Environment Assessment Report

Initial Environmental Examination
Project Number: 42182
November 2008

Socialist Republic of Viet Nam:
Renewable Energy for Remote Commune Sector Project – Nam Nghe Mini-Hydropower Subproject

Prepared by Power Company 1 of Viet Nam Electricity for the Asian Development Bank (ADB).

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I. INTRODUCTION

The Nam Nghe Mini Hydropower Project (MHP) is the core subproject of the Renewable Energy for Remote Commune (RERC) Sector Project which is being considered for financing by the Asian Development Bank (ADB). The RERC Project aims to increase the number of households connected to the grid and to generate the power required by means of renewable energy sources. The Project will be prepared in a manner consistent with the government's strategy for electrification of remote communes through investments by provincial authorities under the supervision and coordination of the Ministry of Industry and Trade (MOIT). Power Company 1 is the executing agency (EA) for the Nam Nghe MHP. The proposed sector loan will focus on the communes that are considered too remote to be connected to the national grid and has potential for electrification using renewable energy such as micro to mini hydropower (0.5 to 7.5 MW capacity). The sector loan will also finance grid extensions consisting of medium and low voltage transmission and distribution lines.An environmental assessment and review framework (EARF) has been prepared for future micro and mini hydro subprojects.

Nam Nghe MHP is planned to be constructed on the Nam Nghe stream west of Hua Bum commune. Hua Bum is a mountainous commune of Muong Te district in Lai Chau province – a remote mountainous province in the Northwestern Vietnam. The subproject is designed with a generation capacity of 5.2 MW to provide electricity for 5 communes.

II. DESCRIPTION OF PROJECT

A. Project Design

The various subproject facilities will cover an estimated area of 4 to 5 ha. The total land to be acquired for the subproject is about 8.3 ha. The construction duration is 24 months and the subproject is expected to be operational around 2011.

The water source for the subproject is the Nam Nghe stream. Location of the subproject is shown in *Figures 1* and *2.*

The preliminary design parameters of the subproject are presented in Table 2.1. The general hydropower layout is based on the following considerations:

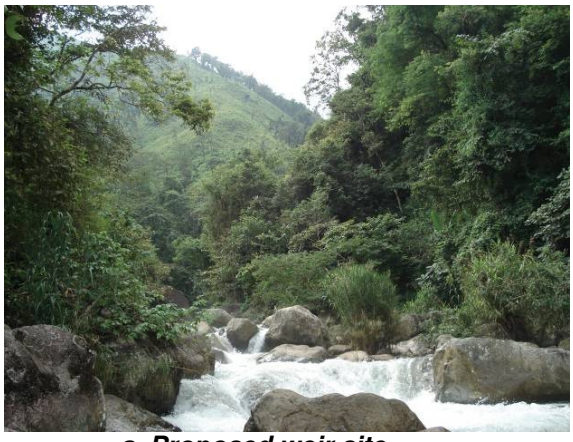
(i) The potential of the Nam Nghe stream is exploited in a run-of-river mini hydropower plant without storage facilities.
(ii) An overflow weir about 14 meters high will be built in the river to divert the flow towards the intake. During operation, the raised water level will not cause flooding of adjacent areas since the river runs through a very steep gully.
(iii) The headrace canal with a total length of 1,400 m is located on the right bank of the river and the penstock will have a total length of 340 m.

Table 2.1. Preliminary design of the Nam Nghe MHP

No	Parameter	Value
1	Name of site	Nam Nghe MHP
2	Location	Hua Bum commune, Muong Te district
3	Name of stream	Nam Nghe
4	Net head	184.5 m
5	Design flow	3.52 m^3/s
6	Design capacity	5.2 MW
7	Distance to the national grid (Muong Mo commune)	51 km
8	Distance to the isolated grid (Muong Te town)	12 km
9	Diesel back-up	none

Source: ENTEC, October 2008

The proposed weir and power house sites are shown in *Figure 1*.



a. Proposed weir site

b. Proposed power house site

Figure 1. Present landscape at the proposed site of the Nam Nghe MHP (July 2008)

B. Description of Civil Works

Intake structures. The intake structure will be located at a narrow stream section with exposed bedrock. Due to the topographical and geographical conditions, the weir is proposed to be the gravity type, entirely overflow and no valve gate. The core of the weir will be built from concrete and then covered with reinforced concrete. The maximum height of the non-oveflow section of both roots of weir is 14 m. The length of the overspill section is 50 m which ensures the safety of the structure when flushing during flood conditions. The intake structure is comprised of the sand flushing sluice and intake orifice.

Headrace, forebay and penstock. The proposed 1.4 km headrace canal will be located on the right bank of the stream which leads through the mountain cliff area and a densely forested area. The headrace will have a rectangular cross section and will be constructed from ferro-concrete. Upon completion of topographical and geological surveys, the structure and energy route options will be modified accordingly. The forebay will be located at the end of the headrace canal. A spillway will also be provided at both ends of the headrace canal to safely convey any water discharged from the headrace away from its banks. Between the forebay and the power house would be a 340 m long penstock steel pipe with a diameter of 1.1 m.

Powerhouse. The powerhouse will be located at the right bank of Nam Nghe stream near the confluence with Nam Bum river. Two Pelton turbine units (each having a capacity of 2,600 kW) including synchronous generators and a control system will be installed. The water used for generation will conveyed by the tailrace back to the main stream. The length of the river between the weir and the powerhouse is almost 2 km. The confluence of Nam Nghe and Nam Bum streams is just downstream of the tailrace.

C. Transmission and Distribution

To connect the households in the hamlets and the national grid to the Nam Nghe MHP, a mini-grid consisting of medium voltage (35 kV) and low voltage (0.4 kV) backbones and low voltage (220 V) house connections will be set up.

Step-up transformers at the powerhouse. Two 3,200 kVA 3-phase step-up transformers will be installed at the powerhouse to step up voltage from 6.3 kV to 35 kV.

35 kV transmission line to grid connection point and load center. A three phase 35 kV transmission line with ACSR (aluminum conductor steel reinforced) conductors and spin-cast concrete poles will be installed from the powerhouse 12 km to the Muong Te town. Along the route to Muong Te town, Pa Mu and Phieng Kham hamlets will be electrified by two 35/0.4 step-down transformer stations. Another three-phase 35 kV transmission line with ACSR conductors and spin-cast concrete poles will be installed from the powerhouse 5 km to Chang Chac Pa, Nam Nghe and Ba Cheo hamlets. The subproject requires installation of a 35 kV transmission lines with a total length of 17 km.

Step-down transformers to local load center. The following step-down transformers will be installed:

(i) One three-phase 75 kVA step down transformer in Chang Chac Pa hamlet
(ii) One three-phase 25 kVA step down transformer in Pa Mu hamlet
(iii) One three-phase 25 kVA step down transformer in Phieng Kham hamlet

0.4 kV distribution line to the hamlets. Distribution lines (0.4 k) with AV conductors and H-figure concrete poles will be set up to supply and distribute the electricity in the hamlets. Nam Nghe and Ba Cheo will be supplied electricity by the 0.4 kV line from the Chang Chac Pa hamlet. A total of 10.5 km 0.4 kV distribution line is required for the subproject.

Single-phase household meters. Single-phase distribution lines will be used for the consumer connections. Electricity meters will be installed for all consumers.

III. DESCRIPTION OF THE ENVIRONMENT

A. Location

Figure 2 shows the proposed location of Nam Nghe MHP. Specifically, the weir will be located at 22º24'30.7" N and 103º56 55.5" E while the powerhouse will be at 22º23'43.5" N and 103º56'44.4" E. The size of the catchment area at the proposed intake is 35 km^2.

B. Physical Environment

1. Climate

From the collected data at the Muong Te Meteo–Hydrological Station at Muong Te district close to Hua Bum commune, climatic characterictics at the subproject site are summarized as follows.

a. Rainfall

Muong Te is one of the regions of highest rainfall in Lai Chau province with the rainy season lasting from April to October. Rainfall on high mountains may reach 3,000 mm per year; whereas rainfalls on medium and low mountains are 2,000 – 2,500 mm per year and 1,500 – 1,800 mm per year, respectively. The dry season starts in November and ends in March with mist and hoarfrost (white ice crystals) frequently occur in January and February. Hua Bum commune is located on medium and high mountains with the highest peak of 1,238 m. With influence of topography, annual rainfall in this commune is high. Values of rainfall measured at Muong Te and Na Hu stations are shown in *Tables 3.1 and 3.2.*

Table 3.1. Rainfall recorded at Muong Te station

Unit: mm

Year / Month	2004	2005	2006	2007
January	38	25	0	120
February	22	18	38	250
March	43	104	7	50
April	148	106	142	188
May	547	136	211	320
June	212	667	432	268
July	537	367	719	755
August	364	800	369	446
September	215	45	249	213
October	45	64	264	46
November	72	61	33	31
December	0	107	1	0
Average	**187**	**208**	**205**	**224**

Source: Yearbook of Laichau province, 2007.

