

elsewhere were brought in medical goods, daily sundries, etc. The said bus convenience has been suspended since the beginning of the rainy season in 1991 due to that road conditions were worse and profit therefrom was decreased. The villagers have been greatly suffered from lack of means for transportation and regional trade. At the reconnaissance time in July 1991, privately owned trucks and motor-bicycles, instead of the bus system, have been used in the region more than in the end of 1990.

5.4 Mineral Resources of Project Area

In southern Laos, particularly in the area close to Vietnam, there have been found veins of potassium, gypsum, iron, coal, gold, silver, lead, tin, etc.

Such exploration of mineral resources has not been conducted so far in the vicinity of the Khet and Project Area. According to the Geological and Mineral Survey Map formulated by a Canadian mineral survey team under ABD fund (issued in 1991), it seems there is possibility that mineral resource deposits are present in the Xe Namnoy basin including Xe Katam River. However, as Xe Katam Hydroelectric Project is a small scale run-of-river type, there seems to be little concern on the effect of the Project.

5.5 Historical and Archeological Remains in Project Area and Vicinity

There is a group of stone monument on a hilltop opened up at Ban Nonghon approximately 20 km south of the project area. The pictures of women, snakes and tigers are carved on the surface of those stone monuments. At another place about 15 km apart from the said place, there are stone monuments depicting cattle on their surface.

It has not been learned yet by whom, when, and for what purpose these stone monuments were prepared. Evaluation of historical and archeological values are being left to future study.

5.6 Impacts to be Brought about by Project Implementation

5.6.1 Impact on Natural Environment

Structures such as the diversion facility, headrace tunnel and powerstation will not be located over a wide area, but in a very limited area along the Xe Katam River and the Xe Namnoy River.

Runoff diverted for the purpose of power generation will be quickly discharged into the Xe Namnoy River and immediately flow down to the junction of the two rivers. Only two falls located at just downstream of the intake will decrease the discharge and may lose water at the driest season.

Since a diversion weir is constructed across the river, the sediment of sand, gravel and/or boulder will deposit behind the weir, which will result in uprading of the river bed in some distance in the upstream of the weir. However, there is scarcely possibility that negative impacts thereby on the environment will be occurred in future.

Accordingly, it is thought the negative impact on forest, wildlife, and various fauna and flora directly caused by the Project implementation may not be so serious or conspicuous.

However, construction works, although in an extremely limited area and limited construction period, will provide the following impacts on the natural environment.

- (1) Felling of forest trees and loss of forest resources necessitated in construction of access roads
- (2) Noise, vibration and air pollution caused by operation of heavy construction equipment and transportation vehicles
- (3) Contamination of river water due to excavation and embankment works
- (4) Loss of forest or land required for transmission lines and substations

Prior to the construction works, it will be important to provide the villagers in the project area with sufficient information on the works and to make them understand on the project implementation.

Care must be exercised to the utmost during the construction period, and mitigation measures taken to minimize the abovementioned negative impacts as much as possible.

5.6.2 Impact on Socio-economic Environment

During the period of construction works and at the stage of operation after completion, there will be frequent movement of many people in the project area, while a great amount of construction materials and other commodities and materials will be brought into the area. Such activities would not have been seen before implementation of the Project.

It is thought that such socio-economic activities will have direct and indirect impacts on the concept of value of residents in the villages. As a result, changes may be brought about in their future patterns of daily life.

The surveys made so far have disclosed that there is no cultivating land and housing caused by the Project implementation. Accordingly, it seems that there will be no possibility to rise troubles concerning compensation for property to be lost, resettlement, etc.

5.7 Environmental Mitigation Measures to Cope with Negative Impact during Construction Work

It is anticipated that negative impacts on the environment may be created within a limited scope caused by the construction work of Xe Katam River Small Hydroelectric Project. To alleviate such affect, it is proposed to take the following environmental mitigation measures as much as possible.

