

EIA/EMMP EXECUTIVE SUMMARY

INTRODUCTION

Background

The Theun-Hinboun Expansion Project (THXP) is planned by Theun-Hinboun Power Company Limited (THPC).

THPC owns and operates the existing Theun-Hinboun Power Plant (THPP) which is a 210 MW run-of-the-river hydropower scheme. This project was the first hydropower project in Lao PDR developed by the private sector under a concession agreement with the Lao PDR Government. The THPP facilities were commissioned in March 1998 and continue to operate successfully.

As a result of the successful completion and operating experience with the existing plant, THPC has proposed a new scheme to regulate the inflow into the Headpond. This scheme, known as the Expansion Project, involves an upstream dam and reservoir on the Nam Gnouang (NG dam site) and expansion of the generating capacity of the Theun Hinboun power station with additional 210 MW.

One reason for proposing the expansion is that the impending completion of the Nam Theun 2 dam upstream on the Nam Theun will reduce the power generation at Theun Hinboun. The expansion of the Theun Hinboun facilities partly mitigate for the reduced water available and the resulting decline in power generation from THPP.

EIA Process

The present Environmental Impact Assessment (EIA) report is prepared by a team of experts from NORPLAN A.S of Norway. The present report is largely based on previous reports and documentation. The primary source of information for EIA preparation has been the Social Action & Environmental Management Plans produced by the consulting company Resource Management and Research (RMR). In addition, information has been gathered from a number of thematic reports addressing environmental issues in the THXP impact zones. Information from the SWECO Feasibility and Hydrology Studies been extensively used. The Lao office of Wildlife Conservation Society (WCS) has provided an assessment of the biodiversity situation in the catchment and proposed a Biodiversity Development and Protection Plan.

The approach used in this study and the structure of the report follows standard EIA guidelines which are also prescribed in Government of Lao PDR regulations. The report is divided in 2 Sections. The first Section contains the main impact assessment part whereas the second Section contains the different elements that together make up the Environment Management and Monitoring Plan (EMMP).

Legal Framework

The report summarises the Lao PDR national administrative and legal requirements in the relevant national sectors, Lao PDR's international commitments, and the environmental and social requirements of International Financing Institutions.

The basic legal framework for the EIA, including the EMMP, is laid down in the Lao Environmental Protection Law of 1999. WREA, formally STEA, have issued National EIA regulations for Lao PDR, and instructed Ministries to develop sectoral guidelines for projects within their respective jurisdictions. The Ministry of Industry and Handicraft - now the Ministry of Energy and Mines – issued guidelines for power and transmission line projects.

PROJECT DESCRIPTION

THXP is composed of two main parts:

- A storage reservoir (NG) and a power plant on the Nam Gnouang upstream of the Theun-Hinboun Headpond; and
- Expansion of the Theun-Hinboun Power Plant capacity to take advantage of increased dry-season flows facilitated by the improved seasonal storage of the NG reservoir.

The planned reservoir is located on the Nam Gnouang which is one of the major tributaries on the Nam Theun/Nam Kading river system. As with the existing THPP, the expansion will divert water from Nam Theun/Nam Kading basin into the Nam Hai/Nam Hinboun river basin to the south. The location of the main project features in relation to landscape and infrastructure elements are shown in Figure ES -1

The Nam Hai and Nam Hinboun river channels downstream of the Theun Hinboun Power Plant will have to convey an increased water flow volume.

Dam

A 65 m high Roller Compacted Concrete (RCC) dam will be built about 1 km upstream of Ban Thasala. The dam site is located on the Nam Gnouang arm of the Theun Hinboun Headpond about 27 km upstream of the existing THPP diversion weir. The NG dam will create an upstream reservoir on the Nam Gnouang reaching at its maximum storage capacity about 100 km upstream from the dam.

A power plant will be integrated into the dam structure. This plant will have an installed capacity of 60 MW. Power from the NG facility will be routed from Ban Thasala to Ban Lao and be sold to EdL for consumption within Lao PDR.

Reservoir

The reservoir is planned with a full supply level (FSL) of 455 masl. The reservoir upstream of the dam at FSL will cover an area of about 105 km² and have a gross storage capacity of 2,450 Mm³. The reservoir will in most dry seasons draw down to an elevation of 420 masl. At that level the water volume will be 0,189 Mm³ and the surface area about 15 km². This will give a live storage volume (water available for power production) of 2,262 Mm³.