Table 3.2. Rainfall recorded at Na Hu station

Unit: mm

Year / Month	2000	2001	2002	2003	2004
January	16.7	68.5	91.6	110.4	35.5
February	45.3	42.4	54.2	16.2	15.2
March	54.7	75.2	112.9	61.6	36.6
April	135.6	84.9	110.7	89	146.7
May	292.1	465.3	478.6	150.7	508.5

Year / Month	2000	2001	2002	2003	2004
June	440.5	475.5	645.5	636.3	228.1
July	503.6	581.7	737.1	548.1	638.5
August	462.1	225.9	442.5	616.4	358.8
September	111.7	177.3	120.1	157.3	152.8
October	72	135.4	154	121.1	57.4
November	8.8	30.5	76.3	5.0	92.9
December	42.5	0.3	66.3	11.2	0
Average	**182.13**	**196.91**	**257.48**	**210.28**	**189.25**

Source: Hydrological Station at Na Hu commune

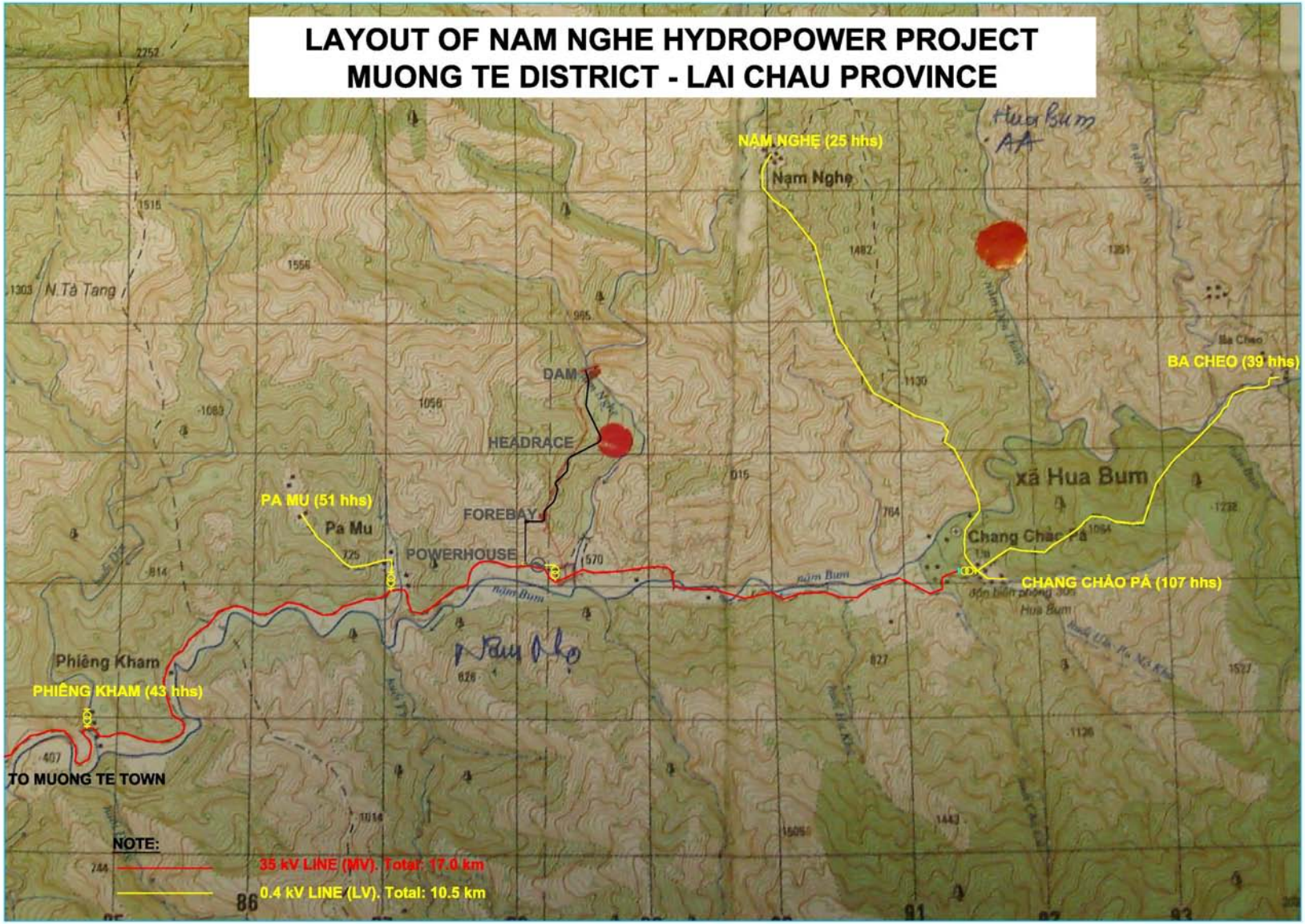


Figure 2. Layout of Nam Nghe hydropower Project – Muong Te District – Laichau Province

b. Atmospheric Temperature

There is clear-cut difference in temperature between sub-regions in Muong Te district. The average temperature at high mountains is 15°C, far lower than the averages of 20°C and 23°C respectively of the medium and low mountains. Annual average temperature at Muong Te is 22.4°C with the highest of 39°C and the lowest of 1°C. The difference in average temperature between the hottest (July) and the coldest (January) is 10°C to 12°C. Average atmospheric temperature at Muong Te are shown in *Table 3.3*

Table 3.3. Averages atmospheric temperature at Muong Te station

Unit: °C

Year / Month	2004	2005	2006	2007
January	16.6	16.8	17.1	17.4
February	18.3	19.0	20.9	17.6
March	21.4	20.0	21.8	20.9
April	23.7	24.2	24.3	22.8
May	25.2	26.4	24.7	25.2
June	26.2	26.4	26.5	26.9
July	26.1	26.7	26.4	25.7
August	26.7	26.0	26.5	26.3
September	25.7	25.8	25.2	25.2
October	22.5	24.0	24.3	23.8
November	20.6	20.9	20.4	19.4
December	15.7	16.9	17.6	18.9
Average	**22.4**	**22.8**	**23.0**	**22.5**

Source: Yearbook of Laichau province, 2007.

c. Relative Humidity

Humidity is dependent on rainfall distribution. Relative humidity of 85% in the rainy season may fall to 75 – 80% in the dry season, and lower than 50% in February. The averages of humidity recorded at Muong Te station are shown in *Table 3.4.*

Table 3.4. Average of humidity at Muong Te station

Unit: %

Year / Month	2004	2005	2006	2007
January	85	87	84	83
February	80	81	81	80
March	51	82	78	79
April	74	82	81	81
May	85	81	84	81
June	88	91	88	85
July	89	88	89	88
August	88	90	88	86
September	88	86	85	84
October	89	86	87	83
November	88	88	86	84
December	88	90	88	83
Average	**83**	**86**	**85**	**83**

Source: Yearbook of Laichau province, 2007.

d. Sunlight

Annual average sunlight hours at Muong Te are 1,881 hours with the highest monthly average of 200 hours in April and lowest of 126 hours per month in June. Annual average sunlight hours recorded in the period from 2004 to 2007 at Muong Te are shown in *Table 3.5.*

Table 3.5: Sunlight hours at Muong Te station

Unit: Hour

Year / Month	2004	2005	2006	2007
January	97	144	147	143
February	157	190	180	152
March	157	137	151	152
April	178	190	167	130
May	174	352	153	148
June	141	88	147	155
July	133	58	141	80
August	179	100	172	139
September	140	168	137	127
October	127	171	151	141
November	143	130	158	131
December	143	116	137	154
Average	**147**	**154**	**153**	**138**

Source: Yearbook of Laichau province, 2007

e. Wind and Typhoons

Because of complicated terrain, annually, in this district 3 types of dominant winds occur: southwest wind from March to July with Foehn effect[1], which is dry and hot; southeast wind from August to October creating heavy rains, particularly on windward sides; and northeast wind from November to March, which is strongly modified as it blows over Muong Te resulting to low-speed wind and dry and cold weather.

f. Critical Weather Phenomena

The different weather phenomena experienced in the area are as follows:

(i) *Mist:* a general phenomenon throughout winter in northwest mountains (particularly in closed valleys).

(ii) *Hoarfrost:* Dry and windless winter creates favorable conditions for hoarfrost. Its frequency is low in areas with elevation of 200 to 300 m but very high in mountains with elevation of higher 500 – 600m.

(iii) *Thunderstorm:* On average, the frequency of thunderstorms in Northwest mountains is 90 – 110 days per year with the highest in June (15 – 20 days) and lowest in winter (only 1 to 2 days per month). In the transition time from winter to spring, thunderstorms may occur together with hail. It is recorded that hails occur 3 – 4 times in a year.

2. Hydrology

All area of Muong Te district is located in the basin of the Da (Black) river, the second largest river in Northern Vietnam. Hua Bum commune is where the Nam Bum stream originates. The Nam Bum stream is a tributary to the Da River. The Nam Bum stream is created by three

[1] Occurs when air rises over the mountains, cools, condenses and stays under the form of a cloud or rains as the air continues to rise. When the air mass descends on the other side of the mountain, the air becomes more dry and warm.

small streams, i.e., Nam Nghe, Nam Pacheo and Nam Den Thang, originating from a mountain in the border with China.

The Da river has a high discharge of over 2,000 m3/s in the flood season and 100 – 200 m3/s in the driest months. The Nam Nghe stream where the Nam Nghe MHP will be located has a total basin area of 35 km2, and average annual discharge of 2.6 – 3.0 m3/s. The maximum discharge of the stream is over 10 m3/s in the flood months (September to October) and it is only under 1.0 m3/s in the driest months (February to April). Nam Nghe empties to Nam Bum stream.

All streams in Hua Bum commune flow through mountainous areas with high slopes, and may cause strong floods from August to October. Such floods may trigger soil erosion, and inflict damage to cultivated fields and infrastructures thereby disrupting the lives of local people. Some pictures of the streams in Muong Te are shown in Figure 3.