(1) Environmental Mitigation Measure for Watershed Preservation

- (a) In constructing the construction roads, the width of deforestation shall be reduced as much as possible in order to protect forest resources and preserve watershed condition.
- (b) Sufficient slope protection work shall be made to maintain the excacation shopes in good condition.
- (c) Excavated materials shall be disposed of at the proposed disposal sites, so that such materials do not mix with river water.

In addition, the turbid water caused by the construction work shall be discharged to the river after it is settled and filtered.

- (d) Construction machines with less noise, vibration, or air pollution shall be employed as much as possible.

(2) Measures for Prevention of Hazards or Troubles on Local People:

- (a) The construction work plan, safety issues and the method of preventing negative impacts caused by the construction work shall be explained in detail to the local people in order to secure understanding and support of the people prior to the project implementation.
- (b) Transportation vehicles with less noise, vibration and air pollution shall be employed as much as possible.

(c) Water shall be sprinkled frequently during dry seasons to prevent dusts.

(d) Speed of vehicles passing villages shall be restricted in order to secure the safety of people and children, and also in order to reduce vibration, noise and air pollution.

"Guards" shall be stationed at relevant spots to control the safety of the traffic.

(e) Careful considerations shall be given in planning the locations of workers' camps and/or facilities so that a fair relation between the workers and local people are kept and troubles can be prevented.

(f) Public relations office shall be organized so that the requests and complaints by the local people are treated in a friendly manner.

5.8 Watershed Conservation Measures in Xe Katam River Basin

(1) General View on Watershed Conservation in Xe Katam River Basin

As described in Section 5.2 and Section 5.3, according to the site survey conducted in December 1990 and July 1991, a part of the forest near the village is burnt and converted to farm land and coffee plantation. The Government has undertaken administrative guidance to prevent the deforestation of high quality forests and shifting cultivation. Owing to this effort, the area of slash-and-burn farming has been reduced in Paksong District in 1990/91 to less than half that of the previous year.

However, according to the hearsay and aerial observation during the site survey, the spots where forests were destroyed and turned to farm land have been found in several places in the Xe Katam River basin.

It is judged that Xe Katam River Small Hydroelectric Project has practically no negative impact on the environment, such as deforestation, because of the small size of the generating facility. Generally speaking, however, the forests in the watershed have the following roles and functions which are directly and indirectly very important for the survival and living activities of not only the local people but also animals and plants in the area.

- (a) Providing conservation effect on the natural environment, such as prevention of soil erosion and regulation of river run-off.
- (b) Providing materials for human livelihood and industrial activities.
- (c) Providing habitat of life zones for animals and plants.
- (d) Providing storage of genetic resources of animals and plants.

The above roles and functions will be substantially deteriorated if forests are destroyed by indiscreet deforestation, slash-and-burn farming, mineral resource mining, road construction, etc. This will lead to negative impact on hydroelectric power generation project or the nature of the river as follows.

- (a) Forest is lost together with foliage and leaves and the function of controlling flood is accordingly diminished. The heavy rainfall directly rushes into rivers resulting in violent floods.
- (b) Soil under the forest is eroded and washed away, thereby degrading the soil on slopes. The eroded soil accumulates on the river channel and changes the river bed gradient.
- (c) When the river water containing the eroded soil enters the reservoir, the effective storage capacity of the reservoir is reduced.

(2) Proposal of Watershed Preservation Measures

(i) Xe Katam River Small Hydroelectric Project is small in its scale and it does not destroy forests if the construction work is executed with care. However, attention must be kept on the preservation watershed of Xe Katam River basin which is related to the Project even after the completion of the construction work. The following measures will be proposed from a broad point of view.

(a) To prepare inventories of forests and watersheds to identify their conditions. The status of forests is constantly monitored by the forest rangers for a long period.

(b) To prepare a standard or a rule which sets forth the objective of land use in utilizing forests, the conditions in constructing structures and use of water, etc., by taking into consideration the current conditions and future objective of utilization of forests.

(c) To make the local people fully understand the objective of the administrative guidance which is currently being conducted by the Government of Laos concerning the regulations on hunting, deforestation and slash-and-burn cultivation, as well as encouragement of settled farming.

