



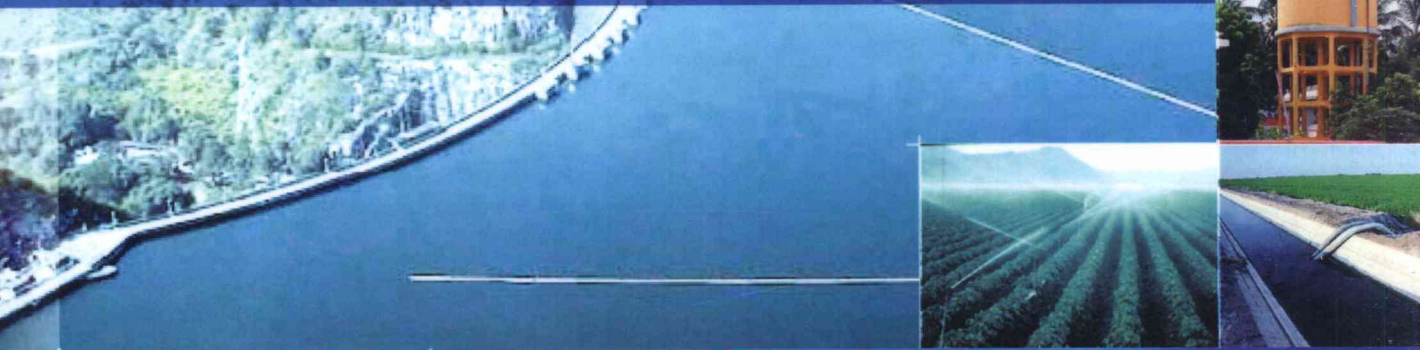
Department of Alternative Energy Development and Efficiency  
Ministry of Energy

Feasibility Study

Environmental Impact Assessment

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**Bhumibol Reservoir Inflow Augmentation Project**

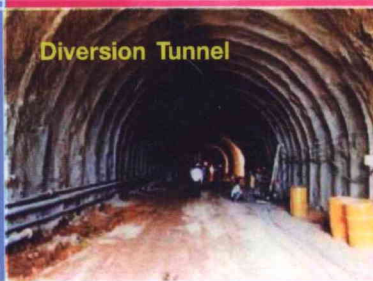


**Environmental Impact Assessment on Diversion Route  
Lower Yuam Reservoir–Bhumibol Reservoir  
Executive Summary Report**

Yuam River



Diversion Tunnel



prepared by



Panya Consultants Co., Ltd.



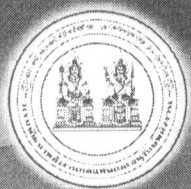
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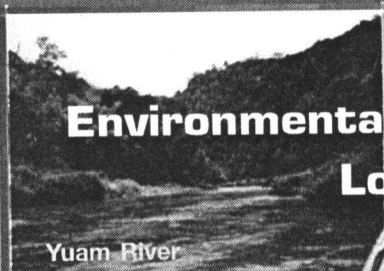
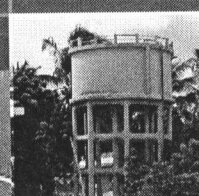
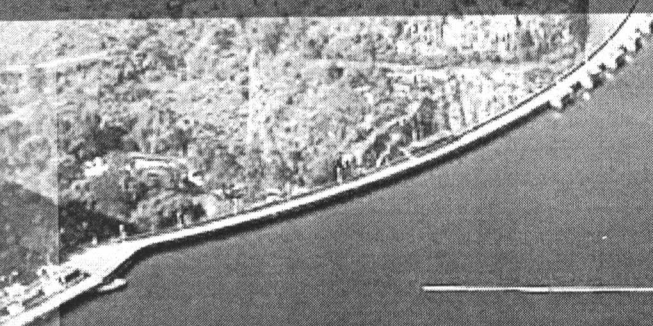
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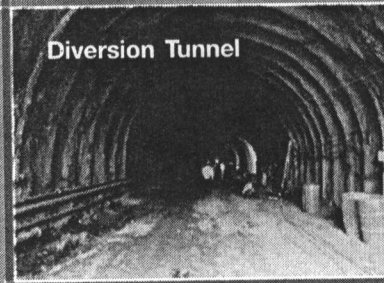
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During the study, the consultant was provided with information, documents and advice from the agencies concerned namely the Electricity Generating Authority of Thailand, Meteorological Department, Royal Irrigation Department, Department of Mineral Resources, Land Development Department, Department of Public Works and Town & Country Planning, Department of Water Resources, Office of Agricultural Economics, National Economic and Social Development Board, Office of the Natural Resources and Environmental Policy and Planning, National Park, Wildlife and Plant Conservation Department, Office of Governor of Mae Hong Son, Chiang Mai and Tak Provinces and various agencies as not mentioned here. Special thanks should be given to the above agencies.

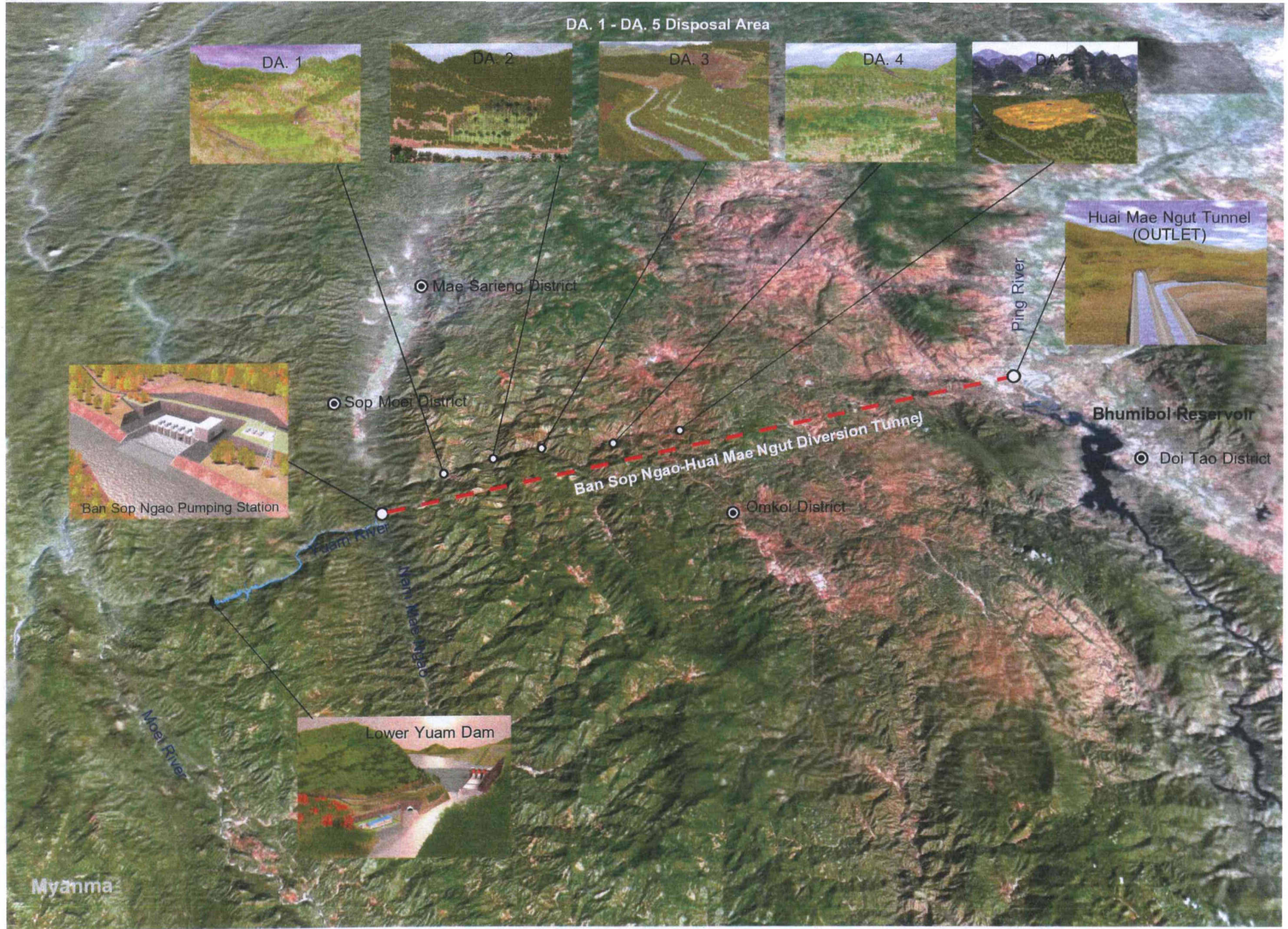
Finally, we would like to cordially thank for the cooperation and support form Bureau of Energy Development.

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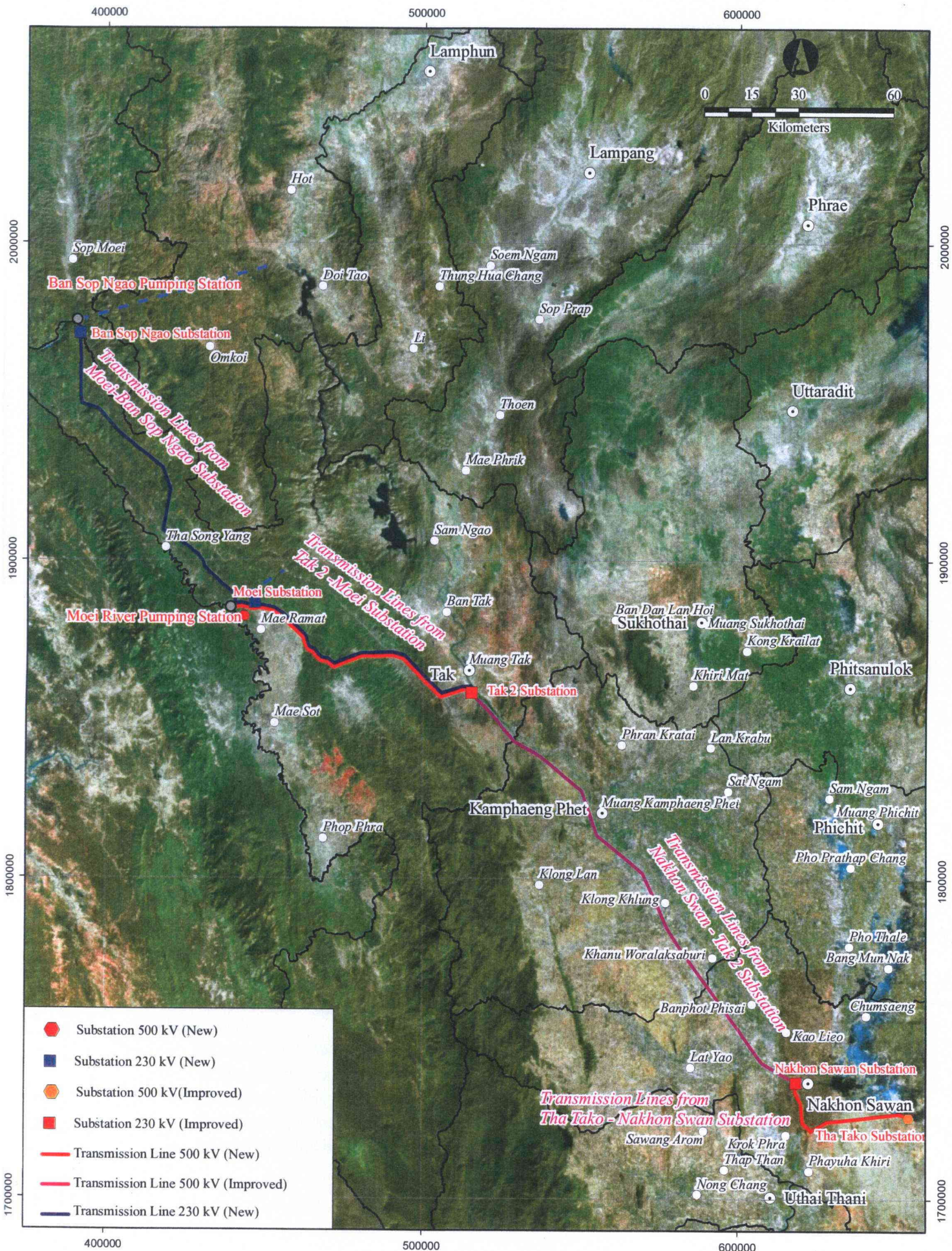
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The Diversion Route of Lower Yuam Reservoir - Bhumibol Reservoir





Map of project's Transmission Line



## Project Summary

### Project Features

The Bhumibol Inflow Augmentation Project on the route of Lower Yuam Diversion Project consists of major components can be concluded as follows:

**Lower Yuam Dam** is located on the Yuam River, about 12 km upstream of its confluence with the Moei River in Sop Moei District, Mae Hong Son Province to store and divert water into Ban Sop Ngao Pumping Station.

**Ban Sop Ngao Pumping Station** is 22 km upstream from the dam. It is located in Ban Sop Ngao, Sop Moei District, Mae Hong Son Province on the left bank of the Yuam River to pump water through pressure conduit leading to the head tank and a 61.85 km diversion tunnel to the outlet at Huai Mae Ngut by gravity. The annual discharge volume is 2,184 million cubic meters (MCM).

**Diversion tunnel** is concrete lined, circular and horseshoe-shaped section. Excavation of the diversion tunnel will be carried out by means of conventional Drilled and Blasted (D&B) and Tunnel Boring Machine (TBM) with 10.0 m diameter. It is horseshoe-shaped section by D&B and concrete-lined with 8.3 m internal diameter. If the tunnel is excavated by TBM, it is circular section and concrete-lined with 8.4 and 9.1 m internal diameter. The total length is 61.85 km. The water flows by gravity with tunnel slope 1:1,500 and outlet at Huai Mae Ngut, Ban Huai Hin Dam, Na Kho Ruea Village, Hot District, Chiang Mai Province upstream of Bhumibol Reservoir.

### General Description

#### Hydrology

- Catchment area at damsite	5,886.50	km <sup>2</sup>
- Annual runoff	2,758.38	MCM
- Maximum flood (10,000 year flood)	4,970.54	m <sup>3</sup> /sec
- Probable maximum flood (PMF)	7,127.83	m <sup>3</sup> /sec
- Average annual diverted flow	2,184.52	MCM

#### Dam

	Lower Yuam Dam	
- Type	Concrete faced rockfill dam	
- Crest elevation	+144.50	m MSL
- Height	69.50	m
- Crest width	9.00	m
- Crest length	200.0	m
- Radial gates (number @ width x height)	3 @ 14.00 x 15.00 m	
- Maximum high water level (10,000 year flood)	+142.07	m MSL
- Maximum retention water level (PMF)	+145.85	m MSL
- Crest of wave wall	+146.00	m MSL

#### Reservoir

- Normal High Water Level (NWL)	+142.00	m MSL
- Water surface area at NWL	3.99	km <sup>2</sup>
- Minimum water level	+137.00	m MSL
- Total storage capacity	80.80	MCM
- Maximum discharge capacity	182.52	m <sup>3</sup> /sec



**Diversion tunnel during construction**

- Number	1	tunnel
- Diameter	7.00	m
- Length	500	m
- Maximum discharge capacity	369.40	m <sup>3</sup> /sec

**Pumping station**

- Total design head	170.958	m
- Pumping capacity (number @ size)	6 @ 63.442	MW
- Annual energy for pumping	1,247.58	GWh
- Pumping discharge/pump	30.42	m <sup>3</sup> /sec

**Pressure Conduit**

Steel lined conduit

- Diameter	6.80	m
- Length	1,822.79	m

**Head tank**

- Height	25.54	m
- Diameter	34.09	m

**Diversion tunnel, concrete-lined, horseshoe-shaped section and drilled by D&B**

- Diameter	8.30	m
- Length	33.39	km

**Diversion tunnel, concrete-lined circular section and boring by TBM**

- Diameter	8.4 and 9.1	m
- Length	2.29 and 26.18	km

Total length 61.85 km

**Huai Mae Ngut Improvement** 5.20 km

**Powerhouse plant at Lower Yuam Reservoir**

- Installed capacity	2 x 4.3	MW
- Type of turbine	Francis	
- Design head	57.8	m
- Design discharge	17.56	m <sup>3</sup> /sec
- Annual energy production	41.68	GWh

**Transmission line system :** It consists of construction and improvement of transmission line from Tha Tako-Nakhon Sawan-Tak 2-Moei-Ban Sop Ngao with total length of about 420.6 km and can be summarized as follows :

- Extension of Tha Tako Substation (500 kV) and Tak 2 Substation (230 kV).
- Construction of Moei Substation (500/230 kV) and Ban Sop Ngao Substation (230 kV).
- Construction of 500 kV transmission lines from Tha Tako–Nakhon Sawan Substation for a distance of 48.5 km.
- Improvement of existing transmission lines from Nakhon Sawan–Tak 2 Substation from 230 kV to 500 kV for distance of 163.6 km.
- Construction of 500 kV and 230 kV transmission lines from Tak 2–Moei Substation for a distance of 90.9 km.
- Construction of 230-kV transmission lines between Moei–Ban Sop Ngao Substation for a distance of 115.6 km.
- Connection of 230-kV transmission lines from Bhumibol Switchyard–Nakhon Sawan to Tak 2 Substation for a distance of 2 km.



