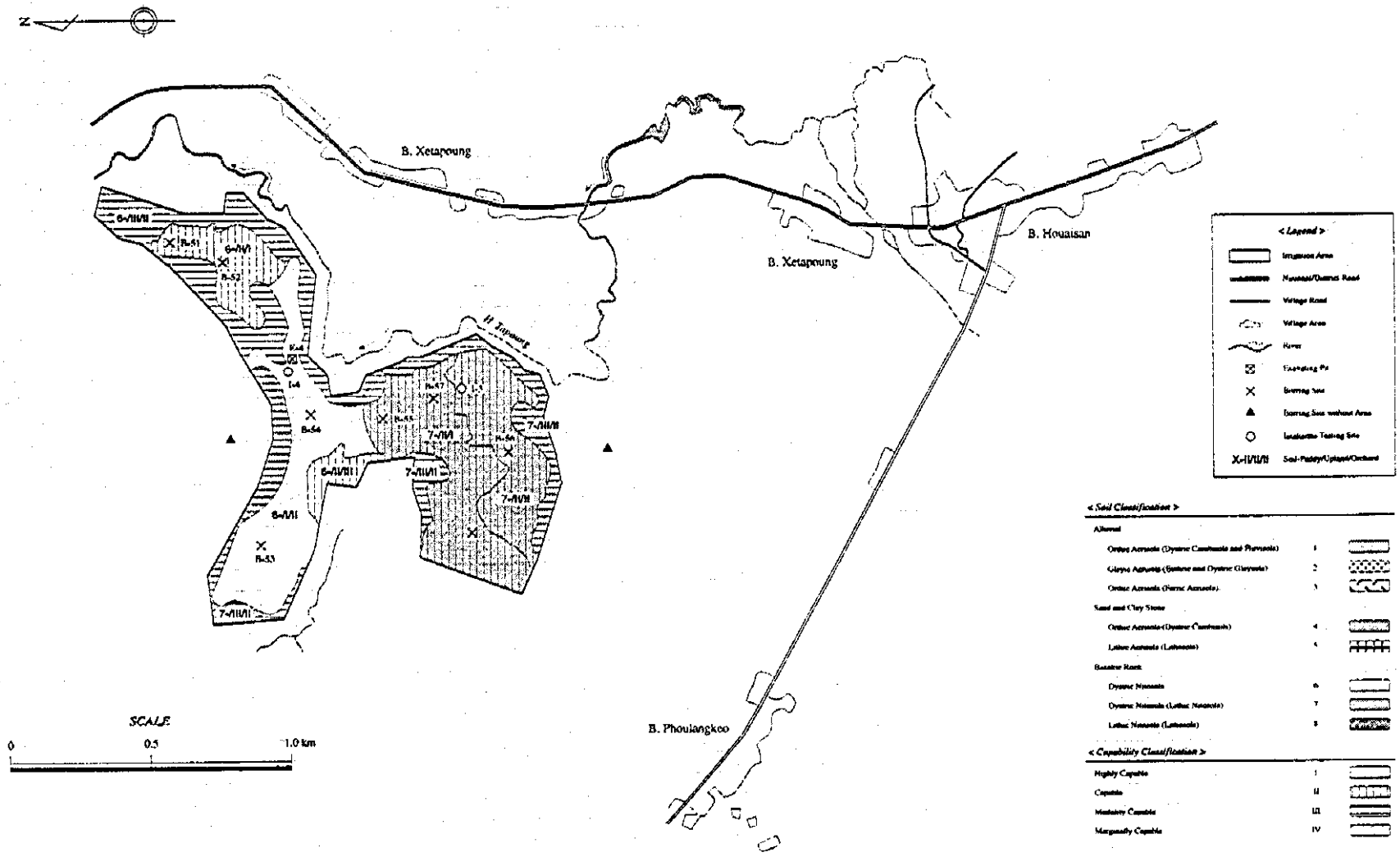


Figure 2.2 Soil and Land Capability of Upper Tapoung Scheme

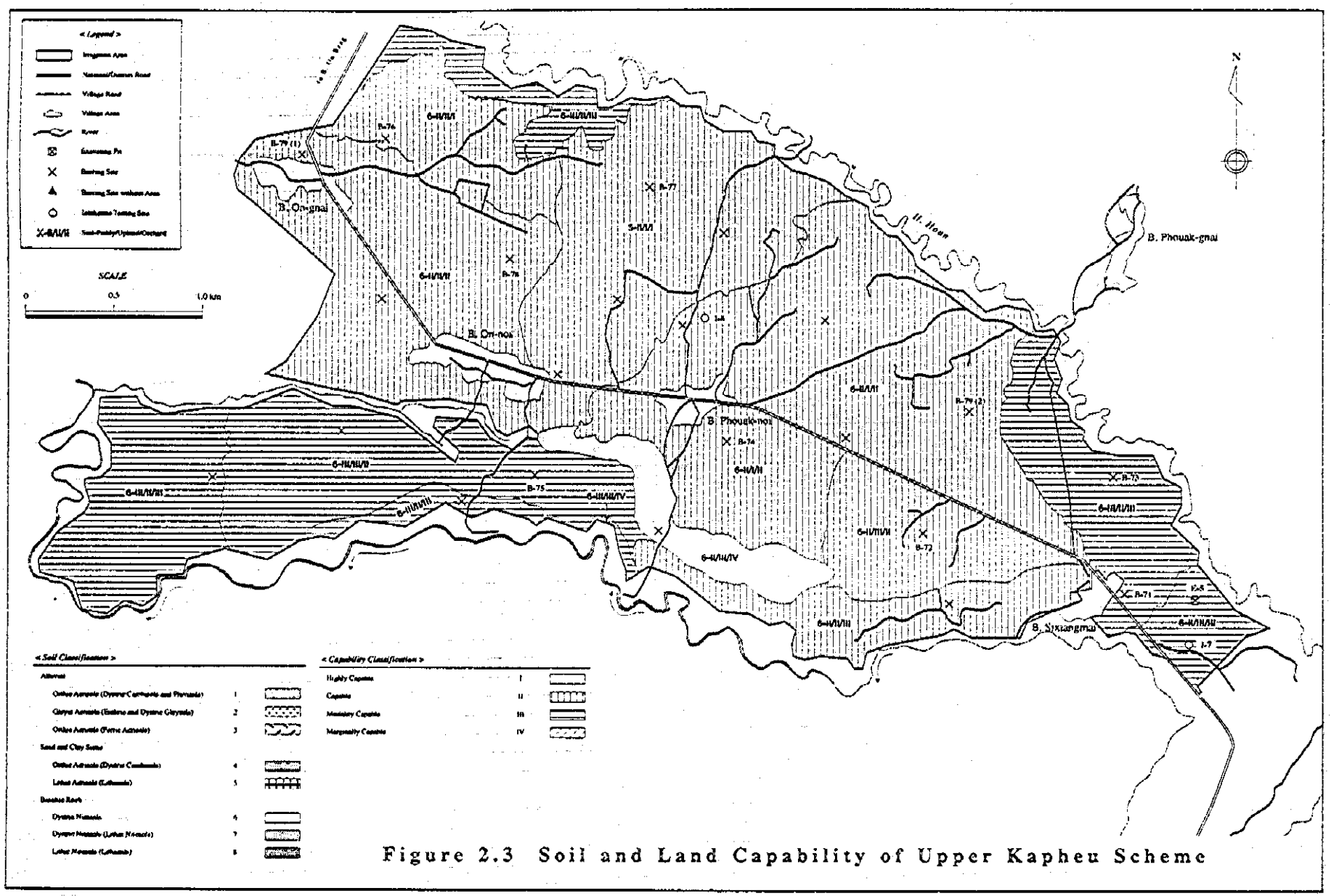
