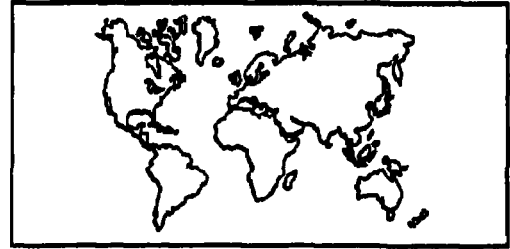


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Report E0035

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INDONESIA - Outer Islands Power Project EA Category A

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Environmental Assessment 4 of 4 April 1994

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Environmental Assessment/Analysis Reports



Report E0035

INDONESIA - Outer Islands Power Project EA Category A

**Environmental Assessment
4 of 4
April 1994**

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**MINISTRY OF MINES AND ENERGY
PERUSAHAAN UMUM LISTRIK NEGARA**

Main Report

E I A

**ENVIRONMENTAL IMPACT ASSESSMENT
BESAI HYDROELECTRIC POWER PROJECT
WEST LAMPUNG
INDONESIA**

1994

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INDONESIA

OUTER ISLANDS POWER PROJECT

Environmental Assessment Summary

Besai Hydroelectric Power Plant

Introduction

1. Pursuant to the objectives of the Government of Indonesia (GOI) to improve the welfare of the population and to support the growth of economic activity by meeting the electricity requirements in an efficient and reliable manner, the State Electricity Corporation (PLN) has proposed to construct a hydroelectric power plant at Besai, in the Lampung province of South Sumatra, under the Outer Islands Power Project. The proposed loan will be made to the GOI. The proceeds of the loan would be onlent to PLN, which is responsible for the implementation of the project. The project is likely to be cofinanced by the European Investment Bank, Austria and Australia, for the turbine generator and transmission components. GOI/PLN will meet the financing gap from their own internal resources.

2. The Electricity Act (Law No. 15 of 1985) defines the legal framework for the electricity subsector of Indonesia. The subsector comprises: (i) PLN, the State Electricity Corporation; (ii) captive plants; (iii) rural electric cooperatives; and (iv) a large number of informal microenterprises providing electricity to rural customers not served by PLN. The provisions of the Electricity Act are amplified in GOI Regulation No. 17/1990 for PLN and No. 10/1990 for others. PLN was established as a public corporation with responsibility for the generation, transmission, and distribution of electricity, and the planning, construction and operation of electric supply facilities. PLN is managed by a Board of Directors headed by a President Director, who is appointed by the President and is accountable to the Ministry of Mines and Energy. Operational responsibility devolves upon 17 regions, and the responsibility for major construction upon 13 project managers. PLN has already appointed a project manager for the proposed Besai hydroelectric power plant.

3. Since 1969, the Bank group has provided about \$ 4.1 billion for the power subsector in Indonesia, through 3 IDA credits, 18 loans, and one supplemental loan. Project Performance Audit Reports and Project Completion Reports on fourteen projects have been issued. The reports have concluded that the objectives set out for these projects at appraisal have been achieved.

Project Description

4. The Besai hydroelectric power plant is proposed to be a run-of-river type development, with a daily regulating storage capacity, to be built in the upper reaches of the Besai river in the Lampung province of Sumatra. The Engineering Services Center of PLN, in

association with their Consulting Engineers, have conducted an environmental assessment (EA) of the proposed hydroelectric plant based on the feasibility study and the preliminary design reports. The plant will have the following components:

- Intake dam
- Power house, about 6 km downstream
- Tunnel and penstock connecting the intake dam and power house
- Access roads to the project site
- Quarrying for stone and gravel to be used for construction
- Construction camp
- Permanent housing colony and offices
- Transmission lines

5. The dam commands a catchment area of 415 sq.km. Located in a steep gorge, the height of the dam will be 9 meters only; however, because of the slope, the net available head at the power house 6 km downstream will be about 240 m. Two turbine-generators will be installed initially in the power house to generate 45 MW each. The headrace tunnel from the dam will run underground for a length of approximately 5 km, and connect through a surge tank, with the underground penstock for a further distance of about 0.6 km leading into the power house. There will be two access roads; one about 2.5 km from the village of Sukapura to the dam site; the other, about 2 km long, in the village of Dwikora. A double-circuit, 16 km long, 150 kV transmission line will connect the power house with the nearest PLN transmission grid to evacuate power generated at the Besai plant.

6. There are possibilities of soil erosion because of land clearing operations. There may also be some minor air and water pollution issues because of construction activities. These adverse effects will be mitigated by appropriate measures as described below in this summary report.

Baseline Data

7. **Geophysical - Climate, Physiology and Hydrology.** It is a high rainfall area (rains for 11 months) with a fairly strong wind (39.31 km/day) blowing from the north most of the time. There are no months of water deficit and the air quality in terms of dust content, gases and noise is considered to be pure. The catchment area is mostly mountainous even though there are some undulating plains in patches. The country rock is basically volcanic deposit. The drainage pattern is characterized by many trenches which finally appear as tributaries of the main river. A catchment area, such as this, has the advantage of having a very small flood discharge. The groundwater level is quite shallow, about 3-12 m from the land surface. The quality of water has been analyzed and found to be clean.

8. **Soil.** The soil has been analyzed based on the factors of chemical and physical properties and the factor of climate. The larger parts of the soil comprises of Inceptisol and is sensitive to erosion. Land is used mostly for Sawah (wet rice cultivation) and also dry

cultivation. Local farmers do not take recourse to conservational measures resulting in very high rate of erosion. Much of the forest area has disappeared; it has turned into farmland and underbrush. Future farming operations must include better land management practices.

9. **Flora.** There are wet-cultivated areas in the farmlands, garden and forest lands. Mainly, there are six types of vegetation consisting of staple crops, like rice and maize, root vegetables like potatoes, and other vegetables like tomatoes, chilies etc. Fruits such as durian, mahogany wood trees, flowers and bamboos also abound. Many popular varieties of wood are found in the forest.

10. **Fauna.** The study has recorded 20 species of mammals, 9 reptiles and 10 birds. There are domestic animals like cows, buffaloes chicken and sheep. Most of the well-known fish varieties are found in the rivers.

11. **Socio-economic Study.** A study of the population of the area has been conducted. The main occupation is farming (more than 80%). But it must be said that farming is not practiced seriously and most of the people go for traditional rice cultivation and unattended coffee plantation. Over the years most of the people tend to migrate towards the Trans-Sumatra Highway in search of employment in small business. People are generally healthy even though malaria and influenza have been reported. In the survey most of the people tended to support the project.

Impacts

12. The environmental impacts of the proposed project can be subdivided into 3 categories; (a) preconstruction, (b) construction and (c) post construction.

(a) **Preconstruction:**

Preconstruction impacts include investigation and surveys, and land acquisition.

(b) **Construction:**

Land clearing and preparation, movement and operation of heavy construction equipment and materials, and the concentration of a fairly large construction labor force, many of whom may come from outside the local region, are the main impacts of the construction stage.

(c) **Post Construction:**

The environmental impacts of the dam and the hydroelectric power plant will be insignificant, except for liquid effluent and solid wastes from the housing colony and office facilities.

13. The project will have both physical and social impacts on the environment and habitat of the area. However, the social impacts are not severe as there are no relocation issues. Most of the affected land for construction activities, comprising the two villages Sukapura and Dwikora, belongs to the Forestry Department of GOI; however, several people cultivate the land and grow coffee crops on it. The area to be inundated covers private land, where the major crop is paddy. The village, Waypetai, is close to this area. No residential homes are affected by the construction; only a few huts used for keeping crops will need to be relocated. The physical impacts can be listed as follows:

- (a) Soil Erosion.
- (b) Air and water pollution from construction and waste disposal.
- (c) Social impact of construction.
- (d) Quarrying.
- (e) Water quality.
- (f) Sedimentation of the reservoir.
- (g) Scouring of river bed below dam.
- (h) Earthquakes and floods.
- (i) Loss of forest lands and wildlife.
- (j) Increase of water related diseases due to impounding.
- (k) Impact on drinking water.

Analysis of Alternatives

14. The run-of-river type development planned for Besai is to provide peaking power to the PLN system in South Sumatra. One of the main objectives of GOI for the electricity subsector is to meet the country's energy requirements in a least-cost way, and conserve exportable petroleum reserves, principally by encouraging the domestic market to substitute oil consumption by alternative, more economical fuels, such as natural gas, coal, hydropower and geothermal. Indonesia's hydroelectric resources are enormous; estimated at about 32,000 MW (out of a theoretical potential of about 75,000 MW), but their development to date has been limited by their geographic distribution relative to the load centers where there is demand for electricity. The Besai site is ideally suited for hydropower development; a dam about 9 meters high constructed at the narrowest portion of a deep gorge, helping to provide a net head of 240 m just 6 km downstream from the dam. No natural gas or geothermal energy is available in the

vicinity; also a coal-fired power plant for peaking purposes is not economical. Other forms of energy for the proposed 90 MW power plant are determined to be not feasible.