1. Den Thang stream

2. One of proposed location of the Project

3. Nam Nghe stream

4. Nam Nghe stream

Figure 3. The streams in Hua Bum commune in the flood season (July 2008)

3. Topography and Soils

a. Topography

Muong Te district has a very complicated terrain with deep vertical and horizontal rifts by high ranges in the northwest – southeast direction with the dominance of high and medium mountains. The average elevation is 900 – 1,500 m above sea level with Phu Xi Lung as the

highest mountain at of 3,076 m. The average slope is 25 – 30º. Main topographical types of Muong Te district include:

(i) *High and medium mountains (higher than 700 m) occupying* about 265,828 ha or 72.12% of the total natural area of the district. The average height is 1,500 m and the slope is at least 25°.
(ii) *Low mountains (lower than 700 m) occupying* about 100,722 ha or 27.33% of the total natural area of the district, mostly in the south and southwest of the district.
(iii) *Narrow valley occupying* 2,033 ha or 0.55% of the total natural area of the district, mostly along small rivers and streams.

b. Tectonic Characteristics

The base of Muong Te is a part of the northwest of Vietnam with complicated tectonic characteristics with main geotectonic mother rocks as follows:

(i) *Acidic crystallized magma rocks (a) including*: granite, liparite, Otophia, etc. which are hard, sterile and hardly weathered;
(ii) *Sedimentary and metamorphic rocks* of fine structure (s) including clay schist, arginite, mica, etc. which are fully weathered and fertile;
(iii) *Sedimentary and metamorphic rocks* of rough particles (q) including sand, sandstone, calcareous conglomerate, etc. which are fertile and hardly weathered;
(iv) *Carbonate rocks (V)* including limestone, dolomite and marl, etc., which are fertile but hardly weathered.
(v) *Alluvia (L)* with medium to fine particles, on which soil is fertile.

c. Soils

Together with effects of terrains and climate, hydrological characteristics greatly contribute to the formation of specific types of soils. It is studied and found that Muong Te district has 23 kinds of soils in four main groups:

(i) *Humic soil on high mountains* (N_1H) formed on acidic crystallized magma and clay schist occupying 36,468 ha (9.9 % of the total land), distributing in communes of Thulum, Hua Bum, Pau, Pavesu and Kalang with elevation of at least 1,700 m. This is gray yellow and always wet and therefore it is easy to be vertically washed away. Its thickness is 50-100 cm, including at least 0.3m of humus. Its structure is classified as light to medium lean.
(ii) *Humic ferralite soil* on medium mountains (N2FH) formed on acidic magma, sandstone, and clay schist occupying: 228,842 ha (62.09% of the total natural land), distributing in communes of Pau, Pa Ve Su, Thu Lum, Bum To, Muong Mo with elevation of 700 to 1700m. It has yellow or light yellow colors, low acidity, high slope and thickness of 30 – 60 cm, inclusive of a thin humic layer. Its structure is classified as light to medium lean. It is being strongly washed and eroded because of nomadic farming.
(iii) *Limestone soil (Fv)* occupying 45,360 ha (1.5% of the natural land). At present, its vegetation cover is almost destroyed, leaving only bushes and creepers. This kind of soil distributes in communes of Muong Mo and Pa Ve Su.
(iv) *Fluvial soil* occupying 82,668 ha (22.43% of the natural land), including may kinds such as : alluvial soil (P), ferralite soil modified by rice cultivation (F1), illuvial (T), peaty soil (G1), distributing in low regions along streams and valleys, mountain bases. This is usually grey, thick, loose, fertile and wet with light to medium strength.

Other groups of soils occupy the remaining area of the district. In general, land in Muong Te district is suitable for various kinds of crops but due to high slope, high rainfall, and low coverage of forest, top soil layer is easily washed away and the land becomes eroded.

C. Terrestrial Ecosystem

The present state of natural ecosystems at Muong Te district are described below

a. Forest and Flora

Forests in Muong Te district has a critical role to play in prevention of flood, soil erosion, protection of hydropower plants and irrigation works, as well as conservation of biodiversity, the environment, and development of ecotourism. Unfortunately, during the last decades the quality of forests there is deteriorated due to expansion of agricultural land.

As of January 2007, the coverage of forests in Muong Te district is about 172,480 ha. (46.80% of the total natural land) with 4 main kinds as follows:

i. Wood Forests

Wood forests occupy 64.5% of forestland, distributing mainly along Vietnam – China border, the Da River and some high mountains on communes such as Mu Ca, Ta Tong, Muong Mo and Hua Bum. The coverage is only 30 to 50% and the reserve is high (80 m^3/ha).

Main botanical families of this kind of forest include *Castanea* (chestnut)*, Theaceae* (tea family)*, Magnoliaceae* (family of flowering plants, of which Magnolia is the most well-known genus), etc. with the dominance of *Castanopsis* (beech) and *Schima* or Mạy Thù Lụ in H'mong language (evegreen trees belonging to the tea family). In addition, at the highland with elevations higher than 1000 m in Tatong, *Betula alnoides* spp. (birch) is found at a significant percentage.

ii. Wood-Bamboo Mixed Forest and Bamboo Forest

Wood-bamboo mixed forest and bamboo forest cover of about 2,262 ha, (1.6% of forestland), distributing along streams such as Nam Na and the Da River.

Common bamboo species include *Neohouzeaua dulloa*, and *Dimerocarpus balansae*, which develop in thick groves that hinder the growth of other wood trees. On average, this kind of forest develops to 15-16 m in height with trees of 10-15 cm in diameter, about 2,500 – 3,000 individuals per hectare with wood reserve lower than 40 m^3/ha.

iii. Premature Forest

Premature forests (also called restored forests) occupy 33.4% of forestland, scattering at all elevations with high concentrations around villages. Developing after milpa (field cultivated for various crops) is abandoned, its status is dependent on the acreage of the milpa and restoration period. Its coverage is usually 30-45% and the average reserve is as low as 15.4 m^3/ha.

The species composition of this kind of forest is diverse. For instance, at Ta Tong (1,500 m over the sea level), *Alnus nepalensis* (alder tree) is the main species. At the same elevation but when soil is wet, *Macaranga heudelotii* is dominant. At dryer and less fertile zones, dominant species include *Cratoxylon cochinchinense, Aporosa microcal, Engelhardtia chrysolepis Hance* and others such as *Castanea (chestnut), Fabaceae* (legume family) species. The appearance of those species shows improvement in forest protection under the policy of allocation of forests to people.

1. Forest at a stream confluence

2. Forest in a valley

3. Forest at low mountain

4. Forest at mountain peak

5. Forest at a trail to the subproject area

Figure 4. Present state of the forest at Hua Bum commune
Photo: VESDEC, July 2008

iv. Planted Forest

This kind of forest occupies only 0.5% of forestland with species such as *Aleurites (small tree-like plants belonging to the spurge family), Pinus khasya (pine), Chukrasia tabularis (c*hickrassy)*, Acacia, Casia* (golden shower tree)*, Dendrocalamus membranaceus* (bamboo) *and Sinocalamus sternoauritus*, distributed mostly in Bum To, Muong Mo, Nam Hang, Bum Nua and Muong Te town. At present, planted forest is allocated to people for protection. Some types of forest in Hua Bum are shown in *Figure 4.*

b. Fauna

According to the survey at the communes Mu Ca, Ta Tong, Hua Bum and the west sides of Muong Mo, Ka Nho, Nam Khao and Muong Te town in 2001, 24 large-size mammal species were found. The species listed in the Vietnam Red Book are *Bos gaurus* (gaur)*, Panthera tigris* (tiger)*,* and *Panthera pardus* (leopard). Other mammal species commonly found are deer (*Cervus, Muntiacus),* monkey *(Macaca assamensis*), wild boar, etc.

According to an initial study in 1991 by the WWF, 222 bird species were observed in Muong Nhe with some rare and endangered ones such as *Lophura nycthemera* (silver pheasant), *Polyplectron bicalcaratum* (Grey peacock-pheasant), and *Anthracoceros albirostris* (oriental pied-hornbill)*.* Various species of reptiles and amphibians are also commonly found in the district.

To date, there have been no specific studies on biodiversity of Hua Bum commune. The abovementioned wild animals, however, may be found in mountainous communes in the locality (including Hua Bum), particularly where there is high cover of natural forest. Current threat to wild fauna is encroachment of local people into the forests.

D. Socio–Economic Environment

1. Economic Development

a. Agriculture

Agriculture – forestry had slow growth of 3.7% per annum in the period of 2003 to 2007. The economic structure at present consists of 67.6% agriculture, 31.6% forestry and 0.8% fishery. The total production of agriculture-forestry in 2007 is VND 92.36 billion.

Agriculture is an important part of the economic growth of Muong Te district. Its production reached VND62.43 billion in 2007 with 60.51% of cultivation and 34.32% of animal husbandry.

Recently, the district has made changes in crop structure towards intensive cultivation yet the yield is still low and unstable because of various difficulties such as shortage of arable land and water, poor techniques and limited application of new technologies.

i. Food Crops

In 2007, land area cultivated for food crops was about 7,070 ha, increasing by 1,410 ha over 2003. Noticeably, the acreages for wet rice and maize increased while that of upland rice decreased.

Table 3.6. Cultivated Food Crops in Muong Te district

No.	Parameter	Unit	Year				
			2003	2004	2005	2006	2007
	Grain output	ton	9,409.7	10,499.7	11,868.2	13,939.5	15,500.0
1	**Winter rice**						
	Acreage	ha	1,089.2	1,185.0	1,410.0	1,674.4	1,850.0
	Yield	100 kg/ha	37.7	38.3	37.9	40.2	40.5
	Output	ton	4,101.6	4,535.7	5,346.6	6,737.3	7,492.5
2	**Summer rice**						
	Acreage	ha	432.0	541.5	652.6	746.5	850.0
	Yield	100 kg/ha	37.2	40.3	39.1	35.5	40.0
	Output	ton	1,574.9	2,181.2	2,552.9	2,499.7	3,400.0
3	**Upland rice**						
	Acreage	ha	2,550.0	2,667.0	2,501.2	2,568.0	2,000.0
	Yield	100 kg/ha	9.1	9.2	8.9	9.3	10.0
	Output	ton	2,346.4	2,381.8	2,332	2,568.0	2,000.0
4	**Maize**						
	Acreage	ha	1,598.0	1,483.0	1,588.0	1,940.5	2,370.5
	Yield	100 kg/ha	8.7	9.5	10.3	11.0	11.0
	Output	ton	1,386.8	1,401.1	1,636.4	2,134.6	2,607.5

Source: Statistics Division of Muong Te District, 2008

The total grain output in 2007 was 15,500 ton, *i.e.* 6,090 ton higher than that of 2003. On average, the output is 305 kg per capita per year. The district still needs 318 ton to reach the minimum norm of 313 kg per capita per year. Compared with the average of the whole province, the grain output of Muong Te is lower by about 19 kg per capita per year.

i. Vegetables and Annual Industrial Crop

The acreage of other crops such as vegetable and beans, etc. reached almost 45 ha in 2007 but the yield was not steady.