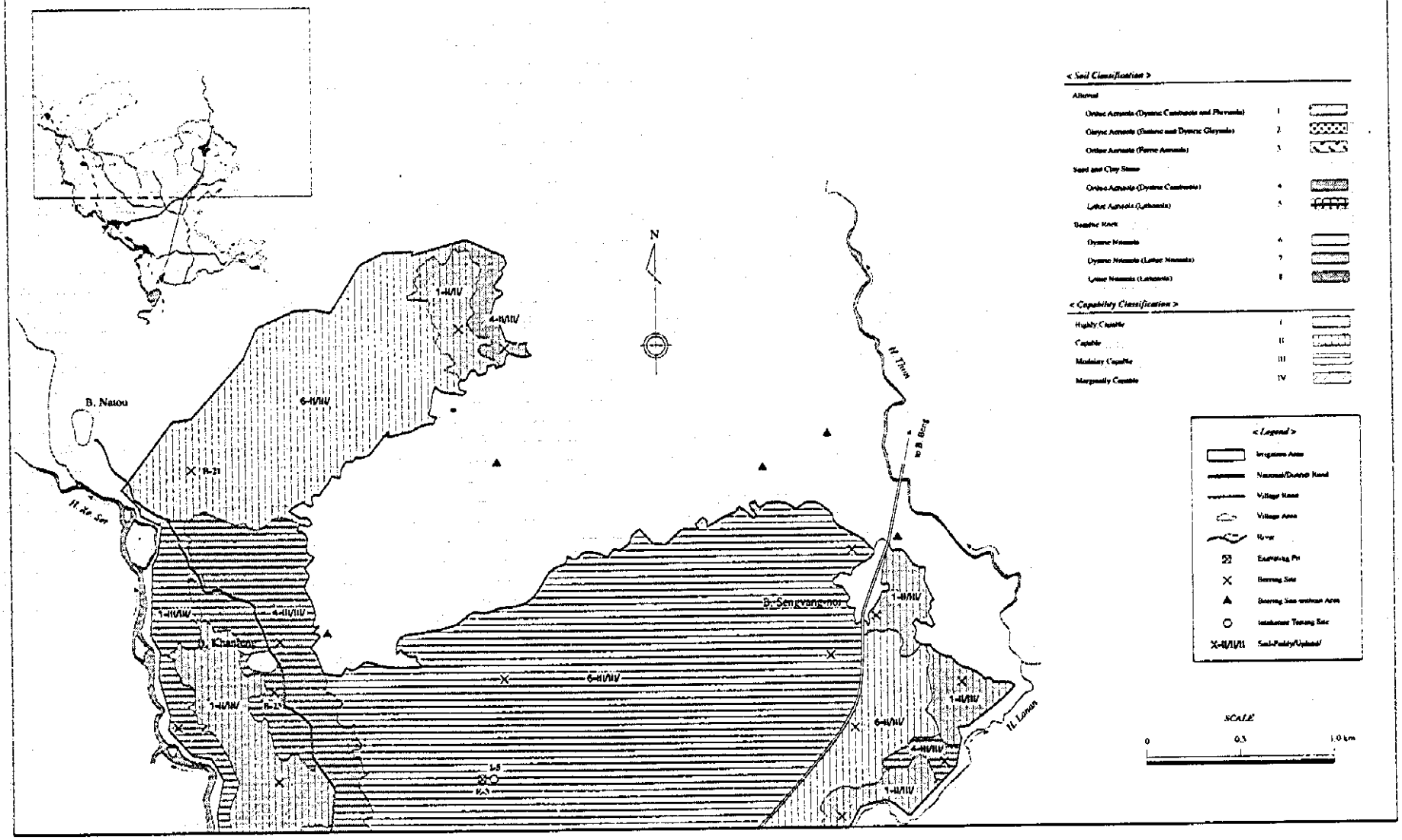


Figure 2.3 Soil and Land Capability of Upper Kapheu Scheme

Figure 2.4 Soil and Land Capability of Lower Xe Set Scheme (1/2)



