



Lao people's Democratic Republic
Salavanh Province
Department of Energy and Mines

Nam Ngao Hydropower Project



Initial Environmental Examination (IEE)

Jan 2014

6. POTENTIALLY IMPACTS AND MITIGATION MEASURES

6.1 *Physical Environmental Impacts and Mitigation Measures*

6.1.1 *Climate*

1) *Anticipated impacts*

The Watershed of Nam Ngao Hydropower Project is influenced by the monsoon climatic variations. The small head pond will result in minor changes to the air temperature and relative humidity over the water resources and around the shore. Some potential exists for the head pond to change the rates and intensity of occurrence cloud base creation or suppression. The magnitude of the changes will be small and not particularly noticeable because of the comparatively small forces created by the head pond in relation to the dominant impacts of the seasonal monsoons. Only minor microclimatic changes are expected.

2) *Mitigation measures*

No mitigation measure is required for this issue.

6.1.2 *Hydrology and water resources*

1) *Anticipated impacts*

The head pond divert the average of 36.0 m³/s from the small head pond via headrace canal and return to the Nam Ngao River supply through the power station and the key changes to the hydrology. Impacts on the riparian vegetation should be limited. More important should be limited to the impact on fish biodiversity. From environmental impact perspective, running the power plant in this manner has certain consequences. The second of river from intake weir to release from powerhouse will effectively be dry for some time during operation of the power plant. Some environmental impacts will be occurred and altered since unlikely that range species in the river including small fishes, aquatic insects and others. The magnitude of impacts during construction, there will be affected on hydrology due to flow diversion and temporary structures that will divert flow. However, during course the power plant in operation without head pond are unlikely have some impacts on the Nam Ngao River.

2) *Mitigation measures*

The minimum riparian releases at the Intake Weirs should be not less than the

natural flow in the dry season to maintain the eco-system.

6.1.3 Geology

1) Anticipated impacts

The erosion impacts due to construction would not be expected to be significant with implementation of adequate mitigation measures.

2) Mitigation measures

For the road construction and excavation works, sufficient measures should be taken to maintain the present natural condition at the intake weirs. Mitigation measures should be implemented with a best management measures followed:

- The catchment area creation should be ensure that mitigation measures to control erosion and sedimentation in the small head pond are implemented and should be ensure that sediment yield will remain at the current estimated low level.
- The banks and bed of the excavated at the intake weir and powerhouse are expected to cause some erosion in areas of poor soil. These areas and non-plant slopes should be protected with trees and grass to control erosion of the banks and bed. The situation should be monitored and if it is determined that any erosion is putting the structural stability of the powerhouse with risk. Also, rectification work should be carried out, especially in the powerhouse and switchyard areas. The major erosion control activity at construction sites for the project should be managed for excavated surfaces especially during the wet season when the volume of runoff is expected to be high.

6.1.4 Sediment transport and erosion

1) Anticipated impacts

The present sediment yield from the catchment is of no consequence to the small head pond or functions during the design life of the project. The long-term protection of watershed area is essential to insure that sediment yield will remain at the current low level. The flows from the intake weir are expected to remove the sandbars and finer sediment bed leaving a coarser substrate.

2) Mitigation measures

The catchment area creation should be ensure that mitigation measures to control erosion and sedimentation into the head pond are implemented and should be ensure that the sediment yield is lower level remain at the current estimated low level.

6.1.5 Erosion during construction and operation

1) Anticipated impacts

Most of the erosion from construction results from removal of vegetation including changes in sediment yields which have frequently been observed after vegetation has removed and catchment areas have been converted to other land uses. The proposed the Nam Ngao Hydroelectric Project maybe will undertake several construction activities for power plant facilities.

The erosion impact due to construction is considered insignificant. However, the project owner or contractor should be carefully with the road construction and excavation works at the intake weir, penstock and powerhouse.

The banks and bed of the excavated for powerhouse foundation are expected to be soil erosion. These areas should be protected with riprap or shot create to control and protect the land slide in wet season. The situation should be monitored.

2) Mitigation measures

Erosion and sedimentation should be controlled during the construction of the project components. If the areas of the site not disturbed by construction activities, in this area should be maintained in their existing conduction. The following main points of measures should be planned to control sedimentation and erosion affected by the project:

- Soil erosion and sediment control practices should be installed prior to any major soil disturbance, or in their proper sequence and. maintained until permanent protection is established. Only areas intended for immediate construction activity will be cleared of vegetation and topsoil, in cognizance of the overall construction schedule. Any disturbed areas that should be left exposed and not subject to any construction traffic will receive a temporary seeding. Following initial disturbance or rough grading, all critical areas subject to erosion should be receive a temporary seeding in combination with straw or a suitable material.
- Dust control activities should be implemented on the construction site. Dust

control should be consistent with the activities. of stabilization with temporary vegetation, and sprinkling with water until the surface is sufficiently wetted to suppress dust

- Soil and spoil removed during the construction process should be stockpiled separately and stabilization measures implemented. The stockpiles should be constructed with stable batters and grassed to prevent erosion. Ridges maybe created on topsoil stockpiles to provide for moisture retention to assist regrowth and slow run off to avoid the areas of drainage lines should be control drainage and erosion from the stockpiles. The erosion of the base of the dump should be considered in planning the location of the site.
- To prevent soil erosion, trees and grass will be planted in the non-plant slopes. Drain system will be established in the quarry area and slag yard will be covered during rainy season. Thus, the construction of the project will not lead to observable change in soil quality.

The project construction sites should be management of excavated surfaces, especially during the wet season when the volume of runoff is expected to be high.

6.1.6 Water and Water Quality

1) Anticipated impacts

The water quality was officially analyzed, however, the observation indicated that the water quality in the Nam Ngao river is good and fresh. The Nam Ngao River has a soft water with near neutral pH, high dissolved oxygen, and low conductivity and nutrients. The river is located in a relatively undisturbed catchment with a number of people engaged in shifting cultivation and practice of coffee gardens.

The water quality might be occasional episodes of anoxia in isolated areas due to small regime of river flow, in river diversion pipe or canal will be considered by construction method, the effect to water quality during construction and powerhouse and the riparian flow.