Muong Te has high potential for short-term (annual) industrial crops, still the acreage thereof is limited and the yield is low. Compared with those of 2003, the acreage of soybean in 2007 expanded by 97 ha while the yield increased by 10 kg/ha.

Table 3.7. Acreages, yields and outputs of annual industrial crops

No.	Parameter	Unit	Year				
			2003	2004	2005	2006	2007
1	**Soybean**						
	Acreage	ha	143.0	140.2	165.0	210.3	240.0
	Yield	100 kg/ha	5.1	4.7	5.7	6.7	6.7
	Output	ton	73.0	65.9	94.0	140.9	158.9
2	**Groundnut**						
	Acreage	ha	77.0	67.5	16.6	151.5	200.0
	Yield	100 kg/ha	3.4	3.8	5.5	6.5	6.5
	Output	ton	26.3	25.7	9.2	98.2	130.0
3	**Cotton**						
	Acreage	ha	105.0	56.0	85.0	85.0	100.0
	Yield	100	3.9	4.0	4.0	4.0	7.5

No.	Parameter	Unit	Year				
			2003	2004	2005	2006	2007
		kg/ha					
	Output	ton	41.3	22.4	34.0	3.0	75.0
4	**Sesame**						
	Acreage	ha	12.0	15.5	6.9	10.0	20.0
	Yield	100 kg/ha	2.5	2.7	3.0	3.0	3.0
	Output	Ton	3.0	4.2	2.1	3.0	6.0

Source: Statistics Division of Muong Te District, 2008

ii. Perennial Crops

Muong Te district is suitable for developing perennial crops but the acreages thereof are still limited without key products.

Fruit trees still occupy very small areas, which are mostly scattered as family gardens. Their products are mostly consumed by families, *i.e.* not commercialized to make full use of their advantages.

It is noteworthy that cardamon has been introduced and some large areas with commercial cultivation are formed at Ta Tong, Ka Lang, Hua Bum, Thu Lum and Pa Ve Su.

Table 3.8. Acreages, yields and outputs of perennial industrial crops

No.	Parameter	Unit	Year				
			2003	2004	2005	2006	2007
1	**Cardamon**						
	Acreage	ha	143.0	140.2	165.0	210.3	240.0
	Yield	100 kg/ha	5.1	4.7	5.7	6.7	6.7
2	**Fruit trees**						
	Acreage	ha	77.0	67.5	16.6	151.5	200.0
	Yield	ton	26.3	25.7	9.2	98.2	130.0

Source: Statistics Division of Muong Te District, 2008

b. Animal Husbandry and Aquaculture

The growth of animal husbandry is still lower than expected with an average of 5.7% per year. The total value of breeding products in 2007 is estimated at VND 21.42 billion.

Breeding is still conducted at family scale in the form of grazing *(Table 3.9)*.

Aquaculture has been introduced in the district but shortage of capital and poor technical application are hindering its expansion and productivity. The whole district has 29.0 ha of aquaculture waters, yielding 9.4 tons in 2007.

The main obstruction to breeding is the poor transportation systems between communes and districts. In other words, products can hardly be commercialized with such poor transport conditions. Furthermore, state support such as for cross-breeds, advanced models of breeding facilities, and veterinary, etc., are still limited.

Table 3.9. Animal husbandry at Muong Te district

No.	Domestic animals	Unit	Year				
			2003	2004	2005	2006	2007
1	Water buffalo	head	7,022	7,124	7,312	7,581	8,000
2	Cow	head	3,056	3,791	3,964	4,073	4,750
3	Horse	head	396	503	519	599	660
4	Goat	head	1,597	2,070	2,373	1,693	2,300
5	Pig	head	13,529	15,359	16,041	17,684	21,000
6	Poultry	head	65,447	63,447	69,371	76,526	82,000

Source: Statistics Division of Muong Te district, 2008

c. Industry and Handicrafts

Main industrial production in the district include hydropower, construction materials, and processing of farm and forest products. Other sectors such as processing of mechanical products and textile, garment are still scattered in household scale. There is no key product based on the local advantage and resources. Underdevelopment may be caused by poor investment in expansion, poor management, shortage of technicians and skilled workers.

The industrial growth rate from 2003 to 2007 is approximately 14.1% per year. The total production of industry-construction in 2007 is VND 25.56 billion, accounting for 16.8% of the local GDP.

d. Industry

i. Power Sources

Current power generation and transmission facilities in the district are presented below:

- *Hydropower:* the district has 6 small hydropower stations of 24KW to 500KW each.
- *Diesel-fueled generators*: the district has one standby station of 512 KW which mainly serves Muong Te town. At present, those generators are obsolete and the capacity is low.
- *Electricity grid:* in the district total length of transmission lines is only 18 km, including 5 km of 10 kV line and 13 km of 400 V line.
- *Transformer stations*: there are 8 stations, including 2 booster stations (Nam Si Luong of 320 KVA and the station for diesel-fueled generators of 180 kVA) and 6 supply stations (10/0.4 kVA) with the total capacity of 770 kVA (2 stations of 75 kVA, 3 of 100 kVA, 1 of 320 kVA).

Table 3.10. Hydropower stations in Muong Te district

No.	Hydropower plant	Capacity	Operation start	Service network
1	Muongmo	30 KW	1993	100 households at Muong Mo
2	Nam Siluong	50 KW	2002	765 households at the town 195 households at Bum Nua
3	Nam Patroi	24 KW	1999	80 households at Gang village, Muong Te commune
4	Phinkho	40 KW		
5	Pacma	20 KW		
6	1,500 hydropower machines	200 W – 500 W		

Source: Report of Muong Te PC on Land Use Planning for Muong Te District till 2015, 2008.

ii. Farm and forest Products Processing

The two forest products processing entities work manually with simple machines. Their products are furniture and rattan materials.

iii. Mineral Resources and Construction Materials

Muong Te is rich in raw materials for the construction industry, for instance limestone and granite at Muong Mo, pebbles and sand at Muong Te town, schist at Bum Nua, kaolin at Kan Ho, and pyrite at Kan Ho, Muong Te, and Ka Lang. This industry is however underdeveloped with no industrial facilities for production. In fact, construction materials are locally produced manually or semi-mechanically.

In 2007 the district produced 885,000 bricks, 1,356.5 m^3 of stone of various kinds and 650 m^3 of sand. The outputs in 2008 are estimated at 2,425,000 bricks and 1,212 m^3 of sand for construction.

There are some mineral resources in Muong Te district such as gold in Bo village. However, mineral resources are not exploited at the district. A hot spring is also found at Pac Ma.

iv. Small Industries and Handicrafts

The district has only one handicraft cooperative (at Bum Nua). Remaining production are through family businesses with typical products of upland settlers such as native handicrafts, clothes, and leather ware, rattan and bamboo products. Although those products are abundant with diversified patterns and designs, they cannot go beyond villages. The value of production in 2007 is VND 364.4 million.

Among other things, main causes of underdevelopment include poor transport conditions, scattered population, low living standards, poor organization for production, shortage of skilled labor and technicians.

e. Trading and Service

It is evaluated that trading and service has developed well in recent years with the growth rate of 20.9% per year. The total value of trading and service reached VND 34.236 billion, accounting for 22.5% of GDP in 2007.

Non-state trading is developed based on family-businesses for expansion of rural market and streamlining circulation of goods. To date, the district has a district market, a central market at Pac Ma and many private shops in communal centers. Particularly, there are 175 trading households in the town. State-run trading still holds the key role in supply of essentials to remote areas, and stabilization of local price and market.

Inflow of goods for local consumption is mostly supplied by other provinces. Outflow of goods is very small, including raw materials (for Lai Chau pulp mill), rattan and bamboo, and some pharmaceutical materials.

Table 3.11. Infrastructure for trading and service

System of trading and service	Year				
	2003	2004	2005	2006	2007
Markets	2	2	2	2	2
Supermarkets	-	-	-	-	-
Commercial centers	-	-	-	-	-
Hotels and restaurants	2	2	2	3	3

Source: Report of Muong Te PC on land use planning for Muong Te District till 2015, 2008.

2. Social Development

a. Demography

Compared to other districts of Lai Chau province, Muong Te has the largest area (about 3,686 km^2) but has the smallest population density (13 inhabitants/km^2) (*Table 3.12*). In this district there are five minority ethnic groups: Han Hi, H'mong, Mang, Thai and Kinh.

There is no data on percentage of each ethnic groups in the district, but in Hua Bum commune the percentage of Han Hi people is 40.4%, H'mong: 29.2%, Mang: 24.1% and Thai: 16.3% in the total of 265 households (1,640 inhabitants).

Table 3.12. Area and population of district in Laichau province, 2007

District/Town	Area (km^2)	Population (Inhabitant)	Population density (Inhabitant/ km^2)
Laichau Town	70.42	19,730	280
Tamduong	764.22	44,691	58
Muong Te	3,685.83	49,020	13
Sinho	2,066.74	76,115	37
Phonhtho	825.04	52,806	64
Thanuyen	1,700.07	94,574	56

Source: Annual Statistic of Laichau Province, 2008

In 2004 – 2007 annual population growth rates of the district are 2.4% which is much higher than the average annual population growth rate of Vietnam (1.55% in the same period). Laichau is one of the poorest provinces in Vietnam. The poverty ratio of the province was 63.57%, 50.95% and 38.89% in 2005, 2006 and 2007, respectively. Ratio of poverty of Muong Te district may be higher than that average figures for the district.

b. Urban Development and Rural Residential Areas

The urban area of the district is Muong Te town, which covers about 1,242ha, (0.34% of the district area) and has 4,299 inhabitants (8.77% of the district population), i.e. 346

inhabitants/km^2. Recently, the district has built up various public works such as offices, public works, lighting systems, post offices, broadcasting stations.

