

3.2.3 Irrigation Water Requirements and Irrigable Areas

The existing irrigation systems which cover 2,662 ha are presently used for supplemental irrigation to wet season rice. Based on the development concept mentioned in Section 3.1, these existing irrigation systems will be developed as rice field. Using the future cropping pattern of rice, therefore, irrigation water requirements for the rice cultivation in both wet and dry seasons are estimated based on the meteorological condition at Oudomxay as shown in Table MF-5. Peak irrigation water requirements for wet season rice and dry season rice are estimated at 0.89 lit/sec/ha in August and 1.42 lit/sec/ha in March, respectively.

As mentioned in ANNEX-MA, the total potential of water resource for irrigation development in the study area is estimated at 21,000 ha of rice field in the wet season, balancing the above mentioned irrigation water requirements and available runoff of the rivers. In the wet season, therefore, all the areas of the existing irrigation systems of 2,662 ha could fully be irrigated. In the dry season, however, the potential water resource could irrigate only about 300 ha of the total irrigable land for cultivation of dry season rice. In the case of upland crops, the land that could be irrigated in the dry season will increase to about 590 ha. A cultivation in the dry season whether rice or upland crop will be determined when the technology of farming practice is established by the activity of the proposed integrated agricultural center.

3.2.4 Proposed Civil Works for Rehabilitation and Upgrading

As already mentioned, there are 135 existing irrigation schemes in the study area. However, field investigation was limited to the schemes with larger command area and good access from the National Road No.2. Data and information on the existing facilities mostly constructed by the farmers groups are also very limited even for very preliminary design of the required rehabilitation and upgrading works. However, overall knowledge of rehabilitation requirements for the schemes are known through the field investigation to enable a studying of scheme models as a basis for further investigation, planning and design required for preparation of concrete rehabilitation programs at the medium and long term development stages. The proposed scheme models are discussed as shown below.

- (1) Scheme Model No.1 with Irrigation Area of more than 100 ha

The existing irrigation schemes for which this scheme model 1 may be applied are very limited in number and located on the main river or their

tributaries. The access to these schemes from the national road is also good in general. The present scheme suffers from the following deficiencies :

- (i) The farmer-built brushwood weir is liable to damage during flood times which results in interruption of stable irrigation supply and requires heavy labour input for repair.
- (ii) The present weir is not capable of diverting available dry season flows for irrigation purpose because of relatively high permeability of the weir body.
- (iii) Lack of intake structure, mostly control gates, leads to excess inflow into the main canal during flood times which results in damage of the canal and its related structures.
- (iv) Both alignment and design of the main canal are not appropriate to serve the whole command area. In addition, the flow distribution is erratic and often affected by cross-drainage flows that may lead to canal breaches due to lack of canal structures.
- (v) Lack of water distribution network including canal structures in the command area makes proper water management difficult, and conflicts happen among water users especially at nursery and transplanting times.

The following civil works will be required to improve the present system for more effective use of available river water in both wet and dry seasons which could increase the productivity of lowland rice field.

- (i) The present brushwood weir should be replaced by a permanent weir of either stone masonry or concrete, depending on the economic feasibility, with appropriate number of intake gates and sand flushing structure. In the design of new weir, consideration should also be paid to full utilization of available potential head in elevation at the weir site so as to expand irrigated area as much as possible.
- (ii) Most of the existing main canals constructed by farmers groups should be re-aligned to command as wide area as possible topographically.

The lined canal by stone masonry may be considered for the larger scheme. Canal structures such as cross drain, offtake, spillway, road culvert, etc. should be constructed, where required. In addition, O&M cum farm road should be provided at least along the main canal.

- (iii) The secondary and tertiary canals should be constructed newly together with the required number of canal structures. These canals will be of earthen type. The design of offtakes on a secondary canal to each tertiary irrigation block should be made, taking into account the size of a Nuay group (usually 3 to 5 ha) to facilitate the farm water management in such an irrigation block.

(2) Scheme Model No. 2 with Irrigation Area between 21 ha and 50 ha

The existing irrigation schemes to be included in this scheme model is 22 in total, and the average command area of a scheme is estimated at about 35 ha. Most of them are located on the tributaries of the main rivers or streams. The intake weirs constructed by water users are usually simple in structure and small in size because of relatively small catchment area. The deficiencies of the present system in this model are the same as those of the system included in the scheme model No.1. Therefore, the required civil works for rehabilitation and upgrading will mostly be the same as those for the scheme model No.1. However, the following should be taken into consideration for the design :

- (i) Stone-masonry type of weir will be more economical in terms of the size of the scheme.
- (ii) The canal network will be more simple than in the scheme model No.1. The tertiary canal may be branched off directly from the main canal because of small command area. All the canals will be of earthen type, and O&M road may not be required. The tertiary canal may be constructed by farmers group, say Nuay unit, under the technical guidance from the project office.

(3) Scheme Model No. 3 with Irrigation Area of less than 20 ha

In the study area, there are 100 schemes which can be included in this scheme model. Particularly, the schemes with a command area of less than 5 ha occupy 60 of the 100 schemes. They have the intake weir with very simple structure located on small streams. The proposed works for rehabilitation and upgrading of these small-scale schemes will be to replace the brushwood weir by a stone-masonry weir. The canal network may be constructed by farmers group under the technical advice and guidance for canal route alignment and construction from the project office.

3.3 Plan of New Irrigation Development

Development plan of new irrigation systems will include three (3) categories such as (i) construction of new irrigation facilities in 13 flat valley bottoms being used for rice cultivation at present ; (ii) development of new irrigation systems including opening of new farm land in 600 ha of currently bush and/or grass land ; and (iii) new irrigation development in gentle sloping hills covering 3,500 ha of land. The preliminary plan of these irrigation development will be as follows, which is prepared mostly by using the available topographic maps on a scale of 1 to 100,000 and 1 to 50,000.

As mentioned in F. 3.1, there exist 13 flat valley bottoms being used for rice cultivation under the rainfed condition in most cases. In fact, farmers in these bottoms are requesting the provincial office the construction of new irrigation systems for stable supply of irrigation water at first to wet season rice. Such bottoms already identified are five (5) sites in Xai district with a total irrigable area of 185 ha, five (5) sites (171 ha of total irrigable area) in Beng and three sites (82 ha of total irrigable area) in Hun. These potential sites could be divided further into two groups : one includes seven (7) sites with a total irrigable area of 257 ha where access to each site could be secured by constructing a relatively short distance road, less than 10 km from the National Road No.2, and the other includes six (6) sites covering 181 ha of total irrigable land which would require the construction of long distance road. Then, it is proposed to implement the former group in the medium term development phase for which further investigations and study will be required to be carried out at the short term stage. The implementation of the latter group is planned to be executed at the long term stage. The irrigation facility such as diversion weir and canal network for all of them would be constructed newly, following the design standard applied for upgrading of the existing irrigation systems.

The irrigation development in the currently bush and/or grass lands covering 600 ha would require the construction of medium size of storage dams together with new diversion weirs and canal networks as well as opening of new farm land. According to the available topographic maps on a scale of both 1: 100,000 and 1: 50,000, in addition, there are narrow gorges suitable for construction of medium size storage dam (10 to 15 m in height) schemes mostly on the tributaries of the Nam Beng river. Since various investigations and study, especially for dam foundation, will be required to formulate the schemes for their implementation, the irrigation development in such lands will have to be included in the long term development programs after further study on technical and economic feasibility of these dam schemes including the construction of new irrigation facilities and opening of farm land is made.

The irrigation development in upland of gentle sloping hills with a total potential of 3,500 ha would require construction of small-scale storage ponds on the foot of the hills to utilize available river water and rainfall as well to a maximum extent mainly in terms of their topography. In addition, a simple piped irrigation system may be considered for more effective use of limited water available from either the rivers or springs. Since data and information useful for preparation of concrete plan for the development are very limited, it is proposed that detailed investigations and studies be carried out at the medium stage development and that the implementation of the development be made gradually during the long term development, taking into account the progress of such investigations and studies.

4. REFERENCES

1. Irrigation Subsector Review, T.A.No.1189-LAO, Draft Final Report : MAF/ADB
2. Medium Term Program for Agricultural Adjustment and Development, Volumes II-V : MAF/ADB, 1991
3. Rural Micro-projects Programme in Luang Prabang Province, Technical Report No.2, Appraisal of Nam Dong Micro-project Area : Commission of the European Communities, 1991
4. Projet de Rehabilitation et d'extension du Perimetre Irrigue de Hoi Lai (Province d'Oudomsay, District de Xay), Avant Projet Detaille : UNDP, 1990
5. Rehabilitation and Extension Project of Nam Fen Perimeter (Oudomsay Province, Xay District), Detailed Project : UNDP, 1991

Table

Table MF-1 Inventory of Existing Irrigation System

Command Area Category	No. of Scheme	Total Irrigation Area (ha)	Average Irri. Area (ha)	Remarks
Xai District :				
Less than 5 ha	39	99.6	2.6	All brushwood weir
6 - 10 ha	7	57.8	8.3	All brushwood weir
11 - 20 ha	11	150.9	13.7	All brushwood weir
21 - 30 ha	4	102.8	25.7	All brushwood weir
31 - 50 ha	5	180.0	36.0	All brushwood weir
More than 51 ha	3	406.5	135.5	Con. weir 1 scheme
Sub-total	<u>69</u>	<u>997.6</u>		
Beng District :				
Less than 5 ha	17	63.4	3.7	Con. weir 1 scheme
6 - 10 ha	10	58.6	5.9	All brushwood weir
11 - 20 ha	3	42.0	14.0	All brushwood weir
21 - 30 ha	1	25.0		All brushwood weir
31 - 50 ha	3	117.3	39.1	Con. weir 1 scheme
More than 51 ha	6	532.9	88.8	Con. weir 2 schemes
Sub-total	<u>40</u>	<u>839.2</u>		
Hun District :				
Less than 5 ha	4	15.0	3.8	Con. weir 1 scheme
6 - 10 ha	3	21.7	7.2	All brushwood weir
11 - 20 ha	6	103.7	17.3	Con. weir 1 scheme
21 - 30 ha	4	110.5	27.6	Con. weir 1 scheme
31 - 50 ha	5	211.4	42.3	Con. weir 3 schemes
More than 51 ha	4	362.7	90.7	Con. weir 3 schemes
Sub-total	<u>26</u>	<u>825.0</u>		
Total, Study Area :				
Less than 5 ha	60	178.0	3.0	Con. weir 2 schemes
6 - 10 ha	20	138.1	6.9	All brushwood weir
11 - 20 ha	20	296.6	14.8	Con. weir 1 scheme
21 - 30 ha	9	238.3	26.5	Con. weir 1 scheme
31 - 50 ha	13	508.7	39.1	Con. weir 4 schemes
More than 51 ha	13	1,302.1	100.2	Con. weir 6 schemes
Total	<u>135</u>	<u>2,661.8</u>	<u>19.7</u>	

Source : Data obtained from both provincial and district offices.

Table MF-2 Priority Ranking of Existing Irrigation Scheme for Stage-wise Implementation in Xai District (1/3)

Sr. No.	Water Source (River/Stream)	Representative Village	Irrigation Area (ha)	Type of Weir	Selection Criteria				Total Development Stage		Remarks	
					A	B	C	D	E	Count		
1	Nam Mao	B. Thiao	35.0	Brushwood	3	2	2	2	2	11	Medium Term	
2	Nam Mao	B. Thiao	5.0	Brushwood	3	1	2	2	2	10	Medium Term	
3	Nam Mao	B. Thiao	35.0	Brushwood	3	2	2	2	2	11	Medium Term	
4	Nam Mao	B. Nale	196.6	Brushwood							Short Term	Located in Xai Model Area.
		B. Nasao, Cheng										
5	Nam Hin	B. Thin	134.8	Concrete	3	3	2	2	1	11	Medium Term	Rehabilitation of canal network only.
6	Houay Lai	B. Donkeo	75.1	Brushwood								To be rehabilitated under UNDP Program.
7	Houay Dou	B. Katon	10.3	Brushwood	1	1	1	2	1	6	Long Term	
8	Nam Fene	B. Bho	18.3	Brushwood								To be rehabilitated under UNDP Program.
9	Nam Fene	B. Bho	11.0	Brushwood								To be rehabilitated under UNDP Program.
10	Nam Fene	B. Bho	38.0	Brushwood								To be rehabilitated under UNDP Program.
11	Nam Fene	B. Bho	40.0	Brushwood								To be rehabilitated under UNDP Program.
12	Nam Fene	B. Bho	13.3	Brushwood								To be rehabilitated under UNDP Program.
13	Nam Fene	B. Bho	9.3	Brushwood								To be rehabilitated under UNDP Program.
14	Nam Fene	B. Bho	13.3	Brushwood								To be rehabilitated under UNDP Program.
15	Nam Fene	B. Bho	2.0	Brushwood								To be rehabilitated under UNDP Program.
16	Nam Fene	B. Bho	5.5	Brushwood								To be rehabilitated under UNDP Program.
17	Nam Fene	B. Bho	3.8	Brushwood								To be rehabilitated under UNDP Program.
18	Nam Fene	B. Bho	2.8	Brushwood								To be rehabilitated under UNDP Program.
19	Nam Fene	B. Bho	2.0	Brushwood								To be rehabilitated under UNDP Program.
20	Nam Fene	B. Bho	3.5	Brushwood								To be rehabilitated under UNDP Program.
21	Nam Fene	B. Bho	15.0	Brushwood								To be rehabilitated under UNDP Program.
22	Nam Fene	B. Bho	4.8	Brushwood								To be rehabilitated under UNDP Program.
23	Nam Ko	B. Mai	25.8	Brushwood	2	2	2	2	1	9	Long Term	
24	Nam Kat	B. Kat	18.0	Brushwood	1	1	1	2	2	7	Long Term	
25	Nam Kat	B. Kat	8.0	Brushwood	1	1	1	2	2	7	Long Term	
26	Nam Kat	B. Kat	4.0	Brushwood	1	1	1	2	2	7	Long Term	
27	Nam Kat	B. Kat	2.0	Brushwood	1	1	1	2	2	7	Long Term	
28	Nam Kat	B. Kat	3.5	Brushwood	1	1	1	2	2	7	Long Term	
29	Tham Nheuang	B. Long Ya	9.0	Brushwood	1	1	1	2	2	7	Long Term	
30	Na Tai	B. Long Ya	24.0	Brushwood	1	2	1	2	2	8	Long Term	
	Sub-total		768.7									

Note : In selection criteria, A= potential accessibility via roads, B= size of the scheme, C= available water resources, D= motivation of irrigation beneficiary, and E= province's priority ranking.

Count standard : Good= 3 counts, Moderate= 2 counts, and Poor= 1 count.

Table MF-2 Priority Ranking of Existing Irrigation Scheme for Stage-wise Implementation in Xai District (2/3)

Sr. No.	Water Source (River/Stream)	Representative Village	Irrigation Area (ha)	Type of Weir	Selection Criteria					Total Development		Remarks
					A	B	C	D	E	Count	Stage	
31	Na Hin	B. Long ya	13.5	Brushwood	1	1	1	2	2	7	Long Term	
32	Houay Ngon	B. Long Ya	10.0	Brushwood	1	1	1	2	2	7	Long Term	
33	Houay He	B. Long Ya	2.0	Brushwood	1	1	1	2	2	7	Long Term	
34	Houay Tao	B. Long Ya	2.3	Brushwood	1	1	1	2	2	7	Long Term	
35	Houay He	B. Long Ya	0.8	Brushwood	1	1	1	2	2	7	Long Term	
36	Houay Lon	B. Long Ya	0.1	Brushwood	1	1	1	2	2	7	Long Term	
37	Vang Et	B. Pong Hieng	29.0	Brushwood	1	1	1	2	2	7	Long Term	
38	Houay Sang	B. Pong Hieng	2.5	Brushwood	1	1	1	2	2	7	Long Term	
39	Houay Ngon	B. Houay Sang	3.0	Brushwood	1	1	1	2	2	7	Long Term	
40	Houay Soum	B. Houay Sang	1.0	Brushwood	1	1	1	2	2	7	Long Term	
41	Houay Ngon	B. Houay Sang	0.5	Brushwood	1	1	1	2	2	7	Long Term	
42	Houay Ngon	B. Houay Sang	1.8	Brushwood	1	1	1	2	2	7	Long Term	
43	Houay Ngon	B. Houay Sang	1.5	Brushwood	1	1	1	2	2	7	Long Term	
44	Houay Ngon	B. Houay Sang	0.8	Brushwood	1	1	1	2	2	7	Long Term	
45	Houay Kha	B. Na Lan	11.0	Brushwood	2	1	1	2	2	8	Long Term	
46	Houay Lan	B. Na Lan	5.0	Brushwood	2	1	1	2	2	8	Long Term	
47	Houay Yang	B. Houay Yang	8.0	Brushwood	2	1	1	2	2	8	Long Term	
48	Houay Lai	B. Konoy	32.0	Brushwood	2	2	1	2	2	9	Long Term	
49	Houay Pong	B. Konoy	15.0	Brushwood	2	1	1	2	2	8	Long Term	
50	Houay Yam	B. Mokpot	3.0	Brushwood	2	1	1	2	2	8	Long Term	
51	Houay Yam	B. Mokpot	2.0	Brushwood	2	1	1	2	2	8	Long Term	
52	Houay Om	B. Pangsouk	3.0	Brushwood	2	1	1	2	2	8	Long Term	
53	Nam Keut	B. Na Houang	24.0	Brushwood	1	2	1	2	2	8	Long Term	
54	Nam Keut	B. Na Houang	2.5	Brushwood	1	1	1	2	2	7	Long Term	
55	Houay Houm	B. Houay Houm	1.8	Brushwood	1	1	1	2	2	7	Long Term	
56	Houay Ngew	B. Na Ngew	3.0	Brushwood	1	1	1	2	2	7	Long Term	
57	Houay Deng	B. Na Houang-tai	1.5	Brushwood	1	1	1	2	2	7	Long Term	
58	Houay Vang	B. Na Houang-tai	1.0	Brushwood	1	1	1	2	2	7	Long Term	
59	Houay Sao	B. Khenken	3.8	Brushwood	1	1	1	2	2	7	Long Term	
60	Houay Ko	B. Na Houang-tai	3.4	Brushwood	1	1	1	2	2	7	Long Term	
61	Houay Nga	B. Na Ngam	3.0	Brushwood	1	1	1	2	2	7	Long Term	
Sub-total										191.8		

Note : In selection criteria, A= potential accessibility via roads, B= size of the scheme, C= available water resources, D= motivation of irrigation beneficiary, and

E= province's priority ranking.

Count standard : Good= 3 counts, Moderate= 2 counts, and Poor= 1 count.

Table MF-2 Priority Ranking of Existing Irrigation Scheme for Stage-wise Implementation in Xai District (3/3)

Sr. No.	Water Source (River/Stream)	Representative Village	Irrigation Area (ha)	Type of Weir	Selection Criteria			Total Count	Development Stage	Remarks		
					A	B	C				D	E
62	Houay Lang	B. Na Ngam	2.5	Brushwood	1	1	1	2	2	7	Long Term	Located in remote areas.
63	Houay Ngon	B. Na Ngam	2.2	Brushwood	1	1	1	2	2	7	Long Term	Located in remote areas.
64	Houay Ngon	B. Na Ngam	12.2	Brushwood	1	1	1	2	2	7	Long Term	Located in remote areas.
65	Nam Hin	B. Na Ngam	3.4	Brushwood	1	1	1	2	2	7	Long Term	Located in remote areas.
66	Houay Sang	B. Koua	3.0	Brushwood	1	1	1	2	2	7	Long Term	Located in remote areas.
67	Houay Sang	B. Salo	8.0	Brushwood	1	1	1	2	2	7	Long Term	Located in remote areas.
68	Nam Khon	B. Chom Ong	2.8	Brushwood	1	1	1	2	2	7	Long Term	Located in remote areas.
69	Houay Pat	B. Naxaythong	3.0	Brushwood	1	1	1	2	2	7	Long Term	Located in remote areas.
	Sub-total		37.1									
	Total		997.6									
	Short Term	1 scheme	196.6									
	Medium Term	4 schemes	209.8									
	Long Term	48 schemes	333.8									

Exclude 16 schemes (257.7 ha) under UNDP.