(ii) It is proposed to implement the following local measures in the naked land where trees have been lost by deforestation or shifting cultivation, or in places where soil erosion is about to occur or the function of river-flow regulation is being lost for the purpose that such negative impacts are not amplified.

(a) To install hedges or fences along contour lines to prevent washing out of soils.

- (b) To have the soil accumulated on the hedges or fences and have vegetation recover on such place.
- (c) To encourage the implementation of agro-forestry systems.
- (d) To provide grassed-channels, collection channels and drainages to release rain water in places where gully and rill erosion are being developed.
- (e) To encourage the forestation with indigenous plants as much as possible.

5.9 Environmental Management and Monitoring Program

In order to monitor the environmental conditions in connection with implementation of the Project, MIH has organized a unit in the ministry to handle environment problems. It is recommended to this unit to provide appropriate mitigation measures and to minimize negative impacts as much as possible by carrying out unceasing observations and surveillance of principal environmental parameters - socio-economic and natural including watershed condition - before start of the Project, during construction, and in the stage of operation of power-station.

As mentioned before, frequent movements or activities of vehicles, materials and many people involved in the works will take place during the construction period, which are not seen before the Project implementation. It is an important factor that safety for the villagers will have to be ensured by taking thorough caution to the response of the village people from a view point of the environmental management.

Table IV-5-1 Trees in the Project Area

Name of Tree		Height of Tree (Short, Medium or Tall)	Deciduous or Evergreen	Commercial Value (1st of 2nd Grade)
Ton Hai	(Ficus sp)	S	D	-
Ton Ghang	(Dipterocarpus alatus)	T	D	2nd
Ton Makko	(Quercus sp)	S	D	1st
Ton Hang	(Pentacme siamensis)	T	D	2nd
Ton Deng	(Xylia kerrii)	T	D	1st
Ton Doo	(Pterocarpus macrocarpus)	T	D	1st
Ton Muong Pa	(Mangifera indica)	T	E	-
Ton Bak	(Anisoptera costata)	T	D	2nd
Ton Peuai Peuai	(Lagerstroemia)	T	D	2nd
Ton Tabeng	(Dipterocarpus)	T	D	-
Ton Xi	(Vatica cinerea king)	T	D	-
Ton Jik	(Shorea obtusa)	T	D	1st
Ton Khene Hin	(Hopea ferrea)	T	E	1st
Rattan (Vai)	(-)	S	E	-
Ton Khai pa	(-)	S	E	-
Ton Doo Nam	(-)	M	E	1st
Ton Samek	(-)	M	E	-

Table IV-5-2 Fishes in the Xe Katam River

In the downstream of the big waterfall on the Xe Katam River		In the upstream of the big waterfall on the Xe Katam River	
Pa Va	(<i>Labeo dyocheilus</i>)	Pa Chat	(<i>Puntius</i> sp)
Pa Eune	(<i>Probarbus jullieni</i>)	Pa Houa Mouan	(<i>Catlocarpio siamensis</i>)
Pa Phane	(<i>Ctenogobius</i> spp)	Pa Lat	(<i>Mastacembelus armatus favus</i>)
Pa Dook	(<i>Clarias</i> spp)	Pa Kang	(<i>Channa gachua</i>)
Pa Ko	(<i>Gyrinocheilus aymonieri</i>)	Pa Koua	(<i>Pseudosciaena soldado</i>)
Pa Kang	(<i>Channa gachua</i>)		
Pa Houa Mouan	(<i>Catlocarpio siamensis</i>)		
Pa Kouane	(<i>Wallagonia moistoma</i>)		
Pa Chat	(<i>Puntius</i> sp)		
Pa Lat	(<i>Mastacembelus armatus favus</i>)		
Pa Phia	(<i>Morulius chrysophekadion</i>)		
Pa Phieng	(<i>Puntis stigmatosomus</i>)		
Pa Ko	(<i>Tachyswrus sciurus</i>)		
Pa Kom	(<i>Nemacheilus kohchangensis</i>)		