The rural area includes 14 communes covering about 588 ha in total with the population of 44,721 inhabitants (90.94% of the district population). Rural residential area of 297.40 ha in total are distributed in commune. On average, a rural household has 349.28 m^2. People lives in mountainous villages, mainly in low land near communal centers. In the recent years many improvements of infrastructure facilities such as roads, electricity, telecommunication and public works have been implemented.

c. Labor, Employment and Income

The district has 17,275 laborers, accounting for 36.43% of the population. Agriculture-forestry labor is dominant with 92.40% but underemployment is high. Employment for people in rural areas of the district is a key concern because the quality of labor is still low. The per capita income in 2007 was VND 3.2 million per year, equivalent to US$ 200 per year. Facilities for travel, learning and health care can generally satisfy local people.

d. Education and Training

Learning facilities and teachers are insufficient to ensure the quality of and demand for education. The district has 29 schools and school equivalents with 771 classrooms and 14,930 pupils in the school year of 2006 – 2007. The facilities for education are limited, some schools are overloaded and promotion of secondary education is difficult.

e. Health care

The district has focused on improvement of medical systems of communes and villages. Nowadays, all villages have nurses. Medical stations were set up at all 15 communes and town. No epidemic occurred in 2007. Targets and programs of health care have been implemented with stepwise investment in medical facilities. Food safety checkup is regularly performed.

f. Social Security

i. Security and Discipline

In general, the district has steady security and discipline though some evils such as drug addiction and robbery still exist. Anti-criminal steering committees are in duty at all communes. The movements of public contribution into social security have high quality.

There are many improvements in information, propaganda and education of legal matters, investigation and checkup of economic and social violations, settlement of claims and denouncements, judgment of criminal cases.

IV. SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Screening and Assessment of Potential Environmental Impacts

As described in *Chapter Two*, the project which has an area of about 8.3 ha will be constructed on Nam Nghe stream in Hua Bum commune, Muong Te district, Lai Chau province.

Based on the project's activities, initial assessment of potential environmental impacts, as well as proposal of mitigation measures for the project are carried out following 3 stages of the project:

(I) Pre – construction stage
(II) Construction stage
(III) Operation stage

The environmental impacts of the project are forecasted based on consideration, analysis and assessment of project's information which is not sufficient, current natural environmental and socio – economic status of Muong Te district and Hua Bum commune.

The Initial Environmental Examination (IEE) process follows the ADB Guideline (2003).

The potential environmental impacts created by the project are screened in *Figure 5* and *Table 4.1.*

Table 4.1: Rapid Environmental Assessment (REA) Checklist

SCREENING QUESTIONS	Yes	No	REMARKS (levels of impacts)
A. Project Siting Is the project area adjacent to or within any of the following Environmentally sensitive areas?			
Protected Area		X	
Natural forest	X		Long-term, minor, mitigable
Mangrove		X	
Estuarine		X	
Buffer zone of protected area		X	
Special area for protecting biodiversity		X	
B. Potential Environmental Impacts			
Loss of precious ecological values (e.g. result of encroachment into primeval forest, disruption of hydrology of natural waterways, regional flooding, and drainage hazards)?	X		Long-term, intermediate, minor
Dislocation or involuntary resettlement of people	X		Minor, mitigable
Loss of agriculture, forestry, income of PAHs	X		Medium, mitigable
Aesthetic degradation and properly value loss due to establishment of plant and ancillary facilities		X	
Soil erosion and siltation due to construction and impacts on stream water quality in rainy days	X		Short-term, medium, mitigable
Noise and dust from construction activities	X		Short-term, minor, mitigable
Fugitive dust during transportation unloading storage of fuel	X		Long-term, minor, mitigable
Risk of oil spills, which could pollute surface and groundwater and soil?	X		Short – term, minor, mitigable
Influence on groundwater	X		Long – term, minor
Changes in flow regimes downstream of the stream	X		Long-term, minor
Logging of reservoir by sediments?	X		Long – term, minor, mitigable
Pollution of water bodies by run – off water	X		Short – term, minor, mitigable
Pollution of water bodies (reservoir, stream) and aquatic ecosystem from agriculture, industry, domestic waste in the stream basin	X		Short – term, minor, mitigable
Air pollution from transport's fuel discharged into the atmosphere?		X	
Public health and safety hazards due to environmental population and electric shocks	X		Long-term, minor, mitigable
Encroachment into forests due to induced development at the district/ commune	X		Long – term, medium, mitigable

1. Classification of impacts

From the technical aspects and location of the project, it is expected that the impacts of the project on the environment may not be complicated. Therefore, the method applied in this IEE is mainly based on judgment, checklist, matrix and network. No environmental model is necessary for quantification. After the screening the potential impacts, these impacts were assessed and classified.

In this study, the anticipated negative environmental impacts are classified into five categories: "*major*", "*intermediate or medium",* "*minor*", practically "*not significant*" or "*no impact*" and *"unknown impacts".*

(I) A *"major impact"* can change an element of the environment or create a strong environmental modification. Such an impact can strongly affect an environmental component and/or on a large group of the population.

(II) *"Intermediate or medium impact"* can significantly change an element of the environment. Such an impact can intermediately affect an environmental component and/ or a medium group of the population.

(III) A *"minor impact"* may slightly change value or use of an environmental component and slightly affect on a small group of the population.

(IV) Some activities of the project may not cause evident impacts. In such cases, the assessment will not be detailed but some commentaries will be given. This type of impact is identified as *"not significant*" or practically *"no impact*".

(V) Some activities of the project may cause some impacts but the magnitude of the impacts can not be predicted. This type of impacts is identified as "*unknown impact*".

In each type of impacts, there are "*negative*" and "*positive*" ones.

Beside the 5 categories, each impact may be assessed as "*mitigable*", "*controllable*" or *"uncontrollable*", *"local", "temporary"*, "*short-term"* or *"long-term"*, depending on the intensity and scale of the impact.

Based on the impact classification in the Environmental Management Plan (EMP) different measures will be recommended to mitigate different types of impacts.

- *No impact and no significant impacts:* These impacts do not need to have measures for mitigation.
- *Minor and medium impacts:* For this type of impacts, the appropriate measures for mitigation should be developed.
- *Major impacts:* It is necessary to have more detailed information and quantification of impacts, and measures for mitigation have to be designed more carefully during project preparation and construction.
- *Unknown impacts:* It is necessary to have further study to know the nature and scale of the impact.

2. Impacts associated with the design and pre-construction stage

a. Impacts on the natural environment due to site selection

The project will occupy about 8.3 ha. The project will be constructed at the bamboo forest with medium reserves (primary forest: 80 m^3/ha; recovered forest: 15.4 m^3/ha; bamboo forest: under 40 m^3/ha); and the main agricultural vegetation species are maize and wet rice.

At Hua Bum commune, where is location of the project, there are some species of wild animals (munjact, wild boar, monkey and even some wild mammal species listed in the Vietnam Red Book) various species of reptiles, amphibians, birds still found. Selection of the site at Hua Bum commune will cause permanent loss of 8.3 ha of land, 80% of the area is forest, which is a habitat of various native vegetation and wildlife species. Such negative impacts on biodiversity is assessed as minor because the area to be cleared is small (8.3 hectares) compared to 172,480 ha total forest cover in Muong Te district.

b. Impact on project affected households (PAHs)

At the site, there are only some households which are owners of land and houses. No public construction facilities (school, office, temple, electrical tower, postage, well, telephone line etc.) are found in this area. Loss in income and properties of the PAHs due to land acquisition will be addressed through implementation of a resettlement action plan to be prepared for the subproject.