Mitigation Plans

15. The mitigation plans for the environmental impacts of the Besai hydroelectric power plant can be listed as follows:

(a) Soil erosion - The river subcatchment area of the Besai may be categorized into two groups; the volcanic group and the hilly group. More than 85% of the area is of the volcanic group. The volcanic material is tuff, covered with andesite and basalt. Soil erosion will be caused by the construction of access roads and temporary works, land clearing and cut and fill operations, disposal of tunnel excavation muck and other spoils. Soil erosion will be minimized by land reclamation, terracing, and replanting.

(b) Air and water pollution - Dust suppression and noise abatement measures, management of waste disposal (domestic and construction) in accordance with acceptable standards will help mitigate these impacts.

(c) Social impacts - The construction site will be designed such that workers have a healthy work environment, adequate recreational facilities outside working hours and living conditions with acceptable health and sanitary facilities. Potable water supply, waste disposal, health and amenities in contractors' temporary camps and facilities will be ensured.

(d) Quarrying - This environmental impact will be minimized by selecting several suitable sites, far apart from each other. Three possible sites for stone and gravel have been identified. Quarry I is 4.5 km and Quarry II is 14 km from the intake dam, while Quarry III is located near the proposed power house site. Sand will be obtained from the surrounding areas of two villages; one about 6 km, and the other about 16 km from the intake dam.

(e) Water quality - Vegetation in the reservoir area will be cleared before inundation to avoid deterioration of the water quality. Because of the daily pondage that will expose parts of the submerged land everyday, the vegetation clearing operation will be undertaken on a regular basis.

(f) Sedimentation - Scouring gates are provided to rid the reservoir of accumulated sediments by flushing on a regular basis. Regreening of the bare land areas are expected to reduce soil erosion and sedimentation.

(g) Scouring of river below dam - The flow rate in the river throughout the year varies between 11.04 and 32.01 m³/s. Even though the steep slope of the river acts as a disincentive for habitation, and there is no irrigation downstream of the dam, PLN has decided that, in accordance with Japanese regulatory practices, the plant will maintain a minimum release of at least 1 m³/s of water from the dam so the river bed between the dam and the power station

never goes dry and that any aquatic life in the area is sustained. No wild animals or migratory fish, however, are known to have been found in the area covered by this section of the river. The discharge of water from the power plant would amount to about 45.6 m³/s, for 4 hours a day, when running at full capacity.

(h) Earthquake and floods - The project has been designed to accommodate the seismic acceleration of the volcanic region. The weir, as stated at the outset, is only 9 m high, and the surface of the reservoir, only 140 ha. The holding capacity of this run-of-the-river type development will be small due to its limited volume. Therefore, the induced seismic effect of the dam is insignificant. A horizontal stilling basin is designed to dissipate the energy of design flood equivalent to 100 years probable peak discharge.

(i) Loss of forest lands and wild life - Most of the forest in the project area has already been converted into coffee plantation. The area to be inundated represents mostly, wild rice cultivation. However, since the area of inundation is small, the loss of land is manageable. Some farmers will lose part of their farmland and will be compensated for the loss in accordance with Bank guidelines for involuntary resettlement and the Presidential Decree, KEPRES 55/1993. This issue is discussed in detail under the Resettlement Plan for Besai. There is presence of wildlife in the vicinity of the project; the main habitat of the animal species is found to be in the adjacent forest area, very little of which is affected by the proposed project.

(j) Water related diseases due to impounding - The reservoir is planned to be of a daily pondage for power generation, which is the inherent nature of a run-of-river type development. The current in the river is expected to be too strong to support mosquito breeding. Additionally, mosquito-larvae eating fish to be stocked in the reservoir would mitigate this negative impact.

(k) Drinking water - The reservoir is relatively far from the dwelling areas. People get their drinking water from the springs or existing wells located near their houses which are not likely to be affected by the impounding of water by the dam.

Resettlement Plan

16. The Resettlement Plan of the Besai plant has the following objectives which are in keeping with the Bank's operational directives.

- development of a timebound resettlement plan, based on replacement valuation and compensation principles of land and other assets affected by the project
- establishment of a budget and an implementation plan
- identification of organizational responsibilities for implementation.

17. The plan has been prepared after consulting the affected people and NGOs who are active in the area. The project affects lands (160 ha) in three villages primarily because of inundation, acquisition for construction of the dam and the power house and for laying roads for the project. The project affected people (PAP) comprise 129 families both in the inundated area as also the construction area. In a social survey which was specially carried out in the area, almost the entire community including the affected families supported the project. The PAPs felt that the project will bring with it improvements in the infrastructure of the area which in turn will help in the growth of both industrial and agricultural activities. PLN is committed to providing them with roads, drinking water supply, sanitation facilities, etc. Most of the PAPs also expressed a desire to get jobs in the project. In the public consultation before the preparation of the resettlement plan, which was held on 14 September 1993, some PAPs raised the question of "Replacement" principle in the matter of compensation and it was explained to them that the GOI would provide for full compensation at replacement value and also other opportunities to the PAPs so that their quality of life would positively improve after the project. A further round of consultation was held with the local NGOs on 22 December 1993 in which the NGOs seemed satisfied with the solutions offered by PLN to their concerns regarding the resettlement aspects.

18. 35% of the PAPs expressed interest in land-for-land compensation. PLN is committed to providing such PAPs with alternate land, after due consultation with them on their choice. PLN will procure the land and hand over to the PAPs who might choose this option. The compensation for land acquisition will be determined by a committee appointed by the GOI as per the relevant Presidential Decree. PLN will encourage the PAPs to take up other activities like small business, trading and will also help them in developing other skills. PLN will make counselling and credit facilities available for such people, if desired. Education and training will be provided by PLN in vocational schools to those who may opt for this option. A budget provision of Rp 660,000,000 (US\$ 330,000) has been made for the implementation of the plan. The resettlement is scheduled to be completed well ahead of the start of actual construction of the project. The resettlement implementation schedule provides for monitoring by a committee over the next five years.

Monitoring and Evaluation

19. The most important area of action is the strengthening of the internal structure of PLN so that they may be in a position to monitor the implementation aspects, as well as the final results of the resettlement plan. Pending this, it has been agreed that an independent organization, such as the local university and some government agencies, would be engaged to monitor the implementation of the resettlement plan, evaluate results, and report on the progress on a periodic basis. The university will be requested to include a local NGO in their monitoring team.

Institutional Needs

20. Provision for Technical Assistance has been made under the proposed project to assist PLN to establish an environmental organization to develop PLN's capability to formulate corporate environmental policies, evaluate environmental assessments of its development projects and monitor environmental impacts and compliance with GOI guidelines for existing projects.

Public Participation

21. Public consultations have been held by PLN at the project site, with local NGO participation. During the public consultations, while 99% of those attending supported the construction of the project, a large majority of the Project Affected Persons (PAP) expressed a strong preference for cash compensation, and an opportunity to work in the construction of the project. While the amount of cash compensation will be determined by the Land Acquisition Committee in accordance with Kepres 55 guidelines, which allows for compensation at the current valuation of the land, the project proponents (PLN) have agreed to provide work to qualified PAPs in the construction of the project.

I. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

1.1 Background

Development is actually the utilization of natural and environmental resources, aiming at improving the living standard and welfare of the population. Therefore, in the implementation of development changes are likely to occur, in the biogeophysical as well as the socio-economic and socio-cultural environment.

The utilization of natural and environmental resources excessively and unwisely will in the end cause an environmental problem to arise. This means that the development undertaken will decrease the environmental quality.

In undertaking a development activity, it is necessary to minimize the negative impact and maximize the positive impact to the environment. Therefore, each activity of development and its results will not be of a temporary character, but will last and give benefit for a long term.

This is so, since in the development process the environmental aspects have been considered, i.e. the balance of the environment in one ecosystem.

The successful development undertaken by the government as of REPELITA I in 1969 has given tangible results in the various sectors. The industrial development and welfare of the population which are ever enhancing have resulted in the demand for electric energy to increase. In the effort to meet the demand for electric power, the Government, through Perusahaan Umum Listrik Negara (State Power Utility), is of intention to develop the Besai HPP (Hydro-electric Power Plant) in North Lampung. The development of this HPP will be carried out in the content of the diversification and conservation of the use of natural oil energy resources.