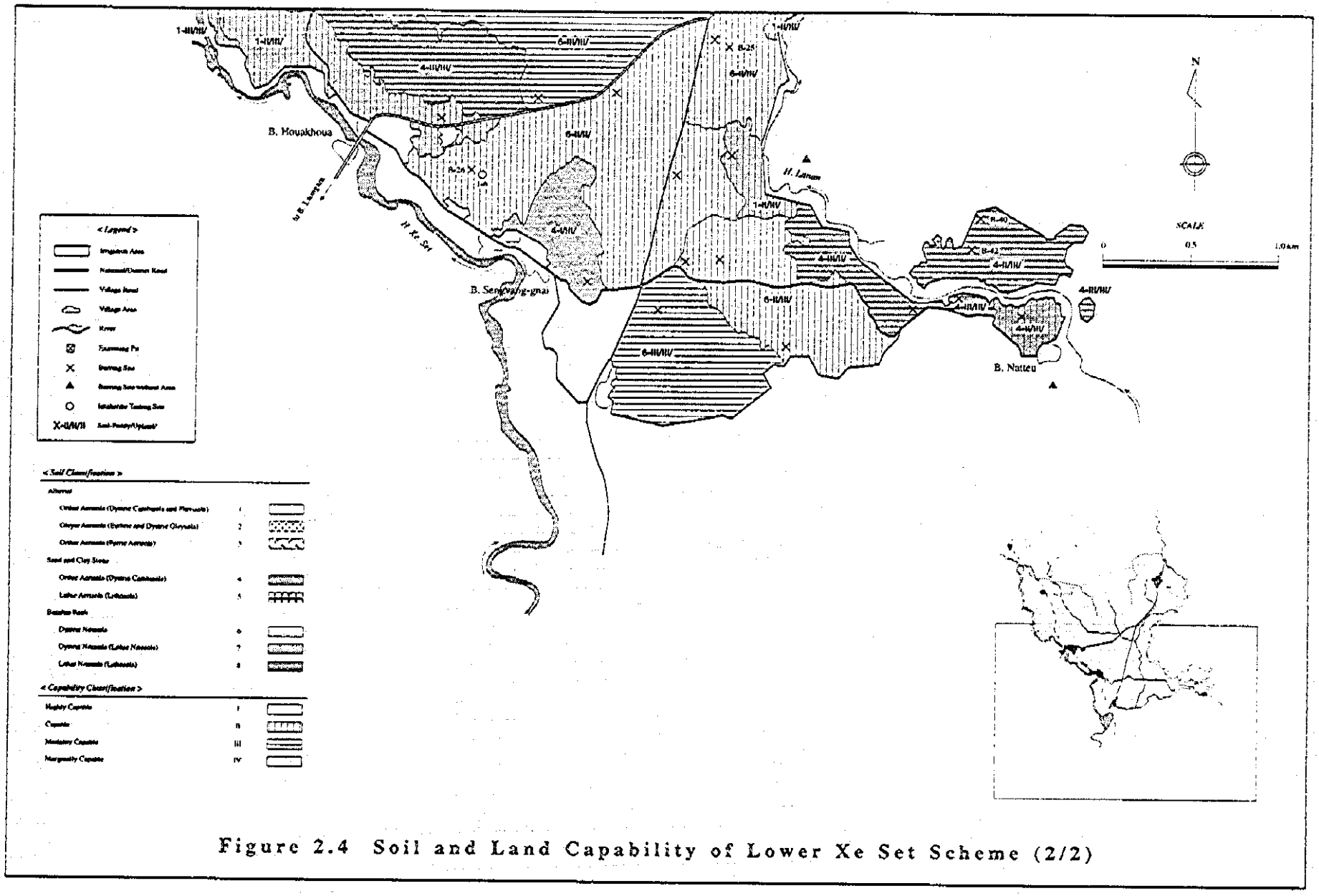


Figure 2.4 Soil and Land Capability of Lower Xe Set Scheme (2/2)