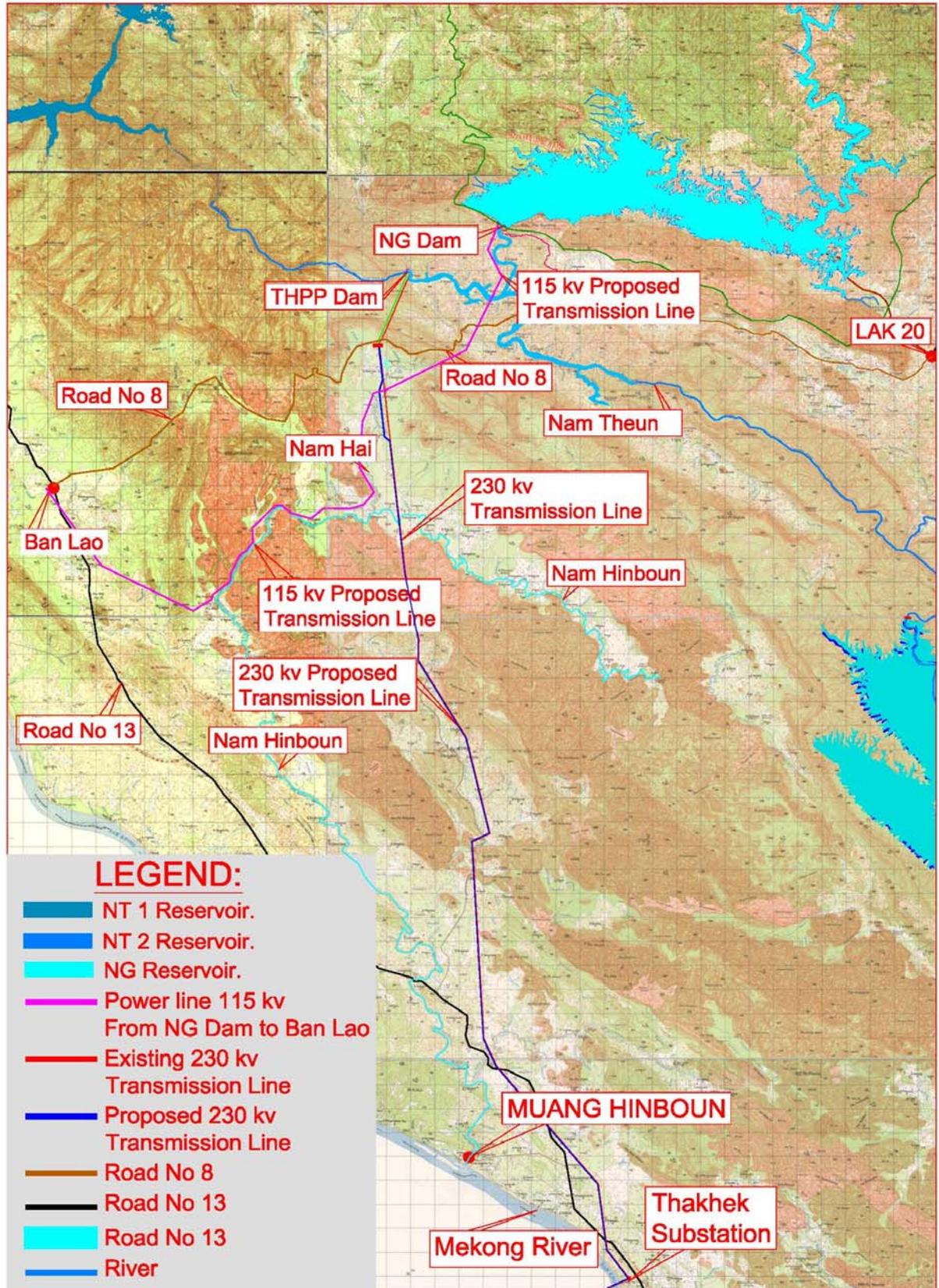


Figure ES-1. Overview of the project area with some major project elements indicated

- Powerhouse** A second diversion and headrace tunnel will have an intake at the existing weir at Ban Kengbit. The arrangement will divert water from the existing THPP Headpond down to the expanded power plant at Ban Khounkham. The new tunnel will be excavated on the right side (west) and in parallel with the existing tunnel. The new powerhouse will be located immediately adjacent to the existing powerhouse building. The expansion of the power plant will consist of a single unit with a nominal capacity of 210 MW.
- The existing tailrace canal, surge pond and regulating weir can accommodate the additional 110 m³/sec water discharge (220 m³/sec in total) with only minor modifications.
- Transmission Lines** The increased power production at the Theun Hinboun Power Plant will require a doubling of the capacity of the transmission of the generated power to the link up with the Thailand transmission network.
- This will require installing a second 230 kV transmission line in parallel to the existing THPP transmission line from the THPP switchyard to the Mekong crossing at Thakhek.
- An additional 115 kV transmission line will be installed to link the NG powerhouse to the national grid at NR13, Ban Lao.
- Project Milestones** The priority construction programme assumes an award of the engineer-procure-construct (EPC) contract in mid 2008. The Commercial Operation Date (COD) of the extended THPP will be in September 2011 and for the NG power plant in January 2012.
- The filling of the reservoir will start in 2011. The level of 439 masl will be reached in June/July 2011 and the full supply level of 455 masl is assumed to be reached at the time of COD for NG in late 2011 or beginning of 2012.
- Operation** With the operation of THXP, the THPP facility will become more of a base load plant than today. The provision of more sustained dry season flows will give flexibility in capacity for longer periods.
- 100% of the energy produced at the expanded THPP powerhouse from THXP will be sold to EGAT. EGAT will be required to take all energy available. This means that they will operate during most days of the year (probably all days). The capacity at which they will operate will vary from wet to dry season. Maximum discharges of 220 m³/s are expected during most of the wet season while fluctuations between full capacity and minimum capacity area expected during the dry season. Discharge flows will vary between 220 m³/s and 90 m³/s for short durations during the latter parts of the wet season.