In accordance with the policy of the Government, the first stage will develop two units of the Besai HPP with a capacity of 2 x 45 MW (90 MW). In order to identify whether the development of the Besai HPP (Project) will bring about a major impact to the environment, a study on the Environmental Impact Assessment (EIA) will be made.

The implementation of this EIA will be in accordance with existing rules and legislation, as set forth in :

1. Act No. 4/1982 on : Basic Rules for Environmental Management;
2. Government Regulation No. 29/1986 on: Analysis on Environmental Impact;
3. Decree of the Minister of State for Population and Environmental Affairs No. Kep-49/MNKLH/6/1987 on : Guidelines for Determining Major Impact;
4. Decree of the Minister of State for Population and Environmental Affairs No. Kep-50/MNKLH/6/1987 on: Guidelines for the Preparation of the Analysis on Environmental Impact;
5. Decree of the Minister of Mines & Energy No.0935 K/OO8/M.PE/1988 on: Technical Guidelines for the Preparation of the Environmental Information Presentation for Hydro-electric Power plant (HPP) Project.

1.2 Objective of Study

Objective

The objective of the EIA study of Besai HPP is as follows:

- a. Identify the project or power plant activities, which particularly bring about environmental impact;
- b. Inventory the environmental feature, which particularly is expected to be affected by project or power plant activities;
- c. Predict and evaluate the environmental impact;
- d. Develop basic management and monitoring plan.

Use

The use of the EIA study is to assist in decision making, the planning and management of the environment of the Besai HPP activity.

1.3 Scope of Study

(1) Area of Study

a. The project or the planned Besai HPP project to be developed has some places of activity (Annex 2) with the following locations:

- Intake dam in the Wai Besai, village of Sukapura.
- Power house in the village of Dwikora.
- Tunnel connecting the intake dam and the power house, with a distance of about 6 km.
- Access road in the village of Sukapura with a length of about 2.5 km to the intake dam and in the village of Dwikora of about 2 km.
- Quarry I, found in the village of Simpang Sari (Simpang Gadis), at a distance of about 4.5 km to the intake dam.
- Quarry II, found in the vicinity of Bukit Kemuning DPP, at a distance of about 14 km to the intake dam.
- Quarry III, found in the vicinity of the power house.
- Sand is obtained from the surroundings of the village of Wai Petai, at a distance of about 6 km to the intake dam and from the village of sindang Pagar at a distance of about 16.5 km to the intake dam.
- Base camp, in the village of Sukapura.
- Housing and offices, in the village of Sukapura.

b. Ecological Borders

The ecological borders are the borders of the Catchment Area which form one ecosystem unit. This HPP Project is located in the Catchment Area of the upstream part of the Tulang Bawang which forms the Sub Catchment Area of the Wai Besai, with an area of about 41,500 ha (415 km²). Geographically the Sub Catchment Area of the Besai is situated between 4°-6° South Latitude and 104°-105° West Longitude.

c. Administrative Borders

The Besai HPP Project is situated in two Kecamatans (Sub- Districts), i.e. the Kecamatan of Sumber Jaya and the Kecamatan of Bukit Kemuning, Kabupaten (District) of West Lampung.

The intake dam is in the Village of Sukapura, Kecamatan of Sumber Jaya at a distance of about 60 km from Kotabumi. The power house is in the Village of Dwikora, Kecamatan of Bukit Kemuning and these two villages lie adjacent to each other.

(2) The Environmental Components Investigated/Observed

The environmental components investigated cover the Physical (soil, hydrology, air, and climate), biological (terrestrial and aquatic biota), and socio-economic and socio-cultural aspects.

1.4 Methodology

(1) Method of Data Collecting

In accordance with the objective of the EIA study, the data used are secondary data and primary data.

Secondary data are collected from the related Departments/Authorities and primary data are obtained through observation in the field, measuring or sample taking, and interviews.

a. Geophysical

Topographical data in the form of the obliqueness of slopes and height/elevation of places are obtained from the topographical map and the land capacity map. Geological data are obtained from the geological map and relevant reports. Data on the soil are obtained from maps, reports, supported with field observation. The spread of soil types is found in the soil map and land unit.

Data on the climate and water discharge are collected from P3SA of the Province of Lampung, the river stream pattern from the topographical map and the groundwater surface from the Health Service of Sumber Jaya.

To know the water quality, water samples are taken from the planned location of the dam site for further analysis in the laboratory.

b. Biology

b.1 Flora

Data on the flora are collected by the inventory method, i.e. by observation in the field. For terrestrial flora, observation is undertaken in each type of land use, consisting of : home garden, sawah (wet rice cultivation), tegalan/ladang (dry cultivation), garden/estate, underbrush, and forest. The data obtained for culture plants are secondary data (village and kecamatan).

The inventory of the underbrush and forest vegetation is done by making observation belts. The belt is made by the "belt transect" method with the description as follows :

- The belt is made along the length cutting the contour line with a dimension of 20 x 100 m. The belt is further divided into five parts, so that 5 belts are obtained, each of 20m x 20 m. Of each sample belt the diameter of each kind of plant at tree level is recorded and measured (DBH > 20 cm).
 - To know the plants at pole level ($10 < \text{DBH} < 20 \text{ cm}$) in the main belt a belt of 10 m x 10 m is made. The diameter of all plants of pole level is recorded and measured.
 - To know the plants at pile level ($1\text{cm} < \text{DBH} < 10 \text{ Cm}$) in the "pole belt" a belt of 5 x 5 m is made. The diameter of all pile plants is recorded and measured.
 - To know the plants at seedling and undergrowth level, in the pile belt a belt of 1m x 1m is made and the kind and number of individual seedlings and undergrowth are recorded.
- As for aquatic flora, observation is made of the water weeds found in sawah land and along the length of the river, in particular those having a calm stream.

b.2 Fauna

Data on terrestrial fauna in the form of domestic animal (cattle and domestic animals of the population) are obtained from secondary data and data on wild animals (mammals, reptiles, and birds) are collected from reliable sources, i.e. forest attendants, hunters, and members of the community. In addition, animal is found during flora observation.

Data on aquatic fauna, particularly fish are obtained from the population who often catches fish and from the members of the community living relatively near the river.

c. Socio-Economic and Socio-Cultural Aspects

Data and information on the social, economic, and cultural condition are obtained by the method of observation and interview. Interview is held with the people selected as respondents by using a set of questionnaire previously prepared. In addition, information is collected from village administrators and public figures and secondary data from the village and Sub-District Office.

In order to obtain representative data, 10 villages have been established as samples consisting of 3 villages directly affected by the impact of the project (Sukapura, Wai Petai, and Dwikora) and 7 villages lying in the upstream part of the project. These seven villages have been selected on the consideration that they are representative of other villages. The existence and activity of these villages in the upstream part of the project are expected not to be affected by the impact of the project, but on the contrary, will bring about a negative impact to the life of the project for the long term.

(2) Method of Data Analysis

a. Geophysical

Topographical and geological data are interpreted from the topographical map, map of land capability, and geological map. Of the information obtained from the topographical and land capability map in the form of the inclination of the slope, a tabulation is made and the proportions measured. Whereas the regional geology is interpreted descriptively.

The analysis of climatological data is made by way of tabulation. To know the type of rainfall and climate of the area of study, a calculation is made by the Koppen method and the Schmidt & Ferguson method.

Data on soil are analyzed by way of interpretation and calculation and the soil classification system. In this case the system used is Soil Taxonomy (USDA, 1975) after which the equivalent is sought according to the FAO/UNESCO system (1974) and PPT (1984). Data on the physical and chemical properties of the soil obtained from the field as well as reports are interpreted qualitatively. Gauging of sedimentation is done by the SDR (Sediment Delivery Ratio) method according to the Robinson (1979) criteria. The gauging of the sedimentation presently occurring is done by calculating the predicted total erosion by the USLE method.

The analysis of data and the use of land is made by way of tabulation, so that the spread of the use of land in various inclinations of the slope can be obtained.

Hydrological data are interpreted from the map (for river stream pattern) and the tabulation made, where as to know the water quality an analysis of the water sample is made in the laboratory.

b. Biological

b.1 Flora

Data on cultivated plants are analyzed by the tabulation method and the data on underbrush and forest vegetation, besides analyzed by way of tabulation, an IVI (Important Value Index) calculation is made of each plant level.

Frequency = Number of belts containing certain plant species.
Density = Number of individuals per belt.
Dominance = Area of basic field coverage.

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency of certain plant species}}{\text{Frequency of all individuals}} \times 100\%$$

$$\text{Relative Density (RD)} = \frac{\text{Density of one species}}{\text{Density of all species}} \times 100\%$$

$$\text{Relative Dominance (RDo)} = \frac{\text{Dominance of certain plant species}}{\text{Dominance of all individuals}} \times 100\%$$

IVI (*Important Value Index*) = RF + RD + RDo and for undergrowth, VI = RF + RD.