Note : In selection criteria, A= potential accessibility via roads, B= size of the scheme, C= available water resources, D= motivation of irrigation beneficiary, and E= province's priority ranking.

Count standard : Good= 3 counts, Moderate= 2 counts, and Poor= 1 count.

Table MF-3 Priority Ranking of Existing Irrigation Scheme for Stage-wise Implementation in Beng District (1/2)

Sr. No.	Water Source (River/Stream)	Representative Village	Irrigation Area (ha)	Type of Weir	Selection Criteria					Total Count	Development Stage	Remarks	
					A	B	C	D	E				
1	Nam Hao	B. Benglouang	85.3	Brushwood								Short Term	Located in Beng Model Area.
2	Nam Hao	B. Bengkham	10.0	Brushwood								Short Term	Located in Beng Model Area.
3	Nam Hao	B. Bengkham	103.0	Brushwood								Short Term	Located in Beng Model Area.
4	Nam Hao	B. Nahhouay	8.0	Brushwood								Short Term	Located in Beng Model Area.
5	Nam Hao	B. Nahhouay	15.0	Brushwood								Short Term	Located in Beng Model Area.
6	Nam Beng	B. Thamun	32.3	Brushwood	3	2	2	2	1	10		Medium Term	
7	Nam Beng Nua	B. Phia	4.0	Brushwood	2	1	1	1	1	6		Long Term	
8	Nam Met	B. Namet	48.0	Brushwood	3	2	3	3	2	13		Medium Term	
9	Nam Met	B. Namet	7.0	Brushwood	3	1	3	3	2	12		Medium Term	Part of Nam Met scheme
10	Nam Lo	B. Gno	150.0	Concrete	3	3	2	1	1	10		Long Term	Already rehabilitated, except for tertiary system.
11	Nam Lo (nua)	B. Sopro	4.5	Brushwood	3	1	1	1	1	7		Long Term	
12	Houay Poang	B. Phonsaat	3.2	Brushwood	3	1	1	1	1	7		Long Term	To be included in the UNDP scheme.
13	Houay Taane	B. Phonsaat	2.3	Brushwood	3	1	1	1	1	7		Long Term	To be included in the UNDP scheme.
14	Houay Nampa	B. Napa-nua	54.5	Brushwood	2	3	1	2	2	10		Medium Term	
15	Nam Phak	B. Napa-tai	5.0	Brushwood	2	1	1	2	1	7		Long Term	
16	Long Khai	B. Napa-tai	4.0	Brushwood	2	1	1	2	1	7		Long Term	
17	Houay makkou	B. Napa-tai	4.0	Brushwood	2	1	1	2	1	7		Long Term	
18	Houay Nam cha	B. Thamun	5.6	Brushwood	2	1	1	2	1	7		Long Term	
19	Kiu Sangvanh	B. Kiusangvanh	4.9	Brushwood	2	1	1	2	1	7		Long Term	
20	Nam Le	B. Pangthong	3.8	Brushwood	2	1	1	2	1	7		Long Term	
21	Houay Kai	B. Pangthong	4.3	Brushwood	2	1	1	2	1	7		Long Term	
22	Houay Hak	B. Na Lai	4.0	Brushwood	2	1	1	2	1	7		Long Term	
23	Houay Chom	B. Phokeo	2.0	Brushwood	1	1	1	2	1	6		Long Term	
24	Houay Phay	B. Namone	12.0	Brushwood	1	2	1	2	1	7		Long Term	
25	Houay Pong	B. Vangva	10.0	Brushwood	1	1	1	2	1	6		Long Term	
26	Houay Pa Ngiu	B. Vangva	4.4	Brushwood	1	1	1	2	1	6		Long Term	
27	Houay Bay	B. Vangva	1.0	Brushwood	1	1	1	2	1	6		Long Term	
28	Houay Vangva	B. Vangva	4.0	Brushwood	1	1	1	2	1	6		Long Term	
29	Houay Muang	B. Sarnkang		Brushwood	1	1	1	2	1	6		Long Term	No data is available.
30	Nam Heng	B. Sarnkang	37.0	Concrete	2	2	2	2	2	10		Medium Term	
31	Houay Kay	B. Khonekham	15.0	Brushwood	2	1	1	2	1	7		Long Term	
Sub-total			648.1										

Note : In selection criteria, A= potential accessibility via roads, B= size of the scheme, C= available water resources, D= motivation of irrigation beneficiary, and E= province's priority ranking.

Count standard : Good= 3 counts, Moderate= 2 counts, and Poor= 1 count.

Table MF-3 Priority Ranking of Existing Irrigation Scheme for Stage-wise Implementation in Beng District (2/2)

Sr. No.	Water Source (River/Stream)	Representative Village	Irrigation Area (ha)	Type of Weir	Selection Criteria					Total Count	Development Stage	Remarks
					A	B	C	D	E			
32	Houay Lay	B. Na Moang	25.0	Brushwood	1	2	1	2	1	7	Long Term	
33	Houay Ling	B. Na Moang		Brushwood	1	1	1	2	1	6	Long Term	No data is available.
34	Houay Chok	B. Thakat	54.8	Concrete	2	3	1	1	1	8	Long Term	
35	Houay Dor	B. Thakat	8.0	Brushwood	1	1	1	2	1	6	Long Term	
36	Houay Ngeut	B. Thakat	85.3	Brushwood	2	3	1	2	1	9	Long Term	
37	Houay Ke Le	B. Thakat	5.0	Concrete	3	1	1	1	1	7	Long Term	
38	Houay Ke Le	B. Benghuang	10.0	Brushwood	3	1	1	2	1	8	Long Term	
39	Nam Ngao	B. Na Home		Brushwood	1	1	1	2	1	6	Long Term	Located in remote area. No data is available.
40	Nam Khon	B. Khon	3.0	Brushwood	1	1	1	2	1	6	Long Term	Located in remote area.
Sub-Total			191.1									
Total			839.2									
Short Term			221.3									
Medium Term			178.8									
Long Term			439.1									

Note : In selection criteria, A= potential accessibility via roads, B= size of the scheme, C= available water resources, D= motivation of irrigation beneficiary, and E= province's priority ranking.

Count standard : Good= 3 counts, Moderate= 2 counts, and Poor= 1 count.

Table MF-4 Priority Ranking of Existing Irrigation Scheme for Stage-wise Implementation in Hun District

Sr. No.	Water Source (River/Stream)	Representative Village	Irrigation Area (ha)	Type of Weir	Selection Criteria					Total Development Stage		Remarks	
					A	B	C	D	E	Count	Stage		
1	Nam Ngat	B. Somxai	50.0	Concrete								Short Term	Located in Hun Model Area.
2	Nam Ngat	B. Phonsavat	59.0	Concrete								Short Term	Located in Hun Model Area.
3	Nam Ngat	B. Phonsavat	30.0	Concrete								Short Term	Located in Hun Model Area.
4	Nam Kham	B. Nakhong	68.0	Concrete								Short Term	Located in Hun Model Area.
5	Nam Kham	B. Nakhong-tai	39.5	Brushwood								Short Term	Located in Hun Model Area.
6	Nam Ngat	B. Nakhong-nua	19.5	Brushwood								Short Term	Located in Hun Model Area.
7	Houay Khao	B. Nangneun	5.0	Concrete	2	1	1	1	1	6		Long Term	
8	Houay Khao	B. Nakhong	48.0	Concrete	3	3	2	2	1	11		Medium Term	Rehabilitation of canal network only.
9	Nam Oun	B. Fen	57.1	Concrete	2	3	3	3	2	13		Medium Term	Rehabilitation of canal network only.
10	Nam Oun	B. Sivilay	30.0	Brushwood	2	2	3	3	2	12		Medium Term	Located at downstream from B. Fen scheme.
11	Houay Sat	B. Nakhong	31.4	Concrete	3	2	2	2	1	10		Medium Term	
12	Houay Sat	B. Naphang	12.0	Brushwood	2	1	1	2	2	8		Long Term	
13	Houay Sat	B. Nakhong	15.0	Brushwood	3	1	1	2	2	9		Long Term	
14	Houay Kua	B. Nangneun	19.0	Concrete	3	2	2	2	1	10		Medium Term	Rehabilitation of canal network only.
15	Nam Heng	B. Naxiangdi	178.6	Brushwood	1	3	2	3	3	12		Medium Term	
16	Nam Yao	B. Phakham	24.5	Brushwood	1	2	1	2	1	7		Long Term	
17	Nam Hene	B. Dou	3.0	Brushwood	1	1	1	2	1	6		Long Term	
18	Nam Phouang	B. Namphouang	42.5	Brushwood	1	2	2	2	1	8		Long Term	
19	Nam Vieng	B. Phouvieng	7.7	Brushwood	1	1	1	2	1	6		Long Term	
20	Nam Mao	B. Dont Na	26.0	Brushwood	1	2	1	2	2	8		Long Term	
21	Nam Mao	B. Phonesavang	7.0	Brushwood	1	1	1	2	1	6		Long Term	
22	Nam Kha	B. Vangnong	19.1	Brushwood	2	1	1	2	1	7		Long Term	
23	Nam Khe	B. Sibounheung	19.1	Brushwood	1	2	1	2	1	7		Long Term	
24	Nam Pa	B. Phone Xai	2.0	Brushwood	2	1	1	1	1	6		Long Term	
25	Nam Lava	B. Nakai	5.0	Brushwood	1	1	1	2	1	6		Long Term	
26	Houay Tang	B. Vangrang	7.0	Brushwood	3	1	1	1	1	7		Long Term	
Total			825.0										
Short Term			6 schemes	256.0									
Medium Term			6 schemes	364.1									
Long Term			14 schemes	194.9									

Note : In selection criteria, A= potential accessibility via roads, B= size of the scheme, C= available water resources, D= motivation of irrigation beneficiary, and E= province's priority ranking.

Count standard : Good= 3 counts, Moderate= 2 counts, and Poor= 1 count.

Table MF-5 Crop Water Requirement

Crop : Rice (Wet season, future condition)

Irrigation efficiency :		50 %											
	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. ETO	mm/day	2.6	3.4	4.3	5.0	5.0	3.6	3.5	4.0	3.7	3.2	2.6	2.3
2. Days	days	31	28	31	30	31	30	31	31	30	31	30	31
3. Cropping calender	days						15	31	31	30	28		
								15	31	30	31	28	
4. Crop coefficient(Kc)							1.10	1.10	1.09	1.04	0.95		
								1.10	1.10	1.07	0.99	0.93	
5. ET _{crop}							4.5	119.4	135.2	115.4	85.1		
								4.3	136.4	118.8	98.2	67.7	
Average	mm/month						2.2	61.8	135.8	117.1	91.7	33.9	
6. Puddling water	mm/month						75.0	75.0					
7. Percolation	mm/month						15.0	46.0	62.0	60.0	59.0	28.0	
8. Effective rainfall	mm/month	6.0	21.0	26.0	78.0	103.0	116.0	138.0	150.0	62.0	60.0	26.0	3.0
9. Net crop water req. (5)+(6)+(7)-(8)	mm/month						0.0	44.8	47.8	115.1	90.7	35.9	
10. Gross crop water req.	mm/month						0.0	89.7	95.6	230.2	181.3	71.7	
	l/s/ha						0.00	0.33	0.36	0.89	0.68	0.28	

Crop : Rice (dry season, future condition)

Irrigation efficiency :		50 %											
	Unit	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1. ETO	mm/day	2.6	3.4	4.3	5.0	5.0	3.6	3.5	4.0	3.7	3.2	2.6	2.3
2. Days	days	31	28	31	30	31	30	31	31	30	31	30	31
3. Cropping calender	days	31	28	31	30	15							
			28	31	30	31	15						
4. Crop coefficient(Kc)		1.10	1.10	1.21	1.12	0.93							
			1.10	1.10	1.21	1.12	0.93						
5. ET _{crop}		6.6	104.7	161.3	168.0	69.8							
			7.9	146.6	181.5	173.6	50.2						
Average	mm/month	3.3	56.3	154.0	174.8	121.7	25.1						
6. Puddling water	mm/month	75.0	75.0										
7. Percolation	mm/month	31.0	56.0	62.0	60.0	46.0	15.0						
8. Effective rainfall	mm/month	6.0	21.0	26.0	78.0	103.0	116.0	138.0	150.0	62.0	60.0	26.0	3.0
9. Net crop water req. (5)+(6)+(7)-(8)	mm/month	103.3	166.3	190.0	156.8	64.7	0.0						
10. Gross crop water req.	mm/month	206.6	332.6	379.9	313.5	129.4	0.0						
	l/s/ha	0.77	1.37	1.42	1.21	0.48	0.00						

Note:

1. ETO of Oudomxay Station is applied.
2. Rainfall data of Oudomxay station is applied.

Figure

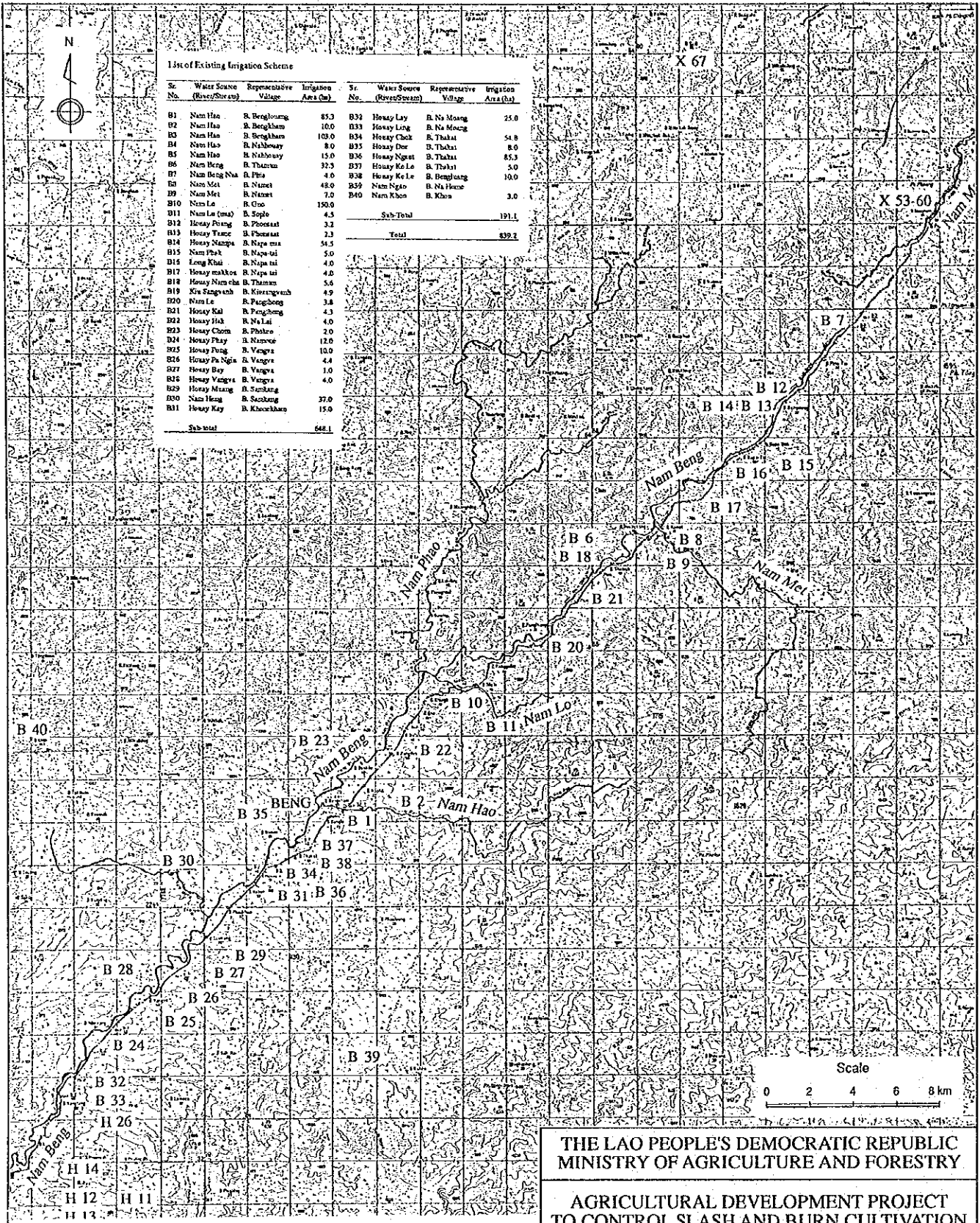
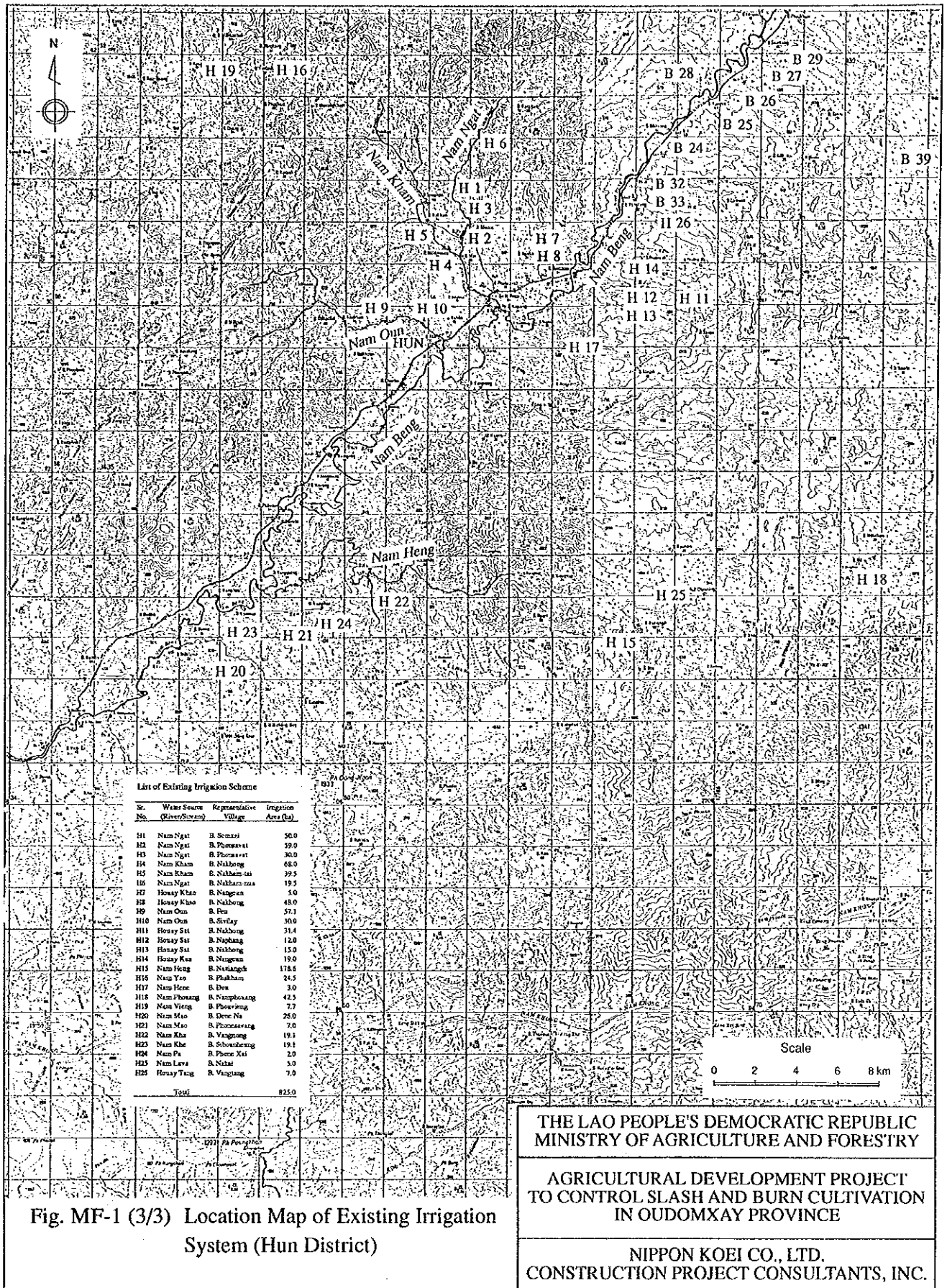


Fig. MF-1 (2/3) Location Map of Existing Irrigation System (Beng District)

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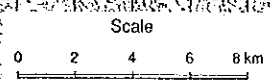
AGRICULTURAL DEVELOPMENT PROJECT
TO CONTROL SLASH AND BURN CULTIVATION
IN OUDOMXAY PROVINCE

NIPPON KOEI CO., LTD.
CONSTRUCTION PROJECT CONSULTANTS, INC.