<b>Implementation Period</b>	7	years
<b>Total project costs (2005)</b>	39,868	million baht
(including investment costs for the transmission line system of the diversion route of Moei River-Nam Mae Tuen)		
• Diversion system and appurtenant structures	31,273	million baht
• Transmission line	8,595	million baht
- Only the diversion route of Lower Yuam Reservoir and Bhumibol Reservoir	4,783	million baht
- Additional lines supporting the route of Moei River-Nam Mae Tuen	3,812	million baht
• The project cost of only the route of Lower Yuam Reservoir- Bhumibol Reservoir	36,056	million baht.

**Annual economic benefit 10,054 million baht**

- Annual energy production increment at Bhumibol powerhouse 516 GWh at 979 million baht. (compared to gas turbine because it can generate power during peak period)
- Annual increase of water consumption is 751 MCM at 6,227 million baht. (compared with the production cost of groundwater)
- Increasing efficiency in the use of cultivated area is 0.85 million rai at 2,769 million baht.
- Annual energy production at Lower Nam Yuam Reservoir is 41.68 GWh at 70.86 million baht.
- Irrigation projects in Hot District and Sop Moei District with an area of 3,350 rai value at 7.76 million baht
- Annual fishery benefits in Lower Yuam Reservoir value at 0.41 million baht

**Annual environmental impacts 65.71 million baht**

- Loss of wood manufacture 7.59 million baht/year
- Loss of forest value (Non-extractive values) 58.12 million baht/year

**Environmental Impact Assessment of Lower Yuam Dam-Bhumibol reservoir Route**

Lower Yuam Reservoir area is used for water storage discharging to Bhumibol Reservoir. It contains flood area of 3.99 square kilometers at storage level of 142 m. (MSL). From the map scale 1 : 10,000 flood is found in river basin around 1.51 km<sup>2</sup> but the rest is found outside the basin (2.48 km<sup>2</sup>). Therefore, impact is expected due to water storage at Lower Yuam Reservoir only 1,550 rai comparing with total project area of 2,230.62 rai. So the impacts are following as

- Watershed is impacted in 1A, 1B another class which are 935.90, 554.19 and 168.78 rai respectively.
- Conservation forest is impacted about 2,170.82 rai and Economic forest is impacted about 1,003.05 rai.
- Compensation for directly affected group has to be given only for the Lower Yuam Reservoir only 2 Thai citizens and 19 Karen hill tribes are compensated, for a total value of 5.31 million baht.
- Total fish production in project area is approximately 411,967 baht/year.
- Average of 2,184.52 million m<sup>3</sup>/year of water is drained to Bhumibol Reservoir which estimated economic cost about 10,054 million baht.

### Mitigation Plan for Lower Yuam Dam-Bhumibol Reservoir Route

- Reforestation must be done to increase forestry in the area to be 6,500 rai.
- Conservation and Supported about the fisheries
- Water resource must be properly managed by setting up a local administrative body to allocate water and enhance water use efficiency as well as to maintain water quality.
- After completion of fill compaction, pile of top soil will be removed to put on top layer with minimum thickness of 0.5 m. for planting tree.
- Develop and support the sustainable production which does not disturb the environment.
- Compensation cost must be carefully reviewed and considered to be given fairly.
- Set the suitable program to prevent improper sanitation in the area.

### Environmental Impact Assessment of Transmission Line System

Tha Tako-Nakhon Sawan-Tak2 whereas some areas along the transmission line from Tak2-pumping station Sop Ngao 206.5 km. length are under watershed class 1A (3,773 rai) and 1B (338 rai). Conservation forest is impacted about 7,417 rai. Total compensation areas about 1,452.75 rai which are agriculture areas only.

### Mitigation Plan for Transmission Line System

- Reforestation must be done to increase forestry in the sam basin area to be 20,000 rai.
- Curtail right of land owership along the transmission line must be fairly compensated.

### Budget to Environmental Management.

The total budget is 1,252.68 million baht which is dived in two part as following.

(1) The total budget of Lower Yuam River-Bhumibol Reservoir is 818.48 million baht which is composed in environmental cost (462.98 million baht) and civil Engineer cost (355.50 million baht) can be shown in below

Construction period	Budget	Implementation period	Budget
1. Excavated rock management plan	1.00	1. Reforestation Plan and Ecological Rehabilitation	46.93
2. Silt reduction plan	41.77*	2. Construction plan of Forest Protection Unit	8.25
3. Wood removal plan	19.14	3. Soil erosion mitigation plan and water quality monitoring plan	1.0
4. Wildlife mitigation plan	1.56	4. Fisheries and Aquatic Resource Preservation Plan in Reservoir	16.5
5. Wastewater (from labour camps) management plan	2.0*	5. Irrigation agriculture development plan	141.5
6. Transportation management plan	5*	6. Occupation promotion and development plan	7.27
7. Asset compensation and relocation plan	52 (included in civil work 5.31 million bath)	7. Flood mitigation plan (included in telemetering work)	43.5
8. Road construction plan (replacing highway No.105 Ban Sop Ngao-Mae Sariang District)	155.31*	8. Monitoring plan according to preventive and mitigation plans	26.0
9. Natural tourism places development plan	40.0*	9. Public relations plan	7.22
10. Landscape management plan (due to excavated materials)	62.61*	10. Monitoring plan (19)	28.85
11. Public health plan	7.0		
12. Fisheries and Aquatic Resource Preservation Plan in Reservoir	37.00		
13. Agricultural occupation development plan	11.13		
14. Public relations plan	8.14		
15. Monitoring plans (19)	26.59		
16. Monitoring plan according to preventive and mitigation plan	15.9		
<b>Total</b>	<b>491.46</b>	<b>Total</b>	<b>327.02</b>
<b>Grand Total</b>			<b>818.48</b>

Remark : \* included in the construction cost



Total budget for the Transmission Line Development is 434.20 million baht which is composed in environmental cost 214.00 million baht and civil engineer cost (224.20 million baht). Can be shown in below

Unit (million baht)					
Construction period		Budget	Implementation period		Budget
1.	Soil erosion mitigation plan	10.00*	1.	Monitoring plan of surface water quality	1.0
2.	Geology and earthquake mitigation plan	206	2.	Wildlife mitigation plan	2
3.	Forest mitigation plan (wood removal plan)	24.86	3.	Forest mitigation and basin management plan (reforestation)	25.9
4.	Basin management plan (reforestation)	142.8	4.	Land use and agriculture mitigation plan	0.4
5.	Transport mitigation plan	3.5*	5.	Monitoring plan	2.5
6.	Socio-economic mitigation plan	0.70*			
7.	Asset compensation mitigation plan	6.2			
8.	Archaeology mitigation plan	0.2			
9.	Land use and agriculture mitigation Plan	0.8			
10.	Monitoring plan of surface water quality	1.05			
11.	Monitoring plan	7.0			
Total		403.11			31.09
Grand total			434.47		

Remark : \*included in the construction of transmission line

**Economic analysis (discount rate of 12%)**

• Net present value	8,919	million baht
• Economic internal rate of return	15.70	%
• Cost/benefit ratio	1.33	
• Production cost of water	3.27	baht/m <sup>3</sup>

**Project investment costs (including inflation, import duty and interest)**

	43,892	million baht
• Project cost (2005)	36,056	million baht
• Import duty	770	million baht
• Inflation	5,012	million baht
• Interest during construction	2,054	million baht

**Financial analysis (discount rate of 12%)**

- Concession period (excluding implementation period)	30	years
- Net present value	5,116	million baht
- Return on equity	15	percent
- Investment period	11	years
- Water charge	3.93	baht/m <sup>3</sup>

**Investment Plan** The appropriate investment approach to be followed can be that the project should be developed and operated by the private sector. The government has to pay 3.93 baht/m<sup>3</sup> for water charge. The return of equity is 15 percent whereas the net present value is 5,116 million baht (12 percent discount rate). The payback period is 11 years and the concession period is 30 years (excluding implementation period).

# Executive Summary Report of Environmental Impact Assessment Bhumibol Reservoir Inflow Augmentation Project

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***Executive Summary Report of Environmental Impact Assessment  
Bhumibol Reservoir Inflow Augmentation Project***

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***Chapter 1 Introduction***

# Chapter 1 Introduction

## 1.1 Introduction

The abundant natural resources of Thailand make it very much suitable for agriculture. Agricultural products serve not only as national food source but also global food source. The export of agricultural products has been a major source of income for a long time; competitiveness should therefore be strengthened in the future. Chao Phraya Basin is the most important national and global food production source. It comprises 8 major rivers such as : Ping, Wang, Yom, Nan, Sakae Krang, Pasak, Tha Chin and Main Chao Phraya covering an area of 157,925 km<sup>2</sup> or 31 percent of the country. It covers 30 provinces consisting of : 14 provinces in the northern and 16 provinces in the central regions of Thailand. The population is 25.5 million. The irrigation area is 16 million rai. The GDP of the Chao Phraya Basin is 3,480,000 million baht/year, of which 590,000 million baht/year is the income from agricultural sector.

Due to economic growth and increasing population, water demand for different activities is rising. From 1993-1994 and 1998-1999, the annual runoff was low. In January 2005, the capacity of Bhumibol Reservoir was only 4,078 MCM or 42.2 percent of the total capacity. Water use in the dry season in 2005 should therefore be managed and closely monitored to avoid the severe water shortage.

At present, water source of Chao Phraya Basin is Bhumibol Dam and Sirikit Dam with the total reservoir capacity of 16,322 MCM whereas the inflow of both reservoirs is 11,045 MCM/year. Particularly Bhumibol Reservoir has a capacity of 9,662 MCM but the annual average inflow is 5,592 MCM. This amount has decreased compared over the years because of increasing water demand in the Ping Basin, in Chiang Mai and Lamphun Provinces. To store water in Bhumibol Reservoir at its full capacity and manage interbasin water for maximum benefits, water from Salawin's tributaries should be stored in Bhumibol Reservoir.

The water volume of Salawin River and its tributaries e.g. Moei River, Pai River and Yuam River flowing along the boundary of Thailand amounts to 106,000 MCM/year and flowing into Gulf of Martaban amounts to 8,937 MCM/year. 74 percent of the water volume is the unused rainfall. An analysis of water volume and future demand shows that there is still a lot of water available.

The Department of Alternative Energy Development and Efficiency (DEDE) and related state agencies realize the importance of water shortage problem in the Chao Phraya Basin, they therefore try to solve this problem by improving existing projects and developing new water resource projects. However, these measures can only partly solve the water scarcity problem. To have a long-term solution, water availability should be augmented. The development of Bhumibol Reservoir Inflow Augmentation Project can also provide a solution to this problem since Bhumibol Reservoir has a potential for receiving a large quantity of water. The water can be taken from donor basins without constructing a new reservoir. For integrated development, local communities should develop water sources efficiently.



The Department of Alternative Energy Development and Efficiency (DEDE) has realized the importance of solving the present and future water scarcity problem, therefore it has conducted various studies to augment the availability to meet the future demand. During 1994 and 1998, water resources development and irrigation projects implemented by other agencies such as EGAT and RID etc. were reviewed. Later on February 2, 1999, the Cabinet had a resolution to let DEDE (its former name was Department of Energy Development and Promotion prior to bureaucratic reform) conduct the Feasibility study and Environmental impact assessment (EIA).

## **1.2 Bhumibol Reservoir Inflow Augmentation Project**

The study is divided into 2 phases. The first phase is pre-feasibility study where 19 diversion routes from the Salawin River and its tributaries are reviewed. Different diversion methods are sought to solve the present water shortage problem. In addition, it is expected that up to 3,800 MCM/year to be short in the future. There is insufficient water in some routes, and as a result, 4 alternative routes are selected to study in engineering, economic, environmental and social aspects including public participation. The most appropriate route with the annual volume of 3,768 MCM is selected. There are two diversion routes as follows :

- 1) Mae Lama Luang–Bhumibol Reservoir with the annual volume of 2,002.59 MCM. This route is feasible to be developed as the first diversion route due to the Yuam River (local river).
- 2) Moei River–Huai Khanaeng Reservoir–Nam Mae Tuen with the annual volume of 1,765.64 MCM. This route will be developed after the first route since water is pumped from the Moei River, (international river).

The second phase is feasibility study and environmental impact assessment of Mae Lama Luang–Bhumibol Reservoir diversion route. Moreover, an engineering study of Moei River–Huai Khanaeng–Nam Mae Tuen is conducted.

In the feasibility study and environmental impact assessment of Mae Lama Luang Reservoir–Bhumibol Reservoir, preliminary field survey, topographic survey, cross-section survey and geological survey etc. are conducted. The feasible diversion route in engineering, socio-economic, and financial aspects with least environmental impacts is selected. The headwork's location at Lower Yuam Reservoir, the pumping station's location at Sop Ngao Village and diversion route of Ban Sop Ngao-Huai Mae Ngut are major components of the project. During preliminary design, cost estimation, construction planning, feasibility analysis, environmental sampling, financial and economic analysis and environmental impact assessment, (transmission line and mitigation measures), EIA will be conducted in line with the guidelines of the Office of the Natural Resources and Environmental Policy and Planning. To Study Environment Impact Assessment of project Because since some parts of project development area are located in the national forest conservation area, national park as well as watershed class 1A and 1B, Environmental Impact Assessment (EIA) has to be conducted to follow the announcement of the Ministry of Science, Technology and Environment on 24 August 1992. The report must be submitted to the Office Environmental Policy and Planning to approve under the National Environmental Quality Act B.E. 2535. Moreover, project type and size are followed the cabinet resolution on 13 September 1994 regarding to water resources development project that is located in conservation forest and contained more than 200 million Baht of construction cost. As a result, the Bhumibol Reservoir Inflow Augmentation Project is prepared under the criteria stated by the Office of Natural Resources and Environmental Policy and Planning. However, the EIA of Transmission Line Route Development is separated from this report because the transmission line project has to be submitted to another approved committee.

### 1.3 Objective of Environmental Impact Assessment

- 1) To study the existing environmental resource for comparison between without and with the project development despite construction period and operation period.
- 2) To make the data base in Geographic Information System (GIS) for analysis and useful to plan the monitoring program.
- 3) To analysis and evaluate development project to environmental resources.
- 4) To recommendation the mitigation and Environmental Impact mitigation plan. (EIMP).
- 5) To propose the monitoring measures and plans.
- 6) To propose the action plan to alleviate the impact.

### 1.4 Scope of Study

1) The study area incorporates headworks, reservoir, pumping station, access tunnel, access road, the disposal area for materials from tunnel excavation, tunnel inlet and outlet. The study area is located in following three provinces:

- Headwork area on the left bank of the Yuam River in Tha Song Yang District, Tak Province, headwork on the right bank of the Yuam River, reservoir, pumping station and tunnel inlet and outlet in Sop Moei District, Mae Hong Son Province.
- The area with materials from tunnel excavation, access roads, access tunnel and tunnel end in Sop Moei District, Mae Hong Son Province and Omkoi District and Hod District in Chiang Mai Province.