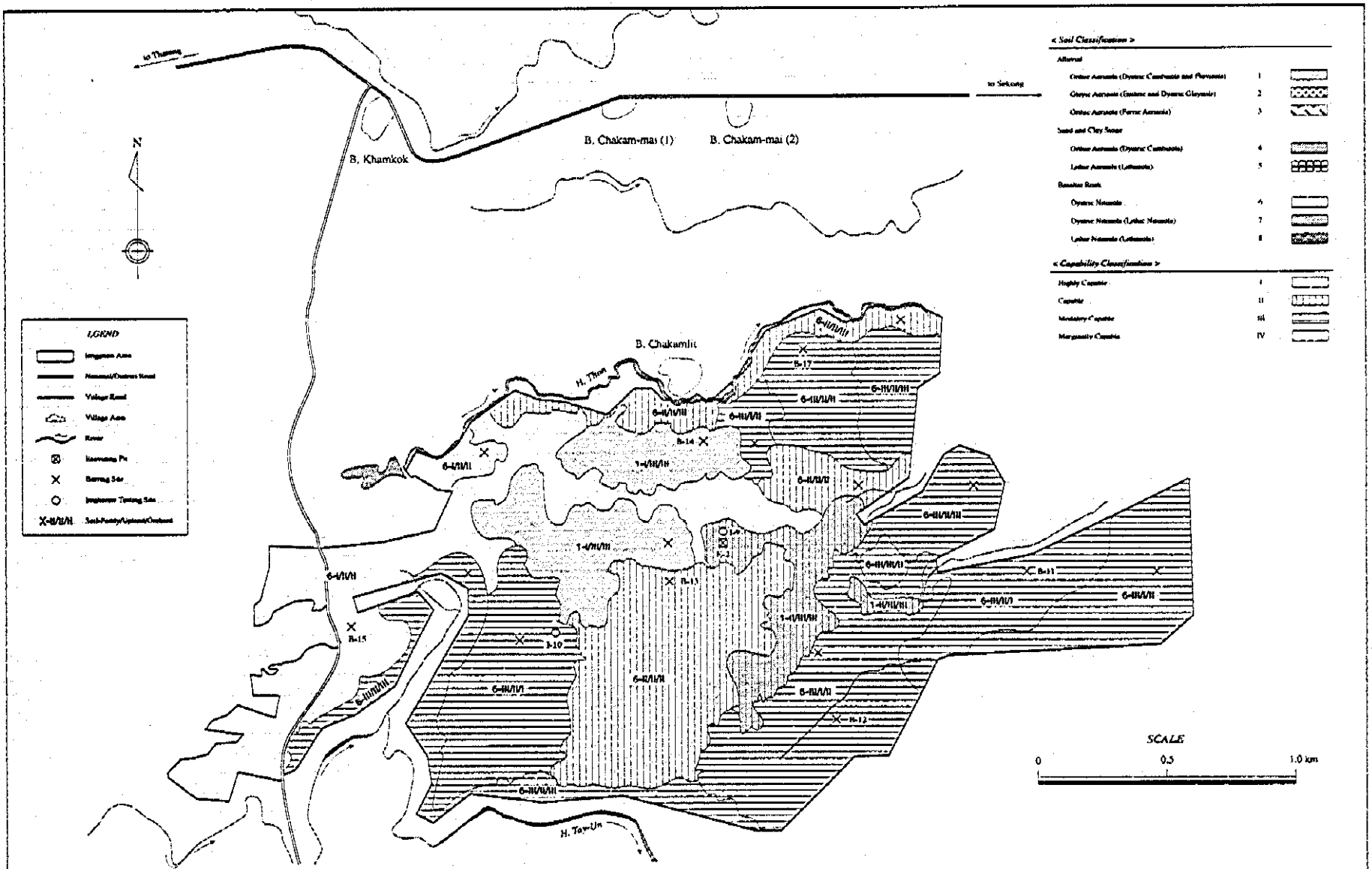


Figure 2.5 Soil and Land Capability of Upper Tay-Un Scheme

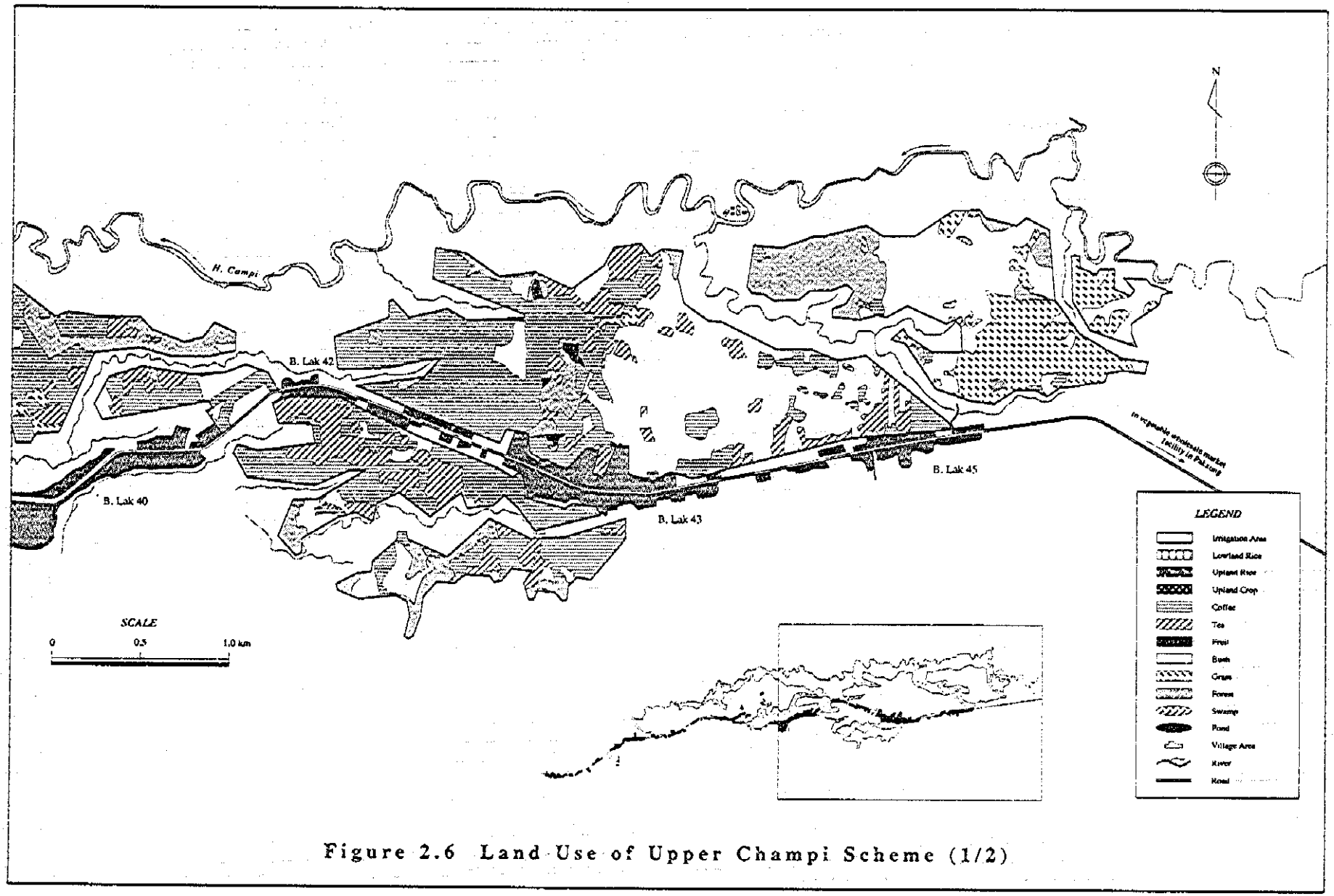


Figure 2.6 Land Use of Upper Champi Scheme (1/2)