3. Initial assessment of environmental impacts during the construction stage

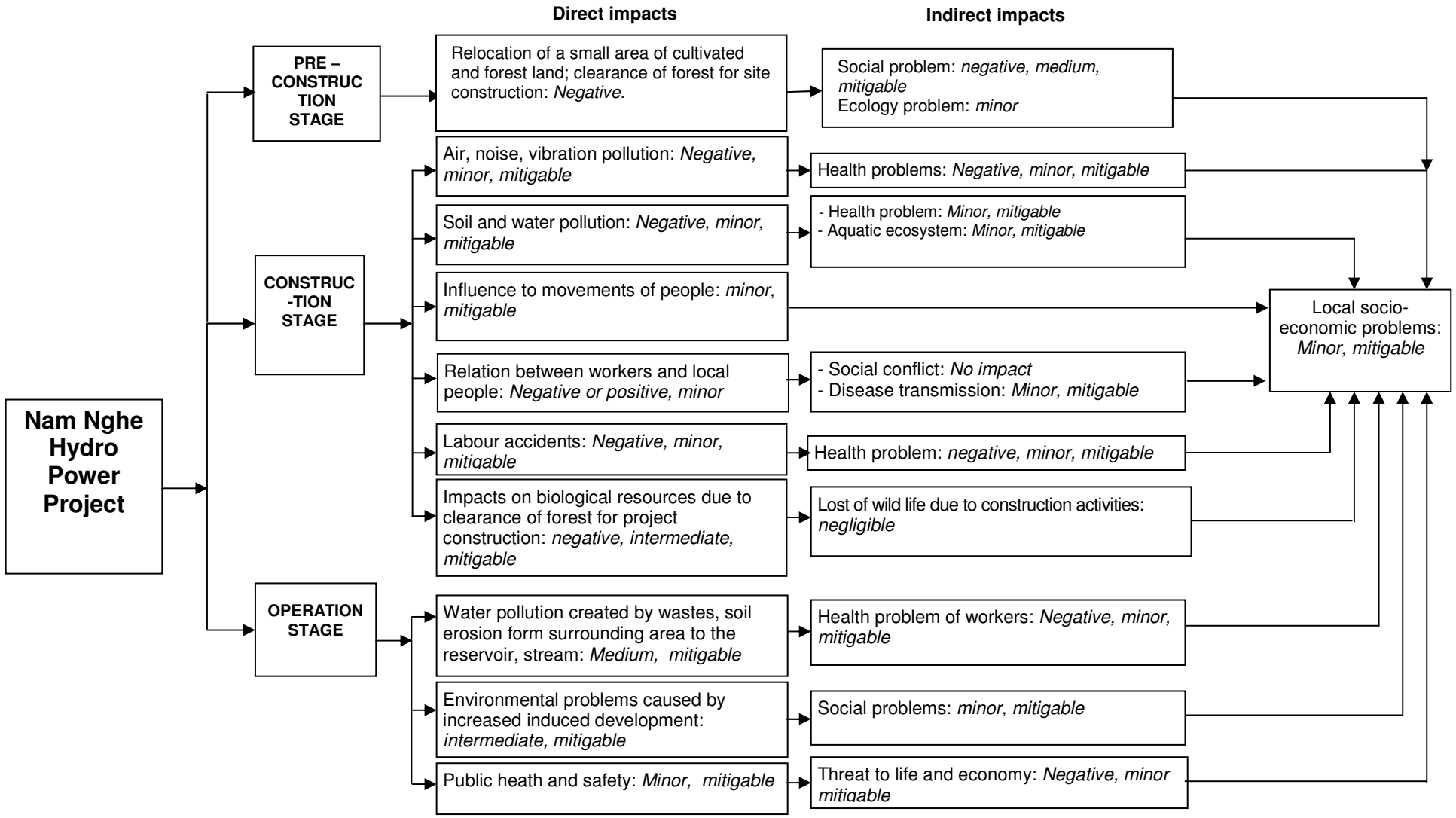


Figure 5: Chart of potential environmental impacts of the Nam Nghe MHP at Hua Bum commune

During *the Construction Stage*, possible environmental impacts include:

a. Increased air pollution

Air pollution during the construction stage may be generated by 3 following factors:

(i) Dust from earthwork (excavation, clearing of a landslide area along the existing access road to facilitate transportation of construction materials, and installation of transmission and distribution lines).
(ii) Dust from transportation of construction materials.
(iii) Exhaust emission containing dust, SO_2, NO_X, CO, and other gaseous emission from construction machines/equipment.

Heavy trucks transporting, construction materials and equipment will generate dust along the road from the center of Hua Bum commune to the subproject site. The dust concentration in the ambient air will likely increase in these areas when trucks operate, especially in dry days. However, dust from transportation activities can settle easily. Therefore, the dispersion of dust is not a problem. As experienced in similar construction sites, when the weather is dry, the affected area of the generated dust from transportation activities is about 30 m from the edge of the road. Transport of materials and equipment for the subproject will utilize an existing 30-km dirt road connecting Muong Te to the subproject site. Only a few households are found near the road. The road is wide enough for a truck to drive on it. Currently, however, the road is blocked by a huge landslide at one point.

Earthworks and transport of materials will generate dust. However, since the subproject site is located more than 1 km away from the main residential site, elevated dust levels are not expected to affect residential areas of Hua Bum commune.

Although impact on air quality is unavoidable, the impacts are expected as *minor and mitigable* by technical and management measures.

Exhaust emissions from construction equipment (concrete mixer, compactors, generators, etc.) and trucks using diesel (or petrol) during their operation contain gaseous emissions and dust. Because the number of equipment and trucks used for construction of the project will be small and since the construction site is open, generated exhaust emissions from construction equipment will easily dispersed such that impacts will not be significant. From monitoring data of many construction sites in Vietnam in normal weather conditions, the impacts on air quality is considered to be *local* (only significant inside the construction site) and *temporary* (within construction period).

b. Impacts by noise and vibration

i. Impacts due to increased noise level

Sources of elevated noise levels during construction of the project include:

- Construction machines and equipment,
- Trucks transporting materials and equipment,

However, since there are no households, infrastructure and public works within and in the vicinity of the subproject site (as mentioned above, the nearest residential site is over 1 km away), noise generated from the construction site will not cause community disruption. Noise impacts are expected to be *minor and mitigable*.

ii. Impacts due to increased vibration

During the construction stage, the sources of vibration are heavy trucks transporting construction materials and equipment. At present, as there are no households at the subproject site and only a few households are located along the road that will be used as access when transporting materials, the vibration due to construction activities will not significantly impact on living and working condition of local people.

c. Surface water pollution

Sources of surface water pollution during construction are:

(i) Domestic waste from worker camps
(ii) Runoff water through the construction area
(iii) Siltation due to soil erosion
(iv) Haphazard disposal of excess soil/excavation spoils.

The labor force during peak construction period is estimated to be 50 workers. Daily amount of domestic wastewater generated from these workers may reach 6.0 m^3/ day. Wastewater contains high concentration of organic matters, suspended solids, nutrients, bacteria and other pollutants which can contaminate surface (Nam Nghe stream) and ground water in this area. Solid wastes will also be generated by workers. Such wastes, if not properly collected and disposed will contribute to pollution. This impact is assessed as *negative* but it is *minor (*due to low amount of wastewater*), mitigable* and *temporary.*

Runoff water flowing through the construction site will bring with it soil, sand, oil, garbage and materials. Runoff water often has high turbidity, suspended solids (SS) content and possibly small amount of oil and grease, hence, it may contaminate the surrounding land and Nam Nghe stream.

Earthwork and leveling activities on construction site will increase erosion, especially in heavy rainy days. The value of total suspended solids of runoff water from construction site may exceed the World Bank guideline of 50 mg/l. Stream pollution caused by runoff water is expected as *minor* but *temporary and mitigable.*

Soil erosion during the construction phase may be caused by earthworks, vegetation clearing and run-off water from construction sites. Soil erosion is considered a problem in the construction area due to the forest cover will be cleared. This causes loss of soil plus damage to water quality of the Nam Nghe stream and downstream basin in the rainy days. Therefore, soil erosion may be assessed as *negative* and *medium* but it is *mitigable*.

d. Impacts on biological resource

i Loss of terrestrial resources

At present, about 80% of the subproject area is covered by tropical rain forest with various species of trees and bamboos. It is estimated that about 1,200 – 1,500 m^3 of bamboo and timber will be lost due to construction of subproject facilities. Additional vegetation cover will be cleared for installation of transmission lines. Following are anticipated:

(i) Loss of a natural habitat for wild animals, as monkeys, deers, wild boars, birds, snakes which commonly occur in the province
(ii) Loss of forest biomass that may contribute to soil erosion, water pollution and other associated impacts

As mentioned above, the negative impacts due to vegetation clearing are considered minor because the area to be cleared is small (8.3 hectares) compared to 172,480 ha total forest cover in Muong Te district. The forest that will be affected by the subproject is a small part of the large forest extending some tens of kilometers from the subproject site to the mountains, therefore, wild animals may migrate to other parts of the forest and are not anticipated to be significantly affected. There are also no protected areas close to the site.

ii Hunting of fauna

Increased hunting of wildlife may occur due to presence of construction workers, particularly in forested areas. However, given the mobility of animals in the wild, the relatively small area that the subproject will cover, magnitude of site works along with mitigation measures that will be implemented during the construction phase, the anticipated impacts to such resources are considered minor.

iii Impacts on aquatic resources

Runoff water may cause adverse impact on the aquatic resources due to high turbidity. It should be noted that runoff water are not expected to contain hazardous substances. Therefore, impact on aquatic resources is expected as *minor* and *temporary* (only during the construction stage).

e. Damage to access roads

Trucks that will be used in transporting materials will traverse the existing 30-km dirt road connecting Muong Te to the subproject site. This impact is considered temporary and minor.

f. Working environment and safety

Accidents which may happen during construction (e.g., electrical shock, falling, etc.). The level and frequency of these occupational accidents will increase if the regulations on labor safety will be not well implemented, construction machines will not be regularly maintained, or workers are not trained about work safety. Because the construction of the power system is small scale, this impact is expected to be *minor and mitigable*.

g. Relation between construction workers and local people

In some cases, conflicts between the construction workers and local people may be caused by the following reasons:

(i) Difference in customs and traditions
(ii) Difference in income
(iii) Encroachment of workers to traditional sites and customs of local people (almost all of the population in Hua Bum commune are minority ethnic groups).

B. Impacts Associated with the Operation Phase

a. Changes in hydrology

The operation of the subproject may cause some changes in hydrological characteristics of the Nam Nghe stream.

(i) In the rainy season water will be stored in the reservoir behind the weir. The reservoir will have an area of about 6,000 m^2 while its storage capacity is conservatively estimated to be about 30,000 m^3. The average depth would be 5

m, and the deepest would be around 10-14 m at the upstream dam face. To illustrate how small the pondage would be, these estimates are offered (the following conditions assume that the power house is not operational): (a) based on a mean annual flow of 2.8 m^3/s, it will take about 3 hours for the reservoir to be filled up; and (b) for four months during the year, flows are higher than the mean annual flow such that in the wettest month it will take less than 1 hour to fill up the reservoir. During the wet season, when flows exceed the turbine discharge capacity of 3.5 m^3/s, the water will spill over the dam and continue down the river bed.

(ii) The change in hydrology is not anticipated to cause significant changes to water quality upstream and downstream of the weir since the pondage is relatively very little as shown above. Further, water will be exchanged daily due to very short retention period. Initially, there may be some effects such as increased levels of turbidity, nutrients and organic matter, but such conditions are expected to occur over a number of days or a few weeks only since basically all the water will be utilized. When flows are >3.5 m^3/s, the excess water will spill, when less than 3.5 m^3/s it will be routed through the turbine.

(iii) According to information on the environment of some existing reservoirs in Vietnam, groundwater at the surrounding to the reservoirs and downstream areas may be influenced by the reservoir. At the areas surrounding the reservoir groundwater tables are raised, but at the downstream areas these seem to have gone down. However, since the water storage capacity of this reservoir is too small, impact on groundwater is not anticipated to be significant.