2) The scope of the environmental impact assessment comprises 4 resources aspects: physical resources, biological resources, human use value and quality of life. The details are following:

- Physical Resources consists 10 items such as: climate, air quality noise and Vibration soil resources, surface water hydrology, surface water quality hydrogeology, groundwater quality, geology and seismology, stockyard and disposal area, mineral resources and geological chemistry, soil erosion and sedimentation.
- Biological Resources consists 4 items such as : aquatic ecology, forestry wildlife resources and watershed management.
- Human Use Values consists 8 items such as : transportation water usage, power consumption, mining industry, flood control, land use agriculture and industry.
- Quality of Life Values consists 7 items such as : socio-economic property compensation, resettlement, public health and nutrition, occupational health and safety, historical values and tourism and esthetic values.

Initial study is collecting secondary data and field survey in 29 item. After that will be analysis and evaluated the impact from development project inspit during construction and operation period. And propose the mitigation plan monitoring measurement.

### 1.5 Procedures of Environmental Impact Assessment

The environmental impact assessment includes the following task:

- 1) Collect basic information from agencies concerned to prepare a database which can analyze and link with other environmental resources.



2) Select factors which change according to areas of project components to determine weight criteria of factors and impact degree and to prioritize the significance of environmental impacts.

3) Analyze the collected data and conduct the field survey in various environmental variables of appropriate alternatives. Besides, the survey result will be used together with the project feasibility study.

4) Study project components and construction plans for environmental impact assessment.

5) In case of evacuation and relocation, analyze the evacuation and relocation and prepare evacuation plans and areas.

6) Assess the impacts by forecast or scientific prediction for both with and without project conditions.

7) Prepare recommendations as well as preventive and mitigation measures.

8) Propose preventive & mitigation measures as well as monitoring measures and plans.

## 1.6 Report Component

The report component consists 5 chapter which detail is following :

1) Chapter 1 Introduction includes of project background, rationale and necessary development project, objective and step of environmental impact assessment study.

2) Chapter 2 Project Description consists appearance of project component such as dam, reservoir, pumping station, tunnel, access road, improvement at tunnel outlet, disposal area management, cost benefit analysis and procedure project planning.

3) Chapter 3 Existing environmental resources mention about 4 resources aspects : physical resources, biological resources, human use values and quality of life values and environmental impact assessment consists about criteria of evaluation impact, direction and level of impact, scope of project study and duration time of impact occur. Moreover Mitigation Plan is about the method to alleviate the negative impact and supplementary to positive impact.

4) Chapter 4 Conclusion Study Result of Environmental Impact Assessment in Lower Nam Yuam-Bhumibol Resource Route.

5) Conclusion of Environmental Impact Study of Transmission Line Route.

***Executive Summary Report of Environmental Impact Assessment  
Bhumibol Reservoir Inflow Augmentation Project***

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***Chapter 2 Diversion Route of Lower Yuam  
Reservoir - Bhumibol Reservoir***

## Chapter 2

### Diversion Route of Lower Yuam Reservoir - Bhumibol Reservoir

The Bhumibol Reservoir Inflow Augmentation Project is divided into 2 phases :

- Phase 1 Pre-feasibility Study and Initial Environmental Examination (IEE) of the diversion alternatives studied by DEDE and agencies involved. Additional potential routes are also studied. In total, there are 19 diversion routes which are prioritized and the most feasible line with least environmental impacts is composed two routes, Diversion Route of LamaLueng Reservoir-Bhumibol Reservoir and Diversion Route of Mae Num Moei-Huai Khanaeng Reservoir-Mae Tun, with total average annual diverted flow 3,768.23 MCM per year. These are pumping in Nam Yuam and Nam Moei, respectively to Bhumibol Reservoir during rainy season. The Diversion Route of LamaLueng Reservoir-Bhumibol Reservoir was selected to be studied in the second phase.

- Phase 2 Feasibility Study and Environmental Impact Assessment of the selected diversion route from phase 1. i.e. the Diversion Route of Lama Lueng Reservoir-Bhumibol Reservoir. Additional Study included field survey, topographic survey, geological survey and boring test river, cross-section survey, type flow in tunnel and study management of maximum high water level in outlet which are composed engineer, economic environmental and social. Conclusion the route studied in feasibility and Environmental Impact is the diversion route of Lower Yuam Reservoir - Bhumibol Reservoir passes through Sop Moei District, Mae Hong Son Province and Om Koi District and Hod, Chiang Mai Province. The project comprises Lower Yuam Dam, Ban Sop Ngao Pumping Station transmission lines, diversion route of Ban Sop Ngao Pumping Station to Bhumibol Reservoir and local project development etc. The project topography is shown in **Figure 2-1**.

#### 2.1 Project Features

1) **Dam and appurtenant structures** consist of major components as follows :

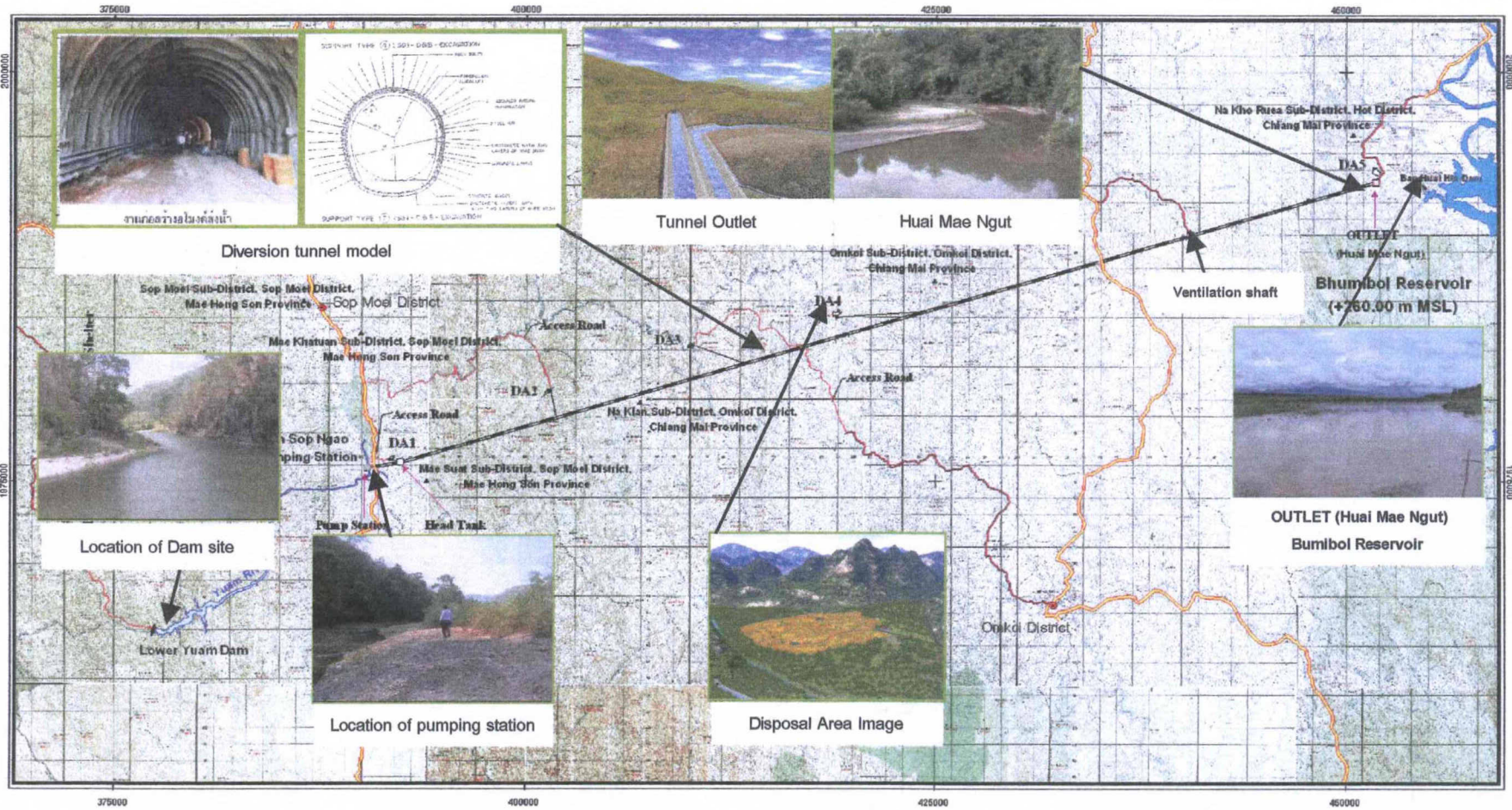
(1) **Lower Yuam Dam** is located on the Yuam River, 12 km. upstream of its confluence with the Moei River in Sop Moei District, Mae Hong Son Province to store water and divert water into Ban Sop Ngao Pumping Station. It is a concrete faced rockfill dam. Its normal water level is +142.00 m. MSL and low water level is +137.00 m. MSL. The dam is 69.50 m. high and 200 m. long with a crest level of +144.50 m. MSL and storage capacity of 80.8 MCM. The layout of Lower Yuam Dam and its appurtenant structures is shown in **Figure 2-2**. The longitudinal-section along the center line of dam is shown in **Figure 2-3**. Some part of reservoir area is locate in Watershed class 1 B shown in **Figure 2-4**

(2) **Spillway** has three radial gates, each 14 m. wide and 15 m. high. Its total length is 42 m. The flood discharge for return period of 10,000 years is 4,970 m<sup>3</sup>/sec.

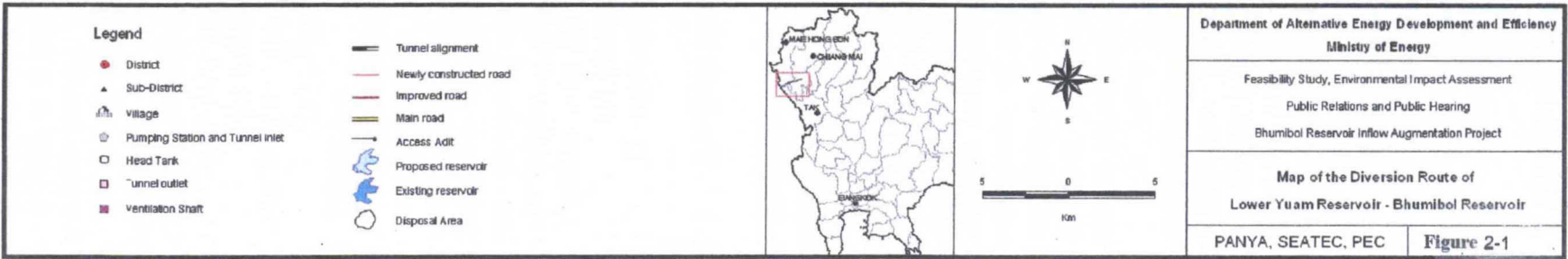
(3) **Powerhouse** is situated on the right bank downstream from the dam. It is 12 m. wide and 58 m. long. The design discharge is 17.56 m<sup>3</sup>/sec and design head is 57.8 m. The installed capacity is 2 x 4.3 MW. The average annual energy production is 41.68 GWh.

(4) **Sediment trap** is located on the Yuam River, 500 m. above Ban Sop Ngao Pumping Station. It is a concrete weir. The canal bed measures 40 m. in width and 75 m. in length. It is designed to trap sediment before discharging into pumping stations. The sand is discharged through a pipe with 1.0 m. in diameter and 21.5 km. in length into the downstream of Lower Yuam Dam.





2-2

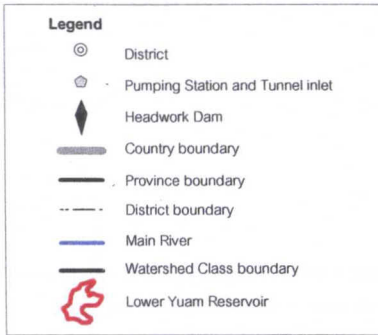
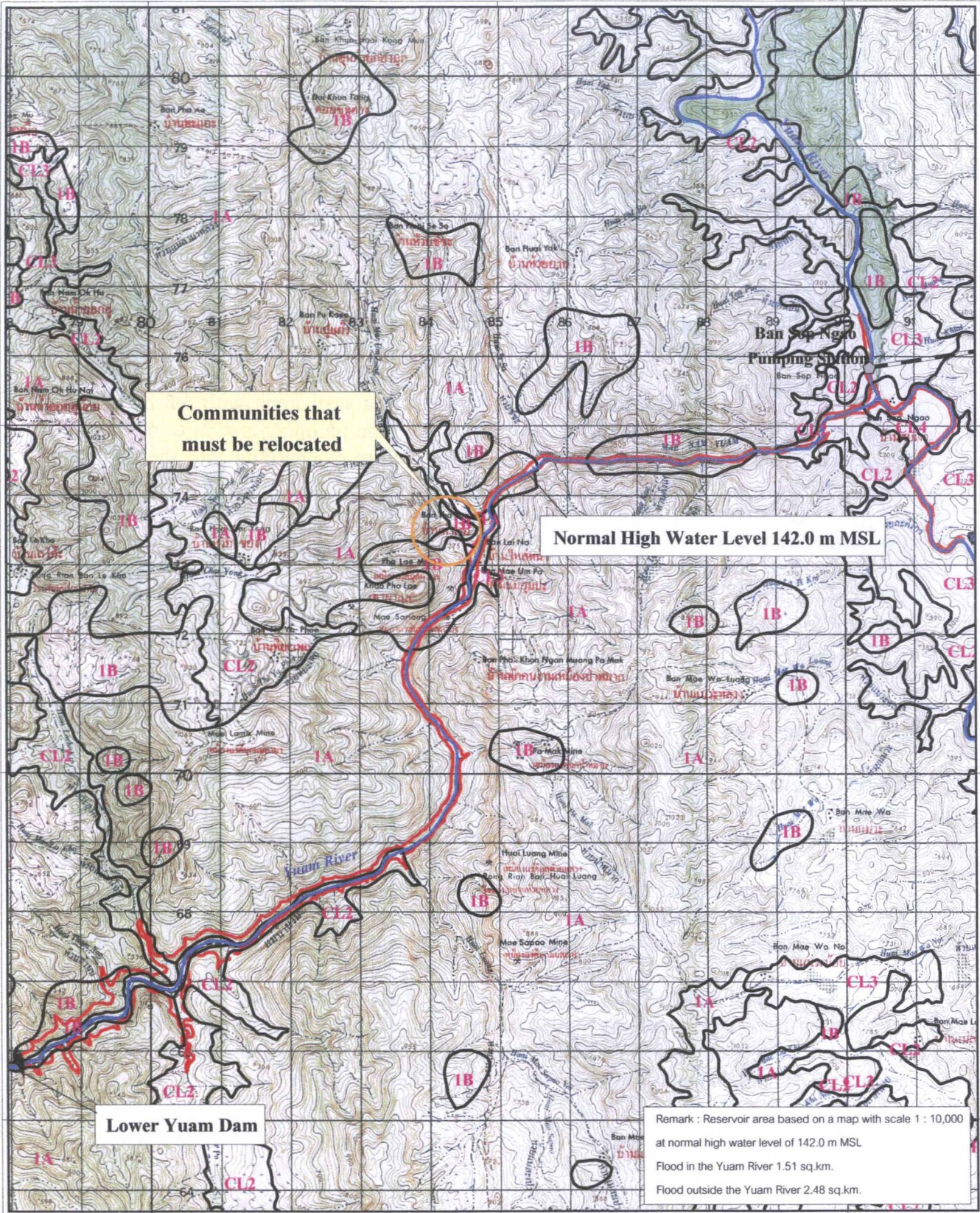












Department of Alternative Energy Development and Efficiency  
 Ministry of Energy

Feasibility Study, Environmental Impact Assessment  
 Public Relation and Public Hearing  
 Bhumibol Reservoir Inflow Augmentation Project

**Map of Flood Area at  
 Normal High Water Level of 142.0 m MSL**

**PANYA, SEATEC, PEC** Figure 2-4



**2) Diversion system** comprises Ban Sop Ngao Pumping Station, pressure conduit, head tank, diversion tunnel and Mae Ngut improvement. The main components of the diversion system can be summarized as follows :

**(1) Ban Sop Ngao Pumping Station** Its structure is reinforced concrete, situated on the left bank of Yuam River at Ban Sop Ngao, Sop Moei District, Mae Hong Son Province. The structure is buried deep at the required level to pump water. It is constructed by open-cut and backfilled. It is 45.16 m. wide, 109 m. long and 40.7 m. high. Six pumps are installed with the capacity of 30.42 m<sup>3</sup>/sec. each and maximum diversion water of 182.52 m<sup>3</sup>/sec. An average annual volume of 2,184.52 MCM. of water is pumped from the reservoir via the approach channel and pumping station to pressure conduit. The cross-section of the intake structure of pumping station is shown in **Figure 2-5**.