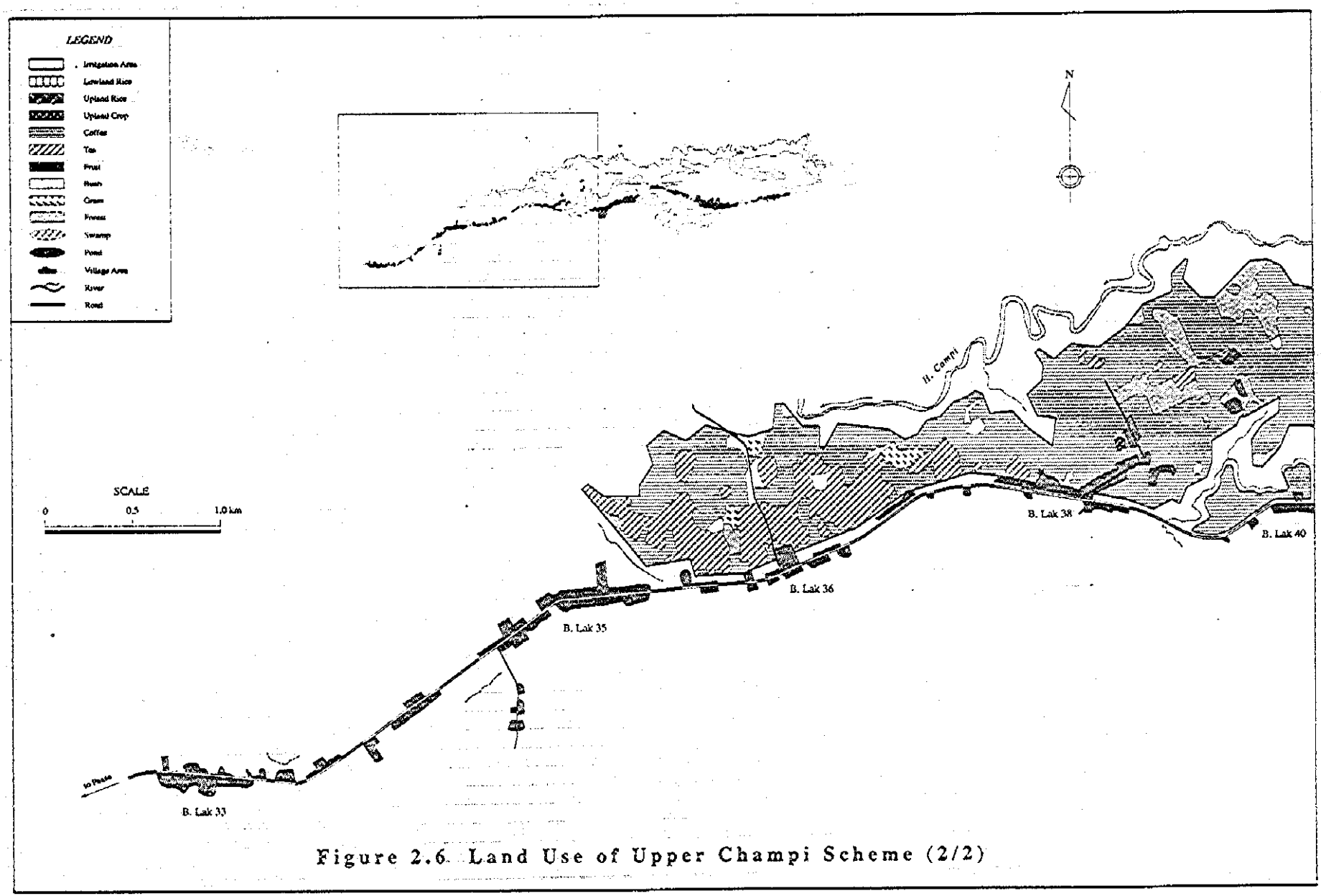


Figure 2.6 Land Use of Upper Champi Scheme (2/2)