The analysis of aquatic flora (water weeds) is done by way of tabulation and data interpretation.

b.2 Fauna

The analysis of data on aquatic fauna (fish) and cattle is done by way of tabulation. To know the similarity index of the existing wild animal species, the data is analyzed by using the Sorenson equation as follows:

$$S = \frac{2C}{A+B}$$

in which: S = Similarity index
A = Number of species in location A
B = Number of species in location B
C = Number of species found in Location A as well as location B

c. Socio-Economic and Socio-Cultural Data

The analysis of socio-economic and socio-cultural data is made by way of tabulation and continued with the interpretation of the data qualitatively and or quantitatively.

II. BRIEF DESCRIPTION OF BESAI HPP PROJECT ACTIVITY

2.1 Objective

The objective of the Besai HPP Project is to increase the power capacity in the area of Lampung in particular and Sumatera in general which according to the demand forecast that area in 1996 will need a power production of 2,894 GWh and an installed capacity of 722 MW. The Besai HPP will have a capacity of 90 MW with a total annual energy output of 396 GWh.

2.2 Description of Activity

1. Type of planned activity : Besai HPP Project
2. Planned location of activity
 - a. Village : Sukapura
 Kecamatan (Sub-District) : Sumber Jaya
 Kabupaten (District) : North Lampung
 Province : Lampung
 - b. Village : Dwikora
 Kecamatan : Bukit Kemuning
 Kabupaten : North Lampung
 Province : Lampung
3. Stages of Activity

The activity schedule in each stage (pre-construction, construction, operation) is as per the table hereunder.

Table 2.1. Activities schedule of Besai HPP

Description Activities	Year					
	1	2	3	4	5	6
Pre-Construction						
- Access Road	■					
- Base Camp	■					
- 20 kV Distribution line	■					
Construction						
- Civil works		■	■	■	■	
- Metal Works		■	■	■	■	
- Turbine & Generator		■	■	■	■	
- Transmission lines & Sub Station		■	■	■	■	
Operational						■

4. Relationship of Project with Other Activities :

- The forest area used for part of the quarry and part of the access road;
- The forest area for the tunnel from the intake dam to the power house with a length of 5,842 m;
- The plantation and bushes in the planned location of the dam;
- Bridges made by the activity of the community of Sukapura and Wai Petai in the planned location of inundation (3 suspension bridges and 1 semi-permanent bridge);
- Yards in part of the access road in Sukapura;

(1). Pre-Construction Stage

a. Plan for Land Acquisition

Land acquisition is implemented pursuant to the Regulation of the KEPRES No. 55/1993 with the establishment of the Committee of Land Acquisition for the State with PLN and the related Department/Authority, as members.

b. System of Compensation

The amount of the payment of compensation for land and plants will be based on consultation between the Committee for Land Acquisition and the population whose land is affected by the project.

(2). Construction Stage

a. Implementation of construction activities

No	Type of Activity	Implementation of Activity	Equipment Used
1.	Land clearing	Project area cleared and levelled	Bulldozer, excavator
2.	Material	Material transported from its source	Dump truck
3.	Construction of dam	Manually and mechanically	---
4.	Construction of tunnel	Manually and mechanically	Excavator, drill, stone cutter
5.	Construction of power house C supporting	Manually and mechanically	---

The implementation of the work can be explained as follows:

Intake Dam

The excavation of the intake dam foundation is carried out by the use of heavy equipment according to the above table. The product of excavation will be transported through the access road and piled up in Spoil Bank No 1.

Table 2.2. The Basai project area to be compensated

No.	Proposed use	Acreage (Ha)	Landuse	Ownership
1.	Basecamp & Access road	15.11 2	- Coffee plantation - Sawah/riceland	Forestry Forestry
2.	Access road to power house	4.2	Coffee plantation & bush	Forestry
3.	Spoil bank & Quarry	12.44	Coffee plantation & bush	Forestry
4.	Power house, surge tank & intake	12.55	Coffee & bush	Forestry
5.	Temporary building	12.13	Coffee & bush	Forestry
6.	Access road to dam site, work adit & surge tank	16.71	Coffee & bush	Forestry
7.	Inundated area	85.35 16.1 *)	- Ricefield & coffee - River bed	Private Government
	Total to be compensated	160.48		

*) will not be compensated

Head Race Tunnel

Because of the length of the headrace tunnel of ± 5 km, before the excavation work is carried out, adit tunnels No. 1, No. 2, and No.3 will be made. Through these adit tunnels, the excavation of the headrace tunnel is carried out to the left and the right. The product of excavation of the headrace tunnel transported through adit tunnel No. 1 is piled up in Spoil Bank 2 and the product of excavation transported through adit tunnel No. 2 and No. 3 is respectively piled up in Spoil Bank 3 and Spoil Bank 4. The tunnel is situated at an average of 100 m depth in the ground, so that the activity of excavation does not affect the land surface on top of it.

Access Road

The access road to be constructed will run along the length of the Wai Besai to the mouth of adit tunnel no.1, 2, and 3 and further to the spoil bank (see Figure 1) .

The access road along the tunnel is not a permanent one. After completion of the project this access road may continue to be used or replanted.

Power house, surge tank, and penstock

These parts will be dealt with manually and mechanically. The product of excavation of the power house will be piled up in Spoil Bank No.5 and No.6; the product of excavation of the surge tank will be piled up in Spoil Bank No. 4 and No. 5, and that of the penstock in Spoil Bank No. 4.

The construction material used in the construction stage which is likely to bring about an impact are stone and sand during mining and transportation.

End disposal of disposed material in the construction stage:
Disposed material will be piled up in layers and levelled with a thickness of maximum 20 cm for each layer and then compacted with a bulldozer.

Manpower needed in the construction stage:

No	Type of manpower	Education/ Expertise	Manpower			Settlement	Total
			New-comer	Local	Foreign		
1.	Expert	University graduate	x	-	x	Project vicinity	75
2.	Middle manpower	Undergraduate, SHS	x	x	-	ditto	250
3.	Labors	-	x	x	-	Base camp	1,000

(3). Operation Stage

a. Capacity of Service

No	Type of Production / Type of Services	Capacity / Capacity of Services
	Electric energy	396 Gwh per year of an installed capacity of 90 MW.

b. Method/Process of Activity

In general, the operational activity of Besai HPP will cover water release, electric power generation and transmission. In the process of water release, the water of the Besai with an average discharge of 26.2 m³/sec. will be taken through the headrace tunnel of 24.4 m³/sec then to be returned to the Besai after turning the turbine in the power house and further reunite with the remaining stream and overflow through the dam. In the downstream part of the power house the water will return to its original condition. The decrease of the discharge from the dam to the power house (± 5 km) will not disturb the environment, since there is no use of water along this trench.

The electricity produced by the generator will be conveyed to the transformer in which the voltage will be stepped up. This high voltage electricity will then enter the network system in the sub-station and from there it will be ready for distribution.

c. Human Resources

c.1 Power plant employees

No.	Position in Work	Education					Origin			Status	
		U	C	SMS	JHS	ES	Loc	Arr	For	P	NP
1.	Head		x					x		x	
2.	Engine operator			x			x	x		x	
3.	Water gate operator					x	x			x	
4.	Maintenance section				x		x	x		x	
5.	Security officer					x	x			x	
6.	Technicians			x	x		x	x		x	
7.	Warehouse section			x	x		x			x	
8.	Driver				x		x			x	

U = undergraduate/graduate
C = undergraduate

SMS = Senior High School
JHS = Junior High School
ES = Elementary School

Loc = Local people/labor
Arr = Labor from outside area
For = Foreign labor

c.2 Educational Facilities and Work Equipment

The education and courses given to the workers are a.o. : network maintenance, HPP basics, operation and maintenance, security guard training, and typewriting.

For the smooth execution of tasks, security and safety of the worker, work outfit will be needed, such as: work dress, safety helmet, voltage-proof shoes, voltage-proof gloves, leather/cotton gloves, raincoat, rubber shoes, safety belt, respiratory protection, eye protection, ear protection, flashlight, electricity welding mask, carbide welding eye- glasses, asbestos welding gloves, and first aid medicines.

III. ENVIRONMENTAL BASELINE

3.1 Geophysical

(1) Climate and Air Quality

a. Rainfall and Temperature

The type of the climate in the area of study is categorized according to Koppen and the type of rainfall is categorized according to Schmidt and Ferguson. In addition the agroclimatological zone in the area of study is categorized according to Oldeman.