POTENTIAL PROJECT IMPACTS

Physical Impacts

- Hydrology** Several significant hydrological changes will determine the impacts:

- Building the dam will create a reservoir, where a major river once flowed;
- The dam will create an absolute physical barrier between upstream and downstream waters, preventing river transport and the migration of fish and other aquatic species; and
- The flow pattern into the THPP Headpond will be more even over the year but the increased capacity of the power plant will lead to larger fluctuations in water level in the Headpond.
- The wet season overflow of the Headpond Weir into Nam Kading will be reduced.
- The intermittent flow pattern in Nam Hai and Nam Hinboun will continue but with a doubling of the maximum flow release.

These hydrological changes will have significant consequences for water quality, for aquatic life and fish biology and for human use of the river and riparian areas.

Water Quality

The deeper waters of the reservoir (below about 10 m or even less) will undergo a reduction in oxygen availability by the end of the dry season. Depending on the season and reservoir operations, there is a substantial risk that the waters will become anoxic.

Under such conditions the biological decomposition (oxidation) process alters to using alternative chemical pathways, and producing hydrogen sulphide, ammonia and methane, which are toxic for most organisms. By end of the wet season a greater part of the lake will be oxygenated by mixing and an inflow of large quantities of oxygen rich water. However, some reduction in oxygen content and some incidents of oxygen deficient water release into the Headpond are expected.

Downstream in Nam Hai, re-oxygenation processes in the tailrace and the aeration weir of the regulating pond are expected to result in discharge of water with acceptable oxygen availability.

The erosive and sediment transport processes in Nam Hai and Nam Hinboun will continue. The total volume of transported sediments will increase significantly but the level of solids per litre of water will be similar to the current situation.

River Morphology

The ongoing process of river bank erosion and river bed sediment transport in Nam Hai and Nam Hinboun will increase with the new intermittent flow regime. The shape and geomorphology of the river reach between the regulating weir and the Mekong will change.

Flooding

In the Nam Hai downstream of Ban Namsanam, the frequency of floods will change. The peak magnitude of a natural 100-years flood previously, under the current THPC scheme occurs on average every 20 years. The THXP releases will cause this magnitude every 2-5 years.

In the Nam Hinboun, upstream of the limestone gorge, the changes in frequency of flood magnitudes will be less pronounced. The peak magnitude of a natural 100-years flood today occurs, on average, every 80 years. With the expansion project, that level will happen every 60 years.

The annually flooded area in the Nam Hai and upper part of Nam Hinboun are presently on average 23 km². This will increase to 38 km² with the THXP releases; the duration of the flooding will increase accordingly.

Rock Falls	There is a risk of large rocks falling from the vertical limestone walls bordering the southern rim of the reservoir. In extreme cases this might cause waves in the reservoir that could be a hazard to life and property for people living close to the reservoir shoreline.
Greenhouse Gases	Research has shown that dams and reservoirs can release significant amounts of 'greenhouse gases', in particular carbon dioxide and methane. However, the expected production and inflow of organic materials into the NG reservoir indicates that the production of greenhouse gasses will be moderate and compare favourably in terms of emissions to thermal plants with similar power outputs.

Biological Impacts

Land and Vegetation	About 500 ha of forest land and 1,750 ha of degraded woodland and bamboo will be inundated by the project. The rest of the approximate 10,000 ha of reservoir land is agricultural land and temporarily unstocked or fallow land.
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The land requirements of other project structures such as camps, quarry, borrow, etc will take around 430 ha of mostly grassland and degraded woodland.

Wildlife & Biodiversity	The reservoir area is very low in wildlife and other biodiversity values. Some of the adjacent and upstream areas are less damaged and the Project could have a negative influence on wildlife and biodiversity due to:
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- General increased human population and economic activity in the project area;
- Improved transport opportunities and better access to remote places;
- Location of resettlement scheme close to a protected area.

The danger is that there will be increases in logging, unsustainable collection of NTFPs, illegal hunting and the wildlife trade.