**(2) Pressure conduit and head tank** It is a steel lined with 6.8 m. internal diameter and 1,822.79 m. length. It takes water from the pumping station to store in the head tank of 34 m. diameter and 25.5 m. height before discharging into the diversion tunnel.

**(3) Diversion tunnel** It starts from the head tank structure, straight-lined to the northeastern direction via high mountains in the north of Omkoi District, Chiang Mai Province. The outlet is at Huai Mae Ngut, Ban Mae Ngut, Na Kho Ruea Sub-district, Hot District, Chiang Mai Province, upstream of Bhumibol Reservoir. The first section of tunnel is concrete-lined, horseshoe-shaped and excavated by drill & blast methods. Its internal diameter is 8.3 m. and its length is 33.4 km. The second section of tunnel is concrete-lined, circular-section and excavated by a Tunnel Boring Machine (TBM) with 8.4 and 9.1 m. internal diameter and 2.29 and 26.18 km. length, respectively. The total length of tunnel is 61.85 km. as shown in **Figure 2-6**.

The construction tunnel must have 4 adit which located in leftside. It's internal diameter 7.5-10 m. and its length is 11.18 km. These adits were material transportation and increasing Oxygen quantity. Additional, Ventilation shulft is at km. 50+100 by raise-Boring which diameter is 3.6 m. and its depth is 619 m.

**(4) Mae Ngut Improvement** At the tunnel outlet, the water is discharged to Huai Mae Ngut before flowing into Bhumibol Reservoir. Huai Mae Ngut is therefore to be trained to receive the maximum diversion water of 182.52 m<sup>3</sup>/sec. by constructing a 5.2 km. canal lined with rip-rap. Its bed is 10 m. wide and 5 m. deep.

**3) Access Roads** The transportation to each components such as dam and appurtenant structures, pumping station, disposal areas, Ventilation shulft and outlet will be set to use the access roads which are apply the temporary roads and some its will be the new road. Distinguishable shown in **Table 2-1**.



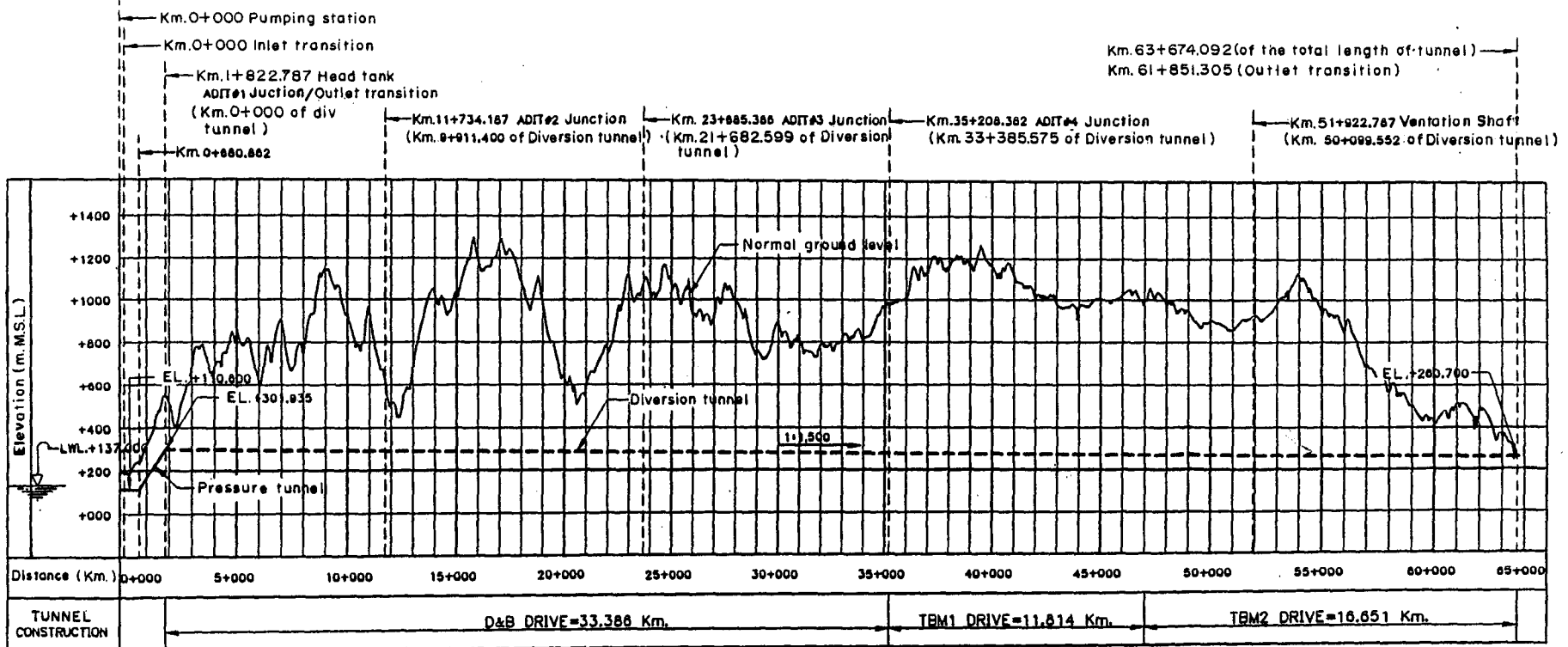


Figure 2-6 Longitudinal Profile of the Diversion Tunnel of Lower Yuam Reservoir - Bhumibol Reservoir



**Table 2-1 Show type and length of access road**

List	Access road arrived to	Length (km)	
		Apply the temporary roads	New roads
1	Dam and Appurtenant structures	28.00	7.00
2	Pumping station	-	0.80
3	Adit 1	-	1.10
4	Adit 2	-	18.50
5	Adit 3	22.30	14.50
6	Adit 4	-	13.00
7	Ventilation shuft	8.9	-
8	Outlet	2.40	6.6
Total		61.60	61.50

**4) Disposal Area :** The total quantity of material from tunnel excavation are 5.56 MCM. Which show detail in **Table 2-2**. The plan is located the five disposal areas which is shown in **Figure 2-1**.

**Table 2-2 The Location of Disposal Area**

Disposal area	Material from	Locate		Area (m <sup>2</sup> )	Quantity (m <sup>3</sup> )
		N	E		
DA.1	Head tank-Pressure conduit Adit No.1	1,976,415	391,166	36,800	425,866
DA.2	Tunnel km 0+000 to km 16+900 Adit No.2	1,980,486	401,277	47,600	701,387
DA. 3	Tunnel km 16+900 to km 27+400 Adit No.3	1,983,236	410,000	56,000	1,014,728
DA. 4	Tunnel km 27+400 to km 45+200 Adit No.4	1,985,230	418,820	96,000	1,662,550
DA. 5	Tunnel km 45+200 to 61+850	1,993,860	451,860	137,080	927,155

## 2.2 Transmission Lines System

Water diversion routes of Lower Yuam Reservoir–Bhumibol Reservoir and Moei River–Nam Mae Tuen jointly use the transmission line from Tha Tako Substation to Nakhon Sawan, Tak 2, Moei Pumping station and Ban Sop Ngao Pumping Station for the distance of 420.6 km and it can be summarized as follows :

- Extension of Tha Tako Substation (500 kV) and Tak 2 (230 kV).
- Construction of high voltage station at Moei Substation (500/230 kV) and Ban Sop Ngao Pumping Station (230 kV).
- Construction of 500 kV transmission lines from Tha Tako–Nakhon Sawan for a distance of 48.5 km.
- Improvement of existing transmission lines from Nakhon Sawan-Tak 2 from 230 kV to 500 kV for distance of 163.6 km.
- Construction of 500 kV and 230 kV transmission lines from Tak 2–Moei for a distance of 90.9 km.
- Connection of 230-kV transmission lines from Bhumibol–Nakhon Sawan to Tak 2 Substation for a distance of 2 km.
- Construction of 230-kV transmission lines from Moei–Ban Sop Ngao for a distance of 115.6 km.

## 2.3 Telemetering System

It is a system for measuring and transmitting data via radio aimed at controlling water diversion from Lower Yuam Reservoir to Bhumibol Reservoirs. The telemetering system consists of stations for measuring water level changes and sending the data to the control station. The components of telemetering system include :

- **Master station** is located at Ban Sop Ngao Pumping Station receiving the data measured at all substations. It is a center of data collection and water diversion control.
- **Two remote stations** are located at Lower Yuam Dam and Bhumibol Reservoirs.
- **Repeater station** is located in Omkoi District, Chiang Mai Province. It collects data from substations prior to sending to the master station.

## 2.4 Estimation of Project Investment Costs

The project investment cost (base price in 2005) is 39,868 million baht as detailed in the table below :

Description	Project cost (million baht)
1. General works	606.22
2. Environmental and mitigation plans	676.98
3. Civil works	
3.1 Temporary coffer dam (upstream and downstream)	41.77
3.2 Diversion tunnel during construction	137.34
3.3 Lower Yuam Dam, spillway and river outlet	1,246.73
3.4 Access roads	142.93
3.5 Permanent residential units and offices	12.25
3.6 Rip-rap weir	1.14
3.7 Pumping station	936.25
3.8 Pressure conduit	477.69
3.9 Head tank	30.73
3.10 Surge chamber	0.00
3.11 Diversion tunnel	15,216.02
3.12 Access tunnel	1,591.71
3.13 Mae Ngut Improvement	310.12
3.14 Excavated materials management	62.62
<b>Total (3)</b>	<b>20,207.31</b>
4. Irrigation Projects	16.65
5. Telemetering system	43.50
6. Hydraulic equipments	1,625.16
7. Electro-mechanical equipments	3,951.10
8. Transimission line system	7,441.70
<b>Total (1 to 8)</b>	<b>34,567.19</b>
9. Contingency cost (10%)	3,456.72
10. Administration (2% of item 1 and 3-8)	745.58
11. Engineering consulting services (3% of item 3-8)	1,098.37
<b>Grand total</b>	<b>39,867.87</b>

## 2.5 Project Implementation Plan

The project construction requires the following operations as shown in **Figure 2.5-1** which can be summarized as follows :

1) Project approval for project construction which takes a period of 3 years includes :

(1) Approval of reports e.g. feasibility study report and EIA report for project approval.

(2) Submission of EIA reports and environmental mitigation measures to the Office of the Natural Resources and Environmental Policy and Planning, Ministry of Natural Resources and Environment.

(3) Submission of project proposal for cabinet approval. This step takes approximately one year.

2) Detailed design and tender documentation takes about one year and a half.

3) Project construction bidding takes around 6 months.

4) Project construction comprises Lower Yuam Dam and appurtenant structures, irrigation system, telemetering system and transmission line system etc. It takes around 7 years.

5) Improvement and monitoring of environmental impacts. This step takes 12 years from project construction until the project completion and another 5 years for monitoring.

6) Other activities e.g. 6 irrigation projects development detailed design and project construction. It takes approximately 3 years.

**Figure 2. 5-1 Construction Plan of Diversion Route : Lower Yuam Reservoir - Bhumibol Reservoir**

Activities	Before construction			During Construction							Period of environmental monitoring				
	1st year	2nd year	3rd year	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	1st year	2nd year	3rd year	4th year	5th year
<b>Project approval</b>															
1) EIA approval	█														
2) Government approval		█													
3) Additional investigation and detailed design			█												
4) Project construction bidding				█											
<b>Irrigation Projects development in 6 areas</b>															
1) Two Irrigation projects in Sop Moei District, Mae Hong Son Province		█	█	█											
2) Two Irrigation projects in Khun Yuam District, Mae Hong Son Province		█	█	█											
3) Two Irrigation projects in Mae Ramat District and Mae Sot District, Tak Province		█	█	█											
<b>Project construction and environmental works</b>															
1) General works				█	█	█	█	█	█	█					
2) Temporary construction				█	█	█	█	█	█	█					
• Road access to construction area				█	█	█	█	█	█	█					
• Electricity for construction				█	█	█	█	█	█	█					
3) Improvement and monitoring of environmental impacts				█	█	█	█	█	█	█	█	█	█	█	█
4) Dam and appurtenant structures							█	█	█	█					
5) Diversion Tunnel							█	█	█	█					
6) Transmission line system							█	█	█	█					
7) Irrigation Projects															
• In Sop Moei District, Mae Hong Son Province								█	█	█					
• In Hot District, Chiang Mai Province									█	█					
8) Telemetering system															

## 2.6 Impacts of Water Storage and Diversion to Downstream Bhumibol Reservoir

**1) Impacts on backwater effect of Lower Yuam Reservoir** When water is stored in Lower Yuam Reservoir, the normal high water level may flood the people's agricultural areas of 142 m MSL with reservoir area of 1.51 km<sup>2</sup>. But if water is diverted to Bhumibol Dam, the water level will slightly decrease. At different return periods of flood at Lower Nam Yuam Dam, there are no impacts on the upstream water level of Yuam River.

**2) Impacts on backwater effect of Bhumibol Reservoir** The maximum high water level of 260 m. MSL of Bhumibol reservoir the water level will well up at upstream of affects the people's agricultural areas during the flood season. But in case of water diversion to Bhumibol reservoir has the to be analysed to assure that the above impact will not happen and will not affect the area upstream from the reservoir in Hot District, Chiang Mai Province. The following criteria is set as below;

(1) The rule curve of Bhumibol Reservoir is set without backwater effect upstream

(2) No water is diverted when the water level is in the rule curve.

(3) Currently, the upper rule curve is at +259.0 m. MSL. In the past, it was at +260 m. MSL resulting in flooding at the downstream of Bhumibol reservoir e.g. in 1995 and 2002, the rule curve was reduced to solve that problem.

(4) Due to the Bhumibol Reservoir Inflow Augmentation Project, the water volume in Bhumibol Reservoir had risen to 259 m MSL for 8 times according to 41 years data analysis (the water level reached the normal retention level at of 260.0 m. MSL. twice). The maximum water level will be set at 259.0 m MSL. without backwater effect to the area upstream of reservoir.



***Executive Summary Report of Environmental Impact Assessment  
Bhumibol Reservoir Inflow Augmentation Project***

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***Chapter 3 Environmental Impact Assessment  
Route of Lower Yuam Reservoir-Bhumibol Reservoir***

## Chapter 3

# Environmental Impact Assessment

## Route of Lower Yuam Reservoir-Bhumibol Reservoir

### 3.1 Study Result of Environmental Impact Assessment (EIA)

EIA will be conducted in line the guideline of the office of the Natural Resource and Environmental Policy an Planning B.E.2541. The scope of study, which are collected the secondary data, survey the existing environmental resource. After that analysis the existing environmental and overlay the project area. Finally, evaluated between existing environmental and project acting both in construction period and operation period. Which shown in **table 3-1** Significant impact of each factor can be summarized as follows :

- **Air quality, noise, and vibration** Air quality had been tested at the dam site and tunnel route to analyze the Total Suspended Particle (TSP) average 24-hour and Particulate Matter smaller than 10 micron (PM-10) average 24-hour. There are 6 sampling station covering 3 days consecutively. The results revealed that all 6 stations contained good air quality and under the standard. TSP was in the range of 0.025-0.144 mg/cu.m. comparing to the standard of air quality of 0.33 mg/cu.m. PM-10 was in the range of 0.015-0.086 mg/cu.m. comparing to the standard of air quality of 0.12 mg/cu.m.