The area of study has a rainfall of 2,614 mm per year with an average daily air temperature of 21.2°C. The lowest average daily air temperature is in August (20.3°C) and the highest in March, April, and December of 21.7°C each.

The highest rain intensity is in December (16.1 mm/day) and the lowest in June (12.1 mm/day). The result of the processing of climatological data is presented in Table 3.1.

Based on the division of the climate type according to Koppen, the area of study has the climate type Af with the following description:

- The air temperature in the lowest month is 20.3°C (18°C).
- Much rainfall in the dry season. The data on rainfall in the area of study show that there is no dry month (month with a rainfall of < 60 mm) and that there are 11 wet months (rainfall of > 100 mm).
- The rainfall in the driest month is 93 mm (60 mm).

b. Wind

The average wind velocity in the area of study is 39.31 km/day with a variety of 27.1 km/day as the weakest wind velocity (May) and 54.1 km/day as the strongest wind velocity in December.

The wind direction in the area of study is variable . The dominant wind direction all year long is from the North, i.e. in the months of April, June, July, August, and November and from the South-West and South-East in September and from the North and South-West in December. In the months Of January, February, March, May, and October the wind direction is dominatingly from the North-East.

c. Air Humidity

The average daily value of the relative air humidity in the area of study is 84.3%. The lowest average daily relative air humidity is in November (82.3%) and the highest in February (85.7%).

d. Solar Radiation

The average daily solar radiation in the area of study is 210.42 cal/cm²/day. The lowest average daily solar radiation is in January (177.2 cal/cm²/day) and the strongest in May (227.1 cal/cm²/day).

e. Duration of Radiation

The average daily duration of solar radiation in the area of study is between 3.9 and 6.8 hours/day or an average of 5.2 hours/day. The shortest duration of radiation is in December and the longest in June.

f. Evaporation

The average daily evaporation in the area of study is 3.81 mm/day. The least average daily evaporation is in July (4.41 mm/day) and the most is in December (4.9 mm/day).

g. Evapotranspiration

In this study the evapotranspiration is counted by the Thornwaite method, as this method is considered quite proper for medium to wet areas. The average evapotranspiration is 7.7 cm/month.

h. Rain Water Balance

The water balance will give important information on the net water received by a certain area, so that it can be known when the surplus months will be and when the months of water deficit.

Adjusted to its objective, the water balance model will be drawn up in the form of a very common quantitative equation, i.e. as based on the rainfall data and the potential evapotranspiration value in that area.

Of the result of analysis as per the Table 3.2, in the area of study there are no months of water deficit, or in other words the area of study has a wet climate with high rain potential.

i. Air Quality

The air quality which should be observed in connection with the activity plan of Besai HPP are noise, dust, and gases. The degree of noise, dust content, and gases in the project location and surroundings is considered to be still low.

Table 3.1. Average Monthly Climatological Data in Area of Study

	Climatological Element	Month												Average
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1.	Rainfall (cm)	31.9	23.9	30.8	26.9	20.2	12.9	13.2	9.3	17.2	19.1	23.6	32.4	21.8
2.	Rainy days (d)	20.3	16.6	18.6	17.7	15.3	10.7	10.8	7.6	11.5	12.6	15.2	20.1	14.8
3.	Rain intensity (cm/day)	1.57	1.43	1.65	1.52	1.32	1.27	1.27	1.22	1.49	1.51	1.55	1.61	1.45
4.	Temperature (°C)	21.5	21.6	21.7	21.7	21.6	20.9	20.4	20.3	20.6	20.9	21.5	21.7	21.2
5.	Wind velocity (km/day)	37.8	41.9	43.4	31.5	27.1	32.7	37.7	37.5	40.4	44.0	43.6	54.1	39.3
6.	Relative Direction	NE	NE	NE	N	NE	N	N	N	SW SE	NE	N	N SW	NE
7.	Relative Air Humidity (%)	82.78	85.7	85.4	83.3	84.9	84.3	85.5	83.5	84.8	83.7	82.3	85.2	85.3
8.	Solar Radiation (cal/cm ² /day)	177.2	210.9	205.3	203.3	227.1	225.2	295.04	221.6	223.27	220.7	204.9	200.6	210.4
9.	Duration of radiation (h)	3.96	4.1	4.94	5.5	5.98	6.8	5.8	6.02	5.7	5.16	4.36	3.9	5.2
10.	Evaporation	3.8	4.12	4.1	4.2	3.9	3.9	3.6	3.9	4.4	4.5	4.4	4.9	4.1
11.	Potential evaporation uncorrected (cm/m)	7.98	8.07	8.16	8.16	8.07	7.48	7.08	6.99	7.24	7.49	7.98	8.16	7.7
12.	Potential evaporation corrected (cm/m)	8.46	7.67	8.48	8.16	8.23	7.40	7.22	7.20	7.24	7.85	8.22	8.65	7.9

Source: P₃SA Lampung Province (Data Processed by Study Team)

Table 3.2. Monthly Rain Water Balance in Area of Study

No.	Description	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.	Temperature (°C)	21.5	21.6	21.7	21.7	20.9	20.4	20.3	20.6	20.9	21.5	21.7	21.6
2.	Temp. Index	9.13	9.16	9.23	9.23	9.16	8.72	8.41	8.34	8.53	8.72	9.10	9.23
3.	Potential Evaporation (cm)	7.98	8.07	8.16	8.16	8.07	7.48	7.08	6.99	7.24	7.48	7.98	8.16
4.	Correction factor	9.06	0.95	1.04	1.00	1.02	0.99	1.02	1.03	1.00	1.05	1.03	1.05
5.	Corrected Evapotranspiration (cm)	8.46	7.67	8.48	8.16	8.23	7.40	7.22	7.20	7.24	7.85	8.22	8.65
6.	Rainfall (cm)	31.9	23.9	30.8	26.9	20.2	12.9	13.2	9.3	17.2	19.1	23.6	32.4
7.	Surplus	23.44	16.23	22.32	18.74	11.97	5.5	5.98	2.1	9.96	11.25	15.38	23.75
8.	Deficit	.	.	.	.	.	.	.	.	.	.	.	.

Source: Result of Calculation from Climatological Data

This is caused by the relatively limited transportation in this area, the non-existence of industry as a source of pollution, and the activity of the people which is still focused on the agricultural sector.

(2) Physiography

a. Topography and Morphology

The physiography of the Besai Sub-Catchment Area can be subdivided into 2 groups, i.e. the mountainous area and the undulating area. More than 85% of this area is mountainous area and the rest is hilly area.

The mountain area forms a natural range originating from mountain and maintaining its original form. In the area of Wai Besai, the mountain area occupies an area of 85%, divided as follows:

- The wavy mountain plain showing inclinations of 0 - 15% occupies 25% of the total area. This area lies in the main route of the upstream of the Wai Besai, or in the middle part of the catchment area. The elevation of the area is between 800 - 1,000 m above sea level.
- The lower slopes of the mountain group showing inclinations of 8 - 15% occupy 25% of the total area. This area lies in the upstream of the tributaries of the Wai Besai, such as the upstream of the Wai Kabut , Wai Campang Kanan , and Wai Hitam. The elevation is between 800 - 1,000 m above sea level.
- The eroded volcano group shows many inclinations of 30 - 70% and occupies 15% of the total area. This area lies in the northern and southern part of the main route of the upstream of Wai Besai. The elevation of this area is between 1,000 - 1,400 m above sea level.
- The middle slopes of the mountain group show many inclinations of 16 - 50% and occupy 10% of the total area. This area lies in the northern and southern part of the main route of the upstream of the Wai Besai. The elevation of this area is between 1,000 - 1,500 above sea level.

The middle slopes of the mountain group show many inclinations of 16-50% and occupy 10% of the total area. This area lies in the western part of the area of study in the upstream of the tributary of the Wai Besai. The elevation of this area is between 1,000 - 1,400 m above sea level.

- The upper slopes of the mountain group show many inclinations of > 30% and occupy 10% of the total area. This area lies in the vicinity of the Sekincau Mountain and forms the spring of a part of the tributaries of the Wai Besai. The elevation of this area is between 1,400 - 1,800 m above sea level.

The undulating area lies in the vicinity of the planned location of the Wai Besai dam. This hilly area occupies 15% of the total area and in general consists of small hills with a wavy pattern. The inclination of this area is between 8 - 30% with an elevation of 700 - 800 m above sea level.

b. Geology

According to its geology (Puslitan 1989), the larger part of the area consists of ancient rock enwrapped in quaternary volcanic deposit. The oldest quaternary volcanic material consists of Ranau tuff with a dacitic and lyparitic structure. This Ranau tuff is in turn covered by young volcanic material varying between andesitic and basaltic. The Sekincau (Mountain) forms one of the volcanic eruption centers in this area.