List of Existing Irrigation Scheme

Sr. No.	Water Source (River/Stream)	Representative Village	Irrigation Area (ha)
H1	Nam Ngat	B. Somvat	50.0
H2	Nam Ngat	B. Phonavatt	59.0
H3	Nam Ngat	B. Phonavatt	30.0
H4	Nam Kham	B. Nibhong	68.0
H5	Nam Kham	B. Nibhong	39.5
H6	Nam Ngat	B. Nibhong	19.5
H7	Houay Kao	B. Nongson	5.0
H8	Houay Kao	B. Nibhong	48.0
H9	Nam Oun	B. Fen	57.1
H10	Nam Oun	B. Sivlay	30.0
H11	Houay Sit	B. Nibhong	31.4
H12	Houay Sit	B. Nibhong	12.0
H13	Houay Sit	B. Nibhong	15.0
H14	Houay Kao	B. Nongson	19.0
H15	Nam Heng	B. Nongson	178.5
H16	Nam Yao	B. Phakhan	24.5
H17	Nam Heng	B. Doo	3.0
H18	Nam Phouang	B. Sompheuang	42.5
H19	Nam Viera	B. Phoueng	7.7
H20	Nam Mao	B. Dene Ni	26.0
H21	Nam Mao	B. Phonavatt	7.0
H22	Nam Kha	B. Vangrong	19.1
H23	Nam Kha	B. Sompheuang	19.1
H24	Nam Pa	B. Phon Kai	2.0
H25	Nam Lava	B. Nibai	5.0
H26	Houay Tang	B. Vangtang	7.0
Total			835.0



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Fig. MF-1 (3/3) Location Map of Existing Irrigation System (Hun District)

Appendix

**APPENDIX-MF REGULATION FOR MANAGEMENT OF NAM KHAM
IRRIGATION SYSTEM IN HUN DISTRICT
(8th May, 1991)**

I. General

The Nam Kham irrigation system is irrigating 68 ha of paddy field with 8,000 m of irrigation canal in total. The villages related to this irrigation system are four (4), which are B. Na Khong, B. Ba Fang, B. Phone Savath and B. Na Home.

- (1) The weir and canals were constructed by farmers groups many years ago, and the farmers groups manage this irrigation system by themselves in accordance with the fixed regulation in order to use the system effectively.
- (2) If some farmers or other persons destroy the weir or canals, they should be punished or penalized.
- (3) Since the agricultural cooperative has been established in 1978, this irrigation system is being controlled by the district administrative committee and the cooperative board. In 1986, the original brushwood weir was replaced by concrete weir by farmers groups with financial assistance from the district and villagers.
- (4) The government policy of the cooperative has been changed in 1988. Then, the cooperative activities were ceased, and the right for land use (paddy field) was given back to the farmers groups. The irrigation system was also given back to the farmers groups for management by themselves.

II. Specific Regulation

- (1) All farmers should control and use this irrigation system effectively.
- (2) In May every year, all of the water users should participate in repair and cleaning of weir and canals in accordance with the amount of paddy seed required for rice cultivation by each water user (one labor/one box of seed). If there is a water user who do not participate in these duty works, he should pay Kip 500 of fine against one labor.

- (3) The irrigation system including water distribution should be controlled in accordance with the arranged schedule since this year. If there is a water user who do not observe this schedule, he should pay Kip 5,000 of fine.
- (4) The water users, who dig canals, make holes in the canal and destroy the canals by other activities, should be punished with a fine of more than Kip 5,000 according to the case.
- (5) If the farmer, who has paddy field at the beginning and the end of canal, makes small weir in the canal or open new paddy field without permission from the other farmers, he should be punished with a fine of Kip 15,000 at the first time and Kip 30,000 from the second time.
- (6) In the next two (2) years, 1992 - 93, the canal should be repaired by widening the canal bottom, dividing the canal in meter based on the amount of paddy seed used by each farmer (one box of seed = one labor). If the farmer do not participate in these duty works, he should be punished with a fine of Kip 5,000 to 10,000 according to the case.
- (7) Such a fine paid by the farmers will be kept by the controller committee and used for repair of the weir and the canals.
- (8) The controller committee is elected by farmers (water users). The committee consists of four (4) staff, one chief, one deputy chief and two members of the committee. Each of them is selected from each village as its representative.
- (9) The function and duty of the committee are as follows :
 - Advice and control all of the farmers for observation of this regulation.
 - Control and punish the farmers who do not observe this regulation.
 - Maintain the weir and canals every year.
 - The committee should have a plan for improving the irrigation system.
- (10) The committee's member will be elected every year.
- (11) The committee will receive Kip 1,000/ha of charge in a year.

ANNEX-MG
SOCIAL INFRASTRUCTURES

ANNEX-MG SOCIAL INFRASTRUCTURES

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1. INTRODUCTION

Agricultural development will achieve its target with both direct measures for increasing agricultural production and indirect ones for improvement of rural living conditions, which will be an integrated balanced agricultural development. However, considering the very poor present conditions of social infrastructures in the study area, the priority of this master plan study will be given to such basic infrastructures as communication, water supply, electricity supply, school, hospital, and village community facilities. On making a development plan, the consideration will be placed on the present conditions of topography, existing infrastructures and villages' distribution patterns for more economical and effective impact. Development level will also be balanced with that of the whole country and other provinces and districts.

2. CURRENT CONDITIONS

2.1 Communication

Oudomxay province is one of the very remote areas like other northern provinces in Laos, with the very limited accessibilities by only three times regular flights a week from Vientiane. Although other accessibilities via road and river communications are available, the conditions of these facilities are very poor, requiring three to four day-traveling from Vientiane to Oudomxay by road and river, and sometimes it is very difficult to utilize such facilities in the rainy season.

2.1.1 Road Network

National roads Route No.1, 2, 3, 4 and No.13-B connect Xai city with Luang Namtha, Luang Prabang, Pakbeng, Khoa and Boten, which are the capitals in neighbouring provinces, or one of the important Mekong river ports in the northern Laos, the second town of Phongsali province and a town of Chinese border, respectively (see Fig. MG-1). These roads are macadam-paved with 6 m carriage way and passable throughout the year, which were constructed in the period of 1973 to 1979 assisted by the People's Republic of China. Because of little or almost no maintenance work, however, the road conditions are very poor with many holes, allowing an average travelling speed of 25 km per hour. Route No.13-B is an earth road and impassable in the rainy season in spite of the important connection with Luang Prabang.

Among the above roads, Boten to Pakbeng Route (part of Route No.1 and Route No.2) with a total length of 236 km is the very important one as the main route for economic activities of trading both within local areas and among the three countries of Laos, Thailand and China.

Route No.2 (Xai to Pakbeng, a total length of 138 Km) goes down approximately in the centre of the study area from north to south-west, playing a key role in all activities of the people in the study area. In addition to Route No.2 from Km-0 (Xai) to Km-122, the study area is also served by Route No.1 from Xai to Km-23 west-northward and to Km-52 eastward and Route No.4 from Xai city to Km-9 north-eastward.

According to the survey by the study team, the daily traffic volume in Route No.2 is estimated at 20 to 30 vehicles at present. However, the feasibility study report on "The Rehabilitation Road Project in Northern Laos" by SIDA shows that the predicted future daily traffic volume will be 150 to 200 vehicles between Boten and Pakbeng via Xai (Route No.1

and 2), 50 to 100 vehicles between Xai and Luang Prabang (Route No.1 and 13-B), and 50 vehicles between Xai and Khoa (Route No.4), respectively. Owing to the importance of the national roads, the rehabilitation project for Route No.1, 2, 3 and 4 has just started in 1992 with a finance of ADB and will be completed in 1995.

In Oudomxay province, there are five provincial roads, among which only one is related to the study area. It connects Xai city with Nga district centre with a total length of 76 km. The condition of this road is very poor, which is almost at footpath level.

Well-designed district road network is a great need, which will play an important role in the people's activities such as public and local communication as well as in marketing of farm inputs and outputs in the study area.

The total length of existing district roads is 202 km in the three districts, which are mostly constructed by the farmers' labour force with a technical supervision and some materials and tools from the provincial and district offices. However, the conditions of existing district roads are very poor. Some parts of these roads are passable by 4-WD vehicle only in the dry season, and some of them are in the conditions that are just opened/cleared the land and excavated by hand without proper route survey and design. The necessity of these roads are very high especially for the remote people, because the road is the only one communication system for economic and other social-welfare activities. In addition to the existing district roads, new construction of district roads with a total length of 298 km is proposed as the future plan by the district offices. These planned roads are presently footpaths and almost are not yet surveyed for road alignment. The distribution and length of the existing and planned district roads are summarized as follows :

	District	No. of Road	Total Length (km)
Existing Roads:	Xai	7	121
	Beng	3	38
	Hun	4	43
	(Sub-total)	(14)	(202)
Planned Roads:	Xai	7	118
	Beng	5	82
	Hun	4	98
	(Sub-total)	(16)	(298)

2.1.2 River Communication

River communication is also very important, especially the Mekong river and the Nam Ou river, a tributary of the Mekong, as an access to the study area.

The Mekong river is connecting Pakbeng with Houayxai (Bokeo Province located on Thailand border) and Louang Prabang. The distance from Pakbeng to Houayxai and from Pakbeng to Louang Prabang are almost the same being 160 km, and the travelling hour for each section varies from six to 12 hours, depending on the capacity of boat and the way of direction, upwards or downwards. The river allows the travel of 100 ton-class boat in the rainy season and 40 ton-class boat in the dry season.

The Nam Ou river is the longest river in Laos, except for the Mekong, with a total length of 448 km, connecting Pakbak (Km-109 on Route No.1) with Luang Prabang. Because of poor conditions of Route 13-B (Connecting Pakmong, Km-80 on Route No.1 to Louang Prabang), the Nam Ou is an indispensable route between Route No.1 and Luang Prabang, allowing the travel of ten (10) ton-class boat in the rainy season and two (2) ton-class in the dry season, with five to six hours of travelling.

2.1.3 Public Transportation

Public transportation service is available, operated by only private individual taxi in the study area, which is under the supervision of the provincial authority, the Department of MCTPC. It is common that pick-ups (1 to 2 ton-class) be used for the people's transportation and truck (6 to 8 ton-class) for goods and materials. The pick-up taxi departs every morning from Xai city to four directions, namely Pakbeng, Louang Namtha, Khoa, and Pakbak. There is also taxi service coming from Hun town to Xai every day.

These transportation services are available, depending on the number of passengers and the amount of trading goods and materials. The daily average number of vehicles for the services is five units of pick-up and three units of truck to Pakbeng, one unit of pick-up and five units of truck to Luang Namtha, three units of pick-up and one unit of truck to Khoa and one unit of pick-up to Pakbak, respectively. Transportation charge is Kip 20 /km/person for people and Kip 60 to 80 /km/ton for goods and materials, for example Kip 3,000 /person and Kip 7,000 /ton between Xai and Pakbeng.

2.1.4 Other Communication System

A city telephone network is available only in Xai city, connecting a total number of 50 units of telephone distributed in the provincial offices, business companies and small number of individuals.

There are telecommunication service offices in each district of Oudomxay, except for Beng and La districts, which are operated and managed directly under the Department of Communication of MCTPC. Telegram and radio services between the stations in other provinces are also available, but the services depend on the weather or other conditions.

Only one post office in Xai city is available for mailing to other provinces and foreign countries. For certain mail receiving, the use of P.O.Box in the post office, 120 in number, is recommended for both private and official use, even though mails are delivered to the district.

2.2 Water Supply System

There are two (2) types of water supply systems in the study area : one is operated by the water supply section of the Department of MCTPC, so-called "Nam papa (Urban Water Supply System)", and the other is "Rural Water Supply System" managed by the village and district office, which is under the supervision of the Department of Public Health.

2.2.1 Urban Water Supply System in Xai City

The Nam papa Oudomxay established in 1987 is administratively and financially under the provincial authority (Department of CTPC), being operated under technical guidance of the Nam papa Vientiane. The water source for this water supply system is a spring in the mountain. The yield of this source is 12 lit./sec in the rainy season and 2 lit./sec in the dry season. The service area of this water supply system is about 460 ha with a total distribution pipe system of 9,500 m, serving about 8,800 people (approximately 50% of total city population). New water tariff is introduced from April 1992, in order to make the operation financially viable, which varies from Kip 40 to 80 /m³ for individual consumers and from Kip 100 to 120 /m³ for business consumers, respectively, depending on the total monthly water consumption.

2.2.2 Rural Water Supply System

Almost all lowland villagers along Route No.2 depend entirely on nearby streams and rivers for their drinking and domestic water. These villages are usually located near the perennial streams and rivers within a few hundred meters walk. These sources mostly are facing to fecal pollution and other types of contamination problems from human and animal origins.

Only the limited lowland villages have access to spring sources, and most of them are not protected against contamination by surface run-off. Shallow dug wells are also very rare and most of existing ones are not properly protected and maintained.

The villages in hilly and middle mountainous areas are in more poor situation of water availability than those of lowland areas because of limited water sources in general. In addition, the villagers hardly ever boil the water before drinking because of lack of personal hygiene.

In recent years, many organizations, such as UNICEF and Quaker, had made efforts for implementation of a number of water supply projects to improve access to safe water at the villages in northern region of Laos. In the study area, such improved water sources as shallow ring wells, hand pumps and gravity flow systems with HDP pipes exist. Although these systems are benefiting the people through time-saving and labour reduction in fetching water, in most cases further improvement works will be required to secure the supply of more safe water especially in its quality.

Although the reliable records of the number and their distribution of shallow ring wells and hand pumps are not available, eight (8) wells are observed and investigated, two wells in Xai, four in Beng and two in Hun districts, respectively. Among them, all hand pump-wells have been turned into open shallow wells because of lack of spare parts and caretakers, and only small groups of population living close to them use these sources.

The gravity flow piped system is strongly demanded by the villagers and considered as an improvement system of present traditional water sources, if water source is available in an effective distance from the village. The water sources of existing systems are located two to four km far from the villages to get clean water. The intake facilities (small reservoirs) are very primitive, installing a small stone masonry dam with a height of a half meter (0.5) and a width of two meters, without any protection from contamination. A water source reservoir is connected with a reservoir tank by HDP pipe, for stable water supply. From the reservoir tank, the water is distributed to the villages where common taps are installed at a ratio of one tap per 15 to 30 families.

There are five existing gravity flow systems in the study area, assisted by Quaker and UNICEF. During the plan/survey and construction stage, the provincial authority of the Department of Public Health is a responsible organization and the benefited people participate in the construction work with the provision of materials from the above external organizations.

After the construction, operation and management are transferred to the district office and/or villages.

Among the five systems, two systems are larger ones which are in Beng town and Hun town, covering five villages and six villages, respectively, and the others are small systems covering only one village each, depending on the village distribution and water source availability.

The existing gravity flow piped water supply systems are summarized below.

Village	No. of Family	No. of People	No. of Tap	District	Const. Year	Assistance
Beng town (5 villages)	362	1,892	26	Beng	1992	Quaker
Hun town (6 villages)	638	3,794	40	Hun	1989	UNICEF
B. Mai	43	300	2	Xai	1990	Quaker
B. Pounghieng	43	288	3	Xai	1991	Quaker
B. Lak	44	320	1	Xai	1991	Quaker

2.2.3 Water Quality

Sampling of drinking water was made in the three (3) districts, 15 water samples in total, 5 for each district, to examine the quality of water currently used for both domestic and irrigation purpose. The results show that there are no serious problems for drinking water except contamination caused by organic manure (see Table MG-1). These samplings were taken during the dry season, and so more serious condition of contamination may occur in the rainy season. For planning of water supply system, the protection from contamination is one of the factors to be considered (for details, refer to Volume III Feasibility Study).

2.3 Electricity Supply

2.3.1 Electricity Supply System in Xai City

Only one public electricity supply system in Xai city is available in the study area. The electricity supply service is operated and managed under the provincial authority of the Department of Industry and Handicraft. The system was established and started the electricity supply service in February 1991. The capacity of generator plant is 100 kW (two units of 50 kW generators), and one unit of the generator is alternately operated at present, because small number of families (218 families) is using the service as of May 1992.

The existing transmission lines, a total length of four (4) km with 22 kV and nine (9) km with 1.4 kV, are planned to be further extended to eight (8) km and 25 km,

respectively, within 1992. Because of the limited budget of the provincial authority and high cost of distribution line to each house which is the consumer's responsibility, however, the progress of the extension work is very slow.

The operation hours of the service are from 19:00 to 22:00 in the hot season (March to August) and from 18:00 to 21:00 in the rather cool season (September to February). And the tariff of electricity service is very low, charging Kip 550 per 20-W fluorescent lamp per month. This kind of public service is just at the beginning stage in Oudomxay, and the operation and management by the authority its self will be achieved step by step with a viable tariff.

2.3.2 Individual Small Generator

There are also individual small generators, and they are mostly concentrated in Xai city, Beng town and Hun town. These small generators are used for private purposes such as shops, hotels, restaurants, gas stations, video houses and also some individual houses. There are some exceptions which belong to the government, having their own generators or solar battery systems for official/public use. They are telecommunication offices, Lao aviation office, Oudomxay provincial hospital, meteorology station, etc.

The data on the number of private use generator are not available. According to the interviews with district officers, however, the capacity of those is very small, almost 1.5 kW, and the number is estimated at about 40 units in Xai city, eight units in Beng town and eight units in Hun town. These information shows very limited availabilities of electricity in the study area, with the conditions that almost the village people are living with kerosene lamps during night time.

2.3.3 Micro-hydro-power Plant in Beng Town

There is only one micro-hydropower plant for rural electricity supply in Beng town. The plant was completed in June 1992 with an economic assistance by the People's Republic of China. The total construction cost was Kip 14 million (US\$20,000 equivalent), which consisted of 80% foreign currency portion and 20% of local portion. The foreign portion was shared by the government of China (to be granted) and the Oudomxay province, and the local portion was born by the beneficiaries in a form of materials such as rock, gravel and log, and man power contribution.