Noise level had been tested in the same area as air quality sampling in 6 stations. The result revealed that noise level was in the range of 36.1-49.4 dB (A) which much more lower than the standard of noise level (70 dB (A)). Vibration is also conducted in the same area and the results revealed that the level was under the standard of Reichster and Meister as well as DIN 4150. During construction, the project process will affect the air quality in 2 parts; (1) preparing the area for tunnel excavation explosion. The quantity of dust can be calculated based on the US. EPA (1997) study and on the hypothesis that the area of tunnel excavation will be opened within 1 hour after completion and one explosion lasts for not over 1 minute. It is found that the distance of 152 m is downstream of the wind with dust density  $900 \mu\text{g}/\text{m}^3$ . In the construction area, no community is living nearby at least in the radius of 1 km. As a result, the impact is low and it lasts only for short period; (2) in the excavation and transport steps, the calculation of dust density is in the range of  $27\text{-}60 \mu\text{g}/\text{m}^3$ , not over the dust standard range of  $330 \mu\text{g}/\text{m}^3$ . Regarding noise and vibration, it will be only temporary disturbance because the construction is mostly carried out under ground at 80-1,000 m depth. The construction area is a long path not covering wide space resulting in low and short duration impact.

- **Soil Resources** will be loose at all project components such as Dam Site, Lower Yuam Reservoir, Tunnel Entrance and Exit, Pumping Station and Disposal Area containing 2,230.62 rai (exclusive of Nam Yuam Flood Area of 943.75 rai). Since the area is located in complexity of soil and mountainous area, the suitable soil in this area is not supported for agricultural activity due to lack of nutrient so impact is low level.

- **Disposal Area** can be divided into each area as follows:
  - Lower Yuam Reservoir is utilized rock and sand for construction of dam and associated buildings in Mae La Ma Luang and Yuam River. After testing of specific gravity, absorption, soundness and organic impurity, this area is supported for concrete mixing under ASTM C-33 standard.

**Table 3-1 Shown the level impact on environmental resource in Bhumibol Reservoir Inflow Augmentation Project**

Item	Construction Period				Operation Period			
	High	moderate	Low	none	High	moderate	Low	none
1 Physical Resources								
1.1 Climate			●					●
1.2 Air quality noise and Vibration			●					●
1.3 Soil			●			■		
1.4 Surface water hydrology				●		■		
1.5 Surface water Quality			●				●	
1.6 Hydrogeology/ground water quality			●				●	
1.7 Geology and Seismology			●				●	
1.8 Stockyard		●					●	
1.9 Mineiral resource and geological chemistry				●				●
1.10 Erosion and Sedimentation				●			●	
2 Biological Resources								
2.1 Aquatic ecology and fisheries		●				■		
2.2 Forest		●					■	
2.3 Wildlife		●					●	
2.4 Watershed management		●					●	
3 Human Use Values								
3.1 Transprotation			●					●
3.2 Water Usage				●	■			
3.3 Power consumption				●			●	
3.4 Mining Area				●				●
3.5 Flood control			■				■	
3.6 Land use				●				●
3.7 Agriculture			●			■		
3.8 Industry				●		■		
4 Quality of Lite Values								
4.1 Socio-economic		■				■		
4.2 Property Compensation			●					●
4.3 Human resettlement			●					●
4.4 Public Health and nutrition			●				■	
4.5 Occupational Health and safety			●					●
4.6 Historical Values				●				●
4.7 Tourism and Aesthetic Values				●		■		

- Negative
- Positive impact

**Level of Impact**

- 1) **Negative Impact** considers about severity, direction and annoyance to people both direct and indirect which composes of 3 levels as follows:
  - **Low impact** means that project development makes some temporary changes to the area and the damage is found in limited area and time. Environmental condition can be recovered to normal condition
  - **Medium impact** level means that project development makes some clearly changes to the area and the damage is found clearly limited area and time. Environmental condition can be changed to over the standard but it can be recovered
  - **High impact** level means that project development makes clearly changes to the area and the damage is found widely area and time. Environmental condition is changed dramatically and the damage is widely occurred in permanent situation.
- 2) **Positive impact** considers to the benefit of project development including 3 levels:
  - **Low impact** level means that benefit is found sometimes and people who receive the benefit are limited.
  - **Medium impact** level means that benefit is found continuously and people who receive the benefit (quality of life) are wider.
  - **High impact** level means that benefit is found permanently and public will be beneficial both provincial and national levels.

- Ban Sop Ngao Pumping Station is composed of soil suitable to use in the project development. After soil test, soil is supported for concrete mixing under ASTM C-33 standard. The reserve material is for from project site about 70 km.

- Tunnel Route composes of Nite rock and sand at Huai Mae Ngut and rock miller is located 30 km. away from project area. After soil test, soil is supported for concrete mixing under ASTM C-33 standard.

From the above areas, soil quality contains similar properties that effects to turbidity in the water but impact is found short and temporary.

- **Surface Water Quality** Surface water investigation and sampling had been done for 16 stations covering 3 seasons at upstream, dam site, reservoir, pumping station, disposal area and tunnel exit (Yuam, Ngao and Huai Mueng). Water condition was generally good to very good condition. Water contained low contamination of organic material, salinity, heavy metal, pesticide and bacteria. Water was run throughout the year and can be used for many activities. Water quality was classified as class 2 announced by the National Environment Board No.8 (B.E. 2537). During construction, topsoil opening will affect to sedimentation flowing to Nam Yuam but the diversion route is prepared to alleviate the impact especially site located in soil bund dividing between up and downstream. Therefore, turbidity and sedimentation are found only short period and temporary impact.

- **Aquatic ecology** Soil surface opening affects water quality and will further continuously extend to aquatic ecology. Project areas don't have rare species and endangered species, which were classified base on the criteria of International Union of Conservation of Nature and Natural Resource (IUCN) in, 2004. But the soil surface opening at the headwork which will bring about turbidity and sediment impact derived from the construction will be limited only in the area of dyke, inclusive of water quality preventive measures available in the community. So, the aquatic ecology impact will be at medium level.

- **Forest** project components are mainly located in mixed deciduous forest so timber volume will be loose around 19,522 cubic meters and cost 195 million Baht. Direct and indirect loss of forest ecology is 2,170.82 rai located in conservation forest mostly situated in dam site and reservoir (1,722.56 rai) so impact is moderate and takes long term.

- **Wildlife** construction activities including higher traffic volume and noise annoyance will disturb wildlife in the forest negatively. There are 106 species living in limited area and 18 species living in waterway/creek. However, around 30 species will be found benefit from project development. Around 113 species are adaptable to the new environment. Environmental mitigation measure is prepared to alleviate problem so impact is moderate.

- **Watershed Management** Project components are mainly located in watershed class 1A, 1B and 3. Lower Nam Yuam Reservoir is mainly located in watershed class 1A (762.17 rai) followed by class 3 (732.28 rai) and 1B (503.52 rai). Other components are found located at every watershed area. Field investigation was done by soil sampling for 34 stations located in sub river basin. Soil characteristic was mostly (52.9 %) dominated by sand loam which contained good water drainage property. However, soil nutrient (potassium, phosphorus, calcium and magnesium) was quite low but organic matter was found in high level. From the calculation of soil erosion (USLE equation), we found average sedimentation of river basin was around 6.38 tons/rai so severity of soil erosion was moderate. During construction, tree will be logged permanently to serve project area so abundance of the forest will be reduced. Therefore, watershed area will inevitably impact especially watershed class 1A and 1B around 1,011.35 rai mostly located in dam site and reservoir area or around 826.93 rai so



environmental mitigation measure must be established to reduce problem. Impact regarding to watershed management is moderate.

- **Transportation** There are 4 transportation routes located nearby the project components to serve the activity. Route number 105 is located near Yuam Pumping Station. Route number 1012 is located near tunnel exit. Route number 1099 serves disposal area 3 and 4. Route number 1194 links to the dam site. Not all transportation routes will be impacted from project development because the activity will not disturb the route. According to the Highways Department (2003), traffic count was done at every routes and the V/C Ratio calculation was between 0.02-0.09% on the route number 105, 1012, 1099 and 1194. Therefore, traffic volume on the road was fast flowing because the Highways Department stated that V/C Ratio shall not be over 80%. During construction traffic volume will be increased due to timber, construction material, worker and equipment transferring so accident is prone to be found. However, village is located scatter so transportation impact is low level. Mitigation shall be considered about large material transferring and public relations to announce people about transferring activity.

- **Socio-Economic** Their career were mainly in agricultural section such as rice field and animal tending. Problem of people was lack of harvested land, inefficiency of transportation and flood situation. Positive thinking about project development was better transportation route and stability of power supply. However, they felt anxiety about relocation and loss of harvested area. At downstream of Yuam River to Moei River was not found any community. During construction will be found positive effect regarding to labor force and job opportunity as well as income from higher merchant. Impact in this period is positive moderately.

- **Property Compensation** there are 21 households located in the Lower Yuam Reservoir area including 2 Thais and 19 Burmese Karen Hill Tribe. The other only 4 Thais households will be loss of agricultural area. Property compensation is totally 5.31 million baht composing of (1) residential-harvested area for 1.096 million baht (2) structural cost for 3.87 million baht and (3) Perennial tree for 0.346 million baht. Since compensation will be done fairly, impact is negatively low level.

- **Human Resettlement** in case of resettlement, right hand side of Nam Yuam conservation forest (100 m. away from the old area) is recommended because the area is being invaded for agricultural area by Ban Tha Ruea Village. However, security reason must be concerned so provincial or district office shall be participated. Therefore, impact to 21 households is low level.

- **Public Health** from the investigation both donor and receiving areas, study area is at risk for Malaria, Hemorrhagic Fever, Japanese Encephalitis and Elephantiasis because mosquito (disease carrier) is found in every area. During construction, worker will be lived in the area and bad sanitary of the camp could be the source of pandemic. Therefore, project development has to find suitable mitigation measure to stop disease dispersion. Impact regarding to public health is low and short time.

- **Occupational Health** during construction, main impact regarding to safety of worker is about excavation work and tunnel explosion so project developer has to find suitable mitigation measure to alleviate impact. Impact is low and temporary.

## 2) Impact During Operation Period

- **Aquatic Ecology** fisheries resources will be found higher because surface water in the reservoir will be increase or around 0.4 million baht.

- **Water Usage** the Bhumibol Reservoir Inflow Augmentation Project will increase water quantity to Lower Chao Praya Basin so water management under the Bhumibol

Reservoir will be 2,184.52 million cubic meters so quality of life and productivity will be better. If calculated from opportunity cost for water increase around 751 million cubic meters at 8.29 baht/cubic meters (referred by the Mineral Resources Department), national economic will be increase 6,227 million baht so impact is greatly found positively.

- **Power Consumption** project development has to pump water from Lower Yuam Reservoir so power is needed for 1,247.58 million units annually or 1,688.58 million baht so impact is low level because the Electricity Generating Authority of Thailand plans to build the transmission line from Tha Ta Ko District of Nakorn Sawan Province to Sop Moei District of Mae Hong Son Province to support project development.

Moreover, the Bhumibol Reservoir Inflow Augmentation Project considers developing hydropower at Lower Yuam Reservoir for 2x4 .3 megawatts so power will be generated 41.68 million units or around 70.86 million baht annually. Bhumibol dam can be produced more power due to higher water level around 516 million kilowatts-hour/year calculated from the alternative cost approach which gas turbine consumes diesel of 3.60 baht/unit or 979 million baht/year.

- **Agriculture** project development will be beneficial due to water supplying to agricultural area of Lower Ping and Main Chao Praya Irrigation Area. Therefore, irrigation will be increased 0.85 million rai during dry period or around 2,769 million baht (412 million baht from Lower Ping Irrigation Area and 2,357 million baht from main Chao Praya Irrigation Area). Moreover, value added will also be found such as higher productivity so positive impact is found moderately.

- **Industry** since water supply will be expanding, industrial section will also be increasing especially the food processing industry. Therefore, agricultural produce will be added value so impact is found moderately positive.

- **Socio-Economic** donor area is beneficial because the Bhumibol Reservoir Inflow Augmentation Project will develop the irrigation area at tunnel entrance area (2,250 rai) and exit area (1,100 rai) so local economic will be expanded 7.76 million baht/year. Moreover, many disasters such as flood situation in Yuam and Moei River Basin in Mae Hong Son and Tak Province will be found positively. At receiving area will be positive impact as well due to increase of irrigation area. Labor which contains 4.97 million people-day will not immigrate to find the job in urban area. Moreover, people in 16 provinces in the central region will be beneficial from project operation. Chao Praya River will contain stable water current. Therefore, positive impact is found in moderate level.

- **Public Health** project development will be positive impact to public health aspect because of higher fish for feeding people. However, the operation of the Bhumibol Reservoir Inflow Augmentation Project will support mollusk dispersion. Impact regarding to public health is low level.

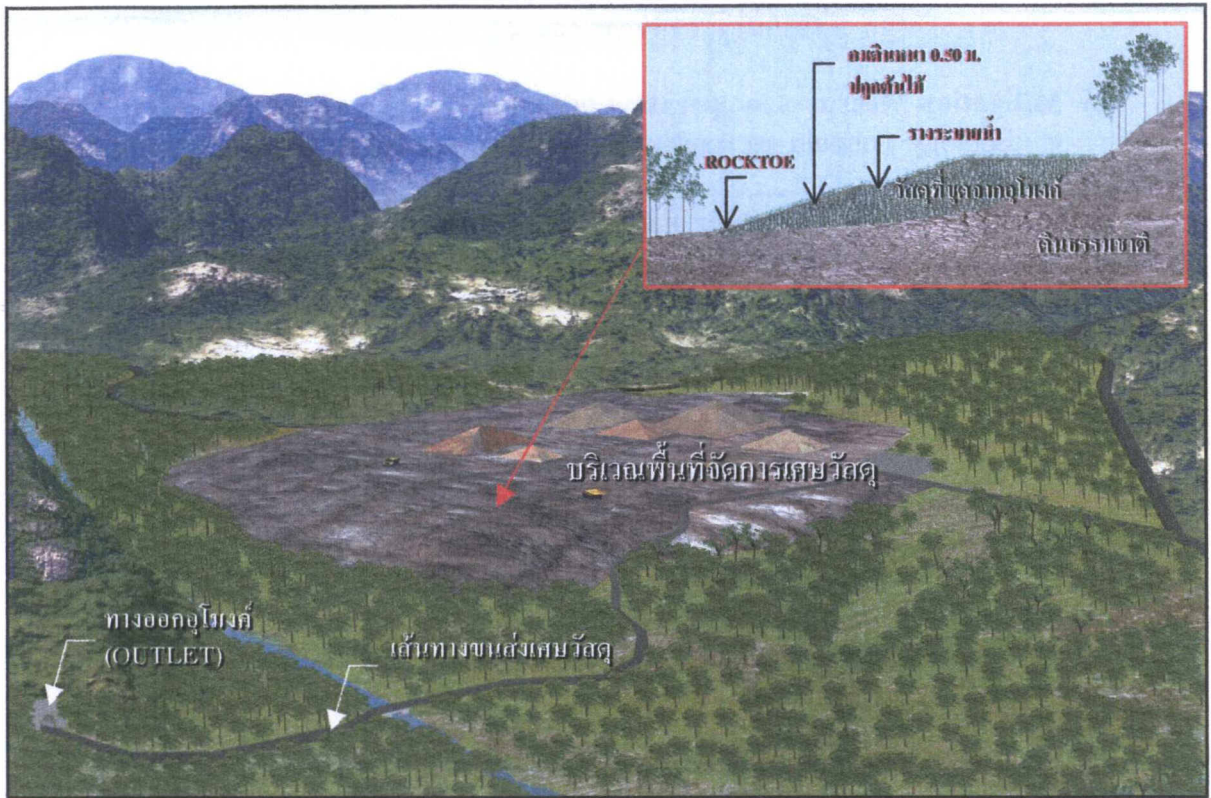
- **Tourism** Lower Yuam Reservoir will make the area more attraction and abundance so recreational area and facility can be provided surrounding the reservoir. In addition, nearby area is found some tourism activities such as boating at Nam Ngao so local people will be beneficial from project development due to higher income from tourism industry.