Table IV-5-3 Results of Water Quality Analysis of the Xe Namnoy and Xe Katam Rivers^{1/}

Item		Xe Namnoy		Xe Katam Dam Site	Remarks
		B. Latsasin	P/S Site		
Date		6/7/91	5/7/91	5/7/91	Se Don river in 1988 ^{2/}
pH		6.08	6.51	7.27	7.23 ~ 7.86
TSS	[mg/l]	8.0	9.0	18.0	2.76 ~ 24.0
Electric Conductivity	[mS/m 25.c]	0.8	1.1	3.7	5.4 ~ 14.7
Ca	[meq/l]	0.021	0.038	0.188	0.257 ~ 0.595
Mg	- " -	0.035	0.067	0.149	0.155 ~ 0.785
Na	- " -	0.006	0.014	0.026	0.080 ~ 0.249
K	- " -	0.001	0.001	0.010	0.028 ~ 0.042
Alk.	- " -	0.013	0.097	0.127	0.415 ~ 1.498
Cl	- " -	0.017	0.014	0.016	0.019 ~ 0.069
SO ₄	- " -	0.036	0.018	0.245	0.003 ~ 0.107
Tot. Fe	[mg/l]	0.120	0.220	0.270	0.035 ~ 0.385
(NO ₃ + NO ₂)-N	- " -	0.017	0.003	0.013	0.057 ~ 0.134
NH ₄ -N	- " -	0.026	0.027	0.032	0.026 ~ 0.044
PO ₄ -P	- " -	0.005	0.004	0.004	0.012 ~ 0.033
Tot. p	- " -	0.007	0.008	0.006	0.008 ~ 0.042
Si	- " -	2.210	3.070	1.530	2.5 ~ 13.5
COD _{Mn}	- " -	0.388	1.018	4.209	1.085 ~ 3.28
Turbidity	- " -	16.0	18.0	20.0	-
Colour	- " -	3.0	4.0	6.0	-
Tot-hardness	[CaCO ₃ mg/l]	1.050	1.900	9.400	-
KMnO ₄	[mg/l]	12.0	14.0	19.0	-

^{1/}: Laboratory of W.Q.A, Ministry of Agriculture-Forestry, Dept. of Irrigation & Micro Hydropower in July 1991

^{2/}: The Environmental Impacts from the Xeset Hydropower Project in Lao PDR, SWECO, 1988

Table IV-5-4 Ethnic Group, Household and Population in Khet^{1/}

Village	Ethnic Group	Household	Population
Huay Kong	Leven	103	581
Nam Tang	Nga Heun	101	530
Nong Tuang	Laven	50	270
Nong Mek	Nga Heun	63	299
Nong Hin	Nga Heun	88	327
Huay Vay	Nga Heun	23	109
Nan Houng	Nga Heun	27	136
Ioy	Laven	96	424
Uppasa	Nga Heun	56	258
Ta Euk Seua	Nga Heun	35	162
Nong Phanouau	Laven	77	360
Huay Chot	Nga Heun	55	283
Done Khong	Nga Heun	17	76
Nam Kong	Nga Heun	60	723
Huay Xoy	Nga Heun	-	-
Nam Leng	Nga Heun	-	-
Se Noy	Nga Heun	32	-
Keo Khune Muong	Nga Heun	30	-
Latsasin	Nga Heun	48	163
Nam Tieng	Nga Heun	24	87
Nam Hane	Nga Heun	17	88
Thong Gnao	Nga Heun	32	138
		(1,075)	(5,052)

^{1/}: As of December 1990

Chapter V Further Investigations

Chapter V Further Investigation

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Fig. V-1-1 Area and Location of Further Investigation
(Topography and Geology)

CHAPTER V FURTHER INVESTIGATIONS

The following investigations should be necessary to perform definite design of the Xe Katam Small-Scale Hydroelectric Power Development Project.

1. Topographic Survey (Show Fig. V-1-1)

Topographic map of 1/500 scale: access road for powerhouse site

(1) Quantity: 0.13 km²

2. Geological Investigation (Show Fig. V-1-1)

(1) Intake dam site: To grasp the permeability of the both intake dam banks.