The main features of the plant are as follows :

- Generating capacity : 3 kW x 2 units
- Water source : Nam Hao river
- Effective head : 3.8 m
- Distribution line : 2.6 km
- Beneficial village : Three villages
- Number of lamp : 235 (20 - 40 W)

After the completion, the plant was operated three times in September when excess water was available from the irrigation system because of heavy rain, and continuous operation was started from early November 1992. Three staff of the industry section of the district office are responsible for operation of the plant.

Even though the continuous operation can be made during non-irrigation period, the flow in the canal is not enough to operate the two units at full time. The one unit is being operated for two hours every two days, supplying the electricity alternately to 117 lamps in one village and 118 lamps in other two villages. Actual generation was 1.7 kW per unit in November. Whenever excess water is available during the daytime, the water is discharged through the plant not for lighting but for radiating heat.

The problems currently encountered are summarized as follows :

- (1) The priority of water supply is given to irrigation purpose.
- (2) Because of low technology in water management of the irrigation system, it is difficult to determine timely when excess water is available for generating purpose.
- (3) Because of traditional brushwood weir and water requirement for domestic use by the people, the amount of water diverted from the Nam Hao river will not be enough for full operation of the plant during the dry season.
- (4) The Nam Hao irrigation system currently serves six villages. On the other hand, the power plant can supply electricity to three villages of the six. In order to operate both the system and the plant properly, balance of the benefit from the same water source should be taken into consideration among the people concerned.

- (5) At present, the electricity charge is set at Kip 600 per 20 W lamp per month. However, no charge has been collected because of unsatisfactory operation of the plant.

2.4 Other Social Infrastructures

Three more subjects, namely school, hospital and community facilities are taken up as other social infrastructures in this section, taking into account the importance of education, health care and village community for rural development in the study area.

2.4.1 School

School facilities and education situation are very poor in the study area, especially in mountainous areas. The number of school and teacher is summarized as follows:

No. of School/Teacher		Xai	Beng	Hun
School	Primary School	84	76	35
	Secondary School	4	3	1
	High School	1	0	1
Teacher	San Soung*	1	3	11
	Sang Kang**	24	15	28
	San Thon***	35	29	30
	Komoun****	108	46	45

Note: *; Graduated from university.
 **; Graduated from 3 years college, after high school.
 ***; Graduated from 2 years technical school, after secondary school.
 ****; Non-certified, graduated from primary or secondary school, supported by the village people.

As described above, the number of "Komoun" teacher is very high which means low level of education. Although the number of primary school seems to be sufficient, about 50% of the existing primary schools has only class I and/ or class II. And 70% of pupils entered the primary schools ceases to learn by class II, though the compulsory education period is five years in Laos.

School houses and their equipment are also very poor because of lack of finance. According to the provincial officers of the Department of Education, the reasons for low ratio of entering the schools are as follows:

- (1) Children are considered as important labour force of their family.
- (2) Lack of the number of teachers (no incentive to go mountainous areas).
- (3) Lack of school facilities (lack of teachers, lack of finance, scattered villages distribution).

2.4.2 Hospital

Health care situations in the study area are as follows:

Facility	Xai	Beng	Hun	Total
Provincial hospital	1 (80)	-	-	1 (80)
Clinic	1 (5)	1 (12)	1 (22)	3 (39)
Sub-clinic	3	4	3	10
Pharmacy (public)	3	1	1	5
Pharmacy (private)	12	3	5	20

Note: Figures in parentheses show the number of beds.

Facility	Doctor	Nurse (Male)	Assistant Nurse
Provincial hospital	8	26	38
Xai clinic	-	2	7
Beng clinic	-	5	13
Hun clinic	-	5	21

Oudomxay provincial hospital and three clinics in the three districts are managed by the provincial authority of the Department of Public Health. Among the clinics, Xai clinic is very poor in both activities and facilities because of the existence of Oudomxay Provincial Hospital nearby. Further, the above ten sub-clinics are mostly not functioning because of poor or no facilities and lack of medicine. Assistant nurse level people or those who have traditional medical knowledge are in charge of the sub-clinics and supported by the village. Because of poor or no facilities and lack of medicine, however, those sub-clinics are not functioning satisfactorily.

Beng and Hun clinics are working in spite of poor facilities and equipment, even electricity and water supply are not available. They received five to ten patients a day and 75 of total inpatient in Beng clinic and 349 inpatient in Hun clinic in 1991.

Oudomxay Provincial Hospital, which was constructed in 1988 by the assistance of Vietnam, has considerably better conditions for both facilities and staff, received a total of 5,048 patients and 2,117 inpatient in 1991. The dominant diseases are the same among the above hospital and clinics, Malaria and Diarrhea in the rainy season and Bronchitis in the dry season.

2.4.3 Community Facilities

Community facilities (houses) exist almost in each village along Route No.2. In the villages which do not have such community facilities for their exclusive use, the villagers utilize a school or village leader's house as community facilities, whenever necessary. The facilities are used for important village communications such as discussions about cooperative activities for farming practice, construction and maintenance of irrigation facilities, roads and schools, and transferring official announce from the districts, etc.

3. SOCIAL INFRASTRUCTURE DEVELOPMENT PLAN

3.1 Physical Constraints

As mentioned in the previous chapter, the main constraints of social infrastructures which will affect directly and/or indirectly profitable agricultural development are summarized as follows:

- (1) Poor condition and lack of the district road network;
- (2) Lack of effective telecommunication facilities; and
- (3) Lack of electric power supply system.

Lack of good transport and communication systems is a constraint especially to the increase in crop production as well as in farm income of the farmers. In the study area, only the National Road No.2, all-weather paved road, is available for transportation of commodities, farm inputs and outputs, as well as for the people's moving from village to village by vehicles. The lack of good transport will also restrain the introduction and expansion of crop diversification by the farmers, especially cultivation of cash crops, in the study area. In addition, the lack of good communication system prevents the farmers from responding quickly to the market signals and being able to transport their products to the markets in order to meet a shortfall or to obtain favourable prices.

In addition, there exist the following constrains to the extension of education and health control, and development of other human needs for the people.

- (4) Lack and poor condition of domestic water supply system
- (5) Lack and poor condition of such public service facilities as primary schools, clinics and community houses.

3.2 Development Concept

Further development of social infrastructures, especially the facilities for people's welfare, education and for promotion of farmer's progressive activities related to the increase in agricultural productivity, should also be taken into consideration in connection with the proposed agricultural development. Such facilities will be as follows:

- (1) The lack of good transportation also restrains the introduction and expansion of improved farming and crop diversification by farmers as well as marketing

of farm inputs and outputs. The first priority will be given to the rehabilitation and grade-up of existing district road network in the study area.

- (2) Villages where rural water supply system is already available are still very limited, only those in each district centre. The rural water supply system has advantages of mitigating hard works by children and women to fetch their domestic water from the adjacent streams and/or rivers, as well as of improving the people's health. The study is made to construct additional rural water supply systems, though it depends on the availability of water sources. In this case, priority is given to the gravity flow piped system, and consideration is also paid to the construction of lined dug wells.
- (3) Although most of the villages in the study area have their own primary school, the buildings and equipment are very poor. Rehabilitation of the school buildings is studied as one of the components in the integrated rural agricultural development program. The rehabilitated school buildings could be used not only for education of children but for adult, especially women, to improve the illiteracy rate.
- (4) The construction of additional community facility, meeting house, is also studied for villages which do not have such a facility for their exclusive use, as one of the components in the integrated development program. This community facility will be used for various purposes such as community's activities for cooperative works, agricultural extension services, training of farmers, health care of the people, etc.

3.3 Development Plan

As mentioned above, development plan for this project component includes those for (i) rehabilitation and grade-up of district road network, (ii) construction of additional rural water supply facilities, and (iii) rehabilitation and construction of primary schools and community facilities, and the program for each plan will be phased, described as follows:

Phasing of the infrastructures development is studied in accordance with the overall agricultural development strategy and also taking into consideration the following weight factors for each of the essential components:

Item	Beneficiary Population	Agricultural Potential (ha)	Availability of Water Resources
1. Road Network	⊙	⊙	-
2. Water Supply	○	-	⊙
3. Electric Supply	○	-	⊙
4. School/Community facilities	⊙	-	-

Note: ⊙: High weight ○ : Medium weight

3.3.1 Short Term Development

There are some district roads in and around the proposed model areas in Xai, Beng and Hun, which are connected to the National Route No.2 being improved by ADB Loan. They are currently very poor in condition and have no structures such as bridges and cross culverts. Because these roads are the main access to the markets in each district, the improvement of these roads will be carried out in connection with the implementation of the model areas as a model in future infrastructures development in other areas.

The short term development will also include the construction of rural water supply systems in the villages which have no water supply system at present, and the rehabilitation of primary schools and community facilities in each model area.

3.3.2 Medium Term Development

The medium term development strategy for social infrastructures will be to improve the main district roads, to construct rural water supply system in the villages where the water sources are available and the population is more than 300, and to study the possibility of micro-hydropower schemes for electrification in the areas where the potential exists. The rehabilitation of primary schools and community facilities will also be made in the villages with a population of more than 500. The project's activities for social infrastructures under the medium term development will generally be concentrated on densely populated villages which will be the base for further extension of integrated agricultural development in the study area.

3.3.3 Long Term Development

Generally, the long term development strategy for social infrastructures will be to expand the project's activities and supports to the improvement and construction of district road network, rural water supply system and school/community facilities in the medium size of villages with a population ranging from 200 to 500.

Development plans of social infrastructures in the short, medium and long term development are summarized in Table MG-2 and described in detail in the following chapter:

4. PROJECT DESCRIPTION

4.1 Development of District Road Network

The improved district roads will provide not only permanent access from the National Route No.2 to each sub-district as well as for local traffic services to accelerate agricultural and socio-economic activities of the people, but also access to the potential areas for future irrigation development. Considering these functions of district roads, selection criteria for phasing of the road improvement to be proposed are studied, taking into account the following two main factors:

- Potential areas for irrigation development
- Beneficial population

4.1.1 Phasing of Road Improvement

There are 18 main potential areas for irrigation development with a total area of about 2,660 ha and 41 sub-districts with a total population of about 100,000 in the three districts. The location of the potential areas and beneficial people related to each district road are shown in Fig. MG-2.

In the study area, there are 33 routes of district roads with a total length of 500 km, including 202 km of roads which are currently passable by 4 WD vehicles in the dry season and 298 km of footpath-level roads. These roads can also be classified into two groups, those with high priority and lower one, respectively, based on the beneficial population and irrigation potential areas related to each of the routes. The high priority group includes 15 routes with a total length of 221 km, and the lower priority group has 18 routes with a total length of 279 km, as shown in Table MG-3.

The high priority roads are further divided into two groups, namely the existing roads (two routes) around the proposed model areas with a total length of 9.4 km which will be improved under the short term development plan. The remaining include 138 km of district roads (eight routes) and 73 km of footpaths (four routes), and would be improved at the medium term development stage.

The lower priority group can also be divided further into two groups, the roads (nine routes) which are currently passable by 4 WD vehicles in the dry season and those presently at footpath level. Their total length will be 79 km and 200 km, respectively. The

improvement of these roads is proposed to be included in the long term and future development programs mainly because of small population and their lower priority in terms of overall agricultural development in the study area.

The development programs by phase of the district road network is summarized as follows and detailed in Table MG-4 and Fig. MG-3:

Development Program	Total Length (km)
1. Short Term Development (1995-2000)	
(a) Improvement of priority district roads in and around the two model areas (from earthen type to gravel road) (*)	10
(b) Strengthening of existing road maintenance system	
(Sub-total)	<u>10</u>
2. Medium Term Development (2001-2005)	
(a) Improvement of priority district roads (from earthen type to gravel road) (**)	138
(b) Construction of priority district roads (from footpath to gravel road) (**)	73
(Sub-total)	<u>211</u>
3. Long Term Development (2006-2010)	
(a) Improvement of lower priority district roads (from earthen type to gravel road) (**)	79
(b) Improvement of lower priority district roads (from footpath to earthen type passable by 4 WD vehicles)	200
(Sub-total)	<u>279</u>
4. Future Program (after 2011)	
(a) Improvement of lower priority district roads (from earthen type to gravel road) (**)	200
Total length	<u>700</u>
(*) : for the whole sections	
(**) : on steep gradients	

4.1.2 Design Standard

The following design standard commonly applied to rural tertiary roads in Laos is applied for the Master Plan study:

- Design speed : 25 km/hour
- Carriage way width : 3.5 m
- Shoulder width : 1.25 m x 2 sides
- Gravel pavement : On steep gradients
- River crossing : Causeway (Irish bridge)

4.1.3 Maintenance System

Almost no maintenance work of the district road network is carried out by the provincial office because of limited budget, staff and equipment, and very limited maintenance work is made only by manpower of the village people. Although it is officially announced that all the district roads should be maintained by each district and the village people, actual efforts by the districts as well as the village people to maintain all the district roads in good condition are limited to small works because of difficulties in financing and no equipment. In addition, heavy equipment kept by the Enterprise of Bridge and Road Construction under the Department of CTCP who is responsible for construction and maintenance of provincial roads is also very poor in both number and condition. The Enterprise has only three units of dump trucks at present. Some equipment will have to be provided for the enterprise in order to assist the district offices and the village people in maintenance of the district road network.

4.2 Development of Rural Water Supply System

A priority will also be given to the supply of clean water for drinking and domestic use, because the present situations of water supply services to the people in the study area are still very poor as mentioned in Chapter 1.

4.2.1 Phasing of Water Supply System Development

For practical implementation of water supply system development under the Master Plan, phasing of the development should be taken into account, selecting the priority villages of areas. The factors to be included in the selection criteria would be:

- (a) availability of water sources;
- (b) prospective population of beneficiary;
- (c) water quality of available sources of supply;
- (d) conditions of existing water supply facilities;
- (e) distance from and access to the available water sources; and
- (f) construction cost per capita of the supply system.

However, data and information on the available water sources are very limited at present, except for some villages located along the National Route No.2 where investigations for future water supply development were already made by the district offices and/or the UNICEF. Therefore, the study is made, taking into account two factors, (a) and (b) in the above, in order to make up selection criteria for the Master Plan Study.

In the study area, there are 435 villages, among which 25 villages are already served by Xai city water supply system; and five villages in Beng and six villages in Hun are receiving the water from the existing town water supply systems. Then, the remaining 399 villages are classified into four groups for stage-wise development of water supply system. The first priority is given to the villages located in and around the three model areas, where available water sources are already confirmed and the average population is rather high between 390 and 440. The villages, with a rather high population of more than 300 on an average and where water sources are assumed to be available, are classified into the second group. The third group includes those with a total population between 200 and 300 on an average and the villages of the fourth group are those with a population less than 200, available water sources of which should be surveyed in the future programs. The stage-wise development of these groups and the number of related villages are summarized as follows:

Group	Development Stage	Xai	Beng	Hun	Total
First group	Short term development	3	4	5	12
Second group	Medium term development	22	7	11	40
Third group	Long term development	22	31	61	114
Fourth group	Future program	100	59	74	233

4.2.2 Proposed Water Supply System

The following type of water supply systems will be studied in terms of economical construction and easy operation and maintenance by the staff concerned as well as the village people.

- (a) Shallow wells with bucket and pulley
- (b) Gravity flow pipe system with distribution network

The shallow wells would have concrete casing, concrete platform, roofing, drain and additional space for bathing and washing.

For the pipe system, consideration will be paid for construction of intake structure with a small reservoir for stable supply of clean water, depending on the capability of O&M and willingness of the recipient community. Springs on the mountain slope are the most desirable source for the gravity flow pipe system, which locate with a distance between 1 and 3 km away from the service area. Small perennial streams are also recommended for economic comparison of either springs or streams. It is preferable that the distribution network could cover as many villages as possible depending on the village location, and has supply taps, each for 50 inhabitants approximately. Unit domestic water consumption of 45 lit./person/day will be

used as a minimum requirement for planning and design of the village water supply system, making reference to similar projects carried out around the study area.

4.3 Development of Electricity Supply

Although rural electrification is one of the main requisites for the people as well as for development of rural socio-economic activities in the study area, the main constraints to the rural electrification are lack of data and information on the availability of water sources and the location. In the Master Plan, preliminary study on electrification schemes in three densely populated areas such as Xai city, Beng and Hun towns is made as shown below.

4.3.1 Xai City

The existing provincial electric supply system in Xai city with a generating capacity of 100 kVA would be sufficient to meet the electricity demand up to the year 2000, based on the following assumption:

Item	1992 (present)	2000 (assumption)
1. No. of consumers in family	239	1,500
2. Potential consumers in family	2,229	15,000
3. Electricity consumption per family (W)	40	60
4. Total electricity consumption (kW)	9.6	90

The operating cost of the existing diesel power plant would be rather high, as compared with hydro-power plant. According to the Department of CTPC, a feasibility study on the Longya hydro-power scheme with a generating capacity of 1,600 kW on the Nam Kho river in Oudomxay province was carried out by China in August, 1991. In addition, the study shows that a possible site for hydro-power development may exist at 32 km from Xai city along the Nam Nuan river. These two hydro-power development schemes may be considered in the future program in connection with the agricultural development in the study area.

4.3.2 Beng Town

Performance and monitoring of the on-going micro hydro-power scheme in Beng town are recommended to obtain data and information useful for future extension of such a micro type of power scheme in other areas. Operating conditions of the existing facility are described in the feasibility report (Volume III) in detail, which also suggests that there exists a proper site for full operation of the facilities, locating at about 8 km upper stream of Nam Hao river from Beng town.

It is proposed that more detailed study and examinations including the economic and technical feasibility will have to be made in connection with irrigation development on the Nam Hao. A full operation of power-plant will enable the people to develop agro-processing business such as rice mill. Therefore, very preliminary plan recommended for the medium term program, is summarized below and shown Fig. MG-4.

Generating capacity	:	5 kw x 2 units
Water source	:	Nam Hao river
Location of power plant	:	8 km upper stream from Beng town
Effective head	:	5 m
Transmission line	:	8 km
Distribution line	:	2.6 km
Beneficial village	:	4 village (B. Namhao, B. Benglouang, B. Bengkham, B. Nahouay)
Beneficial family	:	250 families (40 w /family)

4.3.3 Hun Town

The study on a micro-hydro-power scheme on the Nam Heng for electrification of Hun town is recommended in the medium term development to examine its economic and technical feasibility in combination with the irrigation development.

4.3.4 Electrification in Other Rural Areas

Some perennial rivers in the study area will also have the potential for micro-power development. Investigations and feasibility study of the micro hydro-power schemes in such rivers will be proposed as one of the components in the long term development.

Perennial rivers having the potential for micro-power development are listed below:

District	Village	Water Source
Xai	B. Kho-noi	Nam Kho
	B. Nammiang	Nam Miang
Beng	B. Nammet	Nam Met
	B. Napa-tai	Nam Xat
	B. Xengle	Nam Lo
Hun	B. Nanguen	Hoay Xat
	B. Donkham	H. Kao
	B. Fen	Nam Oun

4.4 Development of Other Infrastructures

The present conditions of primary schools and community facilities in the study area are very poor. Especially, the community facilities are useful for communication and socio-economic activities of the village people and are expected to be utilized further for the farmers' training, establishment of farmers organization, agricultural extension services, etc. Improvement of the primary schools and community facilities will have to be included as one of the components in the agricultural development.

The Department of Education of Oudomxay province has a plan to construct more primary schools in the rural areas, which is (i) primary school (class I&II) in each village; and (ii) primary school (class III,IV&V) in each sub-district.