## 3.2 Mitigation Measures

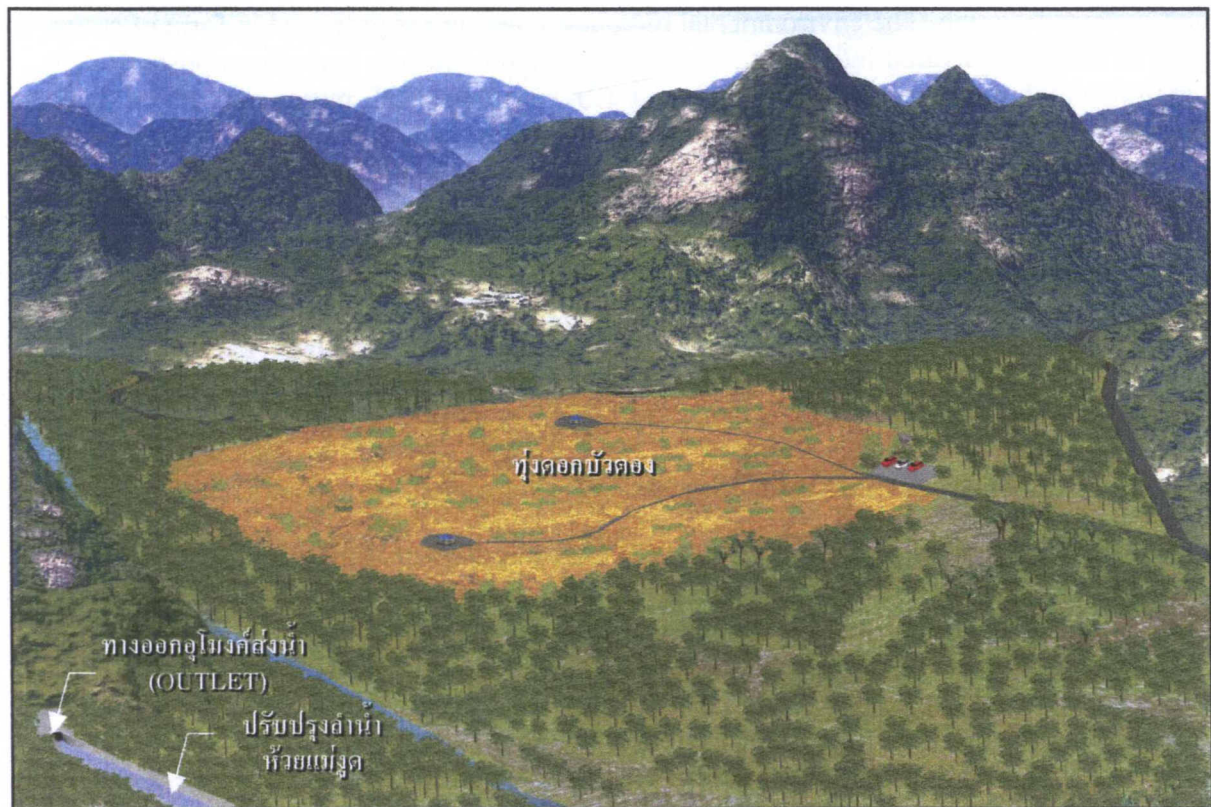
### 1) Mitigation Measures in Construction Period

- Air quality noise and vibration; Protection particle to distribute in construction area and transportation by every methods ex. Spray water regularly, maintenance the engine to suitable for working and the least ventilation of air pollution.
- Soil : To avoid construction in rainy season and cut trees so they fall away from water courses and within the clearing boundary. After that rehabilitate plantation back to pre-construction conditions.
- Surface water : To carry on the mitigation measures as same as the soil resource. Because the impact will be related together. In addition should be primary water treatment from labor camp before drainage to surface water and to avoid lay the material or toilet near surface water more than 50 meters.
- Ecology : To carry on the mitigation measures as same as the soil resource and surface water. Because the impact will be related together.
- Forest : Clear the minimum amount of project boundary. Reforestation should be carried out to rehabilitate to forests in two times the amount. To improve the protection and preserve authority for checking and monitoring the forest's areas in the up stream of Nam Yuam Reservoir.
- Wildlife : should be initial cutting the forest in water's edge and should be clearing follow to the contour line. Before to store water, should be checking to help and move the wildlife in reservoir's area.
- Watershed management : To carry on the mitigation measures as same as the forest. In addition should be conservation soil and water in the process.
- Excavated materials management : Due to tunnel boring, excavated materials should be managed by landscaping or plantation (trees are planted in the same condition of the former area or local plants are grown as shown in **Figure 3-1** and **3-2**).
- Transportation : Limit the weight of truck and restrict speed and excessive acceleration on the road. Inform to community about the process and stand-by the route for use in the construction period, During construction period and after that should be maintenance the road which used carrying the material
- Socio-economic : To make an exception the community which received the impact, can harvest before construction. First priority to consideration affected people for working in project.
- Property compensation : Assets compensation should be fairly and immediately paid. There should be a meeting among effected people.
- Resettlement : In order to be able to finalize the resettlement scheme at the earliest possible period and consult the province and army for security. So that find the resettlement area couldn't far from the old area for adaptation. In the resettlement area should be have public utility equal or more than the old area.
- Public health. : Set the labour camp to be hygienic and training to understand about prevent from disease ex. Contagious disease and epidemic etc. Set up the first aid.
- Occupation : In dangerous area should be used the occupational equipment and training to understand how to use and notice label information for stranger "No entry".





**Figure 3-1 3-D illustration of disposal area before land adjustment**



**Figure 3-2 3-D illustration of disposal area after land adjustment**



## 2) Mitigation Measures in operation period

- Ecology : should be conserved and promoted by releasing fish species in lower Yuam Reservoir.
- Water use : The water management committee in lower Chao Phraya Irrigation areas should be set up to allocate water use equitably and efficiently.
- Agriculture : Economic crops plantation with high return as well as crop rotation and soil fertility maintenance should be supported.
- Power : Checking the powerhouse efficiency in downstream of Lower Yuam reservoir.
- Industry : Should be located industry zoning to avoid in upstream
- Socio-Economic : Supporting the Knowledge factor, market in agriculture and non-agriculture.
- Public health : An understanding on consumption, hygiene, sanitation and prevention from water-born diseases eg. intestinal fluke.
- Tourism : The sanitation and environment of reservoir should be monitored to promote tourism.

### 3.3 Environmental Impact Mitigation Plan and Monitoring Plan

Project development will impact to environmental resources both construction and operation period. Therefore, environmental mitigation measure must be proposed to ensure that impact is least impact to the community and level is acceptable. Moreover, project development will be found positively to the local so benefit shall be maximized and sustained growth. The environmental mitigation measure is proposed in form of action plan so budget is divided into 2 parts: construction and operation period composing of (1) environmental monitoring action plan and (2) environmental mitigation action plan. Budget of action plan implementation is 818.48 million baht dividing into environmental work (462.98 million baht) included in construction cost as well as civil work and telemetering system work (355.5 million baht).

#### 3.3.1 Environmental Monitoring Action Plan

Environmental monitoring action plan composes of 19 plans containing total budget of 55,441,600 baht as stated in **Table 3.3-1** dividing into 7 construction plans (26,591,600 baht) and 11 operation plan (28,850,000 baht) as follows:

##### 3.3.1.1 Environmental Monitoring Action Plan during Construction Phase

- 1) Air Quality, Noise and Vibration Monitoring Action Plan as following details:
  - Air Quality Monitoring Action Plan composes of 4 parameters including Total Suspended Particle (TSP), Particulate Matter smaller than 10 micron (PM-10), wind velocity and direction. Sampling must be operated 24-hour continuously for 3 days consecutively. Sampling areas must be in relation to the project construction site from Lower Yuam Reservoir to Ban Mae Ngut Tunnel Exit containing 6 stations as stated in Environmental Impact Assessment (EIA) report. Monitoring plan must be operated throughout construction period (2-7 years). Total budget is 1.69 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

3-9

Table 3.3-1 Summary of Budget for Environmental Monitoring Program in Bhumibol Reservoir Inflow Augmentation Project

No.	Plan	Construction Phase (year)							Operation Period (year)										Budget Baht	
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	10		
1	Air Quality, Noise and Vibration	-	300,000.00	300,000.00	300,000.00	300,000.00	1,341,600.00	300,000.00	-	-	-	-	-	-	-	-	-	-	-	2,841,600.00
2	Water Quality	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	-	-	-	-	-	-	-	-	-	-	-	2,800,000.00
3	Aquatic Ecology	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	-	-	-	-	-	-	-	-	-	-	-	2,800,000.00
4	Forest	200,000.00	200,000.00	200,000.00	200,000.00	200,000.00	200,000.00	200,000.00	-	-	-	-	-	-	-	-	-	-	-	1,400,000.00
5	Wildlife	170,000.00	170,000.00	170,000.00	170,000.00	170,000.00	170,000.00	170,000.00	-	-	-	-	-	-	-	-	-	-	-	1,190,000.00
6	Transportation	1,680,000.00	1,680,000.00	1,680,000.00	1,680,000.00	1,680,000.00	1,680,000.00	1,680,000.00	-	-	-	-	-	-	-	-	-	-	-	11,760,000.00
7	Socio-economic in construction phase	600,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	300,000.00	-	-	-	-	-	-	-	-	-	-	-	2,400,000.00
8	Public Health (inclusive in construction work)	200,000.00	200,000.00	200,000.00	200,000.00	200,000.00	200,000.00	200,000.00	-	-	-	-	-	-	-	-	-	-	-	1,400,000.00
9	Stockyard	-	-	-	-	-	-	-	250,000.00	250,000.00	250,000.00	250,000.00	250,000.00	-	-	-	-	-	-	1,250,000.00
10	Water Quality	-	-	-	-	-	-	-	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	4,000,000.00
11	Erosion and Sedimentation	-	-	-	-	-	-	-	250,000.00	250,000.00	250,000.00	250,000.00	-	-	-	-	-	-	-	1,000,000.00
12	Flood (inclusive in operation work)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13	Aquatic Ecology and Fisheries	-	-	-	-	-	-	-	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	400,000.00	4,000,000.00
14	Forest	-	-	-	-	-	-	-	8,500,000.00	500,000.00	500,000.00	500,000.00	500,000.00	-	-	-	-	-	-	10,500,000.00
15	Wildlife	-	-	-	-	-	-	-	250,000.00	200,000.00	200,000.00	-	-	-	-	-	-	-	-	650,000.00
16	Water Usage	-	-	-	-	-	-	-	150,000.00	150,000.00	150,000.00	150,000.00	150,000.00	-	-	-	-	-	-	750,000.00
17	Public Health	-	-	-	-	-	-	-	800,000.00	200,000.00	800,000.00	200,000.00	800,000.00	200,000.00	200,000.00	800,000.00	-	-	-	3,800,000.00
18	Resettlement	-	-	-	-	-	-	-	-	-	300,000.00	300,000.00	300,000.00	-	-	-	-	-	-	900,000.00
19	Socio-economic at irrigation	-	-	-	-	-	-	-	500,000.00	-	500,000.00	-	500,000.00	-	500,000.00	-	-	-	-	2,000,000.00
Total		3,650,000.00	3,650,000.00	3,650,000.00	3,650,000.00	3,650,000.00	4,691,600.00	3,650,000.00	1,500,000.00	2,350,000.00	3,750,000.00	2,450,000.00	3,300,000.00	1,000,000.00	2,100,000.00	800,000.00	800,000.00	800,000.00	800,000.00	55,441,600.00

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- Noise Level Monitoring Action Plan composes of 3 parameters including average noise level (Leq), maximum noise level (Lmax) as well as day and night noise level (Ldn). Sampling must be operated 24-hour continuously for 3 days consecutively. Sampling areas must be in relation to the project construction site from Lower Yuam Reservoir to Ban Mae Ngut Tunnel Exit containing 6 stations as stated in Environmental Impact Assessment (EIA) report. Monitoring plan must be operated throughout construction period (2-7 years). Total budget is 0.5 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

- Vibration Level Monitoring Action Plan composes of 2 parameters including frequency and Peak Particle Velocity (PPV). Sampling must be operated 24-hour continuously for 3 days consecutively at 2 stations namely Ban Sop Ngao, Mae Suad Sub District, Sop Moei District of Mae Hong Son Province and Ban Tieng Ang, Omkoi Sub District, Omkoi District of Chiang Mai Province. Monitoring plan must be operated throughout construction period (2-7 years). Total budget is 0.66 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

2) Surface Water Monitoring Action Plan composes of 23 parameters as stated by the National Environment Board regarding to surface water quality sampling Number 8. Sampling must be operated covering wet and dry period throughout construction period (1-7 years) containing 7 stations in Yuam, Nam Ngao, Huai Mueng and Bhumibol Reservoir. Total budget is 2.8 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

3) Aquatic Ecology and Fisheries Monitoring Action Plan concern phytoplankton, zooplankton, benthos, fish, aquatic plant and weed sampling. Sampling must be operated covering wet and dry period throughout construction period (1-7 years) containing 7 stations as same area as surface water monitoring in Yuam, Nam Ngao, Huai Mueng and Bhumibol Reservoir. Total budget is 2.8 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

4) Forest Impact Monitoring Action Plan includes filed survey and timber transferring assessment as well as reforestation program for 6,500 rai. Sapling, seedling, survival rate and land use changes are necessary to monitor. Monitoring plan must be operated throughout construction period (1-7 years). Total budget is 1.4 million baht and responsible by the Royal Forest Department as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

5) Wildlife Resources Monitoring Action Plan concerns type, number and abundance of wildlife changes. Study area must be covered reservoir area and its radius of 1 km covering wet and dry period throughout construction period (1-7 years). Total budget is 1.19 million baht and responsible by the Natural Park, Wildlife and Plant Conservation Department as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

6) Traffic Management Monitoring Action Plan includes traffic count at rush hour covering 2 weekdays and 1 weekend consecutively. Accident and road surface must also recorded on the route 105, 1095 and 1012 composing of 8 stations every year throughout construction phase. Total budget is 11.76 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

7) Socio-economic Monitoring Action Plan covers living condition and social situation changes due to loss of house and harvested land. The plan also assists the relocation and career development throughout construction phase every 6 months during the first year of construction and every year during the year later. Total budget is 2.4

million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

8) Public Health and Nutrition of worker Monitoring Action Plan have to follow the requirement of the Ministry of Labor and Social Welfare and implement throughout construction phase. Total budget is 1.4 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

### **3.3.2 Environmental Monitoring Action Plan during Operation Period**

1) Stability of Stockyard Monitoring Action Plan concerns all 5 areas of disposal area especially erosion and landslide problem. Operation must be paid special attention during rainy season. Total budget is 1.25 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency such as Sub District Administration Organization.

2) Surface Water Monitoring Action Plan composes of 23 parameters as stated by the National Environment Board regarding to surface water quality sampling Number 8. Sampling must be operated covering wet and dry period covering first ten years of operation period containing 7 stations in Yuam, Nam Ngao, Huai Mueng and Bhumibol Reservoir. Total budget is 4 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

3) Erosion and Sedimentation Monitoring Action Plan include water sampling to find Total Suspend Solid and Total Solid at upstream and downstream of Lower Yuam Reservoir and Huai Mae Ngut covering 4 stations. Sampling must be done during wet and dry period for the first four year of operation. Total budget is 1 million baht and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

4) Hydrology and Flood Control Monitoring Action Plan cover water current testing via level and telemetering system throughout operation period. Total budget is included in operation budget and responsible by the Department of Alternative Energy Development and Efficiency or assigned agency.