Due to the river scheme of project type and minimum flooded area, it is not high decomposition rates of biomass which will lead to annual minima dissolved oxygen levels. At the time of construction, precautions will be taken to ensure that low volume of poor quality water will enter the Nam Ngao downstream of the intake weir. The catchment area of the project has almost no people living, thus the biomass released to the water flow is low and the project will not release anoxic water into the riparian flow. In around 2-3 km of downstream area of powerhouse, there is

donated river to maintain the water quality and flow.

2) Mitigation measures

Upstream area of the dam

The water quality mitigation in the small head pond should be reduced of residual biomass level. The salvage logging and head pond clearance should be taken before impounding the small head pond and monitoring to determine the economics and means for continuing the removal biomass, including diameter and poorly formed logs which may be economically harvested for sawn timber, plywood, and chip board from the inundation zone. Firewood collection should be undertaken during the construction, stockpiling fuel for future use by local villages. This methodology to be clears the head pond before inundation to reduce the impact of the biomass.

Downstream area

The water quality releases at the fall should be investigated to manage the concentrations to exceed pre-determined trigger levels. In the area adjacent to the Nam Ngao downstream of the dam and powerhouse and river confluence and area adjacent to the downstream channel, direct impacts on ecosystem should be mitigated through alternative means if water qualities from pre impoundment level.

Due to there is no head pond to store water and regulate river runoff, the impact on the groundwater level is minor. No mitigation measure will be taken.

6.1.7 Air quality

1) Anticipated Impacts

The project area is covered by Houay Xay plateau air condition, which is change dramatically from day and night time. Average temperature is 25.50°C. The impacts on air quality from project the construction of the intake weir, headrace canal, powerhouse and traffic road should be temporary, minor and controllable. The head of a contractor should be required to implement an emission and dust control plan. The Head Contractor's (HC's) emissions and dust control plan should include methods for dust suppression relating quarry sites, crushing and batching plans including road construction, embankment and channel construction, haulage of materials and construction work camps. Methods for dust suppression should be employed as necessary, including water supplying to control dust which will be resulting from the construction activities.

The air pollution will originate from the fugitive dust resulting from construction activities, addition to the land clearing and surface excavation activities request for construction of the project, construction of headrace canal systems will also be a potential source of air emissions from point sources. In addition, there will be increased traffic on unsealed gravel to contribute to air pollution fugitive dust.

2) Mitigation Measures

The construction contract shall be required to implement an emission and dust control plan within their framework. The emission and dust control plan should include methods for dust suppression relating quarry sites, crushing and batching plans including the road construction, embankment and canal construction, haulage of materials and construction work camps. Methods for dust suppression should be employed as necessary, including water supplying to control dust which it will be resulting from the construction activities.

The construction equipment emission as a result of diesel fuel combustion is expected to be minor. However, it would be request that combustion engines be inspected and adjusted as required to minimize pollution levels.

6.1.8 Noise

1) Anticipated impacts

Noise impacts will be mainly originated from the contractors activities. Noise impacts during construction should be temporary and minor, primarily emanating for construction equipment and vehicles. However, some of construction sites of the project are not situated adjacent to areas of human settlement; therefore noise levels are not expected to represent a nuisance factor.

2) Mitigation measures

It should be the responsibility of the head of contractor to implement a noise minimization plan within the framework. The Head Contractors, as part of the noise minimization plan, must ensure that the noise levels from construction equipment and vehicles conform to the requirements of equivalent with the exception of any drilling machines used for explosion. Any noise control devices such as mufflers that are defective will not be allowed.

At additional, those surface construction areas, including quarries, which are within about 5 km far from village, work would be permitted to undertake on the day time. Construction workers exposed to noise levels of 80 dB or more than should be

provided with adequate hearing protection, in accordance with the requirements of the health and safety plan.

6.2 Potential Impact on Biological Environment and Mitigation Measures

6.2.1 Overview of the impacts

Generally, the clearance of vegetation within the intake weir, powerhouse and head pond can lead to fragmentation of already diminishing areas of natural forests and wildlife habitats. Overall, the existence value, as well as the ecological research value of the ecosystem will be diminished. Rare and/or threatened vegetation or wildlife species may also be affected by flooding. The permanently maintained access roads to the intake weir and powerhouse during and after construction will eliminate the ability of the land on which the roads situate to re-grow to species-rich secondary forest.

Based on the land use and forest map and conducting field survey, most vegetation type covered within the project area is Mixed Deciduous Forest, however, there are some Unstocked Forest and Scrub which is severely degraded over most of the project area due indiscriminant clearing for various land use types, in particular slash and burn type of clearing endemic not only for the project area but through the country. In this respect the intake weir and small head pond as well as access roads and transmission lines are sited on the degraded lands and forest, hence would not be a significant cumulative adverse impact, in the already degraded vegetation and wildlife in the project area.

6.2.2 Forestry and terrestrial vegetation

The review of forest cover maps, field reconnaissance and villagers' interview, it indicated that most of the vegetation that will be affected by flooding was Mixed Deciduous Forest covering. Regarding the proposed access road and power house, there would be some commercial tree species, herbaceous and woody stemmed shrubs, grass and bamboo which belong to different type of forests such as Mixed Deciduous Forest.

However, some of the big and high value commercial species were destroyed and removed by various causes including bombing during Indochina war, converting activities for other uses such as clearing and burning for shifting cultivation and logging. It is also confirmed that any areas of sensitivity forest such as National Biodiversity Conservation Areas (NBCAs) and protection forests are not present within the project area especially small head pond and intake weir.

6.2.3 Wildlife and wildlife habitat

Wildlife and wildlife habitat, according to the filed survey and local villagers' interview as well as the data and information gathered from the authorities concerned showed that the only significant habitats remaining occur on the steep slopes. Other more accessible lower and less steep slopes where forests have been destroyed, wildlife and wildlife habitat have also been disturbed, resulting from slash and burn for shifting cultivation and bush fire.

The results of survey and local villagers' interview also indicated that some of the wildlife live mainly on the upper slopes and may move down into the lower area especially around the proposed location of powerhouse and Nam Ngao at night time and they may return back to the comparative safety of the upper slope areas in the day time. Therefore, through the cause of project design and implementation, it is of prime important that the encroachment and habitat destruction is kept to a minimum and for example temporary access roads to the construction sites should be permanently closed and rehabilitated to its original condition after the completion of the construction work.

Overall, due to most of the forest and forest land within the project area have been destroyed through various causes as stated above it was found that there is no significant wildlife and/or wildlife habitat remained within the project areas and Houay Makchan covers an area of reasonably undisturbed habitats.