Aquatic Life and Fish	The project will cause a major change in aquatic habitats, ecosystems and biodiversity in the Nam Gnouang river system by blocking migration routes to the upper reaches. In the new reservoir, the typical riverine species will disappear or be diminished but will most likely be substituted by species favouring lake environments.
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In the reaches of Nam Hai and Nam Hinboun already impacted by the intermittent water releases from the existing THPP, the aquatic ecosystems have been dramatically changed and biodiversity seriously degraded. This situation will continue and in some respects increase as a result of THXP releases.

Construction Phase Impacts

The impacts from construction activities will be similar to those found in most large construction projects. The main potential problems will be:

- Additional sediment load entering the Headpond;
- Water pollution due to accidents, careless handling, disposal and use of oil and fuel and other chemicals used in the construction process;
- Pollution by solid and liquid wastes and sewerage from construction camps and facilities;
- Soil erosion arising directly from project activities, such as the construction of new roads, improvement of existing roads, opening and operation of quarries, disposal of stone and soil spoils, and a number of other project related activities;
- Removal of forest and other vegetation at construction sites and illegal use of forest products by the increased population;
- Air pollution and noise problems;
- Traffic hazards.

Cumulative Impacts

The most important of the cumulative impacts will be the combined impacts of the series of existing, and planned hydropower plants in the Nam Theun/Nam Kading river basin (the existing THPP, NT2 under construction, NT1 and THXP). The THXP will only have a modest impact on impacts on hydrology, water quality, and fish, aquatic and terrestrial life compared to changes resulting from the NT2 and NT1 projects.

Summary of Impacts

The table below provides a brief summary of the potential impacts of THXP. The impact ranking is done without taking mitigation and managerial measures into consideration. In particular, the construction phase impacts can to a large extent be avoided by proper management and good environmental practise.

Table ES-1: Summary of THXP impacts

Potential impact	Impact ranking*
Permanent and operational impacts	
Reservoir (Impact zone 1)	
Improved boat transport opportunities	+
Soil slips and risk of rock fall induced waves	--
Eutrophication and algae bloom	-
Periods of oxygen deficiency and anoxic deep water	----
Reduced sediment content in water	+
Loss of agriculture land	--
Loss of forest land	-
Loss of biodiversity	0
Loss of riverine aquatic habitats and fish biodiversity	--
Risk of introduction of invasive water plants	-
New fisheries opportunities	++
Loss of Pha Kouanchan PPA buffer zone	-
Headpond area (Impact zone 2)	
Periods of oxygen deficiency in water	-
Larger water drawdown fluctuation	-
Impacts on water use and riverbank gardens	--
Nam Hai and Nam Hinboun (Impact zone 3)	
Increased risk of flood damage	----
River bank erosion	----
Increased sediment transport	-
Periods of oxygen deficiency in water	0
Buffering of heavy metal discharges from downstream tributaries.	+
Water logging and degrading of floodplain vegetation	--
Loss of bottom fauna and fish species	--
Nam Kading (Impact zone 3e)	
Periods of oxygen deficiency in water	0

Changes in aquatic habitats from reduced overflow	–
Blocking of fish migration	–
Increased activities close to Nam Kading NPA	–
Construction sites (Impact zone 4)	
Loss of land for permanent facilities	–
Improved infrastructure	++
Catchment (Impact zone 5a)	
Improved transport opportunities	+
Blocking upstream fish migration	–
Increased human pressure on NBAs and PPAs biodiversity	--
Construction Phase Impacts	
Risk of traffic accidents	--
Noise and dust problems	–
Sediment flow downstream caused by construction and spoil disposal	–
Discharge of oil components or other hazardous chemicals to water	–
Spreading of hazardous and domestic solid waste	--
Soil erosion from vegetation clearance and road construction	–
Increased pressure on wildlife and NTFP from labour force and followers	--
Drowning of animals during reservoir filling	–

* Symbols: High negative ---, Medium negative --, Small negative –, Insignificant 0, Small positive +, Medium positive ++, High positive +++

Structure and Organisation of the EMMP

The objective of an EMMP is to provide an Action Plan, so as to ensure effective implementation of mitigation, management and monitoring measures, which are designed to address all identified, significant, environmental impacts, during construction and operation.

The EMMP is based on the information available at this stage of project preparation (August 2007). During the period of detailed project preparation, more details and new project elements might be added which might change the nature and extent of environmental consequences. Thus the EMMP will need continuous revision and updating.

The overall EMMP has been divided into 9 EMMP Sub-plans:

- Reservoir Clearance and Filling Plan

- Catchment Biodiversity Development and Protection Plan
- Water Quality Monitoring
- Fish Monitoring and Mitigation Plan
- Downstream Riverbed Management Plan
- Construction Activities Environment Plan
- Operation Activities Environment Plan
- Transmission Line Environment Management Plan
- Environmental Education Training

Impacts and mitigation measures

The tables below contain information pertinent to the most significant potential environmental consequences of THXP. The impact identification is matched with a brief indication of the mitigation measures recommended for prevention or reduction. The Sub-EMMPs which address the different problems are also indicated.