(3) Hydrology

a. River Stream Pattern

The Wai Besai river is one of the tributary of Tulang Bawang River. Since the physiographical condition of the Besai catchment area is hilly to mountainous, in the drainage pattern in this area many trenches are found, in the form the tributaries of the river itself as well as small rivers of a seasonal character. From the result of the study of the topographical map and observation in the field, it can be seen that the stream pattern of the Wai Besai has the form of a bird feather.

Such a catchment area has a very small flood discharge, since the time, of arrival of the flood from the tributaries is different; on the other hand, the flood lasts long. The tributaries of Besai River are Wai Petai, Wai Campang Kanan, Wai Hitam, and Wai Kabul.

The form of the main river is relatively not a straight line (winding) following the lowest topography, while the stream type is a turbulent one, due to the many large rocks found on the bottom of the river.

b. River Water Discharge

The data on the average monthly discharge can be made an indicator of the catchment area in the upstream part, or its source. The average stream discharge of the Wai Besai varies between 11.04 m³/sec to 32.71 m³/sec. The smallest average monthly discharge is in August and the largest in January (data on the average monthly discharge can be seen in Table 3.3). The small fluctuation of the average monthly discharge is probably caused by the high rainfall all year long in the area of study.

c. Groundwater Surface

The depth of the groundwater surface in the area of study is very closely correlated to the elevation of the place or topography. The shallowest groundwater surface is found in the village of Wai Petai and Purawiwitan, i.e. 3 m from the land surface. These two villages lie in the lowest location, while the village of Tambak Jaya which lies in the highest location/topography has the deepest groundwater depth, i.e. about 3 m. The depth of the groundwater surface in some locations or villages in the area of study can be seen in Table 3.4.

d. Water Quality

The water quality of a water body is determined by the magnitude of the value of each parameter known from the analysis of the water sample in the laboratory. The data on the water quality of the Wai Besai, the sample of which is taken from the planned location of the dam are as presented in Table 3.6.

Table 3.3. Average Monthly Water Discharge of Wai Besai (m³/sec)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1975	29.05	30.86	18.47	23.17	15.68	10.77	10.37	10.25	9.81	13.15	21.28	11.20
1976	15.43	17.58	18.92	23.82	14.20	7.57	6.61	7.58	5.60	7.07	18.44	14.72
1978	24.86	21.77	37.81	23.65	27.98	21.22	17.44	14.26	21.95	18.64	32.18	41.81
1979	34.37	42.77	22.20	29.17	29.37	18.81	18.03	12.28	12.56	13.91	19.88	-
1980	29.75	21.87	22.09	22.96	17.66	13.17	10.37	10.32	12.31	19.82	33.43	35.41
1981	23.11	27.66	28.26	39.10	35.91	18.44	15.74	12.25	20.75	13.01	15.93	16.65
1982	37.08	38.87	19.83	31.28	17.57	8.96	8.16	5.48	-	-	-	-
1983	40.44	17.36	27.73	27.16	28.64	15.21	11.09	6.95	5.18	6.75	17.92	16.92
1985	31.40	23.85	24.41	30.62	17.35	18.99	23.10	17.74	14.98	18.61	18.52	25.29
1986	27.01	23.94	38.17	26.24	19.33	17.72	18.87	15.56	22.77	23.82	32.89	32.17
1987	45.48	27.46	34.91	33.36	28.14	18.84	14.32	10.35	8.11	9.54	14.91	31.06
1988	53.57	35.73	37.54	17.13	22.43	15.53	11.69	7.66	12.29	28.98	22.59	-
Total	391.55	329.72	330.34	327.64	274.26	185.23	165.79	130.66	146.31	173.30	247.97	225.23
Average	32.63	27.48	27.53	27.31	22.86	15.44	13.82	10.89	13.30	15.75	22.54	25.03

Table 3.4. Depth of Groundwater Surface in Some Locations In the Area of Study

No.	Location	Depth of groundwater (m) surface (m)
1.	Sukajaya	12
2.	Sendang Pagar	12
3.	Puralaksana	15
4.	Fajar Bulan	15
5.	Karang Agung	17
6.	Mutar Alam	5-15
7.	Tanjung Raya	15-30
8.	Suka Menanti	13-20
9.	Suka Raja	18
10.	Padang Tambak	60
11.	Tambak Jaya	>30
12.	Srimenanti	15
13.	Semarang Jaya	12
14.	Sumber Alam	13
15.	Simpang Sari	13
16.	Sukapura *)	5
17.	Wai Petai *)	3
18.	Dwikora *)	9
19.	Tri Budi Syukur	5
20.	Purajaya	6
21.	Purawiwitan	3
22.	Muara Jaya	5
23.	Puramekar	5
24.	Tri Mulyo	8
25.	Gedung Surian	8

*) Affected villages

Source: Puskesmas Kecamatan Sumber Jaya

Table 3.5. Result of Analysis of Water Quality of Besai, West Lampung

No.	Parameter	Value	Unit	Equipment/Analysis
1.	pH	6.0	-	pH Meter
2.	Temperature	23.0	°C	Thermometer
3.	Color	40	Hazen	Aquamerck Test
4.	Dissolved solid	27	ppm	Conductivity Meter
5.	Suspended solid	120	ppm	Oven
6.	Turbidity	51	ppm	Horiba water checker/O.7
7.	DO (Dissolved Oxygen)	5.720	ppm	BOD bottle (Titration)
8.	BOD	16	ppm	BOD bottle (Titration)
9.	COD (K ₂ Cr ₂ O ₇)	27	ppm	Titration
10.	CO ₂	4.400	ppm	Titration
11.	Cyanide (Cn)	0.002	ppm	Aquamerck Test
12.	Chloride (Cl)	15	ppm	Aquamerck Test
13.	Sulphide (HS)	0.001	ppm	Aquamerck Test
14.	Conductivity	39	umhos/cm	Conductivity Meter
15.	Sulphate (SO ₄)	205	ppm	Spectrophotometer
16.	Nitrate (NO ₃ -N)	0.142	ppm	Spectrophotometer
17.	Nitrite (NO ₂ -N)	9.070	ppm	Spectrophotometer
18.	Ammonium (NH ₃ -N)	0.283	ppm	Spectrophotometer
19.	Total hardness	5.354	ppm	Titration
20.	Ca hardness	0.715	ppm	Titration
21.	Calcium	0.286	ppm	Titration
22.	Iron (Fe)	0	ppm	Spectrophotometer
23.	Magnesium	1.000	ppm	Spectrophotometer
24.	HCO ₃	12.200	ppm	Titration with pH Mater

Note : Analysis undertaken in Chemical Laboratory of Universitas Lampung, March 1990

(4) Soil

a. Soil Classification

The larger part of the soil in this area consists of Inceptisol (87%) and the rest Entisol (8%) and Ultisol (5%). Inceptisol and Entisol for the larger part occupy volcanic area and another part hilly area, while Ultisol is for the larger part found in hilly area as per the soil map in Annex 3. In detail the division of land type is as per the following Table 3.6.

Inceptisol is soil only recently experiencing a development. The main characteristic of Inceptisol is the existence of a cambic horizon, where the translocation of clay and bases begins to take place. This Inceptisol generally develops in the landscape, which is geologically "relatively" young with a low temperature. In the Wai Besai area, Inceptisol develops from young volcanic prime material in the volcanic landscape. In this area, 4 types of Inceptisol are found, i.e. :

Humitropepts, Dystropepts, Dystrandpepts, and Tropaquepts. This division is based on the properties found in Inceptisol, i.e. the factor of climate, the physical and chemical property of the soil.

- Humitropepts is Inceptisol having an isomesic temperature regime or warmer, a base saturation of > 50% and organic carbon of > 12 kg/m³ to a depth of 1 m.

Table 3.6. Spread of Soil Type in Besai Sub-Catchment Area *)

No.	Type of Soil			Area	
	Soil Taxonomy (1975)	FAO/UNESCO (1974)	PPT (1983)	ha	%
1.	Humitropepts	Eutric Cambisol	Eutric Cambisol	16,703	40
2.	Dystropepts	Dystric Cambisol	Chromic Latosol	15,770	38
3.	Dystropepts	Munic Andosol	Umbric Andosol	4,150	10
4.	Tropaquepts	Gleyic Cambisol	Gleyic Cambisol	312	1
5.	Troporthents	Eutric Regosol	Eutric Regosol	2,490	6
6.	Hapludults	Ortic Acrisol	Chromic Podsollic	2,075	5
Total				41,500.00	100.00

*) Interpretation of the Soil Map of Kota Agung (Center Soil Research, 1989) Supported by Field Observation.