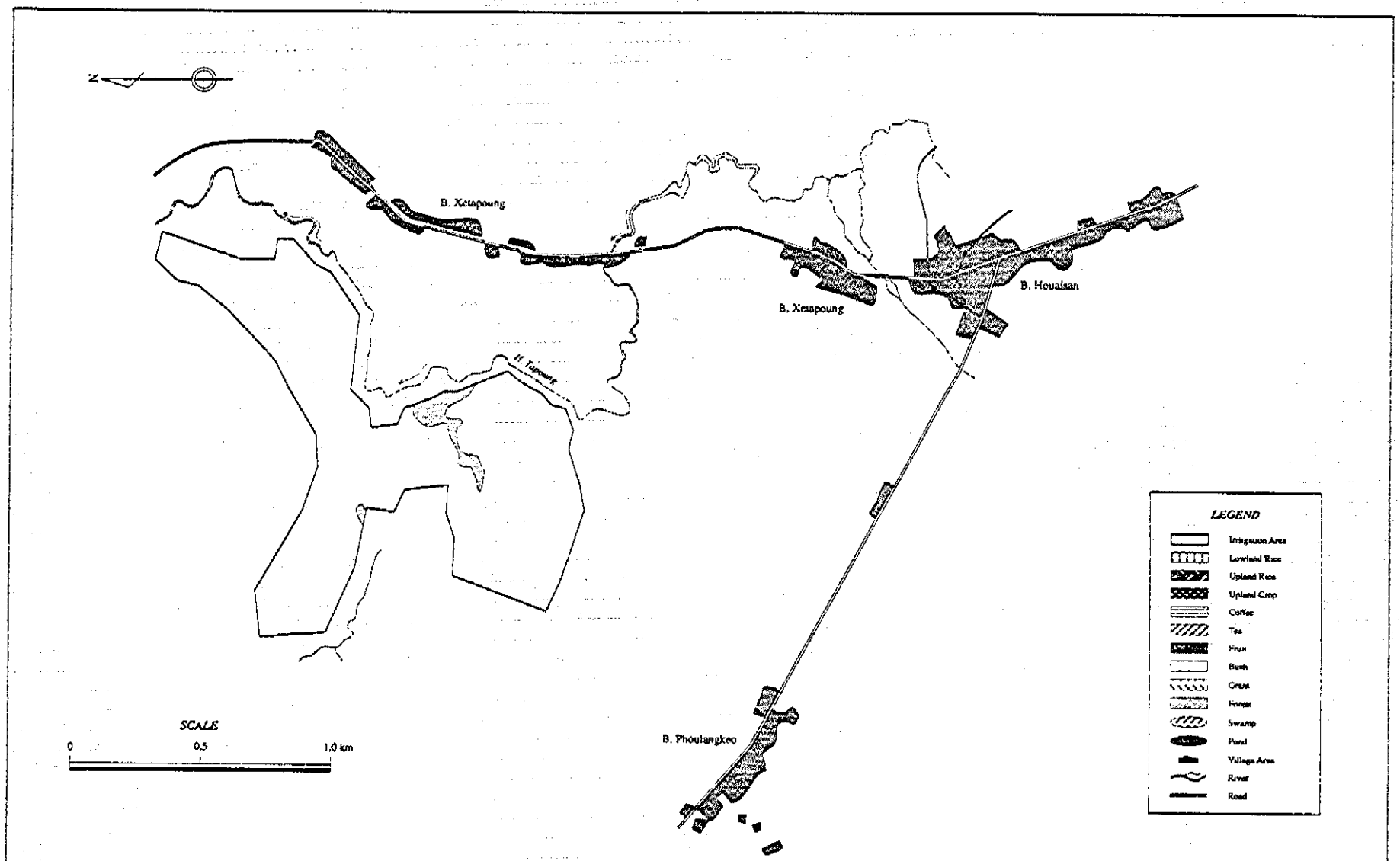
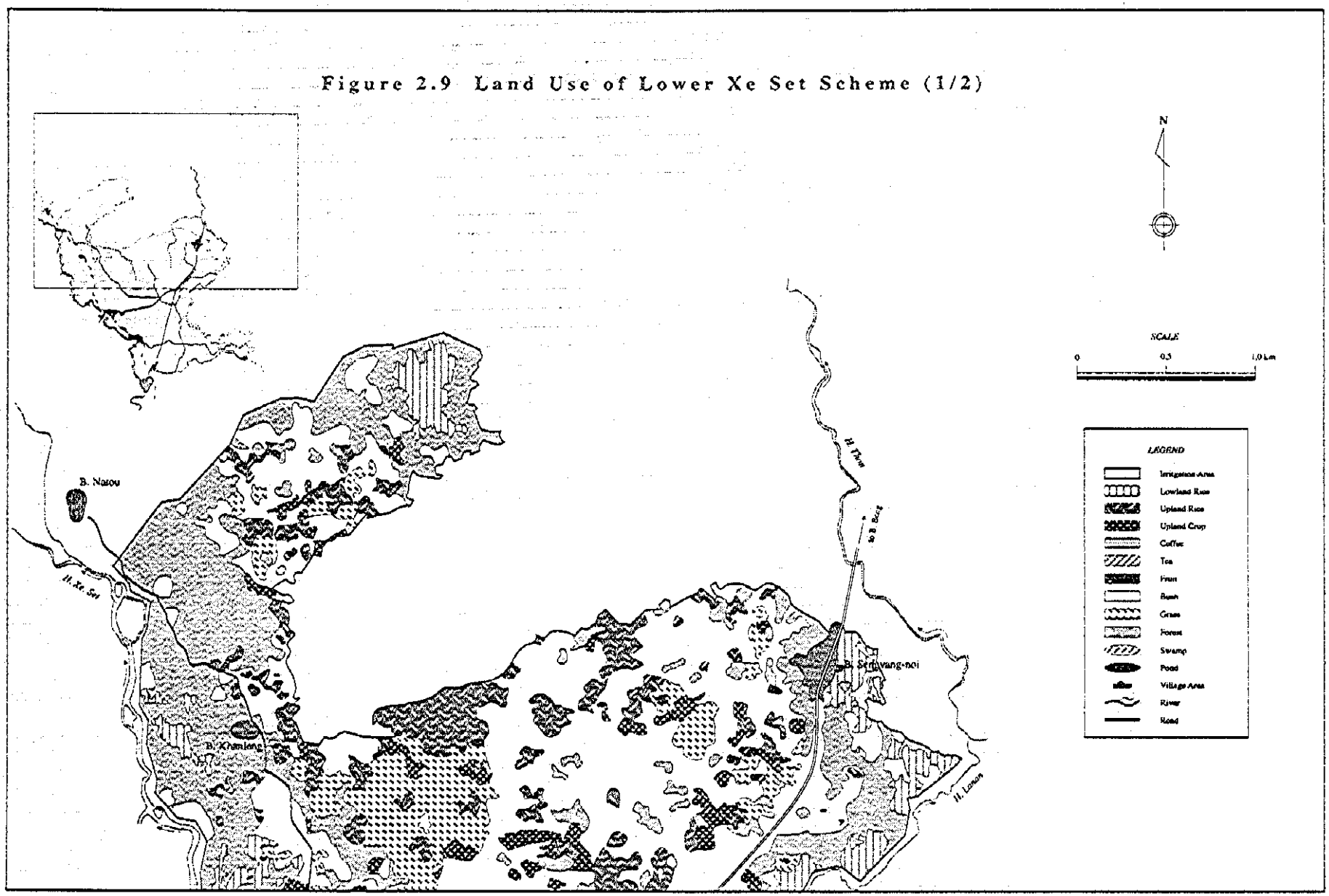


Figure 2.7 Land Use of Upper Tapoung Scheme

Figure 2.8 Land Use of Upper Kapheu Scheme

Figure 2.9 Land Use of Lower Xe Set Scheme (1/2)