5) Aquatic Ecology and Fisheries Monitoring Action Plan concern phytoplankton, zooplankton, benthos, fish, aquatic plant and weed sampling. Sampling must be operated covering wet and dry period during the first ten years of operation containing 7 stations in Yuam, Nam Ngao, Huai Mueng and Bhumibol Reservoir. Total budget is 4 million baht and responsible by Fisheries Department as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

6) Reforestation Monitoring Action Plan includes filed survey to audit reforestation program surrounding reservoir area. Monitoring plan must be operated every year for the first five year of operation. Total budget is 10.5 million baht and responsible by the Royal Forest Department as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

7) Wildlife Resources Monitoring Action Plan concerns type, number and abundance of wildlife changes. Study area must be covered reservoir area and its radius of 1 km covering wet and dry period for the first five years of operation. Total budget is 0.65 million baht and responsible by the Royal Forest as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

8) Water Usage and Irrigation Monitoring Action Plan cover the Lower Ping and main Chao Phraya Irrigation Area by conducting every year for the first five year of operation. Total budget is 0.75 million baht and responsible by the Department of Royal



Irrigation as main agency and supported by the Department of Alternative Energy Development and Efficiency.

9) Public Health and Nutrition Monitoring Action Plan compose of 4 issues including:

(1) Mosquito Investigation as disease carrier of Malaria, Elephantiasis, Japanese encephalitis and Hemorrhagic Fever by conducting sample in 24 stations spreading throughout donor and receiving area in the third, fifth and seventh year of operation.

(2) Mollusk investigation as disease carrier of Schistosomiasis and Liverfluke or Opisthorchiasis in 12 stations as stated in EIA report every year during wet and dry period of the seven years of operation.

(3) Fish investigation as disease carrier of Schistosomiasis and Liverfluke or Opisthorchiasis as same area of investigation as mollusk every year during wet and dry period of the seven years of operation

(4) Community health by analyzing statistic of water born disease from Health Department and Provincial Public Health Office during the third, fifth and seventh year of operation in the following villages:

- Ban Tha Ruea and Ban Sop Ngao, Mae Suad Sub District, Sop Moei District of Mae Hong Son Province
- Ban Mae Wong, Ban Mae Lok and Ban Tieng Ang, Omkoi Sub District, Omkoi District of Chiang Mai Province.
- Ban Mae Ngut, Ban Huai Hin Kam, Na Kho Ruea Sub District, Hot District of Chiang Mai Province.

Total budget is 3.8 million baht and responsible by the Public Health Ministry as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

10) Resettlement Monitoring Action Plan includes field survey of the new area, public health, agricultural efficiency and career development. The activity must be done every year for the first three years of operation. Total budget is 0.9 million baht and responsible by the Agricultural Economic Office as main agency and supported by the Department of Alternative Energy Development.

11) Socio-economic Monitoring Action Plan in the irrigation area covers living condition and social situation changes due to increase of harvested land during dry period. The plan also seeks recommendation of people about water management scheme. The activity must be done in the first, third, fifth and seventh year of operation period. Total budget is 2.0 million baht and responsible by the Agricultural Economic Office as main agency and supported by the Department of Alternative Energy Development.

### **3.4 Environmental Mitigation Action Plan**

Environmental mitigation action plan composes of 20 plans containing total budget of 763.04 million baht dividing into environmental construction cost (407.54 million baht) as well as civil work and telemetering work (355.5 million baht) as shown in **Table 3.4-1** as follows:

Table 3.4-1 Summary of Budget for Environmental Mitigation Measure for the Bhumibol Reservoir Inflow Augmentation Project (Tunnel Route Part)

No	Plan	Construction (year)							Operation (year)										Budget Million Baht
		1	2	3	4	5	6	7	1	2	3	4	5	6	7	8	9	10	
	Construction Phase																		1.00
1	Rock Management from Tunnel Excavation		0.20	0.20	0.20	0.20	0.20												Included in civil work (41.77)
2	Reduction of Soil Sedimentation during Construction																		0.38
3	Timber Transferring																		16.48
	- Investigation and Marking	0.38																	2.28
	- Transferring	10.00	6.48																19.14
	- Tree Logging	0.00		2.28															
	Sub Total (3)	10.38	6.48	2.28															1.56
4	Wildlife Management					0.52	0.52	0.52											Included in civil work (2.0)
5	Domestic Wastewater Management																		Included in civil work (5.0)
6	Transportation Management																		52 Million Baht (compensation is included in construction of 5.31 million Baht)
7	Compensation and Resettlement Plan	1.00	1.00	30.00	20.00														Included in civil work (155.31)
8	Road Construction to replace the Route Number 105/Ban Sop Ngao-Mae Saneng District																		
9	Tourism Development Plan																		Included in civil work (40.0)
10	Aesthetic and Landscape Management at Disposal Area from Tunnel Excavation																		Included in civil work (62.61)
11	Public Health Plan	1.00	1.00	1.00	1.00	1.00	1.00	1.00											7.00
12	Public Relations Plan	3.42	0.76	0.86	0.54	0.64	0.54	1.38	2.81	1.51	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	15.36
13	Reforestation Plan and Ecological Rehabilitation																		16.25
	- Reforestation								16.25										22.10
	- Maintenance for 5 years									4.42	4.42	4.42	4.42	4.42					8.58
	- Maintenance for 4 years														2.14	2.15	2.14	2.15	46.93
	Sub Total (13)								16.25	4.42	4.42	4.42	4.42	4.42	2.14	2.15	2.14	2.15	
14	Check Point Station Construction								2.00										2.00
	- Equipment								4.00										4.00
	- Construction of Check Point including Facility Installation																		1.25
	- Forest Invasion Investigation								0.25	0.25	0.25	0.25	0.25						1.00
	- Training to raise Awareness about forest preservation								0.20	0.20	0.20	0.20	0.20						
	Sub Total (14)								6.45	0.45	0.45	0.45	0.45	0.45					8.25
	Sub Total (14)								0.20	0.20	0.20	0.20	0.20						1.00
15	Soil Erosion and Water Quality Alleviation Plan																		
16	Fisheries and Aquatic Resources Preservation Plan																		30.00
	- Fisheries Resources Management																		6.00
	- Fisheries Development								2.00	2.00	2.00	2.00							13.00
	- Research about biodiversity in the Yuam River Basin	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00								3.00
	- Distribute Fisheries Type								1.00	1.00	1.00								1.50
	- Assessment								0.50	0.50	0.50								53.50
	Sub Total (16)	1.00	1.00	1.00	1.00	1.00	1.00	31.00	5.50	5.50	5.50								
17	Agricultural Irrigation Development Plan																		21.50
	- Lower Ping Irrigation Area								4.30	4.30	4.30	4.30	4.30						120.00
	- Greater Chaopraya Irrigation Area								24.00	24.00	24.00	24.00	24.00						141.50
	Sub Total (17)								28.30	28.30	28.30	28.30	28.30						
18	Career Development and Promotion																		
18.1	Agricultural Extension																		1.20
	- Support Mixed Type Agriculture	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12								0.12
	- Pilot Demonstration Plot	0.02		0.02		0.02		0.02		0.02		0.02							6.00
	- Support Plant and Aquatic Creatures	1.00		1.00		1.00		1.00		1.00		1.00							0.41
	- Set Up Cooperatives								0.41										0.72
	- Support and Promote Cooperative	0.12		0.12		0.12		0.12		0.12		0.12							1.50
	- Movable Equipment								1.50										6.00
	- Support Fund for Cooperative	1.00		1.00		1.00		1.00		1.00		1.00							0.60
	- Marketing Campaign								0.12		0.12								16.75
	Sub Total (18.1)	2.34	0.24	2.34	0.24	2.34	0.24	2.34	1.87	2.34	0.24	2.22							
18.2	Career Development outside Agriculture																		0.55
	- Information Support	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05							0.55
	- Knowledge and Fund Support	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05							0.55
	- Marketing Support	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05							1.65
	Sub Total (18.2)	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15							18.40
	Sub Total (18)	2.49	0.39	2.49	0.39	2.49	0.39	2.49	2.02	2.49	0.39	2.37							
	Sub Total (18)																		Included in telemetering work (43.5)
19	Flood Mitigation Plan								4.00	4.00	4.00	3.50	3.00	1.50	1.50	1.50	1.50	1.50	41.90
20	Audit the Environmental Mitigation Plan and Monitoring Program	2.70	3.20	1.70	1.70	2.20	2.20	2.20											
	Total	21.99	14.03	39.53	24.83	8.05	5.85	38.59	65.53	46.87	43.63	39.61	36.74	6.29	4.01	4.02	4.01	4.02	407.54

### 3.4.1 Environmental Mitigation Action Plan during Construction Phase

1) Rock Management Mitigation Action Plan from tunnel excavation concerns stockyard management to ensure the durability and stability of the area as well as rehabilitation the area as normal condition. Reforestation must be done to increase forest area and recreational area for the public. Budget is included in civil work. Public announcement to the public contains budget of 1.0 million baht during construction under responsible of the Department of Alternative Energy Development and Efficiency or assigned agency.

2) Soil Sedimentation Reduction from construction work is being done by construction planning and growing small plan covering topsoil. Environmental mitigation measure must be well concerned throughout construction phase of 7 years. Budget is included in civil work of 41.77 million baht and responsible by Department of Alternative Energy Development and Efficiency or assigned agency.

3) Wood Transferring is operated around reservoir area and associated project areas during construction of 3 years. Budget of this section is 19.14 million baht under the responsibility of the Royal Forest Department and Forest Industry Organization and supported by Department of Alternative Energy Development and Efficiency as project owner.

4) Wildlife Resources Mitigation Action Measure concern prevention and forcing wildlife to escape reservoir area for the least impact to fauna resources by operating throughout construction period. Budget of this section is 1.56 million baht under the responsibility of the Mae Ngao National Park and supported by Department of Alternative Energy Development and Efficiency as project owner.

5) Wastewater Mitigation Action Plan concerns about environmental sanitation. Budget is included in civil work including of 2 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner.

6) Transportation Mitigation Action Plan includes the transportation requirement criteria as well as road surface repair throughout construction phase. Budget is included in civil work including of 5 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner.

7) Compensation for relocation and property damage mitigation measure by investigating the area. Working committee must be set up for considering about compensation during the construction phase. Compensation as conducted in the EIA report (2005) is 5.31 million baht inclusive of construction cost. Regarding resettlement scheme, budget is set for 50 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner and Department of Land Development.

8) New route construction to replace the route number 105 (Ban Sop Ngao-Mae Sarieng District) is considered to be created starting from the route number 105 to Pumping station containing 550 m. distance under the Highways Department Standard. The construction must be started prior to construction of pumping station in the seventh year. Budget is included in civil work including of 155.31 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner.

9) Natural Tourism Development Program concerns about landscape decoration to facilitate tourism activity as well as support the public utilities and services during the seventh year of construction. Budget is included in civil work including of 40 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner.

10) Aesthetic improvement at disposal area from tunnel excavation is being developed by construction of recreational area and tree growing with native plant. The activity shall be done during the sixth and seventh year of construction. Budget is included in civil work including of 62.61 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner.

11) Public Health Mitigation Measure concerns to alleviate impact during construction phase such as dust, noise and unexpected accident by following the environmental mitigation measure as stated in EIA report. Budget is included in civil work including of 7 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner.

12) Public Relations Mitigation Measure includes making the clear and good understanding of project development to the local throughout the construction phase. Budget is 15.36 million baht under the direct responsibility of Provincial Public Relations Office and supported by the Department of Alternative Energy Development and Efficiency as project owner.

### **3.4.2 Environmental Mitigation Action Plan during Operation Period**

1) Ecology Rehabilitation Program concerns the reforestation program of 6,500 rai and continuous maintenance for another 10 years. Total budget is 46.93 million baht and directly responsible by the Royal Forest Department as a core and supported by the department of Alternative Energy Development and Efficiency as project owner.

2) Establishment of Forest Protection Agency must be concerned to prevent and protect forest invasion by staff investing the area surrounding the reservoir. The Department of Alternative Energy Development and Efficiency is responsible to support the budget of 8.25 million baht and assign the Royal Forest Department to take care of this matter for 5 years. Then the duty will be transferred to the Royal Forest Department.

3) Soil Erosion and Water Quality Control must be implemented to alleviate environmental impact as well as utilized of soil and water conservation scheme at high slope area. The maintenance must be continuously operated during the first five years of operation. Budget is 1.0 million baht and Budget is included in civil work including of 2 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner.

4) Fisheries Resources Conservation and Development Plant at the Lower Nam Yuam Reservoir must be done by setting up the fisheries development agency and support the fisheries resources conservation. The activity must be done continuously for the first ten years of development (7 years of construction and 3 years of operation). Budget is 53.50 million baht under the responsibility of Fisheries Department as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

5) Agricultural Irrigation Development Plan must be done by establishment of administrative organization to train agriculturist at benefit area and promote the agricultural extension regarding to rice species improvement and demonstration project plan. The activity must be operated continuously for the first five years of operation. Budget is 141.50 million baht under the responsibility of the Agricultural Extension Department as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.



6) Career Development and Promotion shall be done by providing the innovative technology for animal tending and crop farming as well as founding sources. Marketing shall be supported the agricultural goods from the donor and receiving area including 6 Sub District Administration Organization. The activity must be done 10 years of project development (7 years of construction and 3 years of operation). Budget is 18.40 million baht under the responsibility of the Agricultural Department as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

7) Flood Disaster Mitigation Plan aims to control water level and storage at the Lower Yuam Reservoir by coordinating with the Bhumibol reservoir via telemetering system. The activity must be done throughout operation period. Budget is included in civil work including of 43.5 million baht under the responsibility of the Department of Alternative Energy Development and Efficiency as project owner.

8) Environmental Audit aims to investigate the mitigation measure that has been stated in the EIA report and recommends as need. The activity must be done during construction (7 years) and operation period (10 years). Budget is 41.90 million baht under the responsibility of the Office of Natural Resources and Environmental Policy and Planning as core agency and supported by the Department of Alternative Energy Development and Efficiency as project owner.

***Executive Summary Report of Environmental Impact Assessment  
Bhumibol Reservoir Inflow Augmentation Project***

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***Chapter 4 Conclusions***

## Chapter 4 Conclusions

### 4.1 Conclusion of Major Impact

The environmental impact have been conducted in line with DEDE's requirements and EIA report preparation guideline of the office of the Natural Resources and Environmental Policy and Planning. The development of Lower Yuam Reservoir and diversion system leads to the following components and activity, such as

- Construction of dam and appurtenant structures with an area of 83.44 rai.
- A reservoir with an area of 3.99 km<sup>2</sup> or 2,494 rai (1.51 km<sup>2</sup> or 944 rai inundated area in the Yuam River bank, the rest of 2.48 km<sup>2</sup> or 1,550 rai 15 inundated outside the river bank).
- Construction of Ban Sop Ngao Pumping Station in Ban Sop Ngao, Sop Moei district of Mae Hong Son Province with an area of 20 rai.
- Disposal area of 237.64 rai from tunnel excavation
- Access road to construction area of 309.04 rai
- Huai Mae Ngut improvement (10 rai) in Na Kho Ruea Sub-district, Hot district, Chiang Mai Province before discharging to Bhumibol Reservoir.

The development the Bhumibol Reservoir inflow Augmentation Project covered 4 environmental tiers as follows :

#### Construction period

1) Air Quality, Noise and Vibration during project construction, There are two main activities effecting to air quality. The first activity is area preparation for tunnel explosion and excavation. The other activity is excavation and transportation which calculation is found between 27-60 micrograms/cubic meter which is under the standard (330 micrograms/cubic meter). Noise and vibration are low impact because the construction area is very far from community. Additional construction is being operated underground or deeper 80-1,000 m.

2) Surface Water Quality during construction, topsoil opening will affect to sedimentation flowing to Nam Yuam. But the diversion rout is prepared to alleviate the impact especially site located in soil bund dividing between up and downstream. Therefore, turbidity and sedimentation are found only short period and temporary.

3) Forest/Watershed Management.