- Dystropepts is almost the same with Humitropepts, only with a low organic carbon requirement.
- Dystrandpepts is Inceptisol characterized by a content weight of F 0.85 g/cm³, or dominated by vitric volcanic ash material with a base saturation of < 50 %.

- Tropoquepts is Inceptisol having an aquic humidity regime and an annual temperature difference of $< 5^{\circ}\text{C}$ in the warm season and cold season.

Entisol is soil not having developed and the larger part of its property is determined by its prime material. No horizon development of this soil has been observed and if any, then very little. This soil develops in the eroded volcanic landscape. In the Besai Sub-Catchment Area only Troportheps is found, i.e. Entisol developing from young volcanoes with an upper course humidity regime and a temperature difference of $< 5^{\circ}\text{C}$.

Ultisol is soil having developed characterized by the existence of an argilic horizon and a base saturation of $< 35\%$. Developing in ancient landscape in the hilly area of Wai Besai.

Hapludults is Ultisol having an upper course humidity regime and no other significant characteristics.

b. Erosion

A large part of the Besai Sub-Catchment Area is sensitive to erosion. Several factors which are of much influence in inducing erosion in this area are, a.o

- The physiography of the area is volcanic and hilly with an average inclination of more than 15%.
- The type of soil which for a large part is sensitive to erosion (Inceptisol and Ultisol).
- The high erodibility of rain (erodibility index between 1,500 - 2,500).
- The factor of land management, where a large part of the agricultural area does not take conservational actions.

From the survey undertaken by PT. Indra Karya and Nippon Koei (1984) the rate of erosion of 0.13 mm/year is obtained (equivalent to 53,950 ton/year).

c. Land Use

The use of land in Wai Besai can roughly be distinguished into two types, i.e. sawah (wet rice cultivation) land and dry land. The use of land in the Besai area can be seen in Table 3.7.

From observations in the field and interviews with farmer, it appears that most of the farmers have not taken conservational measures in their land. Coffee plants which form the main crop in the private plantation are always clear from weeds all year long (cleared/ scraped intensively). This contributes to the high rate of erosion, particularly on land with an inclination of more than 15%.

The research undertaken by the RLKT Station (1989) shows that the value of "plant factor" or C is between 0.007 - 0.541, or an average of 0.226. As a comparison, the value C of a dense forest is 0.0001 and land without plants is 1 (one). Furthermore, the value of the land management factor (P) is between 0.965-2.00, or an average of 0.983.

As a comparison, at an inclination of 15% with terraces (as a conservational measure) the value of P is 0.1 and for land without management, P = one (1).

Table 3.7 Land Use at Some Inclination in the Sub-Catchment Area of the Wai Besai *)

No.	Use of Land	Inclination (%)					Total	%
		0-8	8-15	15-25	25-45	>45		
1.	Wet Rice field (Sawah)							
	- Simple Irrigation	1332	283	-	-	-	1,615.00	3.89
	- Rainwater	150	244	259	149	-	802.00	1.93
2.	Y a r d	507	1544	-	-	-	2,051.00	4.94
3.	Dry Cultivation	1949.9	40.3	145	1457.7	1409.7	5,002.60	12.05
4.	P o n d	215.6	-	-	-	-	215.60	0.52
5.	Private Plantation	3663	2731	1001.1	1105	1949	10,449.10	25.17
6.	Underbrush	864	1784	445	128	-	3,221.00	7.76
7.	Forest	349	583	389	7048	9043	17,412.00	41.95
8.	Others	197	351	120	49	24	741.00	1.79
T o t a l		9,227.50	7,560.30	2,359.10	9,936.70	12,425.70	41,509.30	100.00
Percentage		22.23	18.21	5.68	23.94	29.93	-	100.00

*) Interpretation of the Land Use and Land Capacity Map of the Sub-District of Sumber Jaya

In order that erosion can be suppressed to the minimum and the productivity of the land increased, the effort to be taken is the use of land according to its capacity. The data available show that protected forest occupy an area of 23,295 ha (register No. 44 B and 45 B) and wildlife reserves an area of 6,000 ha, i.e. in Register No. 46 B (REPELITA V, District of North Lampung, Volume II, 1989). The protected forest area is in Wai Tenung and Bukit Rgis, all belonging to the Besai Sub-Catchment Area and the wildlife reserve area is on the Sekincau (Mountain), which for a large part belongs to the Besai Sub-Catchment Area.

Of the forest area (of 29,295 ha), at present only 17,412 ha is left. From the map on land use of the Kecamatan of Sumber Jaya with scale 1 : 25,000 (BPN Propinsi Lampung, 1989) can be seen that the that the forest area of Bukit Rgis for the large part has been changed into farmland and underbrush; the area of Wai Tenung has become a coffee estate, and the area of Sekincau is still underbrush.

In connection with the development plan of the Besai HPP and the reservoir for irrigation in part of the Besai HPP downstream area, it has become time to arrange the use of land in the Besai Sub Catchment Area according to its destination.

The rate of erosion in this area is naturally high due to the high rainfall, topography, and land properties. This rate of erosion is more accelerated by the people (farmers), as the farming pattern does not consider the norms of land conservation.

In order that the hydrology of the catchment area will remain fair, the following should be observed:

- The land management should adopt the norms of conservation, such as making of terraces.
- The use of land should be in accordance with its allocation.
- Part of the protected forest area which has now become farmland should be rearranged.
- Replanting and reforestation should be carried out with a priority for land having a high degree of danger of erosion.

d. Land Use Planning in the Downstream Area

From the information obtained, it appears that no plan has been made for land use in the downstream area of the dam, particularly for sawah land.

e. Land Use in the project site

3.2 Biology

(1) Terrestrial Biota

a. Flora

The vegetation of the Kecamatan (Sub-District) of Sumber Jaya, which forms the Sub-Catchment Area of the Wai Tulang Bawang Hulu, can ecologically be sub-divided into six types, i.e. yard vegetation, sawah (wet rice cultivation), ladang/tegalan (dry cultivation), garden/estate, underbrush, and forest. These six types of vegetation are spread sporadically, with the exception of forest vegetation which is more concentrated in the upstream area.

a.1 Home Yard (Home Garden)

A yard is a plot of land lying adjacent to the house (dwelling place) and has usually distinct borders. Yard land in the Kecamatan of Sumber Jaya covers an area of 2.051 ha (4.90%).

This plot of land is usually planted by way of multiple cropping, combining perennial with seasonal crops, hedge plants, and herbs (spices). In addition, usually the population of Sumber Jaya, originating from West Java in particulars, makes a pond in their yard. Ponds cover an area of 216 ha (0.6%) and others (roads, squares, social facilities, etc) an area of 741 ha (1.8%).

The type of plants much grown by the village population can be seen in Table 3.8

Table 3.8. Types of Yard Plant in Area of Study

No.	Name of Plant	Latin Name	Use
1.	Kacang Panjang/Cow pea	<i>Vigna sinensis</i>	Vegetable
2.	Roay	<i>Dolichos lablab</i>	Vegetable
3.	Emes	<i>Luffa aegyptica</i>	Vegetable
4.	Terung/Egg plant	<i>Solanum spp.</i>	Vegetable
5.	Tomato	<i>Solanum tuberosum</i>	Vegetable
6.	Chilli	<i>Capsicum spp.</i>	Vegetable/spice/medicine
7.	Kencur/Grater galangale	<i>Kaemferia galanga</i>	Spice/medicine
8.	Kunyit/Tumeric	<i>Curcuma domestica</i>	Spice/medicine
9.	Jahe/Ginger	<i>Zibinger officinale</i>	Spice/medicine
10.	Laos/Galangale	<i>Pectuda indica</i>	Spice/medicine
11.	Kecibeling	<i>Sericocolyx crispus</i>	Hedge plant/medicine
12.	Beluntas/Kind of gardenia	<i>Pluchea indica</i>	Ornament/medicine
13.	Kumis Kucing/Herb with diuretic properties	<i>Orthosiphon aristatus</i>	Ornament/medicine
14.	Hibiscus	<i>Hibiscus sp.</i>	Food/fodder
15.	Cassava	<i>Manihot utilissima</i>	Food/fodder
16.	T a r o	<i>Colocasia esculenta</i>	Food/fodder
17.	Sweet potato	<i>Ipomoea batatas</i>	Fruit/Food
18.	Banana	<i>Musa paradisiaca</i>	Fruit
19.	Papaya	<i>Carica papaya</i>	Fruit
20.	Mango	<i>Mangifera indica</i>	Fruit
21.	Rambutan/Nephelium	<i>Nephelium lappaceum</i>	Fruit
22.	Duku/Lanseh tree	<i>Lancium domesticum</i>	Fruit
23.	Avocado	<i>Persea americana</i>	Fruit
24.	Jambu Air/Rose-apple	<i>Eugenia aquea</i>	Fruit
25.	Jambu Batu/Candlenut	<i>Psidium guajava</i>	Fruit