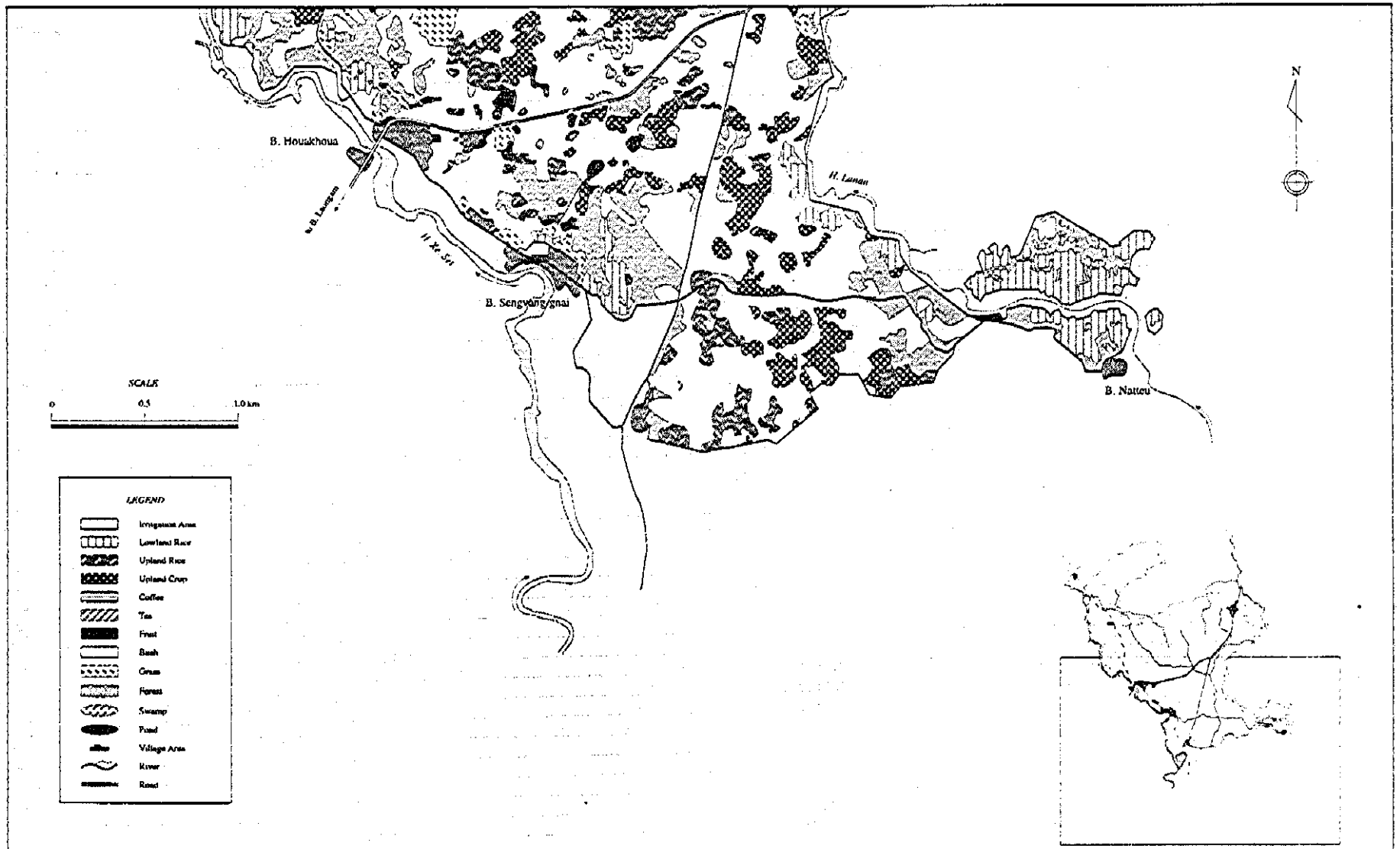


Figure 2.9 Land Use of Lower Xe Set Scheme (2/2)