Table ES-2: Permanent and/or operational impacts of THXP

Predicted permanent or operational impacts	Mitigation measures	Sub-EMMP where the issue will be addressed
Changing part of the Nam Gnouang river into a reservoir.	Necessary consequence of the project. Can not be mitigated.	No management action
Dam creating barrier for up and downstream migration of fish.	Necessary consequence of the project. Can not be mitigated.	No management action
Change in water flow pattern into the THPP Headpond.	Consequence of the NG operation	Included in the project operation design.
Change in water flow pattern downstream in Nam Kading.	Recipient release of 5 m ³ /s.	Included in the project operation design.
Change in water flow pattern downstream the Theun Hinboun power station.	Consequence of the THXP operation	Included in the project operation design.
Reduced O ₂ content (possibly anoxic) in water downstream the NG dam.	Reduction of biomass in the inundated area. Variable intake structure.	Reservoir Clearance and Filling Plan, Chapter 10. Water Quality Monitoring, Chapter 12. Measures might be included in the project design.
Increased turbidity and sediment transport in Nam Hai and Nam Hinboun.	Riverbank stabilisation measures.	Downstream Riverbed Management, Chapter 14
Changes in river morphology in Nam Hai and Nam Hinboun.	Riverbank stabilisation measures	Downstream Riverbed Management, Chapter 14
Accidental water pollution from NG and THPP and substation operation	Oil collection devises. Emergency Plan.	Operation Environment Plan, Chapter 16.
Loss of land by reservoir	Necessary consequence of the	Catchment Biodiversity

Predicted permanent or operational impacts	Mitigation measures	Sub-EMMP where the issue will be addressed
inundation.	project. Can not be mitigated but to some extent compensated	Development and Protection Plan, Chapter 11. Covered in more detail in the RAP.
Loss of land to project features.	Necessary consequence of the project. Can not be mitigated but to some extent compensated	Construction Activities Environment Plan, Chapter 15.
Improved access to relatively unspoiled natural areas and PPA. Increased damage to habitats and result in unsustainable use of natural resources.	Control and enforcement to reduce access and hunting. Wildlife management and protection program.	Catchment Biodiversity Development and Protection Plan, Chapter 11.
Reduction in fish biodiversity in Nam Gnouang.	Improving conditions for "reservoir" fish species Measures to avoid de-oxygenation and eutrophication of reservoir water.	Fish Monitoring and Mitigation Plan, Chapter 13. Water Quality Monitoring, Chapter 12.
Reduction in fish biodiversity and production in Nam Hai and Nam Hinboun.	Reduction of turbidity in the river.	Fish Monitoring and Mitigation Plan, Chapter 13. Downstream Riverbed Management, Chapter 14 Water Quality Monitoring, Chapter 12.
Loss of long distance migrating fish species.	Protecting upstream fisheries.	Fish Monitoring and Mitigation Plan, Chapter 13. Catchment Biodiversity Development and Protection Plan, Chapter 11.

Table ES-3: Potential construction impacts of THXP

Predicted construction phase impacts	Mitigation measures	EMMP where the issue will be addressed
Increased sediment flow downstream caused by construction of tunnels and cofferdams and from spoil disposal.	Spoil disposal planning and sediment retention arrangements.	Construction Activities Environment Plan, Chapter 15. Water Quality Monitoring, Chapter 12. Environmental Education Training, Chapter 18.
Discharge of oil components or other hazardous chemicals to water.	Regulations on oil and other chemical storage, use, collection and final disposal. Oil skimmers/collectors installed at critical places.	Construction Activities Environment Plan, Chapter 15. Water Quality Monitoring, Chapter 12. Environmental Education Training, Chapter 18.
Discharge of domestic waste water from labour camps.	Installation of small wastewater treatment units.	Construction Activities Environment Plan, Chapter 15. Water Quality Monitoring, Chapter 12. Environmental Education Training, Chapter 18.
Spreading of hazardous and domestic solid waste.	Regulation on disposal and collection of solid waste.	Construction Activities Environment Plan, Chapter 15. Environmental Education

		Training, Chapter 18.
Soil erosion from vegetation clearance and road construction.	Include erosion protection measures in the detailed design. Re-vegetation.	Construction Activities Environment Plan, Chapter 15. Environmental Education Training, Chapter 18.
Dust and noise emission from quarrying, crushing and transport activities.	Use machinery with emission, dust and noise reduction facilities.	Construction Activities Environment Plan, Chapter 15. Environmental Education Training, Chapter 18..
Traffic impacts including accident risk.	Dust control on roads. Strict regulation on traffic speed. Road marking.	Construction Activities Environment Plan, Chapter 15. Environmental Education Training, Chapter 18.