In the Master Plan study of improving the primary schools and community facilities, the first priority is given to those of the villages located in and around the three model areas. They will be improved under the short term development plan and are as follows:

Model Area	No. of Village	Ethnic Group	No. of Family	Population
1. Xai	5	Lao Loum	479	2,899
2. Beng	3	Lao Loum	251	1,311
3. Hun	6	Lao Loum & Lao Theung	584	3,044
Total	<u>14</u>		<u>1,314</u>	<u>7,254</u>

For the priority ranking in the stage-wise development of primary schools and community facilities in other 421 villages, except for the above 14 villages, in the study area, consideration is given to the population of each village. The villages with a population of more than 500 will be included in the medium term development, and those with a population between 200 and 500 will be covered by the long term development plan. The remaining villages with a population of less than 200 are proposed to be included in the future program. The number of villages to be included in each development stage is summarized as follows:

District	Medium Term	Long Term	Future Program
Xai	14	37	116
Beng	4	38	61
Hun	12	65	74
Total	<u>30</u>	<u>140</u>	<u>251</u>

5. REFERENCES

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3. The Urban Water Supply Scheme at Oudomxay (Report of field Visit), October 1990 by Sector Development Team for Asia Water Supply and Sanitation, WB/UNDP Project
4. A Diagnostic Survey of Shifting Cultivation in Northern Laos: targeting research to improve sustainability and productivity, 1991 by Social Sciences Division, IRRI

Table

Table MG-1 Water Quality Analysis

Item	Standard	Sample Number														
		X-1	X-2	X-3	X-4	X-5	B-1	B-2	B-3	B-4	B-5	H-1	H-2	H-3	H-4	H-5
1. Turbidity (NTU)	< 2	3.7	1.5	1.6	1.1	1.8	2	1.9	1.7	28.4	6.2	0.8	0.9	5.4	3.3	1.7
2. Color (TCU)	< 5	none	none	none	none	none	none	none	none	< 5	none	none	none	none	none	none
3. Odor		normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal
4. pH	6.6-8.5	7.1	7.3	7.5	7.1	6.25	7.65	7.55	7.45	6.65	7.35	7.4	7.65	7.2	7.5	7.45
5. Nitrite Nitrogen (ppm)	< 10	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
6. Nitrate Nitrogen (ppm)	< 10	none	none	none	none	none	none	none	none	none	none	none	none	none	none	none
7. Chlorine (ppm)	< 200	1.41	31.9	3.54	3.54	4.96	5.67	5.64	12	8.5	5.67	16.3	2.83	7.09	6.38	15.5
8. KMnO4 (ppm)	< 10	6.32	3.16	6.95	2.52	1.89	2.21	2.21	1.26	9.78	4.74	1.58	4.42	2.52	13.58	18.64
9. Total Hardness (ppm)	< 300	120	164	148	98	44	246	108	214	28	126	296	192	226	148	126
10. Iron (ppm)	< 0.3	< 0.06	0.06	0.06	< 0.06	0.15	0	0	< 0.06	< 0.06	< 0.06	0.01	0.2	0.4	0.02	0.02
11. Aluminium (ppm)	< 0.2	0.04	0.08	0.4	0.04	0.1	0.6	0.4	0.5	0.5	0.3	0.01	0.2	0.4	0.02	0.02

(Analyzed by Laboratory of Nam Papa Lac, Vientiane)

Note : Information about sampling water

Sample No.	Village	Water Source	Type
X-1	Xai city	H. Phou Hipi	Water supply tap
X-2	B. Lak 7	Nam Kho	River
X-3	B. Houay Khoum	Nam Mao	River
X-4	B. Mai	H. Phai	Water supply pipe
X-5	B. Tiao	Well	Shallow well with concrete ring
B-1	B. Benghuang	H. Klee	Water supply pipe
B-2	B. Benghuang	Nam Hao	River
B-3	B. Konkham	H. Kon	Shallow well with concrete ring near stream
B-4	B. Namkhong	H. Tachieu	Dug hole near stream
B-5	B. Namet	Nam Met	River
H-1	Hun town	H. Kou	Water supply pipe
H-2	B. Nanguen	H. Khoa	Water supply pipe
H-3	B. Na	Nam Ngat	Dug hole near stream
H-4	B. Somphon	Nam Kham	Dug hole near stream
H-5	B. Navang	Nam Beng	Dug hole in the stream

Table MG-2 Phasing of Social Infrastructures Development

Item	Short Term [1995-2000]	Medium Term [2001-2005]	Long Term [2006-2010]
1. District Road	<p>1. Improvement of the existing district roads in and around the model area (from earth to gravel road for the whole sections) L= 10 Km approx.</p> <p>2. Enforcement of the existing road maintenance system</p>	<p>1. Improvement of the prior district roads (from earth to gravel road on steep gradients) L= 138 Km approx.</p> <p>2. Construction of the prior district roads (from footpath to gravel road on steep gradients) L= 73 Km approx.</p>	<p>1. Improvement of the lower priority district roads (from earth to gravel road on steep gradients) L= 79 Km approx.</p> <p>2. Improvement of the lower priority district roads (from footpath to earthen road) L= 200 Km approx.</p>
<u>Model areas</u>			
2. Water Supply	approx. 12 villages	approx. 40 villages	approx. 114 villages
3. School / Community Facilities	approx. 14 villages	approx. 30 villages	approx. 140 villages
<u>Densely populated villages</u>			
4. Electricity	Observation of the on-going project in Beng town	<ul style="list-style-type: none"> - Study for Hun town - Strengthening of Beng town electricity facilities (New construction of the plant at upper stream of Nam Hao river) 	Study on the availability for other villages in the whole study area
<u>Remote villages</u>			

Table MG-3 Priority Ranking for District Road Development

Road No.	Section	From	To	Dist. (km)	Dist. rict	Remark	Beneficial Sub-District	Nos. of Villages	Population	Irrigation Project No.	Irrigation Project T. Area (ha)	Rank	Evaluation Point
(1)	Km-0(Xai)	B.Longya	B.Pourghiang	22	Xai	*	Bambo Gnai, Longya	19	4,714	2,3	362	A+A	6
(2)	Km-18(Road4)	B.Nasao	B.Tasaluang	4	Xai	*	Longya	13	2,255	-	-	B+D	2
(3)	B.Nasao	B.Tasaluang	B.Nampha	17	Xai	*	Naguan, Banlao, Chomka	53	7,624	6	35	A+B	5
(4)	B.Tasaluang	B.Nampha	B.Tangkok	22	Xai	*	Banlao, Chomka, Chomong	42	5,739	-	-	A+D	3
(5)	B.Nampha	B.Tasaluang	B.Mokchaktai	18	Xai	*	Chomka	12	1,669	-	-	C+D	1
(6)	B.Tasaluang	B.Vangyan	B.Vangyan	12	Xai	*	Chomong	14	1,631	-	-	C+D	1
(7)	Km-14(Road2)	B.Nachang	B.H.Liang	8	Xai	*	Narouang, Nga (1/2) ****	12	12,727	-	-	A+D	3
(8)	Km-14(Road1)	B.Namheng	B.Namheng	6	Xai	*	Kono(1/2) ***, Phonhom	17	3,123	-	-	B+D	2
(9)	Km-11(Road1)	B.Namheng	B.Namheng	6	Xai	*	Honzai(1/2) ***, Phonhom	16	3,069	-	-	B+D	2
(10)	B.Nabon	B.Xiang	B.Namheng	20	Beng	*	Namhen	10	1,426	-	-	B+D	2
(11)	B.Xiang	B.Namkhong	B.Namkhong	12	Beng	*	Banlai, Vienkeo, Phouxai	24	4,151	-	-	A+D	3
(12)	B.Thakat	B.Namtheun	B.Namtheun	12	Hun	*	Banhoue	11	1,852	-	-	C+D	1
(13)	B.Namtheun	B.Na	B.Namtheun	9	Hun	*	Donteko, Naxiandi	24	6,009	12	226	A+A	6
(14)	B.Chantai	B.Namliang	B.Namliang	18	Hun	*	Banhoue	11	1,457	-	-	C+D	1
(15)	Hun town	B.Mokkalai	B.Mokkalai	4	Hun	*	Hun II	17	4,983	13	32	A+B	5
(16)	B.Chantai	B.Mokkalai	B.Mokkalai	4	Hun	*	Chanrai(1/2) ***	7	1,652	-	-	C+D	1
(Sub-total) 202 (km)													
(17)	B.Houayxang	B.Houay Nambak	B.Namkouat(Road1)	25	Xai	*	Longya	13	2,255	-	-	B+D	2
(18)	B.H.Nambak	B.Kanvang	B.Chom-Oung	20	Xai	**	Houanangma	14	3,066	-	-	B+D	2
(19)	B.Nampa	B.Mokchouk(Road1)	B.Mokchouk(Road1)	11	Xai	**	Vienkhan	8	1,116	-	-	C+D	1
(20)	B.Mokchaktai	B.Nachang	B.Nachang	9	Xai	**	Chomoung	14	1,631	-	-	C+D	1
(21)	B.Chom-Oung	B.Sako	B.Namheng	13	Beng	**	Chomoung	14	1,631	-	-	C+D	1
(22)	B.H.Liang	B.Tongchong	B.Khon	13	Beng	**	Phomhom	11	2,117	-	-	B+D	2
(23)	B.Vangyan	B.Namkhong	B.Namkhong	12	Beng	**	Nahouang, Nga (1/2) ****	12	12,727	*****	50	A+B	5
(24)	B.Namheng	B.Namtheun	B.Namtheun	16	Hun	**	Namheng	10	1,426	-	-	C+D	1
(25)	B.Tandu	B.Namliang	B.Namliang	24	Hun	**	Phouxai	6	1,310	-	-	C+D	1
(26)	B.Namkhong	B.Namtheun	B.Namtheun	12	Hun	**	Banhoue	11	1,852	-	-	C+D	1
(27)	B.Na Houay	B.Namtheun	B.Namtheun	12	Hun	**	Nahom, Phonhom	14	2,712	-	-	B+D	2
(28)	B.Phouloung	B.Namtheun	B.Namtheun	13	Beng	**	Nahom	9	1,622	-	-	C+D	1
(29)	B.Phouloung	B.Namtheun	B.Namtheun	21	Beng	**	Phonhom	5	1,090	-	-	C+D	1
(30)	B.Namtheun	B.Namliang	B.Namliang	16	Hun	**	Naxiandi	11	2,854	12	226	B+A	5
(31)	B.Namliang	B.Namliang	B.Namliang	33	Hun	**	Namphour	8	1,432	-	-	C+D	1
(32)	B.Namliang	B.Namliang	B.Namliang	24	Hun	**	Phouviernxai	14	2,027	13	32	B+B	4
(33)	B.Mokkalai	B.Kongmouang	B.Kongmouang	25	Hun	**	Phousei	14	3,559	-	-	B+D	2
(Sub-total) 298 (km)													
(District Road Total) 500 (km)													

****: Ranking and point as follows:
 Population: >= 4,000 (A), >= 2,000 (B), >= 500 (C), >= 500 (D), None (0)
 Irrigation Area (ha): >= 100 (A), >= 30 (B), >= 0 (C), None (D)
 Rank: A, B, C, D
 Point: 3, 2, 1, 0

**: Passable by 4WD vehicle in the dry season, need rehabilitation
 *: Footpath presently, need new construction
 ***: a 1/2 of people is assumed as a beneficial one
 ****: a 1/2 of people of Nga District is assumed as a beneficial one
 *****: Minimum assumption

Table MG-4 District Road Development Plan

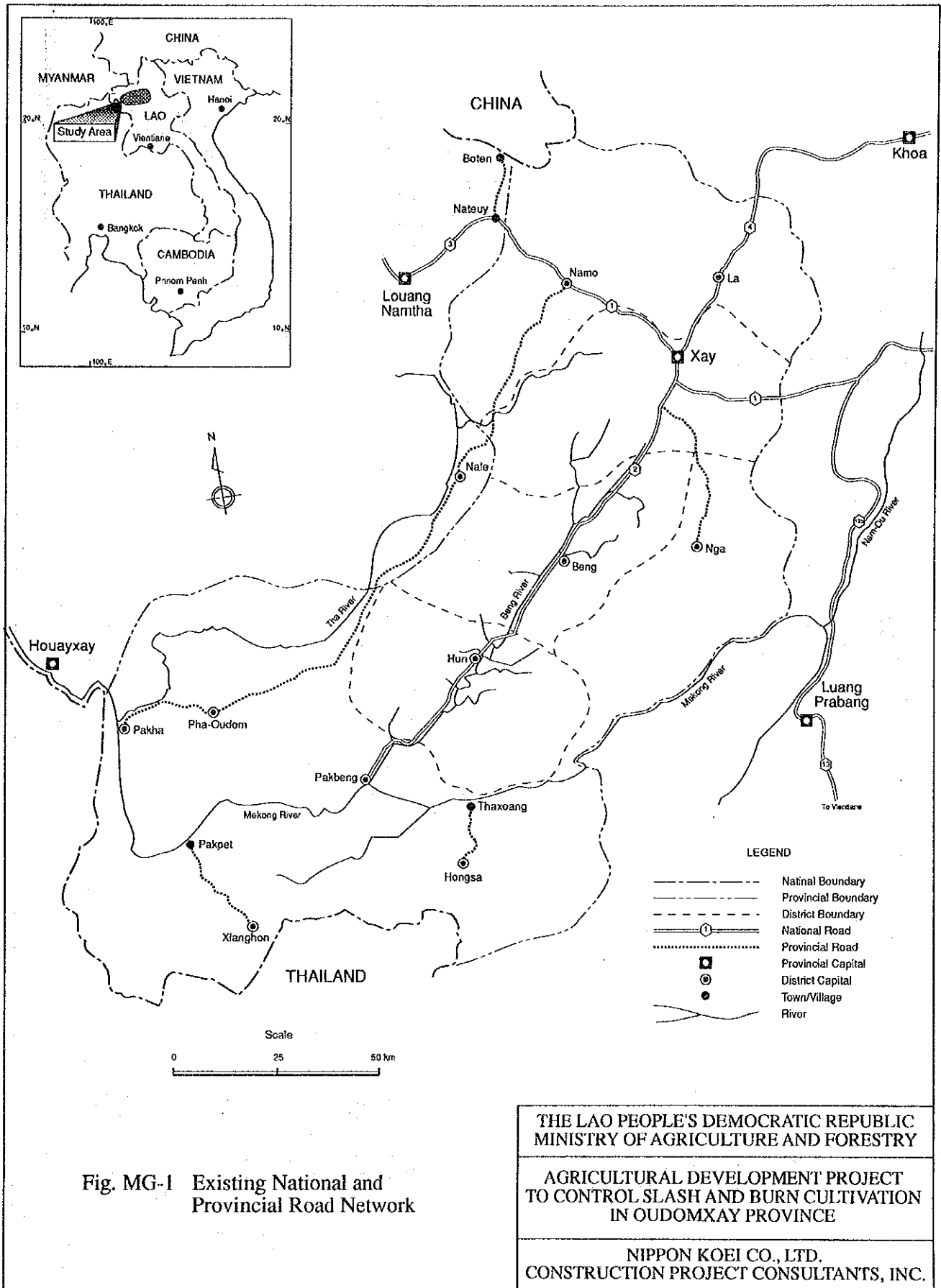
Road No.	Section		Length (km)	District	Remark	Priority Points***
	From	To				
<u>Short Term (1995-2000)</u>						
(3)	B.Nasao	B.Nale	2	Xai	*	5
(15)	Hun Town	B.Somphon	8	Hun	*	5
			(S.T.-total)	10		
<u>Medium Term (2001-2005)</u>						
(1)	Km-0(Xai)	- B.Longya	22	Xai	*	6
(3)	B.Nale	- B.Tasaluang	15	Xai	*	5
(4)	B.Tasaluang	- B.Nampha	22	Xai	*	3
(7)	Km-14(Road2)	- B.Vangyan	12	Xai	*	3
(11)	B.Xiangle	- B.Tangdu	20	Beng	*	3
(13)	B.Nangeun	- B.Namtheun	12	Hun	*	6
(15)	B.Somphon	- B.Namliang	10	Hun	*	5
(17)	B.Houayxang	- B.Houay Nambak	25	Xai	*	2
			(Sub-total)	138		
(18)	B.H.Nambak	- B.Namkouat(Road1)	25	Xai	Km-32, **	2
(23)	B.Vangyan	- Distri.Boundary	8	Xai	to Nga, **	5
(30)	B.Namtheun	- B.Naxiandi	16	Hun	**	5
(32)	B.Namliang	- B.Kang	24	Hun	**	4
			(Sub-total)	73		
			(M.T.-total)	211		
<u>Long Term (2006-2010)</u>						
(2)	Km-18(Road4)	- B.Pounghiang	4	Xai	*	2
(5)	B.Nampha	- B.Tangkok	18	Xai	*	1
(6)	B.Tasaluang	- B.Mokchaktai	12	Xai	*	1
(8)	Km-14(Road1)	- B.Nachang	8	Xai	*	2
(9)	Km-11(Road1)	- B.H.Liang	6	Xai	*	2
(10)	B.Nabon	- B.Namheng	6	Beng	*	2
(12)	B.Thakat	- B.Namkhong	12	Beng	*	1
(14)	B.Chantai	- B.Na	9	Hun	*	1
(16)	B.Chantai	- B.Mokkalai	4	Hun	*	1
			(L.T.-total)	79		
<u>Future Program (after 2011)</u>						
(19)	B.Nampa	- B.Kanvang	20	Xai	**	1
(20)	B.Mokchaktai	- B.Chom-Oung	20	Xai	**	1
(21)	B.Chom-Oung	- B.Mokchouk(Road1)	11	Xai	Km-25, **	1
(22)	B.H.Liang	- B.Nachang	9	Xai	**	2
(24)	B.Namheng	- B.Sako	13	Beng	**	1
(25)	B.Tandu	- B.Tongchong	10	Beng	to Kanvang,	1
(26)	B.Namkhong	- B.Khon	13	Beng	to Nale, **	1
(27)	B.Na Houay	- B.Phouloung	12	Beng	**	2
(28)	B.Phouloung	- B.Nahom	13	Beng	**	1
(29)	B.Phouloung	- B.Lamoua	21	Beng	**	1
(31)	B.Namliang	- B.Phouthong	33	Hun	to Sanouk,	1
(33)	B.Mokkalai	- B.Kongmouang	25	Hun	to Phaoudom	2
			(F.P.-total)	200		
			(Total)	500		