(iv) In the dry season there will be less or no water on the 2-km stretch of Nam Nghe stream bed between the weir and the powerhouse. However, the presence of small tributaries along this stream section are sources of water during the dry season. Further, since the subproject is in a heavily forested site with high annual precipitation (2,500 mm), it is also likely that there will be ground water seeping into the stream bed such that Nam Nghe will not be completely dry between the weir and the power house during dry season operation. There may be some minor impacts just downstream of the tailrace on the Nam Bum stream due to peak operation of the power plant. There is currently no available data on the dry weather flows in the Nam Bum, but 3.5 m^3/s may be added to these flows. The Nam Bum is much larger than the Nam Nghe.

The above impacts are considered *minor* since the reservoir will cover a small area and will have a small storage capacity.

b. Increased surface and underground water pollution

Domestic wastewater: The plant's wastewater, generated mostly from the office, dining room and toilet with the discharge of 1.5 m^3/day (from 10 workers), contains high concentration of organic matters, suspended solids, oil, nutrients and bacteria that could contaminate surface and groundwater. This impact is assessed as *minor* and *mitigable*.

Runoff water: Runoff water polluted by solid matters (soil, sand and rubbish), organic matters, and oil may contaminate the Nam Nghe stream and land surrounding the plant. This impact is assessed to be *minor* and *mitigable*.

c. Pollution by solid wastes

The main source of solid wastes in the plant is domestic solid waste from living activities of workers (about 10 kg/day if the total number of workers to be 10). This amount of rubbish is small but it may reduce aesthetic value of the area and creates unpleasant odor in plant's area. The impact is *minor* and *mitigable*.

Although these solid wastes are small in amount but they may contain oily and hazardous. Due to the amount of this type of industrial solid waste is small and it will be well managed, impact of industrial solid waste from the hydropower plant will be *minor* and *mitigable.*

d. Water-born diseases

Since the reservoir will have a small pondage and short retention period, water will be exchanged on a daily. Hence, creation of stagnant conditions that is favorable for proliferation of disease vectors for malaria, dengue fever, and the like, is not expected.

e. Flood in reservoir area and reservoir hazards

In case of poor management in the flood season dikes of the reservoir may be broken. This may cause damage to the downstream agricultural areas and infrastructure. This impact is negative but is expected to rarely occur provided the dike and reservoir are well-designed and regularly inspected. Further, the storage capacity of the reservoir is very small.

C. Mitigation Measures

The mitigation measures for expected negative environmental impacts are provided in *Table 4.2.*

Table 4.2: Environmental Mitigation Measures

Environmental Concern	Mitigation Measures	Implementation Responsibility	Monitoring / Supervision
Pre-construction			
1. Impacts to biodiversity due to site clearing.	- Careful planning and design of subproject components to ensure that vegetation clearing will only be undertaken as necessary. - Construction facilities such as materials storage, workers' camp, etc. shall not be located in forested areas. - Careful planning of route for transport of materials and equipment to the subproject site, by maximizing use of existing access roads and minimizing the need for creating area of a route traversing the forest. - Ensure that there will be no encroachment outside the planned subproject area. - Strictly define in the contract specifications the extent of vegetation clearing activities for hydropower facilities as well as for transmission and distribution line right-of-way.	Design Consultant Contractor Contractor Contractor Executing Agency (EA)	Project Management Unit (PMU) and Project Supervision Consultant (PSC)
2. Land acquisition impacts.	- Preparation and implementation of a resettlement plan that is consistent with ADB requirements to ensure just compensation and adequate support for affected persons.	Provincial People's Committee (PPC)	
Construction Stage			
3. Increased air pollution due to dust from earthworks during excavation, installation transmission and distribution lines, transport of construction materials, and gaseous emissions from equipment and vehicles	- Proper maintenance of vehicles, construction machines and equipment - Provision of cover on trucks transporting materials (soil, cement, stone, etc.) to minimize dust emission - Water spraying on road sections from the center of Muong Te district to the subproject areas, specially those near residential areas and other sensitive receptors, during dry periods.	Contractor	PMU and PSC
4. Increased noise and vibration levels due to construction activities such as civil works, operation of equipment and transport of materials and equipment	- Regular maintenance and timely repair of vehicles and trucks to reduce noise - Speed limits shall be imposed on construction vehicles when passing through residential areas.	Contractor	PMU and PSC
5. Water pollution due to domestic wastewater from workers' camps including oily wastewater, surface run-off from construction areas that	- Installation of sanitary toilets - Provision of a simple system of open ditches in the construction site in order to collect run-off water. Run-off water will be led to a settling pond for	Contractor	PMU and PSC

Environmental Concern	Mitigation Measures	Implementation Responsibility	Monitoring / Supervision
may lead to siltation of surface water and haphazard disposal of excess soil/excavation spoils	deposition prior to discharge to the receiving body of water. - Proper collection and storage of used lubricant and oil. Off-site disposal of such wastes shall be consistent with national and local regulations. - Compliance with the Government Decision N59/2007/ND-CP April 9, 2007 and Circular N12/2006/TT issued by MONRE on December 26, 2006 on proper management of solid waste, oily waste and batteries. - Spoils shall not be dumped in or near water courses and shall only be disposed in areas approved by local authorities. - Implementation of slope stabilization measures (e.g., planting of grass and other fast growing indigenous species)		
6. Pollution due to solid wastes generated by workers	- Provision of waste bins at construction sites and workers' camps - Collection and disposal of solid wastes twice a week. Disposal sites shall be those approved by local authorities.	Contractor	PMU and PSC
7. Loss of vegetation cover and increased hunting due to presence of construction workers.	- Strict prohibition of hunting and poaching of wildlife - Revegetation of disturbed areas and slopes using indigenous species of trees, shrubs and grasses within subproject site and along access roads - Avoid locating temporary construction facilities such as materials storage, workers' camp, etc. in thickly vegetated areas - Ensure that there will be no encroachment outside the planned subproject area, particularly in densely forested areas - Disposal of excavation spoils shall not cause damage to forested areas	Contractor	PMU and PSC
8. Adverse impacts on aquatic life due to high turbidity	- Provision of a simple system of open ditches in the construction site in order to collect run-off water. Run-off water will be led to a settling pond for deposition prior to discharge to the receiving body of water.	Contractor	PMU and PSC
9. Damage to existing roads	- Contractor shall rehabilitate access roads upon completion of site works	Contractor	PMU and PSC
10. Workers shall be exposed to safety hazards.	- Workers to undergo safety orientation program - Provision of appropriate personal protective equipment - Proper maintenance of vehicles and equipment - Observe regulations on electric safety (TCVN 4086-95), prevention of fire and explosion (TCVN 3254-89) during construction. - Setting up of a first-aid station at the construction site.	Contractor	PMU and PSC
11. Conflict between construction workers and local inhabitants	- Employ, as much as possible local inhabitants, to provide project labor. - Educate workers on proper relations with local people - Registration of workers (as temporary residents) with the police of Hua Bum	Contractor	PMU and PSC

Environmental Concern	Mitigation Measures	Implementation Responsibility	Monitoring / Supervision
	Commune		
Operation Stage			
12. Changes to downstream hydrology	- Careful operation of the reservoir and power generation system plus regular hydrological monitoring to ascertain if the subproject is causing significant adverse impacts so that appropriate mitigation measures could be formulated and implemented.	Operator	Lai Chau PC and EVN
13. Generation of oily wastewater, domestic wastewater, oil spills and leaks and surface run-off could contribute to pollution loading of surface water.	- Effluent from mechanical repair shops and wash water of machines, handling equipment, bottoms of oil tanks shall be treated by an oil-skimming system, and then discharged into the drainage system of the plant. - Use of septic tanks for domestic sewage - Fuel oil will be stored in an area with a concrete basin to contain spills and leaks. The main drain of the storage area will be provided with an oil-water separator. - Maintenance of vegetation cover in areas surrounding plant facilities and along stream embankments	Operator	Lai Chau PC and EVN
14. Generation of solid wastes	- The operator will assign 1-2 workers to handle cleaning of the plant site and and collection of garbage from plant facilities. - Provision of waste collection bins in various locations within the plant facilities - Solid wastes shall be segregated and properly disposed of consistent with national and local regulations - Disposal of used oil and waste batteries shall comply with the Governmental Decision N59/2007/ND-CP April 9, 2007 and Circular N12/2006/TT – CTNMT issued by MONRE on December 26, 2006.	Operator	Lai Chau PC and EVN
15. Damage to the weir	- Regular inspection of the weir and other subproject structures and facilities - Immediate repair of damaged structures	Operator	Lai Chau PC and EVN

V. INSTITUTIONAL REQUIREMENTS AND MONITORING PLAN

A. Institutional Requirements

The EA for the Nam Nghe subproject will be Viet Nam Electricity's (EVN) Power Company 1 (PC1). PC1 will establish a project management unit (PMU) which will be responsible for the day-to-day implementation of the subproject. The Nam Nghe MHP will be operated by a joint venture company to be formed by EVN and the Lai Chau PC.