6.2.4 Aquatic ecosystem

1) Anticipated impacts

The aquatic habitats significant impacts will be occurred within the downstream channel of powerhouse due to construction and operation of Nam Ngao Hydropower project but it is important that the downstream donor river Nam Ngao is big enough for fish migration and incoming sediment load, the dissolved oxygen level, water depth and is enough for the fish survive.

2) Mitigation measures

The villagers training is necessary to prevent them from aquaculture development catching fish during upstream migration along narrow and shallow stretch of the river for spawning in the breeding season and also downstream migration along the narrow and shallow stretch of the river at the end of breeding season for grown development

The results of survey and local villagers' interview also indicated that no mitigation

fishes were founded in the dam site, however, fish way will be introduced in the project. Nevertheless aquatic plants under improper monitoring and control may multiply and spread all over the water surface of the head pond and head pond which will absorb all the available oxygen. In this case it will result in a great reduction of fish population. Moreover illegal fishing will cause to the damage of fish population. There for it require an intensive training of villagers to undertake a proper aquatic weed and fishery management.

Similarly aquatics weeds growth and agrochemical application must be closely monitored to prevent water pollution in the future will be adverse effect on aquatics ecology. Additionally it also require and appropriate aquaculture training to the fish men, to undertake fishes culture in ponds, and the natural ponds for the aquatics conservation activities of the villages.

The small head pond of project will be large potential for fisheries with many species are expected to adapt to head pond condition and establish population. A comprehensive fisheries management plan should be implemented with the local people. Endemic species impacts are minor as most or all of them have known to have part of known distribution range outside the project area or the species are migratory in nature.

An appropriate fishery management plan will be developed to promote. Natural fish species (Indigenous species), for stocking assessment in the head pond, to ensure that the local fisheries community of project area, and the rights to harvest of aquatic resource without depleting and also carryout intensive training to the villagers on fish culture and fishery management plan in the upper and lower head pond. To train the knowledge about fisheries activities in as follows:

- Establishment of fishing ground, and appropriate measure against over fishing
- Reserve and protect breeding ground in small head pond area
- Establishment of a mechanism to maintain a sustainable of fishes stock

6.3 Environmental Impact During Construction and Mitigation Measures

6.3.1 Headrace canal, Intake weir and Powerhouse and switchyard

1) Anticipated impact on wildlife/wildlife habitat

The project design based that headrace canal and power house are located in the same area, so far we can group the impacts on these issues together due to construction sites of these four main project components will be interrupted to wildlife and wildlife habitats are similar. As mentioned earlier, some species of wildlife still

remains on the upper slope where are consider as outside project. However, wildlife within the area is under considerable hunting pressure. Intake weir and power house areas are considered as degraded forest, only cemetery forest nearby where need to be considered during the construction phase. In addition, the forest and vegetation within this construction area will be cleared for access road from the intake weir to powerhouse and powerhouse site, so the wildlife habitat will also be severely disturbed by the forest clearing activity during construction stage, this will be the supported factor for exacerbation. The boisterous noises from construction machines will also disturb the natural living of the wildlife. Moreover, the construction workers may hunt wildlife within and around the project area. The direct impact zone consisted large degree of very steep hillside and relatively inaccessible gorge which has prevent it from being exploited and it considered the low value.

The clearance of vegetation, resulting in potential loss of habitat, local biodiversity, and local resources (wild animals) by the presence of machines to construction of headrace canal and other powerhouse, potential disturbance of wildlife, particularly due to project-related noise, vibration by machines.

Strict rules against logging outside the approved construction areas and wildlife hunting and poaching will be imposed on project staff, workers, and all contractors engaged to the Project, with penalties levied for anyone caught carrying and using fire arms, or using animal snares and traps. Project owner work closely with district forestry officers shall be directly responsible for dissemination of all regulations and information concerned to its staff and/or employees as well as for any misconduct made by its staff and workers.

Increased pressure on ecological resources due to in-migration to the area or simulation of the local economy, improved management of ecological resources by the local community, increased knowledge of local ecology due to wildlife and also fauna surveys (as part initial impact assessment and ongoing monitoring).

2) Mitigation measures

Key recommendations to minimize the impacts of the Nam Ngao Hydropower Project on local biodiversity and ecological resource use and to maximize potential project related benefits include:

- Minimizing the noise and vibration generated during construct a project- by-project activity by ensuring that all wild animals;
- Undertaking a site specific survey of disturbed areas, once the location of project facility has been finalized, to map vegetation types and identify any rare or endangered wildlife species and other fauna species;

- Minimizing the impacts of wildlife hunting by appropriate siting of project facilities, protect the high-value habitat and effective site rehabilitation;
- Supporting the local conservation initiatives concerned with the protection of high-value habitat, or endangered species:
- Establishing an appropriate program to monitor the effects of the project on biodiversity and ecological resource use.

6.3.2 Forest and vegetation

The project could result in the following potential impacts (both positive and negative) on terrestrial biodiversity and conservation:

1) Anticipated impacts

Direct impacts

- Clearance of vegetation, resulting in potential loss of habitat, local biodiversity, and local resources (NTFPs).
- Potential disturbance of forests particularly clearance of forest, due to project related noise and vibration.

Indirect impacts

- Increased pressure on ecological resources due to in-migration to the area or stimulation of the local economy.
- Improved management of ecological resources by the local community due to Nam Ngao Hydroelectric Power Project initiatives
- Increased knowledge of local ecology due to vegetation surveys (as part of initial impact assessment and ongoing monitoring).

2) Mitigation measures

The proposed Nam Ngao Hydropower activities at powerhouse and headrace canal will involve the clearance of vegetation to excavate the pits and construct project facilities and infrastructure. The exact nature of the vegetation to be cleared is dependent upon the final location of project facilities. The two deposits are located within areas broadly identified as relatively intact habitat. Although within this broader area, the deposits themselves are predominantly located in land comprised of forest regeneration, bamboo and scrub. There is no flexibility in the location of pits and little flexibility in the siting of dam, so some clearance of intact habitat will most likely be unavoidable during pit excavation and dam construction. However, there is greater flexibility in the location of other project facilities such as the processing plant, camp,

heap leach pads, and therefore the potential to avoid disturbance of higher value habitat by careful siting.