Organisation

For the effective implementation of the EMMP, several parties will be involved with different duties and responsibilities and a new organisation will be established.

THPC Structure

The THPC will be handling all issues related to the THXP Project on behalf of the investors. The Company has for the purpose of the social and environmental monitoring and management programmes related to the operation of the existing Theun Hinboun power plant operation, established an Environmental Management Division (EMD). This Division has been reorganised as a Social and Environmental Division (SED). This unit will be given an extended mandate and budget and will be the main execution unit for The THXP Management Plans.

The THPC Head Office in Vientiane will have a Social and Environmental Division Manager and administrative support staff for supervision and control of the SED activities. The SED will have its offices at the THPC power plant site at Khounkham. The organisation setup and elements of the SED and the EU is shown in Figure ES-2.

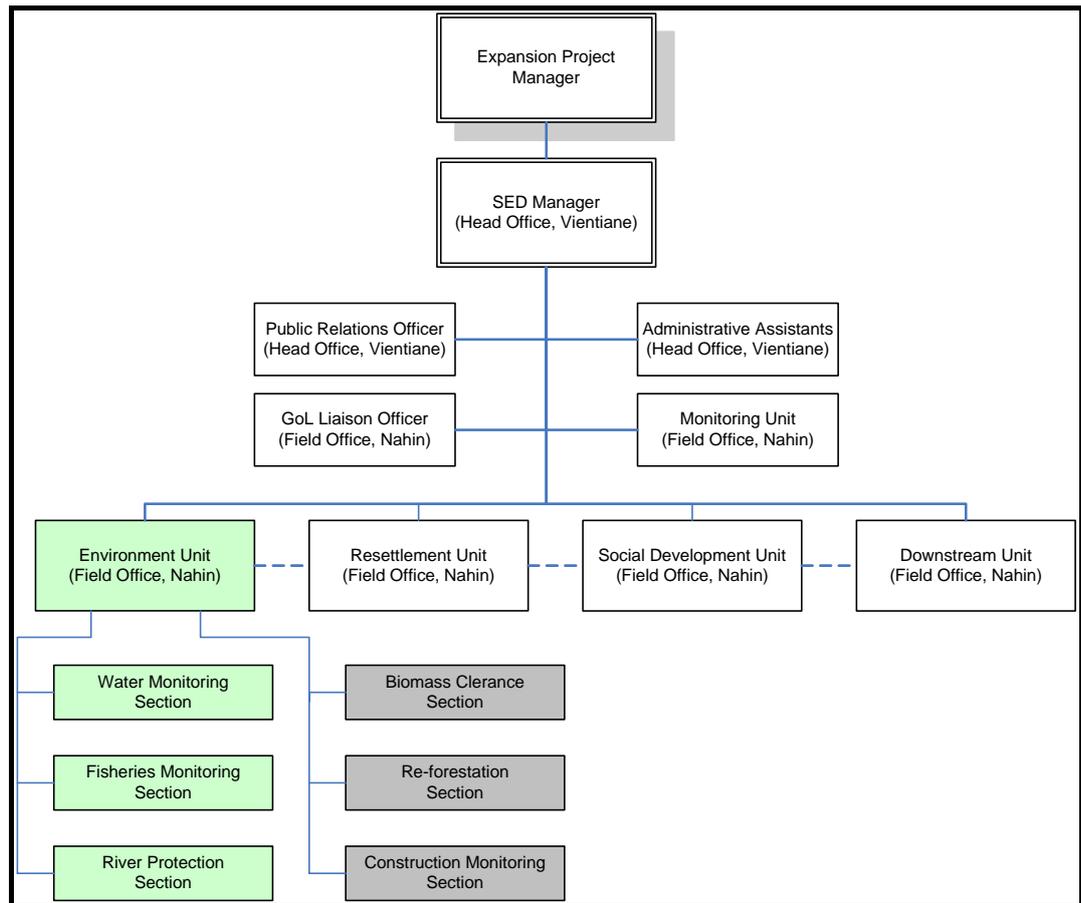


Figure ES-2. Organisational setting of the SED Environmental Unit

Head Contractor

The Head Contractor will be responsible for avoiding or minimising environmental impacts from construction activities. Environmental performance requirements and standards for environmental protection will be laid down in the Concession Agreement, in ISO 14001 and general principles of best environmental practise. The specific details for this will be included in the contract between the Company and the Contractor. The Contractor will develop and implement detailed management and monitoring plans for specific construction activities (oil and hazardous waste management, road erosion control, domestic waste water handling, etc).

Sub-Contractors

The Sub-contractors will have to comply with the overall principles of the Contractors Environmental Management and Monitoring Plan. For this purpose a senior official will be designated to overview the Sub-contractors activities and give advice or warning whenever necessary.