The institutional responsibilities for implementation of mitigation measures and monitoring plan are as follows:

Table 5.1: Institutional Responsibilities

Organization	Responsibilities
PC1	– Prepare contractual requirements ensuring that there are provisions requiring contractors to implement environmental mitigation measures indicated in the IEE – Ensure that environmental protection measures proposed in the IEE will be incorporated in the detailed design
PMU	– Monitor the contractors environmental performance on a quarterly basis and prepare monitoring reports – Document and address comments or complaints from the local residents – Conduct spot checks to ensure that contractors are implementing the environmental mitigation measures. – Report any environmental incidents to the Project Director. – Through PC1, submit environmental monitoring reports to DONRE and ADB on a quarterly basis
Design Consultants	– Ensure that environmental protection measures are incorporated into the design – Update the mitigation measures during the detailed design phase
Project Supervision Consultant (PSC)	– Train staff of PMU on environmental monitoring – Assist the PMU in monitoring and preparing reports on the environmental performance of contractors – Recommend additional mitigation measures during the construction stage, if necessary
Contractor	– Implement environmental mitigation measures specified in the IEE – Implement additional mitigation measures, as necessary
Operator*	– Implement mitigation and monitoring measures during operation phase – Prepare quarterly environmental monitoring reports and submit these to DONRE – Implement mitigation measures, as necessary

* joint venture company to be formed by EVN and Lai Chau PC

B. Cost Estimation for Environmental Monitoring Program (EMoP)

1. This section estimates the marginal costs for conducting the EMoP (Table 5.1) for the Nam Nghe MHP. The total marginal cost of the EMoP from the start of construction through to the end of the first year of operation is about 200,000,000 VND. The identified mitigation measures in Table 4.5 shall be included in the tender documents to ensure that associated costs for specific measures (e.g., revegetation of disturbed areas, provision of septic tanks, etc.) will be included in the contractors' bid cost. The cost for environmental management training of PMU staff shall be included in the subproject cost under the contract of the PSC.

Table 5.2 General requirement for environmental monitoring for the Nam Nghe Hydropower Project

No	Parameters	How to monitor	Frequency	Responsible agency
	Construction stage			
1.	Soil erosion	• Field observation to assess if: i. excavation and other site works cause soil erosion, ii. appropriate mitigation measures are applied by the contractor to avoid soil erosion.	Quarterly	PMU (with assistance from PSC)
2.	Spoils disposal	• Field observation to assess if the contractors: i. undertake proper stockpiling of excavated soil ii. dispose of spoils in areas approved by local authorities iii. do not cause damage to surrounding forests, agricultural land and water courses due to haphazard stockpiling and disposal of spoils	Quarterly	PMU (with assistance from PSC)
3.	Surface water quality	• Sample collection and testing for turbidity, total suspended solids, pH, dissolved oxygen and total coliform downstream of the weir. • Field observation to determine if the	Quarterly	PMU (with assistance from PSC)
4.	Encroachment on surrounding forests	• Field observation to assess if: i. vegetation clearing and site works are confined within the planned area/location of subproject facilities ii. no unnecessary vegetation clearing is being undertaken iii. illegal hunting is being undertaken by construction workers	Quarterly	PMU (with assistance from PSC)

No	Parameters	How to monitor	Frequency	Responsible agency
5.	Noise and vibration around construction site and residential areas adjacent the road used for material transportation	• Field observation to determine if: i. noise and vibration levels are unacceptable at the residential areas close to the project site, ii. construction machines annoy or cause nuisance to local people, and iii. appropriate mitigation measures are applied by the contractor to minimize noise and vibration impacts. • Field measurements of noise and vibration levels when there are complaints from local people.	Quarterly	PMU (with assistance from PSC)
6.	Dust	• Field observation to determine if: i. construction activities are causing heavy dust emission, and ii. appropriate measures are implemented by contractors to minimize dust emission. • Field measurements of dust levels when there are complaints from local people.	Quarterly	PMU (with assistance from PSC)
7.	Solid waste and site clean up after completion of construction	• Field observation to determine if the contractor: i. conducts proper collection and disposal of domestic wastes, construction wastes and cleared vgetation ii. cleaned up the construction sites after completion of site works, and iii. disposed of construction wastes in areas approved by local authorities iv. rehabilitated damaged access roads	Quarterly	PMU (with assistance from PSC)
8.	Safety measures	• Field observation to determine if the contractor: i. conducted safety orientation for workers, ii. provides workers with suitable personal safety equipment, and iii. abides by technical and safety regulations.	Quarterly	PMU (with assistance from PSC)

No	Parameters	How to monitor	Frequency	Responsible agency
9.	Construction material management (including oil/lubricant)	• Field observation to determine if the contractor properly handles and stores construction materials.	Quarterly	PMU (with assistance from PSC)
	3. Operation Stage			
	Soil erosion	• Field observation to determine if erosion-prone areas such as slopes and stream embankments are adequately protected.	Semi-annually	Operator
	Water pollution	• Field observation to determine if domestic wastewater generated by employees are adequately treated using septic tanks. • Field testing (pH, SS, turbidity, DO, EC, temperature) and laboratory analysis (NH4+, NO3-, total N, total P, Fe, Al, Zn, BOD, oil, total coliform) of water samples to be analyzed for assessment of water quality of the reservoir and downstream of the power house.	Semi-annually	Operator
	Aquatic resources	- Field observation and interviews with regard to fish catch upstream of the weir and downstream of the power house	Semi-annually	Operator

Table 5.2 Cost estimation for environmental monitoring for the Nam Nghe Hydropower project

No	Item	Amount (VND)
Pre-Construction Stage		
Construction Stage		
1	Labour requirement: 2 man-months x 10,000,000 VND/month	20,000,000
2	Cost for environmental analysis (water quality, air quality and noise)	20,000,000
3	Supporting cost (lump sum): accommodations, transportation, sample collectors, writing report	80,000,000
Operation Stage (per one year)		
1	Labour requirement: 2 man-month/year x 10,000,000 VND/month	20,000,000
2	Cost for environmental analysis	20,000,000
3	Supporting cost (lump sum)/year: accommodations, transportation, sample collectors, report writing	40,000,000
	Total	**200,000,000**

VI. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

A. Organization of Public Consultation

In July 2008 a public consultation on the environmental issues related to the construction and operation of the Nam Nghe MHP in Hua Bum commune.

The public consultation was implemented through meetings with the local authorities, and interviews with local people on their present socio-economic condition and comments on the environmental issues of the project.

1. Meetings with local authorities

Separate meetings conducted by the environmental specialist with the following local management authorities have been held:

(i) People Committee of Muong Te District (Mr. Nguyen Van Sang, Vice Chairman of Muong Te PC).
(ii) SONRE of Muong Te District (Mr. Nguyen Van Hien, Head of section; Mr. Pham Van Trung, expert).
(iii) Department of Industry and Trade, Laichau Province (Mr. Nguyen Van Bien, Deputy-director)
(iv) Section of Industry and Trade, Muong Te District (Mr. Le Van Tuan, Head)
(v) Project Management Board of Muong Te District (Mr. Tran Cong Vinh, Deputy-Director).
(vi) People Committee of Hua Bum commune (Mr. Po Vo Suyn, chairman).

Agendas of the public consultation meetings with the local authorities were as follows:

- Presentation of the (i) current condition of the environment, socio-economic status of Muong Te District and Hua Bum Commune and related issues, (ii) objectives of the subproject, and (iii) potential environmental impacts of the subproject.
- Discussion on environmental protection measures.

2. Interview with local people

To gather information on the living condition, environmental issues and comments of the local people on the environmental issues of the subproject, interviews were conducted involving 6 households in Hua Bum Commune. *Figure 7* show some photos of the interview. *Table 6.1* is the list of respondents.

Table 6.1 List of respondents in Hua Bum Commune

No	Name	Ethnic Group	Profession
1	Po Xi Hu	Hanhi	Agriculture
2	Ly Phi Tu	H'mong	Agriculture
3	Po Loang Choang	Hanhi	Agriculture
4	Po Xe Ca	Hanhi	Agriculture
5	Po Vo Tu	Hanhi	Agriculture
6	Po Xi Vuon	Hanhi	Agriculture

B. Comments of local authorities and residents on environmental Issues of the subproject

1. Comments of local authorities

During separate meetings with the representatives of the Muong Te district, Hua Bum Commune's PCs and SONRE, the environmentalist have obtained useful data/ information on the present environment and socio-economy of the district and commune were abtained.

The main comments and requirements are summarized as follow.

Figure 7. Interview with local residents of Hua Bum commune, July 2007

i. Mini-hydropower plants are supported to be developed in Muong Te district as these will provide energy for the remote areas of Lai Chau province, contributing to poverty alleviation and promotion of cultural, and social development of local people particularly the ethnic minorities.

ii. To date, local authorities do not have detailed information on the Hua Bum hydropower project and requested that the project owner furnish the provincial authorized agencies with the results of the feasibility study (FS). MOIT shall provide Lai Chau PC with the FS report, followed by the technical design, as soon as these become available.

iii. In case the plant will be constructed in Hua Bum commune its negative impacts on the environment may not be serious. However, the project owner should (i) properly conduct resettlement policies to support local poor households in improvement of living and production conditions, and (ii) properly manage construction activities to protect the existing forest and prevent environmental pollution. These concerns raised by the local officials

will be addressed through implementation of a resettlement plan based on ADB requirements and implementation of environmental and mitigation measures indicated in this IEE.

2. Comments of local people on the environmental issues of the project

Except for one respondent who is not aware of the social and environmental issues related to the subproject, the interviewed residents consider that the Nam Nghe MHP will not cause significant environmental problems provided affected persons are adequately compensated and contractors implement measures to mitigate impacts due to dust, noise, road damage and destroy forest during construction of the hydropower plant. Such impacts have been identified in this IEE and appropriate mitigation measures will be implemented during various project phases. The issue on land acquisition will be addressed through implementation of a resettlement plan.

VII. CONCLUSION

During construction and operation phases, the Nam Nghe MHP may cause some negative environmental impacts which are considered minor and mitigable. Environmental mitigation measures and monitoring plan as well as corresponding institutional responsibilities have been identified to address such impacts. This IEE is sufficient for environmental assessment of this subproject and a full EIA is not necessary.

REFERENCES:

1. Law on Environmental Protection of Vietnam.
2. MONRE of Vietnam, Circular 02/2006/TT – BTNMT, 2006.
3. ADB, Environmental Assessment Guidelines, 2003.
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5. VESDEC (The Environmental Protection Center), Results of Environmental Surveys at Muong Te District, July, 2008.
6. DONRE of Laichau Province, Data on the Environment and Socio – Economy at Muong Te District, July, 2008.
7. Muong Te PC, Report on Socio – Economic Development of Muong Te District, 2007.