The habitat types identified in the project area during the survey are locally and regionally common. At a regional scale, the reduction in available habitat due to clearance for hydroelectric power purposes will therefore be dam and no impacts on biodiversity are expected. At the local scale, habitat reduction and loss of biodiversity is expected to be minor -however the loss of locally available forest, bamboo could disrupt current community resource use (in particular, the collection of NTFPs).

It is also confirmed that any areas of sensitivity forest such as National Biodiversity Conservation Areas (NBCAs) and protection forests are not present within the project area especially head pond/small head pond and intake weir. However, some of the big and high value commercial species were destroyed and removed by various causes including bombing during Indochina war, converting activities for other uses such as clearing and burning for shifting cultivation and logging.

6.3.3 Project area

1) Anticipated impacts

The Land Use Types and Forest Cover maps show that within the project area which will be directly affected by flooding are almost Upper Mixed Deciduous Forest (UMD), none valuables timber, bamboo.

2) Mitigation measures

- Vegetation clearance shall be taken before head pond impounding.

6.3.4 Disposal of spoils

1) Anticipated impacts

The Nam Ngao Hydropower Project will create spoil disposal areas that are majority come from ground excavation for foundation of powerhouse area and will consist of sandstone. Some of this may be used in concrete aggregate, but it is expected that the bulk of this will be placed in the spoil heaps which have been initially sited in depression so as to reduce their visibility. After the operation is finished the heaps will be landscaped and revegetated as part of the site protection and rehabilitation plan. However, alternatively, the spoil should be placed in heaps so that it can be used at a later date for other development purposes. This should be further considered during detailed design stage.

2) Mitigation measures

- The excavated spoil can also be used for other construction purposes if the construction is done simultaneously.
- Appropriate place has to be identified for the disposal of the excavated spoil (The spoil can be dumped a little further away from the canal area).

6.3.5 Access road

1) Anticipated impacts

Access road needs to be constructed from the intake weir to powerhouse (approximately 1 km). Due to mountainous terrain and steep slope, the roads must have sufficient drainage and where necessary the steep gradient drain shall be lined with rock or concrete in order to ensure the minimization of the soil erosion. In less steep batter or embankment vegetation cover shall be used.

The road should have adequate turnoffs for water runoff and they shall be provided along the road to break up the length of slope runoff effect. This should be located and maintained at a vertical and interval of at least 2 meters. Excessive earthwork and vegetation clearance shall be kept to a minimum at all times.

2) Mitigation measures

- Frequent Spraying of water during construction to minimize the pollution of air
- Minimize the distance of the access road as much as possible.

6.3.6 Impact due to camping

1) Anticipated impacts

According to the laws and regulations concerned, logging outside the approved construction areas and wildlife hunting and poaching within the area will be strictly enforced on project staff, workers, and all contractors engaged to the Project, with penalties levied for anyone caught carrying and using fire arms, or using animal snares and traps. Project staff and workers will not be allowed and have no right to hunt wildlife and cut any tree except for dead fuel-wood. However, the best way, the Contactor should provide bottled gas or kerosene to workers for cooking as an alternative to fuel-wood.

Removal of forest products and hunting including timber and Non-Timber Forest

Products (NTFPs) from this area is not allowed except for some kind of NTFPs such as wild-vegetable, wild-fruits, bamboo shoot, mushroom, rattan shoot and some wild starchy roots and this will need to be strictly controlled so as to avoid any further depredation of these resources. Some forests still remain within the project areas particularly in the powerhouse site and near the intake weir. Camping within this area should not cause any impact on forest. Worker camps should not be established within the proximity of any rich forest like mixed deciduous forest and attention must be paid with siting of the worker camps so that the workers do not interfere with any wildlife.

Burning to clear vegetation and wastes within the construction sites will not be permitted. Project owner shall be directly responsible for dissemination of all regulations and information concerned to its staff and/or employees as well as for any misconduct made by its staff and workers. These requirements will be stipulated in the contract document. These issues need to be also stated in the Environmental Management Statement prepared by the Project Owner/Contractor.

2) Mitigation measures for vegetation clearance

To minimize impacts due to vegetation clearance, it is recommended that:

- Wherever possible, facilities should be located away from areas of higher value habitat or significant NTFP collection. Sensitive habitats should be identified and designated as ‘no go’ areas and fragmentation of habitats (e.g. by access road construction) minimized.
- Vegetation clearance should be minimized and restricted to the immediate working area.
- Erosion should be minimized by effective drainage control to prevent additional loss of land.
- Buffer zones of vegetation shall be left along stream banks to maintain riparian habitats and prevent sedimentation.
- If economic trees need to be removed as part of the site clearance, the local community should be given access to these trees.
- Effective rehabilitation should be undertaken to ensure that areas of project disturbance are returned to pre-existing habitats or land uses or other habitats/uses as agreed between the Nam Ngao Hydropower Project and the community, government and other stakeholders.
- Rates of land clearance in the project area should be monitored and regular terrestrial flora and fauna surveys undertaken to assess the effectiveness of the proposed management measures. Improved management measures should be developed as required.

6.3.7 Potential Impact from the Transmission Line Construction

Generally, construction of the 22 kV transmission lines will typically involve the following tasks:

- Vegetation clearing from at least 4 m ROW by felling and lopping of trees, shrubs and bamboo including disposal of waste from site clearing to provide adequate clearance between vegetation and the conductor
- To gain access to the alignment wires. Access tracks will be cut from various points along the main roads to which the Transmission Line (TL) runs more or less parallel. Where soil conditions dictate, the tracks will be surfaced with suitable road topping material.
- The sites for lattice steel towers will be cleared and grubbed, and holes dug to permit construction of each of the four tower footings. At locations where rock or densely compacted soil is encountered, rock drills will be used to create holes for the tower anchor bolts. In such cases compressors will be required on site to provide compressed air for the pneumatic drills.
- Cement and aggregates will be carried to the each tower site to make concrete that will be poured into the holes to serve as the tower footings.
- The steel components and bolts for the lattice steel towers will be carried to each tower site, where the tower will be assembled and erected manually. When once the towers are in place, the insulators will be installed and pulling wheels will be hung from each insulator string. Nylon ropes will be run along the centerline of the alignment from tower to tower.
- Drums of conductor wire will be transported to strategic locations on the alignment connected to the nylon ropes, which will then be connected to (gasoline) powered winch that is secured further along the alignment. Conductor wire will be secured to the nylon rope, which will be winched in one at a time to string the conductors from tower to tower, through the wheels suspended from the insulators. The conductor wires will be secured to the insulators with the appropriate tension and sag.
- Grounding rods and/or continuous buried "counterpoise" (grounding) wires will be installed as required.
- Temporary equipment stockyards, work camps and field mobile offices will be

constructed. The main stockyards will be located near existing towns where advantage can be taken of transportation systems, existing vacant level land and, wherever possible, fenced off secure areas. Work camps along the transmission line will generally consist of temporary tent camps that will be moved as the construction proceeds along the alignment. Camps will house small work crews and will, therefore, not require any significant infrastructure.