The project area around 3,173.83 rai which dam site and reservoir areas contain large piece of land. Reservoir area contain 3.99 km<sup>2</sup>. or 2,493.75 rai which is 944 rai flooded floods inside Yuam River Basin (1.51 km<sup>2</sup>.) and outside 2.48 km<sup>2</sup>. or 1,550 rai when there is project development, the conservative forest inside Yuam River will be lose as same. Therefore the project area will be lose the conservative forest around 2,170.82 rai. Which main impact is in dam site and reservoir around 1,639.12 rai (75.5%). The total cost in economic equal 195 million baht. For watershed management is in class 1A and 1B around 1,490.09 rai as same as the main impact is in the dam site and reservoir around 1,305.67 rai (67.6%)

## Operation Period

Since, development the Bhumibol Reservoir Inflow Augmentation Project will average annual diverted flow to Bhumibol Reservoir about 2,184.52 MCM. The benefit will be occurred, as following :

1) Aquatic Ecology : Fisheries resource will be found higher because surface water in the reservoir will be increase or around 0.4 million baht.

2) Agriculture : Project development will be beneficial during dry period in Lower Ping irrigation area 0.157 million rai and main Chao Praya Irrigation area 0.696 million rai. Therefore average agriculture products are increasing about 794,831 ton or total average economic cost is about 2,769 million bath. The benefit return on water quantity is equal 3,248 baht/rai or 1.93 baht/m<sup>3</sup>

3) Water Usages : The Bhumibol Reservoir inflow Augmentation Project will increase water quantity. If calculated from opportunity cost for water increase around 751 million cubic meters at 8.29 baht/cubic meters. (Referred by the Mineral Resources Department), national economic 6,227 million baht.

4) Power Consumption : Bhumibol dam can be produced more power due to higher water level around 516 million kilowatts/hour/year which calculated from the alternative cost approach from gas turbine comes diesel of 3.60 baht/unit or 979 million baht/year. Moreover, the bhumibol Reservoir inflow Augmentation Project considers developing hydropower at Lower Yuam Reservoir for 2x4.3 megawatts so power will be generated 41.68 million units or around 70.86 million baht annually.

## 4.2 Mitigation Plan

- Construction Period
  - Air Quality Noise and Vibration : Protection particle to distribute in constructing area and transportation by every methods.
  - Surface Water : Avoid lay the material or toilet near surface water more than 50 meters.
  - Forest and Watershed management : Clear the minimum amount of project boundary and monitoring deforestation up and downstream of Lower Yuam reservoir.
  - Resettlement : Assets compensation should be fairly and immediately paid on only one paying.
- Operation Period
  - Ecology : Should be conserved and promoted by releasing fish species in Lower Yuam Reservoir.
  - Agriculture : Economic crops plantation with high return as well as crop rotation and soil fertility maintenance should be supported.
  - Water use : The water management committee in lower Chao Phraya Irrigation area.
  - Power : Checking The powerhouse efficiency in downstream of Lower Nam Yuam Reservoir.



### 4.3 Environmental Monitoring Plan

Environmental impacts due to project development can be mitigated by following 20 preventive and mitigation plans and 18 monitoring plans. The total budget is 818.48 million bath comprising environmental construction work for 462.98 million bath and civil and telemetering works for 355.50 million bath.

Unit : million baht			
Construction period	Budget	Implementation period	Budget
1. Excavated rock management plan	1.00	1. Reforestation Plan and Ecological Rehabilitation	46.93
2. Silt reduction plan	41.77 (included in civil work)	2. Construction plan of Forest Protection Unit	8.25
3. Wood removal plan	19.14	3. Soil erosion mitigation plan and water quality monitoring plan	1.0
4. Wildlife mitigation plan	1.56	4. Fisheries and Aquatic Resource Preservation Plan in Reservoir	16.5
5. Wastewater (from labour camps) management plan	2.0 (included in civil work)	5. Irrigation agriculture development plan	141.5
6. Transportation management plan	5 (included in civil work)	6. Occupation promotion and development plan	7.27
7. Asset compensation and relocation plan	52 (included in civil work 5.31 million bath)	7. Flood mitigation plan (included in telemetering work)	43.5
8. Road construction plan (replacing highway No.105 Ban Sop Ngao-Mae Sariang District)	155.31 (included in civil work)	8. Monitoring plan according to preventive and mitigation plans	26.0
9. Natural tourism places development plan	40.0 (included in civil work)	9. Public relations plan	7.22
10. Landscape management plan (due to excavated materials)	62.61 (included in civil work)	10. Monitoring plan (19)	28.85
11. Public health plan	7.0		
12. Fisheries and Aquatic Resource Preservation Plan in Reservoir	37.00		
13. Agricultural occupation development plan	11.13		
14. Public relations plan	8.14		
15. Monitoring plans (19)	26.59		
16. Monitoring plan according to preventive and mitigation plan	15.9		
<b>Total</b>	<b>491.46</b>	<b>Total</b>	<b>327.02</b>
<b>Grand Total</b>		<b>818.48</b>	

### 4.4 Summary of Significant Environmental Impact

The Environmental Impact Assessment Result from the Bhumibol Reservoir Inflow Augmentation Project can be summarized the environmental impact as follows:

1) The activity of Yuam River drainage and its branch to build Lower Nam Yuam Reservoir will be alleviated annual flood situation at river downstream at Ban Mae Suad and Ban Mae Suad Mai, Mae Ka Kuan Sub District, Sobmoei District of Mae Hong Son Province located 10 km away from Ban Sop Ngao Pumping Station. Since the community is situated along the riverbank, it faces flood situation nearly every year. Therefore, the drainage activity will reduce the flood situation.

2) During operation, telemetering system will be installed between Lower Nam Yuam and Bhumibol Reservoir so flood situation will not be found at downstream of Bhumibol Reservoir. There are 21 households affecting from project development composing of 2 Thais and 19 Burmese Karen Hill Tribes. The other 4 Thai households are affected about agricultural area. Total compensation is 5.31 million Baht. Other project components are located in left hand side of Yuam forest and Tha Song Yang forest as well as tunnel route is located underneath the surface at least 80-1000 m so impact to the environment is low level.

3) Lower Nam Yuam Reservoir area is used for water storage before discharging to Bhumibol Reservoir. It contains flood area of 3.99 square kilometers at storage level of 142 m (MSL). From the map scale 1:10,000, flood is found in river basin around 1.51 km<sup>2</sup>. (37 %) but the rest is found outside the basin (2.48 km<sup>2</sup>). Therefore, impact is expected due to water storage at Lower Nam Yuam Reservoir only 1550 rai comparing with total project areas of 2,230.62 rai so impact area is quite low.

4) Water pumping is being done in Yuam River for 8 months (June-January) during rainy season because water is excessive so there is no impact in receiving area. From calculation, water must be stored to preserve ecological balance at least 4.52 cubic meters/second.

5) Disposal area from tunnel excavation is located away from tunnel route less than 1.0 km so environmental impact is quite low level.

6) Tunnel exit to Huai Mae Ngut is located away from Bhumibol Reservoir only 5.2 km and not passed any community.

7) After project completion, tourism and merchant activity in Sobmoei and Mae Sarieng District of Mae Hong Son Province and Hot District of Chiang Mai Province will be better.

8) Local job opportunity and income increase will be found during project construction and operation period.

9) Transmission line route is selected route that is least impact to the environmental and community. Moreover, environmental impact assessment is being done under the guideline stated by the Office of Natural Resources and Environmental Policy and Planning to illustrate and proposed about environmental mitigation measure.

#### **4.5 Next Step for Operation**

Submit the Environmental Impact Assessment Report to the Office of Natural Resources and Environmental Policy and Planning (ONEP) composing of main report, appendices report, executive summary report, action plan for environmental mitigation measure report and feasibility study report to the ONEP (Water Sources Section) to approve and give recommendation to the report before submitting to the National Environment Board and Cabinet Meeting for approval.

***Executive Summary Report of Environmental Impact Assessment  
Bhumibol Reservoir Inflow Augmentation Project***

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***Chapter 5 Environmental Impact Study of  
Transmission Line Route***

## Chapter 5

# Environmental Impact Study of Transmission Line Route

### 5.1 Introduction

The site observation along the selected transmission line route from Tha Tako Substation to Ban Sop Ngao with total distance of 420.6 km showed no sensitive areas including watershed class 1A and 1B along the transmission line from Tha Tako-Nakhon Sawan-Tak2 whereas some areas along the transmission line from Tak2-pumping station Sop Ngao 206.5 km length are watershed class 1A and 1B as well as conservation area. Therefore, Environmental Impact Assessment (EIA) has to be conducted for the transmission line Tak2-Sop Ngao pumping station to follow the announcement of Ministry of Science, Technology and Environment on 24 August 1992.

### 5.2 Existing Condition of Significant Environmental Resources

1) Water quality : The surface water quality is good, which can be used for domestic domestic use, aquatic fauna conservation, fisheries, swimming and water sport.

2) Forestry : The transmission line Tak2-Sop Ngao 206.5 length passes through 141.2 km of conservation forests, 52 km of economic forests and 8.3 km of buffer zones of national reserved forests. There are 3 types of forests found in the study area including deciduous dipterocarp forest, mixed deciduous forest and hill evergreen forest summarizes forest inventory in the project area including forest areas, number and volume of forest trees, and number of bamboos, saplings and seedlings.

3) Wildlife : In the study area crossing over by the transmission line, there are 21 species of amphibians, 34 species of reptiles, 152 species of birds and 38 species of mammals. None of these wildlife species are included in conserved wildlife category according to Wildlife Conservation and Protection Act, 1992 and he ministerial regulations specify some species of wildlife as protected wildlife, 2003.

4) Watershed Management : The transmission line Tak2-Sop Ngao passes through 73.6 km of watershed class 1A, 9.2 km of class 1B, and 45.8 km, 45.5 km, 24.8 km and 8.7 km of watershed class 2,3,4 and 5 respectively.

5) Transportation : In the construction of the transmission line, there are 2 highways directly involved; i.e. Highway no.105 and highway no.1175. The current traffic status of these 2 highways is relatively free-flowing despite two-traffic lane asphalted roads.

6) Land use : Along the transmission line route, the area is most the forest area accounted for 78.78, following by agricultural area, residential area and water body area equivalent to 19.39%, 1.46% and 0.37% respectively.

7) Socio-economics : There are 992 households, 8 villages in 3 districts of Tak Province, namely The Song Yang District, Mae Ramat District and Muang District; situated along the transmission line route. The average population is 576 persons/village. Approximately 69% of villagers are farmers with average annual income of 18,715 baht per household.

8) Property compensation : The land which has to be compensated as land use right expropriation covers totally 1,452.75 rai, divided into land with title deed 65.75 rai, land with documentary of right 851 rai and reserved land 536 rai. No construction building has to be compensated in the route of transmission line.

9) Archaeology and history : there are 1 archaeological site in Muang District and 4 archaeological sites in Mae Sot District, Tak Province. These places are far from the transmission line route.

### 5.3 Environmental Impact Assessment

Results of the environmental impact assessment of the selected transmission line route : Tak2-Sop Ngao pumping station length 206.5 km are summarized. The potential impacts are as follows :

#### 1) During construction phase

(1) Soil erosion : Main activities caused soil erosion and affected downstream water quality include open cutting of surface soil for foundation construction and storage of soil left towers in the construction area.

(2) Forestry : During the construction phase, all trees in the right of way (ROW), 80-100 m width, along the transmission line route will cut off for the safety of the transmission line. Value of these trees is estimated to 341.62 million bath as followings :

- Trees (diameter bigger than 30 cm)	123,301,690	baht
- Seedlings	13,668,130	baht
- Saplings	155,155,410	baht
- Bamboos	49,495,100	baht
Total	341,620,330	baht

(3) Wildlife : Wildlife inhabiting in the project area will be affected because their habitats and feeding areas are directly and indirectly disturbed. The affected wildlife can be divided into 3 groups, they are :

Group 1 : Negative impact	97	species
Group 2 : Positives impact	7	species
Group 3 : No impact due to their adaptation to new environmental condition	148	species

(4) Watershed management : Total area of tree cutting off in the ROW along the transmission line route is amounted to 11,459 rais which affects the potential of water absorption and rain water retention.

(5) Transportation : Increase of traffic volume from construction maternal transportation is slight and cause non-significant impact to highway traffic. However, safety impact in Highway No.105 and Highway 1175 may occurs during the construction phase.

(6) Socio-economics : Construction of the transmission line has no adverse impact to communities inhabiting along the transmission line route but some of them may have opportunity be employed by the project for low technology jobs.

(7) Property compensation : Total compensation cost for the 1,452.75 rai of land for land use right expropriation is totally 6,097,500 baht, divide into land with title deed 2,600,000 baht, land with documentary of right 2,127,500 baht and reserved land 1,340,000 baht. No construction building. All of the expropriated land are agriculture land.

(8) Historical values : No historical place is found in the area along the transmission line route; thus, there is no historical impacts caused by the project.



## 2) During operation phase

The single activity of the transmission line is to supply power to the pumping station. Environmental impact of such activity is non-significant. However, some indirect impacts on wildlife and land use may happen as follows :

- (1) Wildlife : People may use the road constructed for the project purpose and the ROW to access hunting area.
- (2) Land use : People may use the constructed road and the right of way (ROW) to access forests for illegal logging.

## 5.4 Mitigation Measures

Prevention and mitigation measures during construction phase and operation phase are summarized as follows :

### 1) Construction phase

- (1) Soil erosion : Open cutting of surface soil for foundation construction should be carefully done. Cutting soil should be kept in good condition and covered up after finishing to avoid erosion.
- (2) Geology and earthquake : The transmission line route is located in degraded rock area as well as seismic prone area. The foundation and tower of the transmission line system must be designed to safely support the degraded rock as well as the safety bear the impact caused by the earthquake.
- (3) Forestry : Mitigation measures are to clearly illustrate logging area along the transmission line route, to use motor raw for logging trees, to provide the workers with information of fire protection and to contact the Forest Industry Organization (FIO) for timber logging.
- (4) Watershed management : Tree cutting should be avoided in particular area as valley and reforestation in such area should be immediately implemented.
- (5) Wildlife : Illegal wildlife hunting by project workers must be effectively and efficiently prevented.
- (6) Transportation : Mitigation measures include training truck drivers to follow the traffic rules and regulation as well as requesting the local traffic policemen for help in case of transportation of large construction materials and equipment.
- (7) Land use and agriculture : Prior to construction, farmers should be informed to harvest their agricultural production i.e. rice and corn farmed along the transmission line route.
- (8) Socio-economics : Public relations should be conducted to inform the progress of the project development to the affected people and local people inhabitation along the transmission line route.
- (9) Property compensation : Compensation for decrement of right to use land should be conducted right after the project approval and informed the affected people prior to the compensation payment. Such compensation must be conducted on the fair basis.
- (10) Archaeology and History : Any suspected archaeological materials found in the project area during the construction of the transmission line and foundation must be informed to the relevant agencies including the Department of Fine Arts and the Department of Mineral Resources.

### 2) During Operation Phase

- (1) Forestry : The project should coordinate the National Park, Wildlife and Plant Conservation Plant for its collaboration to deliver knowledge on forest management and conservation to local communities inhabiting along the transmission line route.

(2) Land use and agriculture : The project should coordinate the Agricultural Extension Department to specify the suitable plant species for cultivation in the affected areas. The affected landowners are allowed to cultivate the suitable plant species under the criteria of the Electricity Generating Authority of Thailand.

(3) Socio-economics : Low technology jobs such as maintenance work should be reserved to the local people living along the transmission line route.

## **5.5 The budget in environmental Impact Assessment**

### **1) Environmental Mitigation Measure**

- Forest resources and watershed management, reforestation and rehabilitation program at the same river basin throughout the transmission line route of containing 22,920 rai.

- Property compensation must be done fairly and rapidly as well as meeting between directly affected groups.

**2) Environmental Monitoring Program** there are 15 action plans to follow the monitoring program containing total budget of 434.20 million Baht dividing into construction cost in environmental part (214.00 million Baht) and construction cost for transmission line development (220.2 million baht).

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