*: Passable by 4WD vehicle in the dry season, need rehabilitation

**: Footpath presently, need new construction

***: Classified according to the factors of irrigation potential and beneficial population

Figure

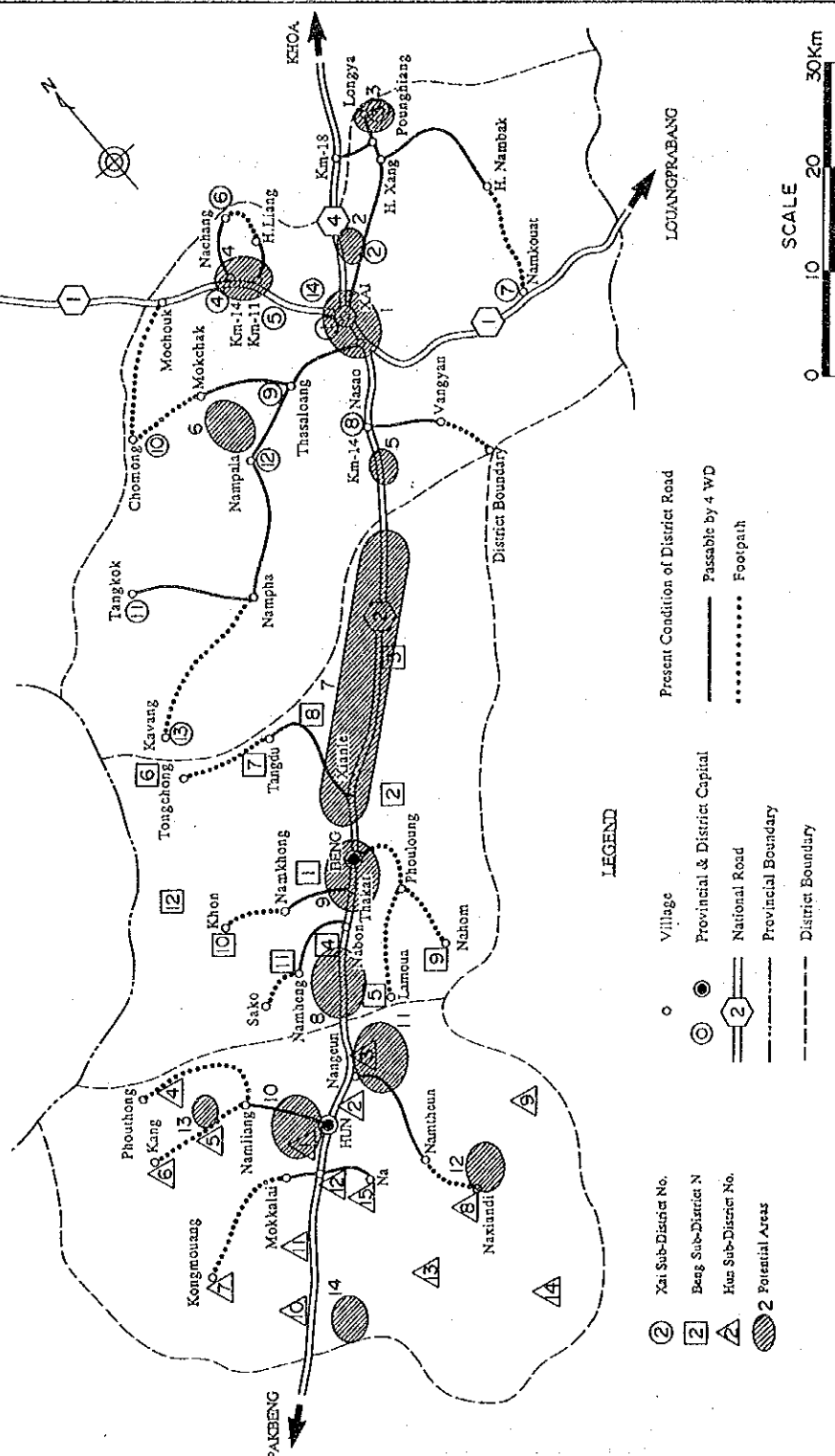


BRIGADION POTENTIAL AREA (Based on Irrigation Scheme)

No.	Commune	Village	Sub-District	District	Area (ha)
1	Nak		Xai	Xai	492
2	Bo		Banbo-pud	Xai	277
3	Longya		Longya	Xai	85
4	Konol		Konol	Xai	80
5	Nabovang		Nabovang	Xai	20
6	Naguan		Naguan	Xai	35
7	Ojo		Bangho	Beng	545
8	Samlang		Phonai	Beng	96
9	Beag		Beag	Beng	309
10	Hin		Hin	Hun	438
11	Naguan		Dowabo	Hun	56
12	Natong		Nakchak	Hun	226
13	Phakben		Phakben	Hun	32
14	Shomkhang		Shomkhang	Hun	2,662

POPULATION BY SUB-DISTRICT

HUN District		BENG District		XAI District		
No.	Sub-District	Population	Sub-District	Population	Sub-District	Population
1	Hin I	5,150	Beag	3,273	Xai	7,588
2	Hin II	3,451	Bangho	3,671	Banbo-pud	2,459
3	Dowabo	3,155	Naga	3,681	Longya	2,255
4	Nabovang	2,672	Phonai	2,047	Konol	2,011
5	Phakben	1,866	Phonabon	1,990	Honai	1,903
6	Pho-viavai	2,027	Vinhoo	1,310	Phonabon	2,117
7	Phonai	3,539	Vinhoo	1,286	Hovanang	2,066
8	Nakchak	2,454	Baidi	1,555	Nabovang	1,486
9	Namhong	1,432	Nabon	1,622	Naguan	1,885
10	Shomkhang	2,467	Banbann	1,452	Chomeng	1,531
11	Naguan	2,185	Nabon	1,426	Chomai	1,469
12	Chantai	3,504	Phonai	970	Brotan	2,459
13	Pakong	1,754			Vinhoo	1,116
14	Doungdon	2,305			15 Village	6,020
15	Banbann	1,457				
(Sub-total)		39,718	(Sub-total)	23,163	(Sub-total)	37,446
				(Total of 3 districts)		100,227



- LEGEND**
- Village
 - ⊙ Provincial & District Capital
 - ② Xai Sub-District No.
 - ③ Beag Sub-District No.
 - ④ Hun Sub-District No.
 - ⑤ Potential Areas
 - Present Condition of District Road
 - Passable by 4 WD
 - Footpath
 - National Road
 - Provincial Boundary
 - - - District Boundary

Fig. MG-2 Distribution of Population & Irrigation Potential Areas

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
 MINISTRY OF AGRICULTURE AND FORESTRY

AGRICULTURAL DEVELOPMENT PROJECT
 TO CONTROL SLASH AND BURN CULTIVATION
 IN OUDOMXAY PROVINCE

NIPPON KOEI CO., LTD.
 CONSTRUCTION PROJECT CONSULTANTS, INC.

District Road Length		Beng District		Xai District	
No.	Km	No.	Km	No.	Km
13	12	10	6	1	22
14	9	11	20	2	4
15	18	12	3	3	17
16	4	13	4	4	22
30	16	25	10	5	18
31	33	26	13	6	12
32	24	27	12	7	12
33	25	28	13	8	6
		29	21	9	6
				17	25
				18	25
				19	20
				20	20
				21	11
				22	9
				23	9
(Sub-District)	141	120	239		
		(Total)	500		

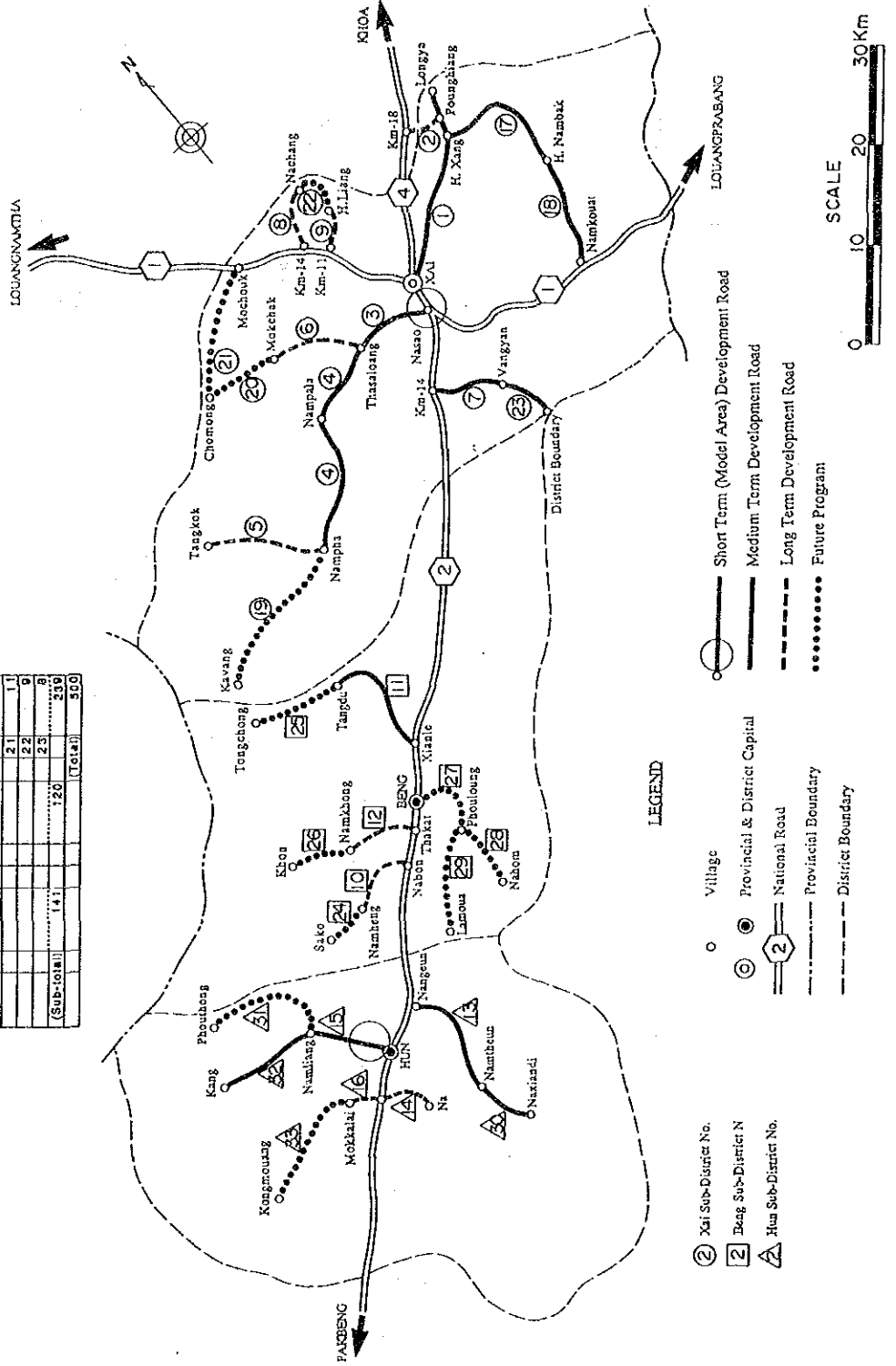


Fig. MG-3 District Road Network Development Plan

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
 MINISTRY OF AGRICULTURE AND FORESTRY

AGRICULTURAL DEVELOPMENT PROJECT
 TO CONTROL SLASH AND BURN CULTIVATION
 IN OUDOMXAY PROVINCE

NIPPON KOEI CO., LTD.
 CONSTRUCTION PROJECT CONSULTANTS, INC.

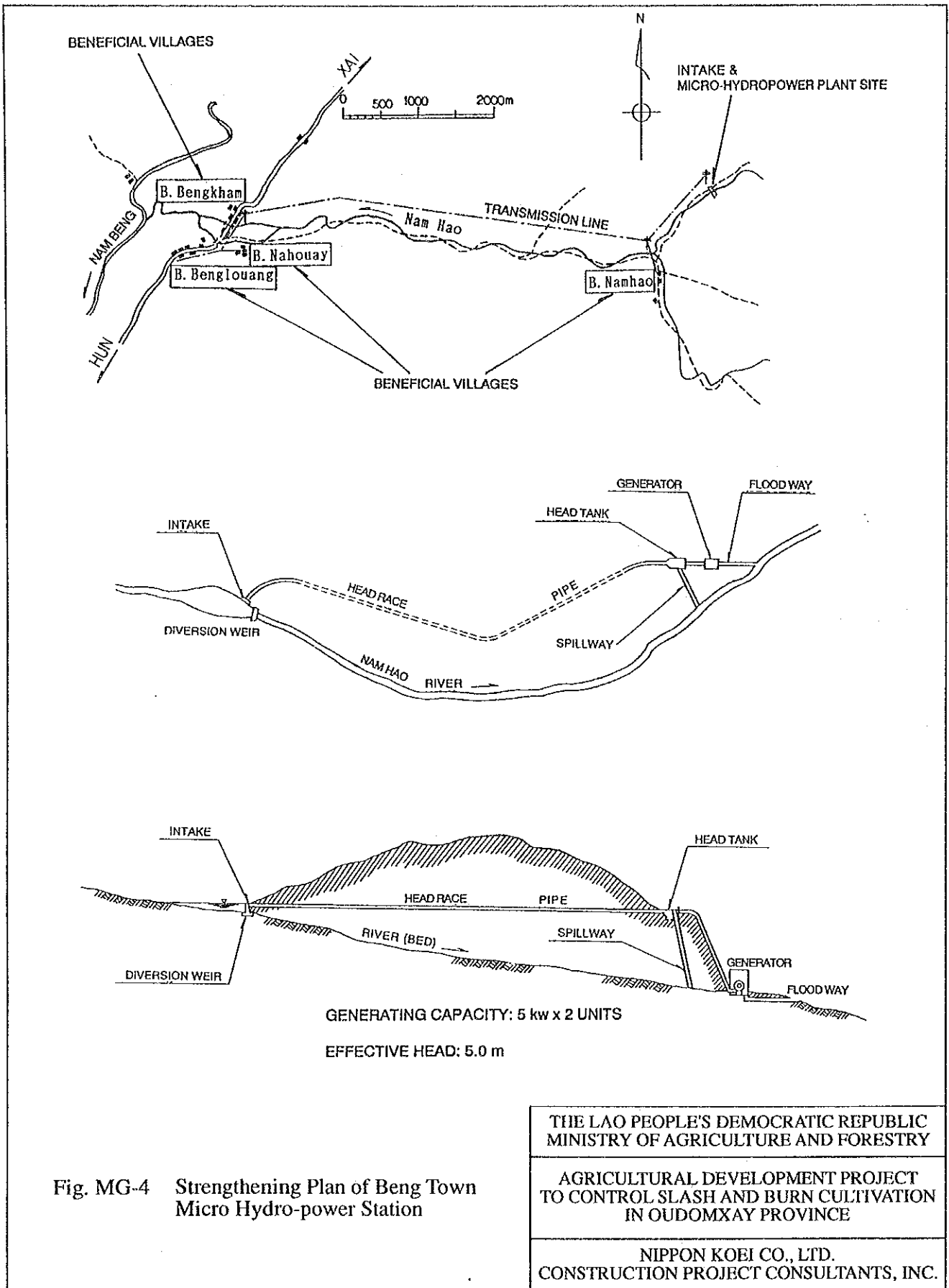


Fig. MG-4 Strengthening Plan of Beng Town Micro Hydro-power Station

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC MINISTRY OF AGRICULTURE AND FORESTRY
AGRICULTURAL DEVELOPMENT PROJECT TO CONTROL SLASH AND BURN CULTIVATION IN OUDOMXAY PROVINCE
NIPPON KOEI CO., LTD. CONSTRUCTION PROJECT CONSULTANTS, INC.

**ANNEX-MH
ENVIRONMENT**

ANNEX-MH ENVIRONMENT

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1. INTRODUCTION

It is understood that the present most serious environmental problem seen in the study area is the destruction of forests mainly due to slash-and-burn cultivation and its related activities of rural people. In this connection, it is reported that some signs of the destruction of forests such as soil erosion, increased floods and muddy flows in the wet season and decreased runoff in the dry season are observed in the study area. Apart from the impacts of the slash-and-burn cultivation on the destruction of forests, some affection on the regular flight is also reported; the excessive smoke hanging in the air by the slash-and-burn cultivation activities sometime brings on the prohibition of landing at the airstrip in Xai township (provincial capital) in March to May.

On the other hand, this is the problems not only in the study area but also those in the Northern Region of Laos, which includes 7 provinces such as Bokeo, Luang Namtha, Phongsaly, Houaphan, Oudomxay (the study area is situated), Luang Prabang and Sayaboury. Therefore, various studies and policies for elimination or alleviation of this problem has been made and proposed mainly by the international institutes and/or donor countries. In addition, various pilot projects for elimination or alleviation of this problem has been implemented with a foreign assistance. The past and on-going foreign assistance projects are given in Table MH-1.

However, only a limited information on the extent of existing forest areas and slash-and-burn cultivation areas is available at present, although slash-and-burn cultivation shows not only a serious destruction of forests but also a disturbance of development of forestry, agriculture and water resources in the study area. Therefore, the objectives of environmental study for this Master Planning are set to identify the extent of slash-and-burn cultivation and to evaluate its impacts on forest resources, watershed management and agricultural development potential.

In line with the above objectives, the study on the measures to the environmental problems in the study area is made under the Master Plan Study on the Agricultural Development Project to Control Slash and Burn Cultivation in Oudomxay Province. The results of study and the proposed measures to the environmental problems in the study area are compiled and presented in this ANNEX.

2. CURRENT CONDITIONS

2.1 Regional and Provincial Condition

Up to now, the results of "Forest Reconnaissance Survey" using aerial photographs of 1981/82 and Spot images of 1988/89 implemented by the Forest Inventory Project Office under financial assistance with Swedish International Development Agency (SIDA) are only the source of reliable data to identify the quantitative extent of existing forest areas in the Northern Region and the Oudomxay province. According to this reconnaissance survey, the land use conditions of the Northern Region in 1981/82 and 1988/89 are estimated as follows:

Land Use	1981/82		1988/89		Change	
	(1,000 ha)	(%)	(1,000 ha)	(%)	(1,000 ha)	(%)
NORTHERN REGION						
Current Forest	3,349.1	37.2	3,199.4	35.6	-149.7	-4.5
Bamboo Area	700.9	7.8	338.3	3.7	-362.6	-51.7
Slash-and-burn Area						
Currently Used (Ray)	352.5	3.9	610.7	6.8	258.2	73.2
Fallow (Unstocked)	4,024.1	44.7	4,254.0	47.3	229.9	5.7
Sub-total	4,376.6	48.6	4,864.7	54.1	488.1	11.2
Permanent Agriculture Land						
Paddy Field	58.6	0.6	76.6	0.8	18.0	30.7
Other Agriculture Land	4.8	0.1	4.8	0.1	0.0	0.0
Sub-total	63.4	0.7	81.3	0.9	17.9	28.2
Other Area	509.5	5.7	515.8	5.7	6.3	1.2
Total	8,999.5	100.0	8,999.5	100.0	0.0	0.0
WHOLE COUNTRY						
Current Forest	11,639.1	49.2	11,181.6	47.2	-457.5	-3.9
Bamboo Area	1,567.8	6.6	1,165.3	4.9	-402.5	-25.7
Slash-and-burn Area						
Currently Used (Ray)	615.4	2.6	711.7	3.0	96.3	15.6
Fallow (Unstocked)	6,354.2	26.8	6,928.1	29.3	573.9	9.0
Sub-total	6,969.6	29.4	7,639.8	32.3	670.2	9.6
Permanent Agriculture Land						
Paddy Field	759.0	3.2	914.5	3.9	155.5	20.5
Other Agricultural Land	42.3	0.2	93.8	0.4	51.5	121.7
Sub-total	801.3	3.4	1,008.3	4.3	207.0	25.8
Other Area	2,702.3	11.4	2,685.1	11.3	-17.2	-0.6
Total	23,680.1	100.0	23,680.1	100.0	0.0	0.0

Source: Reconnaissance Survey, Forest Inventory and Management Office, July 1991 (see Table MH-2 and Table MH-3).

The reconnaissance survey results indicate the serious condition of the forests in the Northern Region suffering from a slash-and-burn cultivation activities because of considerably low proportion of the current forest (only 36%) and high rate of the slash-and-burn cultivation area (54%) as compared with the whole country (47% and 32% respectively) in 1988/89.