- When once construction has been completed, sites that are no longer required (e.g., access tracks, storage and camp sites) will be reinstated. This will include removing debris or other contaminants, and returning the site to the same (or better) condition in which it was found. Where it was necessary to gain access to the alignment across agricultural lands, these areas will be reinstated to ensure future productivity.

Based on the field observation and review of land use and forest cover map, it is anticipated that most of the vegetation that will be affected is unstocked forest and scrub which include herbaceous, woody stemmed shrubs and bamboo. This is the characteristic early serial stage vegetation community that becomes established following logging and shifting cultivation. It is not anticipated that any areas of old forest will be encountered along the proposed rights-of-way. Nor does it appear that the alignment will pass through any species-rich areas of second growth forest and any NBCA or protected area. However, this will be confirmed when the detailed alignment survey is undertaken. In the event that trees may need to be cut through second growth stands, the overall impact of such tree removal is deemed to be minor, as only a few if any such areas are likely to be encountered. Also, the rapid rate of growth, estimated at 0.5 m³/ha/year, for tree species in most of Laos means that those areas currently classified as woody scrubland, have the potential to become secondary forest land. There is no any area appeared as wildlife habitat due to most of forestlands have been converted from time to time by slash and burn for shifting cultivation.

7.1.7 Power and mining

16 villages in Houay Xay district can access electricity or 48 % of all villages. Comparing with annual plan is 38 % of households that can access electricity or 968 households equal to 85 % of all households. There are 10 projects small and big hydropower in the district.

7.1.8 Education

There are 63 schools in province, which is primary school 57, secondary school 5 and high school 1 (7 class rooms, 115 students, female 68 people and teacher 8 people). In Houay Xay district, there are 27 primary school (97 classrooms, 984 students, 297 female, 88 teachers, 44 female teachers), 3 secondary school (984 students, 412 female) and 1 high school (667 students, 280 female, 64 teachers, 24 female teachers).

7.1.9 Health care

There is a district general hospital only 10 beds, and 8 health aid stations and 8 beds, it is serves in average 5 beds/1000 patients. There are 30 health care staffs 19 female. They are 2 bachelor degree healthcare staffs, 1 female. 12 healthcare staffs are diploma degree, 5 female and 15 healthcare staffs are diploma, 7 female. There are 21 first aid kids in village and they are using gravity fed water and dwell water in 22 village and 1 village cluster.

7.1.10 Water Sources

For most rural communities around the project area, water supply is provided by natural sources such as ground water and small stream around the village was used for other household water needs. For households, the mountain spring is used by the nearby villages for drinking; a gravity-based system is used to store water for washing and other uses. Where this is not available, mostly women and children for household used to fetch water from river or creek.

7.1.11 Cultural condition

There are 4 ethnic groups in Houay Xay district, consisting of Lao-low land, Ka Tang, Houay Xay and Pa Ko.

7.1.12 Tourism Condition

There are totally 4 natural tourism sites in Houay Xay districts additional 2 new sites. Average national and international tourists 300 people/year, and there is 3 restaurants.

8. ENVIRONMENTAL MANAGEMENT & SOCIAL DEVELOPMENT PLANS

8.1 Environmental Management Plan

8.1.1 Framework and aim

The Nam Ngao Hydropower Project's environmental management plan (EMP) & social development plan (SDP) are prepared based on Initial Environmental Examination results where they have been identified and analyzed including proposal for appropriate management and mitigation measures to the natural environments and the project affected persons. The main aims of the environmental management plan and the social development plan include the followings:

- Describing the environmental management measures which will be carried out as part of the project implementation.
- Addressing all environmental management measures that during the project's pre-construction, construction, operation and decommissioning (closure) stages will be implemented. The environmental management plan (EMP) intent to incorporate all significant social and environmental impacts identified in the Initial Environmental Examination (IEE) study and it includes the appropriate mitigation measures as developed in the environmental management plan (EMP) and the social development plan (SDP) and any other similar requirements required for the natural, social, economic and cultural components.
- Providing fair and prompt compensation to all persons or households affected by the project improving the economic development of alternative livelihood strategies for villages in the Watershed area.
- Providing technical assistances to households in the watershed area to ensure that economic activities are not subject to interrupt the watershed.
- Maintaining the social structure and networks of the affected communities. While the social development plan (SDP) aims at least at restoring pre-project conditions for the communities, and at bringing some improvement in the overall situation wherever possible, its objective is clearly not to force the local population to accept any major change in their lifestyle. Where triggered by the project, development takes place, it should be gradual and in line with the perceived needs, the capabilities and the aspirations of the population.

8.1.2 The physical environment

8.1.2.1 Water Management at Site

1) Specific objective

The main objectives of water management at site for the Nam Ngao Hydropower

Project are:

- To ensure that the water quantity and quality, abstracted from the catchment and discharged from the project, complies with regulatory requirements; and
- To minimize impacts on local water users and environmental values.

2) Management Measures

The clean runoff up gradient of disturbed, erosion prone land (i.e. construction camps, quarries, borrow pits and spoil dumps) will be intercepted by diversion channel and directed around the disturbed areas and back into natural drainage lines.

Dirty water from erosion-prone land, disturbed will be collected in interception channels and, if necessary, directed to sedimentation ponds, prior to being released to the environment.

The resident area must far from river about 150.0 m. Construction and camp areas will need to be provided with septic sanitation facilities and treatment system during construction period with adequate capacity (15 people/toilet). No untreated human waste should be allowed to enter any watercourse where this will affect water quality, aquatic environments and human health.