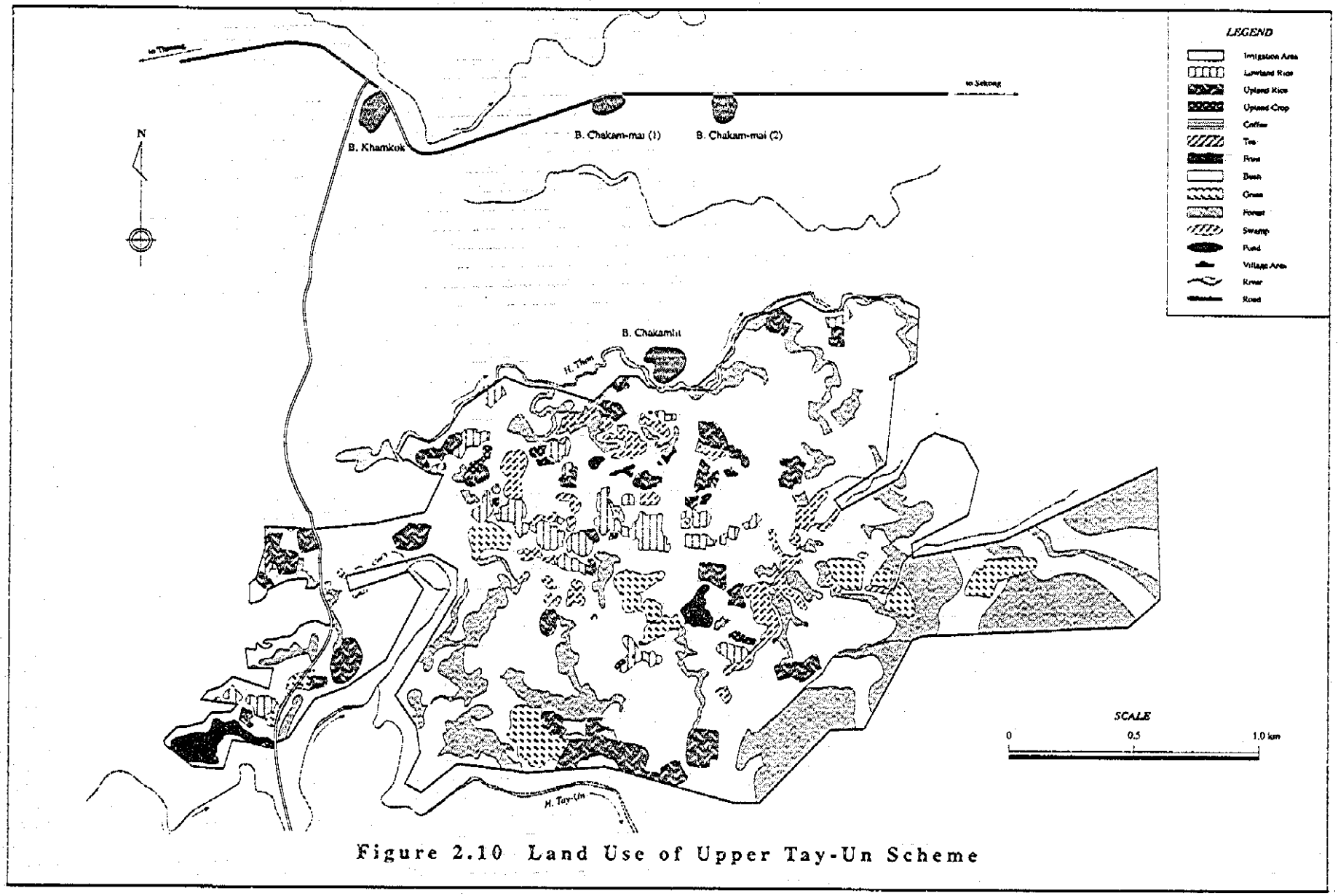


Figure 2.10 Land Use of Upper Tay-Un Scheme

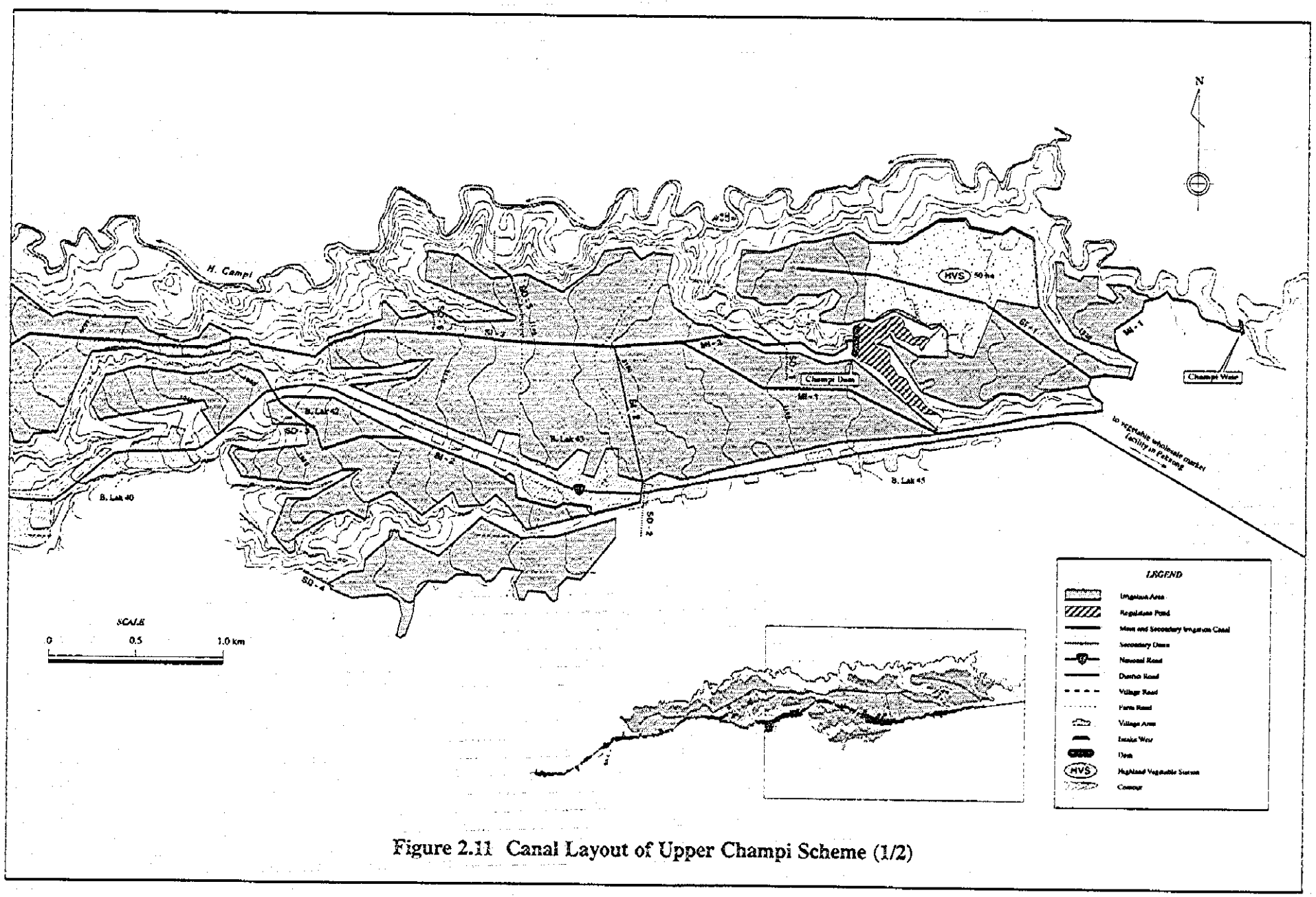


Figure 2.11 Canal Layout of Upper Champi Scheme (1/2)