1) Drilling

Right bank	20 m x 1 drillhole
Left bank	20 m x 1 drillhole

2) Permeability test Using the both right and left bank drillholes

4 point x 2 drillhole = 8 points

(2) Headrace tunnel: To grasp the geological conditions

1) Drilling

The middle of tunnel route 40 m x 1 drillhole

- 2) Laboratory test Using the cores

Specific gravity, uniaxial compression, and tensile tests (3 specimens)

- (3) Penstock route: To grasp the geological condition of the talus deposit

- 1) Pitting 2 m x 2 m x 2 m (depth) x 1 pit

- 2) Laboratory test To use the specimen of the pit

Sieve analysis and consolidation test (3 specimens)

3. Meteorological and Hydrological Observation

- (1) Continuation of Observation

We have not gotten enough hydrological data in the Xe Namnoy River Basin including the Xe Katam River as mentioned in chapter II 1.3. The observation shown below which has begun February 1991 should be continued to go on with the project.

- 1) Rainfall Observation

- Ban Xekatom (Xe Katam River Basin)
- Ban Tangvay (Xe Katam River Basin)
- Ban Houaykong (Xe Namnoy River Basin)
- Ban Latsasin (Xe Namnoy River Basin)
- Ban Namakong (Xe Namnoy River Basin)

- 2) Water Level and River Runoff Observation

- Ban Nonghin (Xe Katam River Basin 171km²)
- Ban Latsasin (Xe Namnoy River Basin 537km²)

(2) Additional Observation

River runoff observation in the Ban Latsasin Gauging Station during rainy season is not possible actually. Necessary equipment should be installed in this gauging station as soon as possible, because the runoff data of this station is necessary to make a study of the large scale hydroelectric power development in the Xe Namnoy River Basin, which was studied in chapter II.

Probable maximum discharge for spillway design, sediments volume and evaporation must be estimated accurately, when the project with a reservoir is studied. It is strongly recommended that new additional observations shown below should be commenced.

- Rainfall observation in upper reaches and right bank area of the Xe Namnoy River Basin
- Observation of atmospheric pressure, vapor pressure and dew point temperature in the Xe Namnoy River Basin
- Evaporation observation by Class A Pan in the Bolaven Plateau
- Observation of suspended loads in the Xe Namnoy River Basin including the Xe Katam River

4. Power Survey

As above mentioned, demand forecast made in this study is not based on historical trend data. There are some possibilities to revise this demand forecast, because several uncertain data included in the forecast processing.

Data and information to be required are shown below.

- (1) Monthly peak demand, typical daily load curve of working day and holiday in each season in areas advanced electrified areas such as Champassak and Saravan Provinces.

(2) Monthly energy and annual energy data in above mentioned area.

For reference, data of (1) and (2) are acquisitioned at the secondary terminal of main transformers in Bangyo Substation and at the sending terminal of 22 KV transmission line in Major Substations.

(3) Hourly operation record of Xe Set and Selabam Hydropower Stations.

(4) Same data as (3) of Xe Katam.

(5) Hourly dispatched power data to Sekong and Attapeu same data as (1)

Whole data will be analyzed and studied in order to define demand forecast.

5. Review of Establishment Operation and Maintenance Organization

In order to operate the Xe Katam Hydroelectric Powerstation and to keep high efficiency, it is indispensable to review and prepare establishment of suitable operation and maintenance organization.

And also, it is required to review how to train employees to become useful workmen or engineers, who will organized above organization.