GoL Organizations

In accordance with GoL regulations covering environmental standards and procedures and technical guidelines (2003, MIH/DOE and 2006, STEA), the involvement of GoL at all implementing levels must be ensured. This applies to institutional augmentation and capacity building for existing organisations and for project-specific organisations. The objective is to ensure long-term sustainable environmental protection and enhancement.

Through its role as a secretariat of NEC, WREA is a key organisation in determining the content of an EMMP and in controlling and monitoring its implementation. WREA's approval of the proposed EMMP prepared by the Company is necessary before the project can be initiated, and WREA specifies the requirements and processes for environmental management and monitoring of the EMMP to be included in the Concession Agreement.

Line Agencies The governmental representatives involved in more detailed planning and control of the implementation of the EMMP, will come from the Governmental offices at Provincial and District level, in this case from the Khammouane and Bolikhamxay WREA office (STEO) and the Provincial and District Offices of the Ministry of Agriculture and Forestry (DAFO and PAFO).

EMU To oversee THXP, WREA will establish an Environmental Management Unit (EMU) with representatives of relevant Central, Provincial and District authorities.

Independent Experts The Company will in many cases have to use individual professionals or NGOs for specialised tasks. This might be for ecological studies, fish and water quality monitoring and training and education of local communities, construction workers and operational staff.

There are in particular many challenges for achieving successful management of the Nam Gnouang catchment. Addressing this issue will require creative scientific, social and management contributions from many biodiversity conservation specialists, many of whom work in Lao PDR and/or regional universities or for international conservation NGOs, e.g. WCS, IUCN and WWF.

In addition to the self monitoring carried out by SED and the independent monitoring performed by the EMU, it is recommended to establish an Environmental Panel of Experts (PoE) to provide an independent review and guidance on the treatment of environmental issues associated with the THXP project.

Capacity Building and Long-term Institutional Arrangements

The Company will have to support the EMU and central, provincial and district level GoL organisations involved in implementation. Emphasis will be on strengthening the capacity of the involved institutions and on providing training in data collection, analysis and management information systems.

Handover Strategy A handover strategy will need to be developed before the end of the construction period. This strategy will outline steps for the handover of responsibilities to WREA and District counterparts

EMMP SUB-PLANS

Reservoir Clearance and Filling Plan

The Plan will require implementation of activities aimed at producing the following results:

- Good quality water developed in the reservoir and downstream.
- Clear waterways for navigation by boats.
- Improved fishery potential in the reservoir.
- Potential obstacles removed to establish new fisheries in the reservoir.
- Timber and NTFP resources salvaged.
- The aesthetic appearance of the reservoir region enhanced with improved accessibility.
- The production of floating debris and water plant infestation risk in the reservoir substantially reduced
- Minimized losses of domestic and wild animal life
- The recovery, where practical, of any materials or objects that are possibly of cultural, academic or scientific interest

The main element of the plan is the removal of as much as possible of the all surface vegetation (including commercial timber) in the reservoir area. Any representative items of important scientific interest will be salvaged.

Catchment Biodiversity Development and Protection Plan

The Plan has proposed two strategies for compensating the assumed impacts on biodiversity caused by the planned THXP developments. These strategies are:

- The creation of a Provincial Protected Area encompassing areas around the reservoir.
- Regeneration/rehabilitation of degraded forests and old upland agricultural areas in the catchment.

The strategies will both support the overall goal of protecting the integrity of the biodiversity in the Nam Gnouang catchment and reduce the erosion which is important to the lifespan of the reservoir.

More specifically the objectives can be formulated as:

- Regain ecosystem integrity of areas surrounding the NG reservoir including a full complement of flora and fauna;

- Preservation of abundance of habitats and forest lands;
- Increased forest cover in the catchment;
- Reduced potential for hunting, collecting and trade of wildlife and other forest products;
- Preserved water resources within the watershed for national socio-economic development, including fisheries;
- Prevention of the establishment of agricultural areas in the catchment by villager living north of the inundation zone;
- Reduced risk of soil erosion and sedimentation in the catchment, particularly during flood events;
- Increased tourism potential;
- Maintained aesthetic value of the catchment.

For practical planning implementation purposes the overall Catchment Biodiversity Development and Protection Plan has been divided into two separate programmes; Provincial Protected Area Programme and Forest Regeneration/Rehabilitation Programme.

Water Quality Monitoring

A Water Quality Monitoring Section is proposed to be established under the Environmental Unit of SED to manage the water quality monitoring programme. The programme will in particular focus on the issues:

- risk of discharge of hazardous chemicals during construction;
- discharge of domestic wastewater and sewage from sites and camps;
- sediment loads from construction activities;
- eutrophication and oxygen depletion in reservoir and release of anoxic water downstream;
- monitor and analyze the prevailing changes in water quality at pertinent points throughout the watershed;
- downstream change in water temperature; and
- downstream riverbed erosion and sediment transport.