The survey results show an increase in the total slash-and-burn cultivation area of the Northern Region from 4.4 million ha in 1981/82 to 4.9 million ha in 1988/89. Therefore,

the extent of slash-and-burn cultivation area has become over 50% of the Region in 1988/89. This increase affects on change in land use of the Region and about 360,000 ha of bamboo area and 150,000 ha of forests were mainly changed into the slash-and-burn cultivation area during the same period. On the other hand, the destruction of forests during this period was only 4.5% and seems to be not so serious problem, because the bamboo area was considered to play a buffer function for the destruction of forests. However, if the trends in increasing of slash-and-burn cultivation area is to be continued, the bamboo area will not be able to play a buffer function due to its limited extent. Without any measures to control the slash-and-burn cultivation area, the forests will be directly affected by the slash-and-burn cultivation activities and be considered to put themselves in danger of accelerated destruction.

The survey results also show a decline in the ratio between total slash-and-burn cultivation area and currently used area from 12 in 1981/82 to 8 in 1988/89 because the currently used area enlarged its about 1.7 times with the annual growth rate of 8.2% even though the total area increased only 11%. This decline indicates that the rural people have attempted to expand the current used slash-and-burn cultivation area not only enlargement of the total slash-and-burn cultivation area but also shortening of the average rotation cycle from 12 years to 8 years due to limited available lands. It is well known that if the rotation cycle of the slash-and-burn cultivation is long enough, soils can restore its fertility at their original level. However, the rotation cycle in the Region has become shorten and this tendency is expected to continue in the future. It is desirable to start a study on the remedial measures for soil fertility degradation by the shortening of slash-and-burn cultivation rotation cycle at once.

For Oudomxay province, only the data in 1981/82 are available by this reconnaissance survey. Based on this, the destruction of forests in Oudomxay province seems to be serious as compared with the Northern Region, because the proportion of forests of the Region accounts for 36% in 1988/89, but the province accounts only 29% even in 1981/82 as shown below:

Land Use	Area (1,000 ha)	(%)
Current Forest	398.6	29.0
Bamboo	150.4	11.0
Slash-and-burn Area		
Currently Used (Ray)	61.4	4.5
Fallow (Unstocked)	712.5	51.9
Sub-total	773.9	56.4
Permanent Agriculture Land		
Paddy Field	18.6	1.3
Other Agriculture Land	1.0	0.1
Sub-total	19.6	1.4
Other Area	30.0	2.2
Total	1,372.5	100.0

Source: Reconnaissance Survey, Forest Inventory and Management Office, July 1991 (see Table MH-4).

2.2 Conditions in the Study Area

2.2.1 Forest Areas

Followed by the "Forest Reconnaissance Survey" mentioned above, the Forest Inventory Study has been implemented since 1991 in assessing and mapping (the land use and forest map on a scale of 1:50,000) the forest resources. This study is also carried out by the Forest Inventory Project under assistance with SIDA. The definition of the land use class and forest type for the reconnaissance survey has been modified and improved to the Forest Inventory Study as follows:

Main Group	Land Use Classes and Forest Types
Current Forest	Upper Evergreen Forest (UE), Lower Evergreen Forest (LE), Upper Dry Evergreen Forest (UDE), Lower Dry Evergreen Forest (LDE), Upper Mixed Deciduous Forest (UMD), Lower Mixed Deciduous Forest (LMD), Dry Dipterocarp Forest (DD), Gallery Forest (GE), Coniferous Forest (S), Mixed Broadleaved and Coniferous Forest (MS), and Forest Plantation (P).
Potential Forest	Bamboo (B), Unstocked Forest (I), Natural Regeneration (N), and Ray (RA).
Other Wooded Areas	Savannah (SH), and Heath, Stunted and Scrub Forest (SR).
Permanent Agriculture	Rice Paddy (RP), Agricultural Plantation (AP), and Other Agricultural Land (OA).
Other Land Use	Barren Land and Rock (R), Grass Land (G), Swamps (SW), Urban Areas (U), and Other Areas (O)
Water	Water (W).

Source: Field Manual, National Forest Inventory, Savannaketh 1992. The detailed definition of land use class and forest type are given in Appendix-MH1.

The Forest Inventory Study covers the whole country but the inventory study in the Northern Region has not started and is not expected to be finished during the survey period of this Master Plan Study. Therefore, the data for assessing to the extent of forests and slash-and-burn cultivation related to the study area are only available for the statistical data obtained from provincial and/or district offices at present.

In this context, the study team requested the Forest Inventory Project Office in Vientiane to prepare the land use and forest map in the study area which is mainly focusing on the slash-and-burn cultivation area and forests with a simplified land use class, i.e. current forest, bamboo, unstocked, ray, paddy field, urban area and other areas because of the time limitation of this Master Plan Study.

In response to the request, the Forest Inventory Project produces the land use and forest map (1:50,000) using Spot images of 1989 and 1990. The index of the land use and forest maps is illustrated in Fig. MH-1. Based on the maps, the current forest areas and land use in the study area is estimated as follows:

Category	Xai District		Beng District		Hun District		Study Area	
	(1,000 ha)	(%)	(1,000 ha)	(%)	(1,000 ha)	(%)	(1,000 ha)	(%)
Forest area	117.7	52.3	78.5	50.6	99.4	55.8	295.5	53.0
Bamboo area	0.0	0.0	24.3	15.7	6.8	3.8	31.1	5.6
Slash-and-burn cultivation area								
Currently used (Ray)	22.1	9.8	13.6	8.8	19.1	10.8	54.8	9.8
Fallow (Unstocked)	67.8	30.1	25.4	16.4	46.8	26.3	140.0	25.1
Sub-total	89.9	39.9	39.0	25.2	66.0	37.1	194.9	34.9
Permanent agriculture land								
Paddy field	1.2	0.6	1.0	0.6	0.9	0.5	3.1	0.6
Other agriculture land	0.7	0.3	0.7	0.5	2.1	1.2	3.5	0.7
Sub-total	1.9	0.9	1.7	1.1	3.0	1.7	6.6	1.3
Other area	15.5	6.9	11.4	7.4	2.9	1.6	29.8	5.3
Total	225.0	100.0	155.0	100.0	178.0	100.0	558.0	100.0

Note: Planimeter estimation from the land use and forest map (1:50,000) prepared by the Forest Inventory Project except for the permanent agriculture land which is estimated on the basis the data obtained from District Offices (see Table MH-5).

Based on the above, the ratio of forest areas in the study area is estimated at about 53% (2,955 km²) and all districts show more than 50% which is high compared with the province (29% in 1981/82), the Northern Region (36% in 1988/89) and the whole country (47% in 1988/89) estimated by the forest reconnaissance survey mentioned in the Section 2.1. The bamboo area in Xai and Hun districts is considered to play a buffer function for the destruction of forests because their ratio is quite a low. While the bamboo area in Beng district seems to be not well functioned as a buffer so that the ratio of bamboo area remains considerably high and the ratio of forests shows the lowest among the study area.

It seems that the destruction of forests by the slash-and-burn cultivation activities in the study area is serious but not critical at present. However, the forests in Xai and Hun districts will directly be affected by the slash-and-burn cultivation activities because of limited extent of bamboo as a buffer. The forests will be considered to put themselves in danger of accelerated destruction without any measures to control the slash-and-burn cultivation area.

However, the Forest Inventory Study defines a current forest as areas being suitable for forest production and having a tree cover with crown density of at least 20%. Therefore, only the statistical data in each district office are available for the extent of the primary forest areas. By the data, the ratio of the primary forests in the study area is estimated at about 14% as follows:

District	Area (Km ²)	Proportion (%)
Xai*	231	10.3
Beng**	95	6.1
Hun**	441	24.8
Total	767	13.7

Note: *; Monographie Provinciale et Etude de Districts et Villages, La Province d'Oudomsay, UNDP, January 1991.

**; Estimated on the basis of the district data.

This low ratio of the primary forests shows that most of the forests in the study area seem to be covered by secondary and/or degraded forest mainly due to the effect of slash-and-burn cultivation activities.

In addition, the aerialphoto interpretation of the Russian-sponsored aerial photographs, on a scale of 1:30,000 shot in 1982 obtained from the National Geographic Department in Vientiane, is made for the comparison study on the transition of primary forests in the study area. The aerial photographs cover all the study area but for only small part of the northeastern area as shown in Fig. MH-2, and are enough to estimate the proportion of the primary forests in the study area. The proportion of primary forests in 1982 by aerial photo interpretation is estimated at 14.3% in the study area. The proportion of primary forests has slightly declined from 14.3% in 1982 to 13.7% in 1991 and about 3,300 ha of primary forests have been destroyed or degraded during this period.

The destruction of primary forests seems to be not so serious. According to the aerial photo interpretation, most of all the primary forests are located at the steep slopes in the mountainous area so that they are probably not suffered from the slash-and-burn cultivation activities.

2.2.2 Slash-and-burn Cultivation Areas

Slash-and-burn cultivation is a common activity of the farmers in the uplands at medium to high altitude of the study area. It is reported that about 60% of families is engaged in slash-and-burn cultivation on an average. To identify the trends of slash-and-burn cultivation area, the statistical data obtained from each district office are analyzed. According to

this, the slash-and-burn cultivation areas are stable between 12,000 ha and 15,000 ha during the last 10 years as shown in Table MH-7. However, the reliability of data on the slash-and-burn cultivation area is little doubt for the following reasons:

- (1) The data of slash-and-burn cultivation area are compiled by each village for the declaration of tax and the planted area is estimated from the amount of input seed; 50 kg of input seed is equivalent to 1 ha of upland rice field. However, planted areas with low productivity due to lack of water, weed, pest, low fertility of soils, are exempted from taxation and are not included in the data. Therefore, the data are rather small comparing to the actual slash-and-burn cultivation areas.
- (2) The population in the study area has increased with an annual growth rate of 2.8% in the same period. Because of population pressure, the rotation cycle of slash-and-burn cultivation has become shorter, especially the rotation cycle in low altitude areas is more or less than 3 years in accordance with the interview survey. As a result, the destruction of forests can be observed along the national road No. 2 across the lowland areas.

In order to assess the extent of the slash-and-burn cultivation area more accurately, the results of forest inventory study are examined. By this, the total slash-and-burn cultivation areas are estimated at about 55,000 ha or 35% of the study area. This ratio is considerably low compared with the Northern Region (54% in 1988/89) but slightly high to the whole country (32% in 1988/89) estimated by the forest reconnaissance survey mentioned in Section 2.1.

The estimated slash-and-burn cultivation area is correspond to about 3 to 4 times the statistical data mentioned above. However, judging from the available labor force (estimated from population) in the study area, it is very difficult to cultivate the all estimated slash-and-burn cultivation areas and the areas under utilization for upland rice are not exceeded about 50% (27,000 ha) of the estimated areas. Therefore, it seems that useless enormous lands in the study area are burned annually by the rural people due to uncontrolled slash-and-burn activities. These useless enormous lands are estimated at more than 28,000 ha in 1989/90. This may cause a rotation cycle more shorter in the study area and degradation of soil fertility.

A rotation cycle of the slash-and-burn cultivation in the study area is estimated on the basis of the ratio between total slash-and-burn cultivation area and currently used area. The rotation cycle in each district is estimated at 4.1 years in Xai, 2.9 years in Beng and 3.5 years in Hun, respectively. These results are significantly short compared with the Northern Region of

8 years in 1988/89. However, the rotation cycle in the study area seems to be more than 2 times (6 to 8 years) the results because of the over burning of lands mentioned above.

2.2.3 Watershed Management

Because soil erosion, increased floods and muddy flows in the wet season and decreased runoff in the dry season are evident in the study area, the provincial government demarcates some forests as a "Reserved Forest", where the slash-and-burn cultivation and illegal logging activities are prohibited, for protection of forest and water resources. The location of the existing Reserved Forests in the study area is illustrated in Fig. MH-3. The management of the reserved forests is handed over to the villagers so far under control by a village chief due to insufficient forestry staff in the province government.

To assess the impacts on the Reserved Forest in the study area, the specific runoff (discharge per 1 km² of catchment area) analysis is made on the basis of the discharge measurements records of the Nam Beng, Nam Ko rivers and their tributaries made by the study team during the dry season in 1992 as shown in the ANNEX-MA METEOROLOGY AND HYDROLOGY. The specific runoff of the rivers is calculated as follows:

Location	Name of River	Specific Runoff (litre/sec/km ²)
Xai District	Ko*	1.4
	Hin*	1.0
	Mao*	1.6
	Hoi Lai**	4.2
	Fen**	2.9
Beng District	Hao*	1.9
	Phao*	0.6
	Lo*	2.4
	Met*	5.2
Hun District	Kham*	1.0
	Heng*	3.1
	Oun*	0.8

Note: *; Estimated from discharge measurements made by the Study team during the dry season in 1992.
 **; Estimated by Small Scale Irrigation Project in Northern Lao, UNDP.

According to the above table and Fig. MH-3, it can be seen that the rivers showing relatively high specific runoff such as Hoi Lai, Hen, Lo, Met and Hen rivers, are situated in the existing Reserved Forest areas demarcated by the provincial government. Although the management of Reserved Forest is not appropriate so far, an establishment of the reserved forest is considered to be one of the effective measures to conservation of water resources.

It is considered that the condition of forest in watershed showing low specific runoff is deteriorated and this situation is getting worse and worse. Some counter measures for the watershed areas having less than 1 lit/sec/km² of specific runoff such as Hin, Phao, Kham and Oun watersheds are essential.

3. MEASURES TO ENVIRONMENTAL PROBLEM IN STUDY AREA

3.1 Basic Concept

The most serious environmental problem in the study area is destruction or degradation of forests due to the slash-and-burn cultivation activities by rural people but their situations are currently not critical as seen in the Luang Prabang province. In near future, however, the forests will be considered to put themselves in danger of accelerated destruction without any measures to control the slash-and-burn cultivation activities. Therefore, the basic concepts for elimination or alleviation of this environmental problem are formulated. The core of this concept is the dual measure (direct and indirect) which will contribute to suitable, economical and sustainable land use in the study area. The concept for measures to environment problem is proposed as follows:

- (1) Elimination or alleviation of the forest resources destruction by direct control to the slash-and-burn cultivation activities of the rural people through establishment and/or development of appropriate technologies and measures, and their extension and implementation.
- (2) Elimination or alleviation of the forest resources destruction by indirect control to the slash-and-burn cultivation activities of the rural people through diversification of the cropping system, and agro- and socio-economy of the rural people.

To accomplish the latter concept, this Master Plan Study proposes an integrated agricultural development including not only measures for increase in agricultural productivity but also other supporting measures such as strengthening of the government institutes, improvement of rural socio-economic conditions in the study area. The essential program to be taken in this development plan is itemized as follows and details are given in the ANNEX-MD AGRICULTURE, ANNEX-ME AGRO-ECONOMY, ANNEX-MF IRRIGATION AND ANNEX-MG SOCIAL INFRASTRUCTURES in this volume:

- (1) Increase and Stabilization of Agricultural Productivity (ANNEX-MD and ANNEX-ME),
- (2) Development of Agricultural Production Infrastructures (ANNEX-MF),
- (3) Development of Social Infrastructures (ANNEX-MG), and

- (4) Women in Development (ANNEX-MD and ANNEX-ME).

Therefore, this environmental study mainly focuses on the former concept. To achieve the former concept in the study area, the measures to elimination or alleviation of the forest resources destruction by direct control to the slash-and-burn cultivation activities are formulated on the basis of the findings through the field works and the "Quick Response and Low Input" point of view.

3.2 Measures to Environmental Problems

3.2.1 Findings of Field Work

The findings related to the measures to elimination or alleviation of the forest resources destruction by direct control to the slash-and-burn cultivation activities through the field works can draw the following:

- (1) At present, there is only little basic data for evaluation of the slash-and-burn cultivation activities such as the extent of the slash-and-burn cultivation area and its transition, rotation cycle, cultivation method and pattern, relation to the race, land tenure, etc.
- (2) Establishment of the reserved forest by the provincial government is considered to be one of the effective measures to conservation of water resources even the management of the reserved forest is not appropriate.
- (3) In the study area, useless burning of enormous lands is practiced burned annually by the rural people due to uncontrolled slash-and-burn activities, and the lands under such a useless burning are estimated at more than 28,000 ha in 1989/90.
- (4) At present, the rotation cycle in the study area averages 6 to 8 years. However, the rotation cycle in low altitude areas is less than 3 years due to population pressure. The crop yield survey made by the study team indicates that the yield of upland rice in 3 to 5 year-rotation cycle area is 1.4 ton/ha which is the same as the provincial average.

3.2.2 Measure to Environmental Problem

Based on the findings mentioned above, the following 4 programs for the measures to environmental problem, which seem "Quick Response and Low Input" program, are proposed to the study area.

(1) Program for Evaluation of the Slash-and-burn Cultivation

There is only little basic data for evaluation of the slash-and-burn cultivation activities as mentioned above. Therefore, in order to contribute to formulation of a proper control and management plan for the slash-and-burn cultivation activities, collection and evaluation of the basic data will be carried out under this program.

(2) Reserved Forest Establishment Program

As explained above, establishment of the reserved forest is considered to be one of the effective measures to conservation of water resources. Therefore, the new reserved forests at the critical watersheds based on the discharge measurement of rivers during the dry season will be established under this program.

(3) Management Program for Uncontrolled Fire

Useless enormous lands are burned annually due to uncontrolled slash-and-burn activities as mentioned above. In order to reduce the useless burning lands and forests, the training of the fire control technique to the rural people will be carried out under this program.

(4) Program for Analysis of the Minimum Rotation Cycle

The result of crop yield survey show that crop yield in 3 to 5 year-rotation cycle area is the same as 6 to 8 year-rotation cycle area at present. If this can be kept at it is and sustainable, the total slash-and-burn cultivation area could be reduced more than 40% in area to produce same amount of rice. To clarify the minimum rotation cycle by several conditions, therefore, analysis of a relation between rotation cycle and yield by soil type and slope class will be carried out under this program.

4. DESCRIPTION OF THE PROJECT

4.1 Program for Evaluation of the Slash-and-burn Cultivation

(1) Objectives:

- (i) contribute to formulate a proper control and management plan for the slash-and-burn cultivation activities, and
- (ii) strengthen the ability of provincial government staff.

(2) Project Description:

- (i) collect the basic data on the slash-and-burn cultivation activities such as the extent of the slash-and-burn cultivation area and its transition, rotation cycle, cultivation method and pattern, relation to the race, land tenure, etc. through agronomic, forestry, agro-economic, socio-economic and social survey,
- (ii) make inventory related to the existing slash-and-burn cultivation farming activities by ethnic group and physical condition,
- (iii) analyze the existing slash-and-burn cultivation farming systems and evaluate their long-term sustainability, and
- (iv) train the provincial government staff.

(3) Project Duration: 18 months for study and planning.

(4) Project Cost: US\$ 250,000

(5) Execution: the planning section of the Integrated Agricultural Station (refer to ANNEX-MD AGRICULTURE) will mainly be responsible for this program in cooperation with the Agriculture and Forestry department of the provincial government.

(6) Comment: the land use and forest maps to be produced under the "Forest Inventory Project" with SIDA financial assistance will give much contribution to this program.

4.2 Reserved Forest Establishment Program

- (1) Objectives:
 - (i) prevent the destruction of forest resources,
 - (ii) contribute to water resources conservation, and
 - (iii) contribute to soil conservation.

- (2) Project Description:
 - (i) evaluate the specific runoff of each watershed by the discharge measurement of rivers in the dry season by using staff gage which will be installed by the Metro-Hydrological Network Improvement Program as mentioned in ANNEX-MA METEOROLOGY AND HYDROLOGY,
 - (ii) set up the criteria for establishment of a new reserved forest,
 - (iii) train the better control and management of reserved forest to the rural people, and
 - (iv) monitor the situation of established reserved forest.