All hydrocarbons (e.g. fuels and lubricants) and chemical reagents will be stored in safe places, fully bundled areas constructed and managed in accordance with relevant International Standards and Material Safety Data Sheets. Oil, fuel and lubricant storage areas should be located well away from any water courses. Project Developer will ensure that containers of reagents and drums of used oil or grease are stored under cover at all times.

Potentially oily runoff from areas such as vehicle maintenance bays, equipment lay down areas, or refueling stations will be contained by perimeter bundling or interception drains. Oily runoff will be directed through appropriately designed and sized oil/water separators prior to discharge to the environment. Oil/water separators will be regularly cleaned and maintained.

Emergency response and clean up procedures following hydrocarbon and reagent spills will be developed. Project Owner will ensure that staff and contractors are adequately trained in hydrocarbon and reagent transportation, handling and emergency response and that appropriate equipment is available and regularly maintained for spill response.

Furthermore, Water Supply System Program will be conducted to provide clean, adequate water to village around the project area.

8.1.2.2 Erosion and sedimentation management

1) Specific objective

The management of erosion and sedimentation of Nam Ngao Hydropower Project will be based on:

- Minimizing the sediment erosion from areas directly and indirectly disturbed by the project; and
- Minimizing impacts on downstream land and water users and environmental values due to erosion, sedimentation or increased suspended sediment levels.

2) Management Measures

The land area disturbed by the project will be minimized, and the time of exposure to erosion processes will be minimized by implementing a progressive approach to land clearing and rehabilitation. Vegetation buffers will be retained around cleared areas to provide a habitat corridor for local fauna and a natural source of seed and organic matter that will facilitate later rehabilitation of these areas. Vegetation buffers will also be maintained along streams to help minimize the release of eroded sediments to watercourses. Topsoil will be progressively stripped during land clearance and retained in stockpiles for use in rehabilitation. The potential for erosion of landforms such as spoil dumps, topsoil stockpiles, channel verges and other engineered slopes will be reduced by ensuring that:

- Soil and spoil removed during the construction process should be stockpiled separately and stabilization measures implemented. The stockpiles should be constructed with stable batters and grassed to prevent erosion. Ridges may be created on topsoil stockpiles to provide for moisture retention to assist re-growth and slow run off to avoid the areas of drainage lines should be control drainage and erosion from the stockpiles. The erosion of the base of the dump should be considered in planning the location of the site.
- Batter angles will be limited to a maximum of 30-45 degrees, wherever possible and overall constructed slopes will be a maximum of 20 degrees.
- Diversion canal and sedimentation ponds will be constructed to reduce the potential for sediment to become entrained in surface runoff and to encourage the deposition of eroded sediment within the project area. Contour banks, filter fences, vegetative or mulch barriers will be used to reduce the velocity of runoff entering dirty water channels. Where flow velocity cannot be reduced sufficiently to prevent erosion, channel surfaces will be protected

with erosion resistant lining materials (e.g. rip rap). Grassing or concreting (e.g. stone pitch drains) may be required for longer-term protection of slope stability.

- Sedimentation ponds will be designed to reduce flow velocities sufficiently to allow for required sediment deposition. The design of sedimentation ponds will include the following erosion and sedimentation control measures that embankments will be constructed with suitable materials to minimize the risk of failure due to erosion or excessive seepage rates.

8.1.2.3 Waste management

1) Specific objectives

The objectives of solid and liquid waste material management for the Nam Ngao Hydropower Project include:

- Reducing potential health and environmental risks associated with waste generation and disposal;
- Minimizing the use of hazardous materials on site and seek safer alternative materials where possible; and
- Promoting the efficient use and conservation of resources, reduce the need for waste treatment facilities, and reduce the requirement for raw materials.

2) Management Measures

Waste management procedures will be based on the following hierarchy (in decreasing order of preference): (i) Minimize the waste production and maximize waste recycling and reuse; and (ii) Promote safe waste disposal.

The volume of waste generated will be minimized by:

- (i) Procuring supplies that produce less waste by virtue of the way they are produced packaged or consumed.
- (ii) Maximizing the efficiency of all on-site activities.
- (iii) Non-hazardous materials will be used in preference to hazardous materials, wherever possible.

Project owner will educate staff, contractors and the local community on the need to minimize litter generation and procedures will be established for segregating different types of waste at the location where they are generated to maximize the recovery of recyclables. Solid waste will be segregated into four categories, based on available markets/viable-end products for the materials (although an economic return will not

be a pre-requisite). The suggested categories are as follows: Biodegradable materials -vegetation and food scraps; recyclable materials -processed timber; hard plastic: glass; metal; paper and cardboard; and tires: Non-hazardous residue waste; Hazardous waste. Clearly labeled, color-coded bins will be placed at designated locations for temporary storage of Segregate materials.

To keep sanitary conditions, materials to be temporarily stored for reuse or recycling will be emptied and cleaned of residue waste. Recyclable and reusable waste will be collected regularly and transported to the site waste management facility for segregation prior to reuse or to sending off-site for recycling. Any proceeds from the sale of recyclable materials will be donated by Project owner to the local community.

Do not allow burning waste in open area. Plastic containers that have been used for chemicals must be destroyed so that these do not re-enter use as household water containers. Any non-hazardous residue waste that cannot be reused or recycled will be deposited in general litter bins located around the project site. Waste from these bins will be collected regularly and transferred to a site for deep burial in a location away from project and community dwellings and at least 50 m from surface waters.

Hazardous waste disposal will be undertaken to ensure that the long-term risk to employees contractors. The local community and environment, is minimized. Project owner will return hazardous waste items to the suppliers, where possible. If on-site disposal of hazardous waste is unavoidable, disposal will be in accordance with the material safety data sheets that the suppliers are required to supply with the item. If burial of hazardous waste is unavoidable, it will be buried in a designated waste landfill, constructed with a synthetic or compacted clay basal liner to minimize the long-term risk of contaminant escape.

8.1.2.4 Dust, noise and vibration

1) Specific objective

The management objective of dust, noise and blast for the Nam Ngao Hydropower Project is to prevent nuisance, health and safety effects on the community and impacts on the natural environment, particularly during project construction.

2) Management Measures

Topsoil removal land clearing and will be kept to a minimum, and rehabilitation will be undertaken progressively, to reduce the potential for dust generation associated with wind erosion (particularly during the dry season). Where possible, activities such as loading and dumping of topsoil will be scheduled to coincide with favorable winds

and weather conditions.