Fish Monitoring and Mitigation Plan

The plan will address future changes in fish biology and aquatic ecology caused by the Project, the main elements being: blocking the migration of fish upstream Nam Gnouang, fish species development

in the NG reservoir, and the potential of further degradation of fish biodiversity and fisheries in Nam Hai and Nam Hinboun.

The objectives of the plan will be:

- Improve the knowledge of the species composition and biology of fish species and other aquatic fauna in the catchment;
- Monitor the changes in fish and aquatic biodiversity caused by project related impacts;
- Identify potential measures to reduce or to compensate for the expected impacts on fish and aquatic biodiversity.

Downstream Riverbed Management Plan

The plan will address the issues of the altered river hydrology, sediment flow and erosion in Nam Hai and Nam Hinboun downstream of the power plant. Problems resulting from the construction activities and from the long term operational phase will be addressed. The plan will include the following elements:

- Monitor riverbank erosion and river morphology; and
- Develop plans and construct river protection or training work.

Construction Activities Environment Plan

The plan covers potential sources of environmental hazards caused by project construction activities such as water pollution, noise and dust problems, erosion, etc. In addition, the environmental impacts and the pressure on nearby natural resources from the influx of several hundred workers and camp followers will be addressed. The plan identifies nine activities or themes. These themes will be elaborated and detailed standards prescribed in the Head Contractors Environment Management Plan.

Operation Activities Environmental Plan

The main focus for this phase would be to prepare an Emergency Response Plan for oil pollution and accidental water releases and provide a permanent system for wastewater treatment, solid waste handling and oil collection.

Transmission Line Environment Management and Mitigation Plan

The plan covers potential sources of environmental hazards caused by project construction activities. These are water pollution, noise and dust problems, erosion, etc. The plan identifies several activities or themes. These themes will be elaborated and detailed standards prescribed in the Head Contractors Environment Management Plan.

Environmental Education

Environmental education activities to inform on good environmental practices and the sustainable use of natural resources will focus on three audiences: construction team leaders, the workers themselves, and local residents. It is recommended to adopt training and educational techniques already successfully employed for Lao PDR.

BUDGET

A summary budget for the different EMMP components and activities and the operations of the SED and EMU under WREA and other GoL organisations are given in Table ES-4 below. Some of the cost items have not been specified. This is the case where: (i) the expenditures cannot be separated from the other regular construction and operation costs of the hydropower project, and (ii) where there is the need for and possible design of mitigation measures can only be determined after a period of operational phase monitoring.

Overview of Environmental Costs		Total Budget	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ODC2-1	Environmental	3 466 500	157 000	229 000	229 000	212 500	216 000	390 000	412 000	412 000	409 000	400 000	400 000
a	Downstream Erosion Monitoring and compensati	163 500	2 000	6 000	6 000	9 500	20 000	20 000	20 000	20 000	20 000	20 000	20 000
b	Fish monitoring and mitigation	248 000	16 000	24 000	24 000	24 000	24 000	34 000	24 000	24 000	24 000	15 000	15 000
c	Water quality monitoring	202 000	8 000	34 000	24 000	24 000	22 000	15 000	15 000	15 000	15 000	15 000	15 000
d	Environmental Awareness	52 000	-	10 000	10 000	10 000	10 000	6 000	3 000	3 000			
e	Reservoir Clearance and filling plan	306 000	131 000	60 000	55 000	25 000	20 000	15 000					
f	Reforestation	1 385 000	-	40 000	50 000	60 000	60 000	175 000	200 000	200 000	200 000	200 000	200 000
g	Projected Area Plan	1 110 000	-	55 000	60 000	60 000	60 000	125 000	150 000	150 000	150 000	150 000	150 000
ODC2-6	Monitoring and Evaluation	200 000	-	25 000	15 000	20 000							
b	WREA EMU Monitoring	200 000	-	25 000	15 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
ODC2-7	GoL Allowances and Support	1 565 000	-	43 750	96 000	96 000	73 750	218 000	207 500				
d	Logistic support & capacity building for WREA, Vientiane	170 000	-	26 750	40 000	40 000	28 750	12 000	4 500	4 500	4 500	4 500	4 500
e	Logistic support & capacity building for WREA, Provincial & District Offices	135 000		11 000	40 000	40 000	30 000	4 000	2 000	2 000	2 000	2 000	2 000
f	Logistic support & capacity building for other GOL Environmental Agencies (DoR, MEM, EdL)	60 000		6 000	16 000	16 000	15 000	2 000	1 000	1 000	1 000	1 000	1 000
g	Environmental Protection Fund (\$200,000 annually after COD to 2038)	1 200 000					-	200 000	200000	200000	200000	200000	200000

Table ES-4. Summary table of EMMP and GoL Support costs