- (3) Project Duration: 15 years.

- (4) Project Cost: US\$ 150,000

- (5) Execution: the Agriculture and Forestry department of the provincial government will be responsible for this program in cooperation with the Integrated Agricultural Station.

- (6) Comment: for the time being, the specific runoff of less than 1 liter/sec/km² is provisionally proposed as a standard in order to establish a new reserved forest and the establishment of new reserved forest at the watersheds of Hin, Phao, Kham and Oun rivers is proposed from the results of discharge measurement made by the study team.

4.3 Management Program for Uncontrolled Fire

(1) Objectives:

- (i) prevent the destruction of forest resources, and**
- (ii) contribute to conserve the degradation of soil fertility.**

(2) Project Description:

- (i) identify the the sound fire control technique of slash-and-burn practices in the study area or Luang Prabang province,**
- (ii) establish the demonstration plots in and around the district capitals,**
- (iii) train the proper fire control technique to the village chief and/or his assistants in the demonstration plot, and**
- (iv) monitor the extent of useless area due to uncontrolled fire.**

(3) Project Duration: 15 years.

(4) Project Cost: US\$ 300,000

(5) Execution: the Agriculture and Forestry department of the provincial government will be responsible for this program in cooperation with the Integrated Agricultural Station.

(6) Comment: initially the training of rural people will be focused on the Lao Theung people, because about 80% of the slash-and-burn cultivation lands is estimated to belong to this ethnic group in the study area.

4.4 Program for Analysis of the Minimum Rotation Cycle

- (1) Objectives:
 - (i) clarify the minimum rotation cycle of slash-and-burn cultivation by soil type and slope class,
 - (ii) reduce the potential areas for slash-and-burn cultivation, and
 - (iii) contribute to prevent the destruction of forest resources.

- (2) Project Description:
 - (i) undertake the periodical yield survey and soil sampling in the different rotation cycle lands,
 - (ii) analyze the survey results and evaluate the possibility of long-term sustainability of land use,
 - (iii) set up the minimum rotation cycle of slash-and-burn cultivation by soil type and slope class, and
 - (iv) inform the minimum rotation cycle under several conditions to the rural people and its judgement.

- (3) Project Duration: 5 years for study and planing and 10 years for extension.

- (4) Project Cost: US\$350,000 (US\$250,000 for study and planing and US\$ 100,000 for extension)

- (5) Execution: for study and planing, the planning section of the Integrated Agricultural Station will mainly be responsible in cooperation with the Agriculture and Forestry department of the provincial government. For extension, the Agriculture and Forestry department of the provincial government will be responsible.

Table

Table MH-1 Past and On-going Foreign Assistance Projects

Name of Project	Assistance	Period	Objectives
Forest Management and Conservation Project	IDA	1992 to	1) to develop an appropriate management and regulatory capacity, and 2) to achieve sustainable levels of resource use.
Upland Agricultural Development Project	IDA	1991 to	1) to reduce rural poverty, 2) to expand export earnings, 3) to improve food security, 4) to control erosion, and 5) to strengthen key agricultural institution.
Forest Development and Watershed management in the North	UNDP & FAO	1985 to 1989	1) to train and demonstrate improved land use and watershed management, and 2) to train, demonstrate and develop community forestry program.
Rural Micro-Project Program	EC	1990 to	1) to improve incomes and living conditions of the rural population, and 2) to conserve the local soil, water and forest resources.
The Lao-Swedish Forestry Cooperation Programme	SIDA	1991 to	1) Central Support (to provide administrative and technical support to this program and to provide certain input) 2) Forest Inventory (to support the National Office of Forest Inventory and Planning in assessing and mapping the forest resources of Lao) 3) Silviculture (to assist in the development of national policies for land and forest resources development, and to develop technical knowledge for plantation program) 4) Forestry Training (to support the establishment of training and extension system) 5) Forest Resources Conservation (to support the development and establishment of forest conservation system) 6) Shifting Cultivation (to develop methods for stabilizing shifting cultivation and forest encroachment)

Table MH-2 Forest Reconnaissance Survey in Northern Region

Land Use/Vegetation Class	1981/82		1988/89		Change	
	(1,000 ha)	(%)	(1,000 ha)	(%)	(1,000 ha)	(%)
1. Current Forest	3,349.2	37.2	3,199.6	35.6	-149.6	-4.5
Dry Dipterocarp	72.8	0.8	67.5	0.8	-5.3	-7.3
Lower Dry Evergreen	0.0	0.0	0.0	0.0	0.0	-
Upper Dry Evergreen	95.5	1.1	72.9	0.8	-22.6	-23.7
Lower Mixed Deciduous	0.5	0.0	0.5	0.0	0.0	0.0
Upper Mixed Deciduous	3,134.5	34.8	3,012.8	33.5	-121.7	-3.9
Gallery Forest	17.4	0.2	17.4	0.2	0.0	0.0
Coniferous	9.5	0.1	9.5	0.1	0.0	0.0
Mixed Broadleaved and Coniferous	19.0	0.2	19.0	0.2	0.0	0.0
2. Potential Forest	5,077.5	56.4	5,203.0	57.8	125.5	2.5
Pure Bamboo	700.9	7.8	338.3	3.8	-362.6	-51.7
Unstocked	4,024.1	44.7	4,254.0	47.3	229.9	5.7
Ray	352.5	3.9	610.7	6.8	258.2	73.2
3. Other Wooded Area	206.6	2.3	215.0	2.4	8.4	4.1
Savannah, Open Woodlands	141.7	1.6	150.1	1.7	8.4	5.9
Heath, Stunted and Scrub	64.9	0.7	64.9	0.7	0.0	0.0
4. Permanent Agriculture Land	63.4	0.7	81.4	0.9	18.0	28.4
Rice Paddy	58.6	0.7	76.6	0.9	18.0	30.7
Fruit Plantation	0.0	0.0	0.0	0.0	0.0	-
Other Agricultural Land	4.8	0.1	4.8	0.1	0.0	0.0
5. Other Non-Forest Land	302.9	3.4	300.9	3.3	-2.0	-0.7
Barren Lands/Rock	3.5	0.0	3.5	0.0	0.0	0.0
Grassland	240.0	2.7	238.0	2.6	-2.0	-0.8
Urban Areas	18.4	0.2	18.4	0.2	0.0	0.0
Swamps	0.0	0.0	0.0	0.0	0.0	-
Water	41.0	0.5	41.0	0.5	0.0	0.0
6. Total	8,999.6	100.0	8,999.9	100.0	0.3	0.0

Source: Lao Forest Inventory and Management Office, July 1991.

Table MH-3 Forest Reconnaissance Survey in Whole Country

Land Use/Vegetation Class	1981/82		1988/89		Change	
	(1,000 ha)	(%)	(1,000 ha)	(%)	(1,000 ha)	(%)
1. Current Forest	11,639.2	49.2	11,181.5	47.2	-457.7	-3.9
Dry Dipterocarp	1,447.0	6.1	1,469.5	6.2	22.5	1.6
Lower Dry Evergreen	97.3	0.4	57.6	0.2	-39.7	-40.8
Upper Dry Evergreen	1,086.1	4.6	1,065.6	4.5	-20.5	-1.9
Lower Mixed Deciduous	1,001.3	4.2	897.4	3.8	-103.9	-10.4
Upper Mixed Deciduous	7,549.9	31.9	7,176.1	30.3	-373.8	-5.0
Gallery Forest	97.7	0.4	85.3	0.4	-12.4	-12.7
Coniferous	118.6	0.5	136.5	0.6	17.9	15.1
Mixed Broadleaved and Coniferous	241.3	1.0	293.5	1.2	52.2	21.6
Potential Forest	8,537.4	36.1	8,805.1	37.2	267.7	3.1
Pure Bamboo	1,567.8	6.6	1,165.3	4.9	-402.5	-25.7
Unstocked	6,354.2	26.8	6,928.1	29.3	573.9	9.0
Ray	615.4	2.6	711.7	3.0	96.3	15.6
3. Other Wooded Area	1,581.8	6.7	1,551.4	6.6	-30.4	-1.9
Savannah, Open Woodlands	989.9	4.2	960.7	4.1	-29.2	-2.9
Heath, Stunted and Scrub	591.9	2.5	590.7	2.5	-1.2	-0.2
4. Permanent Agriculture Land	801.3	3.4	1,008.2	4.3	206.9	25.8
Rice Paddy	759.0	3.2	914.5	3.9	155.5	20.5
Fruit Plantation	10.2	0.0	10.2	0.0	0.0	0.0
Other Agricultural Land	32.1	0.1	83.5	0.4	51.4	160.1
5. Other Non-Forest Land	1,120.4	4.7	1,133.6	4.8	13.2	1.2
Barren Lands/Rock	105.0	0.4	112.2	0.5	7.2	6.9
Grassland	647.5	2.7	634.0	2.7	-13.5	-2.1
Urban Areas	88.9	0.4	134.0	0.6	45.1	50.7
Swamps	35.7	0.2	21.5	0.1	-14.2	-39.8
Water	243.3	1.0	231.9	1.0	-11.4	-4.7
6. Total	23,680.1	100.0	23,679.8	100.0	-0.3	0.0

Source: Lao Forest Inventory and Management Office, July 1991.

Table MH-4 Forest Reconnaissance Survey in Oudomxay Province

Land Use/Vegetation Class	1981/82		1988/89		Change	
	(1,000 ha)	(%)	(1,000 ha)	(%)	(1,000 ha)	(%)
1. Current Forest	398.6	29.0	-	-	-	-
Dry Dipterocarp	12.1	0.9	-	-	-	-
Lower Dry Evergreen	0.0	0.0	-	-	-	-
Upper Dry Evergreen	0.0	0.0	-	-	-	-
Lower Mixed Deciduous	0.2	0.0	-	-	-	-
Upper Mixed Deciduous	384.8	28.0	-	-	-	-
Gallery Forest	1.5	0.1	-	-	-	-
Coniferous	0.0	0.0	-	-	-	-
Mixed Broadleaved and Coniferous	0.0	0.0	-	-	-	-
Potential Forest	924.3	67.3	-	-	-	-
2. Potential Forest	150.4	11.0	-	-	-	-
Pure Bamboo	712.5	51.9	-	-	-	-
Unstocked	61.4	4.5	-	-	-	-
Ray	13.9	1.0	-	-	-	-
3. Other Wooded Area	13.6	1.0	-	-	-	-
Savannah, Open Woodlands	0.3	0.0	-	-	-	-
Heath, Stunted and Scrub	19.6	1.4	-	-	-	-
4. Permanent Agriculture Land	18.6	1.4	-	-	-	-
Rice Paddy	0.0	0.0	-	-	-	-
Fruit Plantation	1.0	0.1	-	-	-	-
Other Agricultural Land	16.1	1.2	-	-	-	-
5. Other Non-Forest Land	1.1	0.1	-	-	-	-
Barren Lands/Rock	6.3	0.5	-	-	-	-
Grassland	3.3	0.2	-	-	-	-
Urban Areas	0.0	0.0	-	-	-	-
Swamps	5.4	0.4	-	-	-	-
Water	1,372.5	100.0	-	-	-	-
6. Total						

Source: Lao Forest Inventory and Management Office, July 1991.

Table MH-5 Land Use in the Study Area

District	Sheet No.	Currently Forest	Bamboo	Ray	Unstocked	Paddy Field	Settlement Area	Other Area	Total
Xai	F-47-120W	785.7	0.0	109.3	56.1	0.0	0.0	0.0	951.1
	F-47-120E	6,203.0	0.0	6,575.2	19,418.3	0.0	0.0	2,425.1	34,621.5
	F-47-132W	23,568.3	0.0	6,468.8	9,658.9	0.0	0.0	0.0	39,696.1
	F-47-132E	26,018.5	0.0	5,472.2	25,548.6	0.0	0.0	1,896.3	58,935.6
	F-48-109W	29,115.6	0.0	2,051.4	1,190.4	0.0	0.0	6,876.9	39,234.2
	E-48-121W	30,260.2	0.0	1,397.1	11,612.9	0.0	0.0	6,238.4	49,508.6
	F-48-121E	1,745.7	0.0	8.9	298.3	0.0	0.0	0.0	2,052.9
Sub-total	117,697.0	0.0	22,082.9	67,783.4	0.0	0.0	17,436.7	225,000.0	
Beng	F-47-131E	4,324.8	0.0	1,115.8	175.1	0.0	0.0	0.0	5,615.7
	F-47-132W	20,321.7	6,963.2	5,898.2	7,443.4	0.0	0.0	0.0	40,626.5
	F-47-132E	18,396.1	0.0	2,198.0	13,436.2	0.0	0.0	8,516.5	42,546.8
	F-47-143E	1,559.3	83.3	161.0	7.1	0.0	0.0	0.0	1,810.7
	F-47-144W	24,872.5	17,255.4	4,228.8	4,139.8	0.0	0.0	1,726.0	52,222.4
	F-47-144E	9,019.6	0.0	0.0	231.6	0.0	0.0	2,926.5	12,177.8
	Sub-total	78,494.1	24,301.9	13,601.8	25,433.2	0.0	0.0	13,169.0	155,000.0
Hun	F-47-11E	37,519.6	0.0	1,527.5	844.4	0.0	0.0	0.0	39,891.6
	E-47-12W	18,457.7	0.0	1,970.4	8,271.8	0.0	0.0	0.0	28,699.9
	E-47-143W	17,153.9	0.0	5,280.6	8,804.7	0.0	0.0	0.0	31,239.2
	F-47-143E	0.0	116.3	8,110.4	15,950.6	0.0	495.4	2,437.6	27,110.4
	F-47-144W	16,796.9	6,635.5	1,944.1	12,706.1	0.0	0.0	3,000.6	41,083.2
	F-47-144E	9,427.8	0.0	307.8	240.2	0.0	0.0	0.0	9,975.7
	Sub-total	99,355.9	6,751.8	19,140.8	46,817.9	0.0	495.4	5,438.2	178,000.0
Total	295,546.9	31,053.7	54,825.4	140,034.6	0.0	495.4	36,043.9	558,000.0	

Table MH-6 Number of Aerial Photographs

Line No.	No. of Aerial Photo	No. of Sheets
9/III	82 - 9026 to 82 - 9030	5
9/III	82 - 9047 to 82 - 9053	7
9/III	82 - 9058 to 82 - 9069	12
15/III	82 - 9734 to 82 - 9741	8
15/III	82 - 9747 to 82 - 9754	8
24/II	82 - 7464 to 82 - 7467	4
25/II	82 - 7587 to 82 - 7603	17
25/II	82 - 7669 to 82 - 7682	14
25/II	82 - 7713 to 82 - 7719	7
25/II	82 - 7805 to 82 - 7817	13
25/II	82 - 7870 to 82 - 7888	19
25/II	82 - 7911 to 82 - 7927	17
26/II	82 - 8141 to 82 - 8142	2
26/II	82 - 8190 to 82 - 8191	2
27/II	82 - 8214 to 82 - 8236	23
27/II	82 - 8251 to 82 - 8270	20
27/II	82 - 8277 to 82 - 8290	14
27/II	82 - 8293 to 82 - 8304	12
27/II	82 - 8310 to 82 - 8322	13
29/III	82 - 9792 to 82 - 9803	12
29/III	82 - 9811 to 82 - 9821	11
	Total	240

Table MH-7 Upland Rice Area and Population
(1982-1991)

Year	Population (No.)	Upland Rice Area (ha)
1982	-	11,790
1983	79,279	12,720
1984	81,691	15,060
1985	84,181	14,390
1986	86,671	15,110
1987	89,240	13,460
1988	91,890	12,900
1989	95,623	11,990
1990	97,745	12,220
1991	101,267	12,750
Annual Growth Rate	2.8%	0.8%
Average	89,732	13,239

Figure

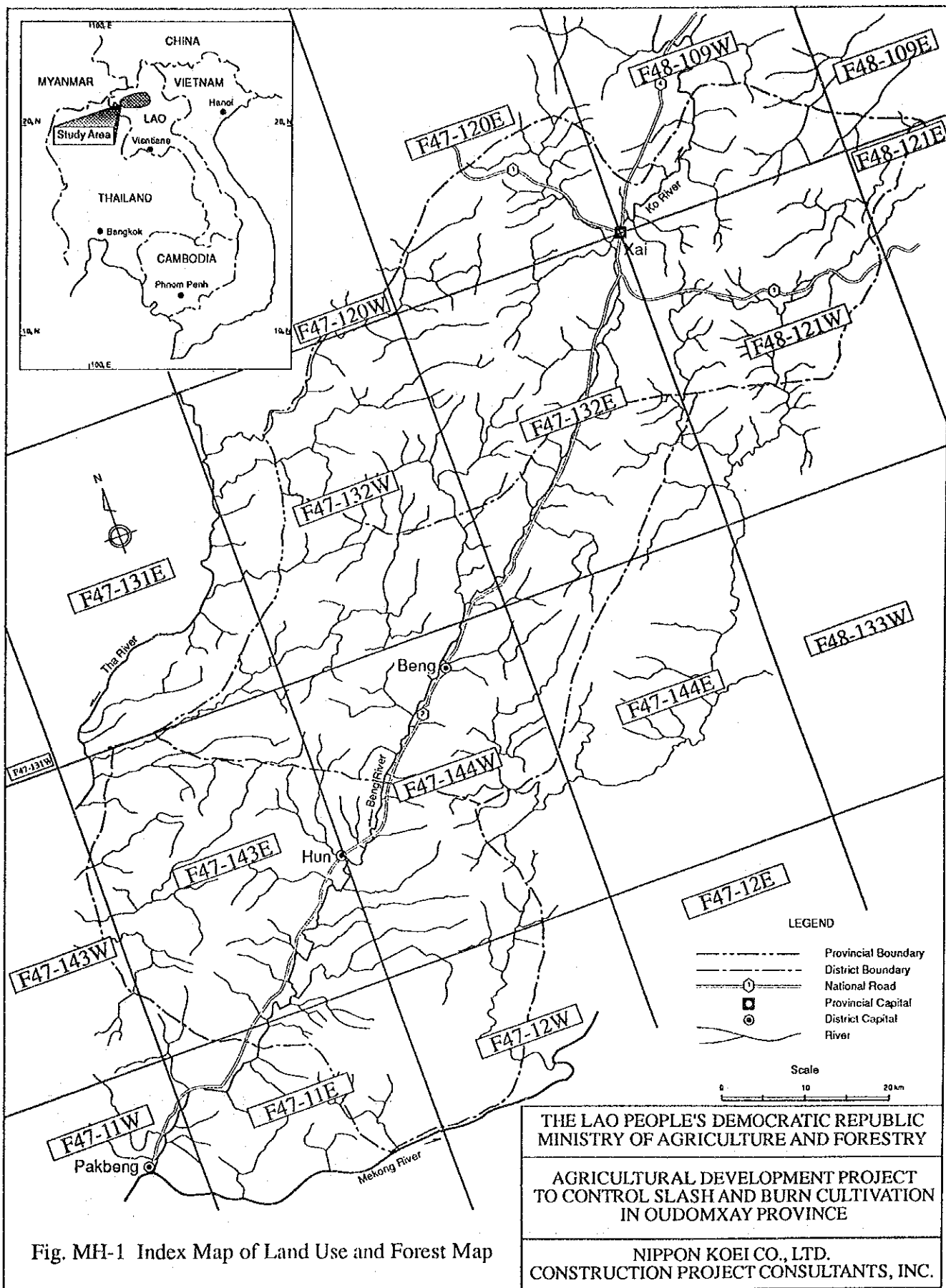


Fig. MH-1 Index Map of Land Use and Forest Map