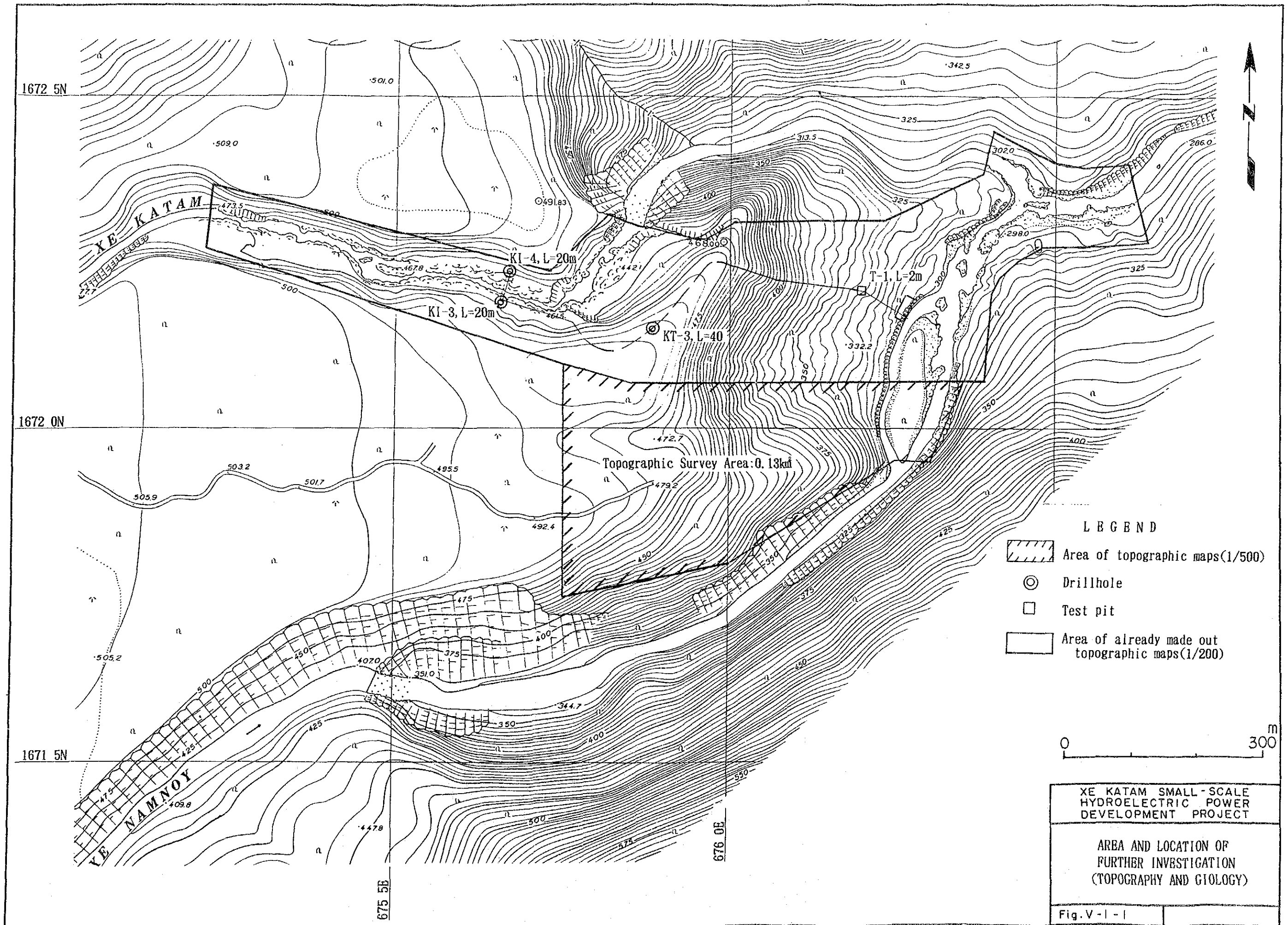
It is required to review that how many numbers of engineers are adequate, what is according to installed capacity and number of units with referring management of existing hydro power station as the Xe Set and Selabam Stations.

With regard training of engineer, it seems practical and useful way that some engineer who is working in existing hydro power stations, and have various experience of technology, shall transfer technologies to untrained engineers.

In addition, it is necessary to prepare action program for training.

6. Establishment of Tariff System

It is recommended that suitable tariff system shall be established with referring results of financial analysis and existing tariff systems in the southern provinces.



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