Gravel crushing and screening areas and concrete batching plants should be sited at least 1000 m away from camp sites and construction areas so that dust and noise generated by these operations does not impact on workers' health. Washings from these areas should be intercepted and treated. Bulk cement delivery rather than bags should be used wherever possible so as to reduce dust emissions and eventual problems with disposing of the large number of bags.

To manage dust generation associated with project-related vehicle movements: (i) Roads used by project-related vehicles will be regularly watered (at least once per day in dry conditions), Maintenance road in good condition, Improve road condition such as paved and concreted. (ii) Limited speed of vehicles. (iii) Cover plastic sheet firmly on truck that contained construction material to prevent any solid drop from the truck. (iv) Clean truck's wheel before leaving construction site to reduce dust occurrence.

All contractors and employees will be instructed to comply with company designated speed limits. The watering of spoil dumps, topsoil stockpiles and disturbed areas will be undertaken. If necessary, to suppress dust under dry and windy conditions.

The area of construction, including quarries should have restricted working hours in day time from 8 am to 5 pm., including restricted times for above ground blasting. In case, there is a need to run construction 24 hrs try to reduce activities that might generate noise in night shift. Construction workers exposed to noise levels of 70-80 dB or more than should be provided with adequate hearing protection, in accordance with the requirements of the health and safety plan.

The Noise control options such as exhaust and radiator silencers will be fitted to construction equipment, in particular, trucks and loaders. Construction activities and use of heavy vehicles will be minimized during night time. Emissions from reversing alarms may be regulated to reduce intrusiveness, particularly at night.

8.1.2.5 Waterway clearance

Water quality mitigation in the small head pond should be reduced of residual biomass level. The salvage logging and head pond clearance should be taken before impounding the head pond and monitoring to determine the economics and means for continuing the removal biomass, including diameter and poorly formed logs which may be economically harvested for sawn timber, plywood, and chip board from the inundation zone. Firewood collection should be undertaken during the construction, stockpiling fuel for future use by local villages. This methodology to be clears the

small head pond before inundation to reduce the impact of the biomass.

Clearance of head pond needs to ensure that water quality releases should be investigated and concentrations exceed pre-determined trigger levels. In the area adjacent to the Houay Makchan downstream of the dam and powerhouse and river confluence and area adjacent to the downstream channel, direct impacts on local people should be mitigated through alternative means if water qualities from pre impoundment level.

The project owner will closely coordinate with Provincial Agriculture and Forestry Office (PAFO) and District Agriculture and Forestry Office (DAFO) to undertake the head pond clearance.

8.1.2. 6 Rehabilitation

1) Specific objectives

The rehabilitation for the Nam Ngao Hydropower Project aims to:

- Give vegetative groundcover to help stabilize land disturbed or modified by project activities as soon as possible after such disturbance ceases; and
- Reduce impacts on and risks to public safety, land and water resource use and the environment during the life of the project and post-closure. Wherever possible, return productive land capability, environmental value or other benefits to the government and local community.

2) Approach to rehabilitation

Project Developers approach to rehabilitation will be as follows: (i) land disturbance will be restricted to the dry season; (ii) re-vegetation programs will recognize the need to stabilize disturbed surfaces prior to the onset of the wet season; (iii) Constructed slopes will be battered to safe and stable angles, with drainage provided as required controlling erosion; (iv) top-soil will be stripped and reused, as outlined below and disturbed land will be rehabilitated as soon as practicable after it is no longer active; and (v) re-vegetation will be undertaken in accordance with short-term requirements for ground stabilization and the longer-term achievement of designated end land uses. Newly re-vegetated areas will be fenced to protect them from grazing or disturbance by animals.

3) Re-vegetation

Depending upon rehabilitation objectives, plant species will be established on disturbed areas from one or a combination of the followings: The propagates (seeds, lignotubers, corms, bulbs and roots) stored in the topsoil (i.e. natural establishment) sowing seed.

The Project Developer will grow in a nursery or purchased from the community. Transplanting individual plants is from areas to be disturbed, or from natural areas. Spreading prostrate grass species should be considered as well as the selection of suitable grass species will need checking with local authorities. The re-vegetation will take into account the seasonal distribution of rainfall and temperature to optimize, as far as possible, conditions for germination and survival.

Planting along contours to maximize moisture availability and limit erosion. Ensuring the pit hole sides are not glazed to allow for good root development and infiltration of water to ensure that the Project Owner are sun 'hardened' before being planted in the field.

Clearing the area around the Project Owner and placing mulch over the exposed surface to minimize competition from weeds. Placing protective guards around individual the Project Owner to prevent animal damage and/or fencing-off re-vegetated areas to prevent livestock access.

Watering is required after planting if necessary, and watering during the initial dry season is also required to ensure the plant viability. In most cases, seed will be sown immediately prior to the expected onset of reliable rains. Seed beds will be carefully prepared to ensure that the soil is well aerated, free of weeds, and loose enough for the Project Owner to grow up through the soil and send down roots. The seed will be located at the optimal depth for germination and placed in good contact with the soil to ensure it can take up water easily. If the seed is to be broadcast (hand sown), it should be done before the seed bed has the chance to consolidate and form a surface crust. All re-vegetated areas must be fenced immediately after planting to protect them from grazing or disturbance by animals.

8.1.3 The Biological Environment

8.1.3.1 Specific Objective

The general objective of biodiversity and conservation management for the Nam Ngao Hydropower Project is to minimize project impacts on local flora and fauna.

8.1.3.2 Management Measures

The Project Owner is committed to protect and manage the existing environment to prevent further degradation of species. This will be achieved through effective planning and management of site activities to minimize the disturbance of significant vegetation or wildlife habitat. Where possible, Project Owner will site infrastructure away from potential areas of conservation value to ensure that overall impacts to vegetation and wildlife habitat are minimized. Project Owner will ensure vegetation clearance is kept to a minimum so as to reduce the impacts on existing vegetation and fauna habitats. A Catchment Management Plan will be developed to assist in catchment land use planning and to discourage uncontrolled vegetation clearance.

The Project Owner will restrict the access of workers to forested or protected areas and will prohibit hunting and forest product collection as a condition of employment. Adequate food (including meat) will be provided to workers (including contractors) and alternative cooking fuels to wood (e.g. bottled gas, kerosene) will be provided.

The Project Owner will support and encourage activities aimed at increasing the biodiversity within the region (e.g. by providing financial or logistical support to village conservation program through social development). To help control logging activity, Project Owner will minimize access roads through areas of intact forest and rehabilitate disused access roads. As far as possible, the company will ensure that easements for transmission lines, pipelines etc. avoid areas containing economic timber.

8.1.4 The Transmission Line Construction

The construction of 22 kV distribution line from powerhouse to connection point with EdL grid and transmission line route will follow the existing road due to easy for operation and maintenance of the line, the following management plan shall be taken by project owner or contractors:

- Vegetation clearing for Right of Way (ROW) are not permit over than 4-6 m ROW by felling and lopping of trees, shrubs and bamboo including disposal of waste from site clearing to provide adequate clearance between vegetation and the conductor wires.
- To gain access to the alignment, access tracks will be cut from various points along the main roads to which the Transmission Line (TL) runs more or less parallel. Where soil conditions dictate, the tracks will be surfaced with suitable road topping material. The rehabilitation of access road will be restricted and incorporated in the contractor's agreement.
- The sites for lattice steel towers will be cleared and grubbed, and holes dug to permit construction of each of the four tower footings. At locations where rock or

densely compacted soil is encountered, rock drills will be used to create holes for the tower anchor bolts. In such cases, compressors will be required on site to provide compressed air for the pneumatic drills.

- Cement and aggregates will be carried to the each tower site to make concrete that will be poured into the holes to serve as the tower footings.
- The steel components and bolts for the lattice steel towers will be carried to each tower site, where the tower will be assembled and erected manually.

To keep away from any impact on social and culture of the people along the distribution line route and the appropriate measures will be direct implemented and managed by Environmental Management Office (EMO).

8.1.5 Contractors Environmental Management Plan

Contractors and sub-contractors that work on the project including design, construction, and operation and decommissioning will be required by Project owner to develop and implement a Contractors Environmental Management Plan (CEMP) for their works. The Contractors Environmental Management Plan must be consistent with all management and mitigation measures and other environmental and social provisions of the project's approved Environmental Management Plan (EMP) & Social Development Plan (SAP).

All relevant sections of the EMP&SAP shall be provided to contractors and sub-contractors bidding for works on the project. The setting out of the Contractor's responsibilities and obligations with regard to meeting the requirements of the EMP & SAP will be incorporated as a condition of Contract documents.

8.2 Social Development Plan

8.2.1 Socio-Economic Management

The socio-economic management objective will be to: (i) ensure that the local community is able to benefit and derive opportunity from the project and that such benefits and opportunities are distributed as equitably as possible, (ii) minimize adverse project-related impacts (both direct and indirect) on the local community and ensure that where significant adverse impacts are unavoidable, adequate compensation is provided or mitigation measures implemented.

The exact nature of these programs will depend upon the possibilities given in the area, but also on input, suggestions and requests for the villagers themselves, as it is recognized that such projects need to be developed out of the communities' own initiatives in order to be successful and sustaining to watershed area.

Considering the spirit of local villagers and the tempo status of local area, the project have new tempo building program introduced in the nearby village to meet the demand of surrounding villagers.

To implement environmental management, it should list environmental concerned and mitigate measurement appropriately and compliance to GOL rule and regulation. That is included list of major impacts and main mitigation measure and important. To protect buffer zone, risk zone, high value of environment and social zone and others, details is described as below:

Table 8.1: Conclusion of significant impacts and mitigation measure

Aspect	Detail of impact and level		Mitigation measure	
	Impact	Level	Term	Measure
Dust	Dust from construction	Low	Short	Prevent source of dust generate in construction area
Noise	Disturb nearby people and wildlife	Low	Short	Construction site far from community
Soil	Soil erosion during construction period and sedimentation	Medium	Short	<ul style="list-style-type: none"> Bank protection from soil erosion, tree or grass planting in risk area Sediment gate discharge
Water	Sedimentation from plant	Medium	Short	Remove the sedimentation
Forest	Some forest are cut from catchment area before construction	Low	Short	<ul style="list-style-type: none"> Logging from project has to hand over to relevant administration Replantation
Wildlife	It might be alerted from people and machine	Low	Short	<ul style="list-style-type: none"> Construction site does not cover significant wildlife area
Aquatic life	Turbidity of water during construction period	Low	Short	Promote aquatic life
Land use	In order to extend road to project site, build resident building and construct power some agricultural land might be effected during construction period	Medium	Long	Compensation from each condition.
Agricultural product	The products such as coffee, tea and some crops might be cut during construction	Low	Long	Compensation from each condition
Traffic	<ul style="list-style-type: none"> Construct road to project site 	Low	Short	Set up signs

	<ul style="list-style-type: none"> Traffic during construction period might confuse 			
Health & safety	It might injure or sick of workers or local people	Low	Short	<ul style="list-style-type: none"> Quality control and safety planning, Medical checking and training
Waste disposal	Environmental and social impact	Low	Short	<ul style="list-style-type: none"> Waste disposal is prohibited Specify dumping area.
Social problem	Degraded of culture and tradition	Low	Short	<ul style="list-style-type: none"> Staffs must to obey local culture and tradition.

8.3 Management Arrangements

The project owner will have ultimate responsibility for ensuring the environmental management plan (EMP) & social development plan (SDP) are implemented. During construction, the implementation of certain management activities will be undertaken by the Contractor in accordance with the requirements of this environmental management plan (EMP) & social development plan (SDP). During operation, all management activities will be undertaken by project owner with specialist support as required. The implementation of the environmental management plan (EMP) & social development plan (SDP) will require staffing and support systems, as outlined below.

8.3.1 Project steering committee

The project steering committee shall be set up before the project commencement of the construction. This committee is comprised of representatives from Department of Energy and Mines, Department of Agriculture and Forestry, Department of Tourist, Provincial Water Resources and Environment Office, Lao's Women Union, Youth Union, lao National Front for Construction, Department of Health and Department of Information and Culture, the committee will chair by provincial vice governor.

The main responsibilities of this committee are to manage overall of the project activities and resolve the problem may rise during project implementation, for instance the compensation cost that may not be solve by District Working Committee, consider the tax exceptions of Import materials are required for construction as agreed and specified in project concession agreement.

The Project Environmental and Social Management Office (ESMO) will be assigned as the secretary of this committee and they may meet quarterly basic or 6 months period and ad hoc basic as required by the project during course of the project