Table 3.8. Types of Yard Plant in Area of Study (continued)

No.	Name of Plant	Latin Name	Use
26.	Kemiri/Candlenut	<i>Aleurites moluccana</i>	Fruit/spice
27.	Coconut	<i>Cocos nucifera</i>	Fruit/timber
28.	Nangka/Jackfruit	<i>Artocarpus integrifolia</i>	Fruit/timber
29.	Soursop	<i>Annona muricata</i>	Fruit
30.	Citrus fruit	<i>Citrus sp.</i>	Fruit
31.	Durian	<i>Durio zibethinus</i>	Fruit
32.	Pineapple	<i>Ananas comosus</i>	Fruit
33.	Coffee	<i>Coffea sp.</i>	Flower
34.	Clove	<i>Eugenia aromatica</i>	Fruit
35.	Pepper	<i>Piper nigrum</i>	Fruit
36.	Cocoa	<i>Theobroma cacao</i>	Fruit
37.	Petai/Pungent bean	<i>Parkia speciosa</i>	Fruit
38.	Jengkol/Larger pungent bean	<i>Pithecolobium lobatum</i>	Fruit
39.	W a r u	<i>Hibiscus sp.</i>	Firewood
40.	Binčinu	<i>Hibiscus sp.</i>	Firewood/medicine
41.	Petai Cina	<i>Leucaena sp.</i>	Firewood/fodder
42.	Lantoro	<i>Leucaena sp.</i>	Firewood/fodder
43.	Kaliandra	<i>Calliandra calothyrsus</i>	Firewood
44.	Sengon	<i>Farasierianthes falcataria</i>	Firewood
45.	Gamal	<i>Glaricidae</i>	Firewood/fodder
46.	Pinang/Areca nut	<i>Pinanga kuhli</i>	Fruit/medicine
47.	Aren/Sugar palm	<i>Arenga pinnata</i>	Fruit/sugar
48.	Bamboo	<i>Bambusa sp.</i>	Multipurpose

a.2 Wet Rice Cultivation (Sawah)

Rice cultivation land in the Kecamatan of Sumber Jaya occupies an area of 2,417 ha or 5.80 % of the total area. A large part of the sawah land lies in the outskirts of the Wai Besai and Wai Tenung with simple irrigation (utilizing the available water sources such as spring water) and another part depends on rainwater for irrigation.

In some places, as in Sukajadi, Wai Petai, and Sukapura, part of the sawah land sometimes is flooded by the overflow of the Wai Besai in the rainy season. In general the sawah can be planted once or twice a year with an average production of 30 - 45 quintal/ha (1 quintal = 100 kg) per harvest.

a.3 Dry Cultivation (Ladang)

Tegalan/Ladang (dry cultivation) covers an area of 4,993 ha (12%). This vegetation occupies a flat area, inclined to very inclined plane (more than 45°) and is spread sporadically between the garden/estate and underbrush.

The ladang/tegalan vegetation is generally a combination of seasonal crops and perennial with different composition of types. The types of plants mostly found are presented in Table 3.9.

a.4 Private Plantation

The private plantation vegetation covers a quite large area, i.e. 10,449 ha (25.20%). It found in the area of the Kecamatan of Sumber Jaya form small holder's estates with coffee as the main commodity. Smallholder's coffee estate are generally found and land with a great inclination, even in an inclination of more than 100% (45°). In order to have a high production, the ground under the coffee trees is always cleared, usually by scraping. This scraping besides clearing the undergrowth, also destroys the surface structure, so as to aggravate erosion.

From the viewpoint of land and water conservation, this vegetation is of a damaging character.

a.5 Bushes

Bushes vegetation occupies an area of 3,221 ha (7.8 %) and is seemingly a former site of ladang or coffee estate left and abandoned by the owner. In the bushes sometimes forest plants or other perennial are found growing solitair. In addition, often some coffee plants are found which spreadly wild, or neglected. The spread of bushes vegetation is almost even, one connected to each other, so as to give an impression of vastness, from the valleys, river banks to mountain slopes. The vegetation is dense with a quite high diversity (covering tress, shrubs, bushes, grasses, and ferns), Table 3.10.

Table 3.9. Types of Major Plant Much Grown in Ladang/Tegalan (Dry Cultivation) in Area of Study

No.	Name of Plant	Scientific Name	Function
1.	Padi Gogo (Rice from dry Cultivation)	Oryza Sativa	Food
2.	Maize	Zea mays	Food/fodder
3.	Cassava	Manihot utilissima	Food/fodder
4.	Sweet Potato	Ipomoea batatas	Food
5.	Taro	Colocasia esculenta	Food
6.	Ganyong	Canna edulis	Food
7.	Kunyit/Turmeric	Curcuma domestica	Spice/medicine
8.	Sereh/Citronella	Cymbopogon Citratus	Spice/medicine
9.	Jahe/Ginger	Zingiber Officinale *)	
10.	Laos/Galingale	Luctura indica	Spice/medicine
11.	Kencur/Greater galingale	Kaemferia sp	Spice/medicine
12.	Terung/Egg Plant	Solanum spp	Vegetable
13.	Tomato	Solanum sp	Vegetable
14.	Chilli	Capsium spp	Vegetable
15.	Peanut	Arachis hypogaea	Vegetable
16.	Cucumber	Cucumis sativus	Vegetable
17.	Emes	Luffa aegyptica	Vegetable
18.	Kecipir		Vegetable
19.	Roay	Dolichis lablab	Vegetable
20.	Jambu/Rose-apple	Eugenia spp	Fruit
21.	Mango	Magnifera spp	Fruit
22.	Nangka/Jackfruit	Artocarpus spp	Fruit/timber
23.	Rambutan/Nephelium	Nephelium lappaceum	Fruit
24.	Duku/Lanseh tree	Lancium spp	Fruit
25.	Durian	Durio zibhetinus	Fruit
26.	Soursop	Annona muricata	Fruit
27.	Citrus fruit	Citrus spp	Fruit
28.	Avocado	Persea americana	Fruit
29.	Papaya	Carica papaya	Fruit
30.	Banana	Musa paradisiaca	Fruit
31.	Pineapple	Ananas comosus	Fruit
32.	Coffee	Coffea sp *)	Fruit/Pit
33.	Clove	Eugenia aromatica *)	Flower
34.	Cocoa	Theobroma cacao	Fruit/Pit
35.	Pepper	Piper nigrum *)	Fruit/Pit
36.	Sengon	Paraserianthes falcataria	
37.	Kemiri/Candlenut	Aleurites moluccana	Fruit
38.	Aren/Sugar Palm	Arenga pinnata	Sugar/fruit/fiber
39.	Manii	Maesopsis emini	Construction wood
40.	Lamtoro	Leucaena glauca	Construction wood/green fertilizer
41.	Acacia	Acacia sp	Construction wood
42.	Gamel	Glericidea	Firewood/cattle fodder/manure
43.	Dadap	Erithrina sp	Shadow tree
44.	Nahogany	Swietenia sp	Construction wood
45.	Cinnamon	Cinnamomum sp	Bark
46.	Jati/Teak Wood	Tectona grandis *)	Construction wood
47.	Kaliandra	Caliandra callothirsus	Firewood/green manure
48.	Bamboo	Bambusa sp	Multi purpose
49.	Bamboo	Dendrocalamus sp	Multipurpose

*) of high economic value

Table 3.10 Types of Plant Found in Underbrush in the Area of Study

No.	Name of Plant	Scientific Name	IV *)
1.	Beringin/banyan tree	Ficus Benyamica	5.42
2.	Kiciat	Ficus septica	10.85
3.	Kihampelas	Ficus ampelas	1.09
4.	Kemiri/Candlenut	Aleurites moluccana	17.39
5.	Sengon	Faraserianthes falcata	4.34
6.	Kluwih/Breadfruit	Artocarpus commune	2.15
7.	Bayur	Pterospermum javanicum	2.17
8.	Laban	Vitex pebescens	6.51
9.	Coffee	Coffea sp.	19.56
10.	Kirinyuh	Eupatorium inulifolium	21.70
11.	Saliera	Lantana camara	10.85
12.	Harandong	Melastoma malabathricum	23.87
13.	Tepus	Achrasoccinum sp	2.57
14.	Putri malu	Mimosa pudica	8.69
15.	Jukut riut	Mimosa invisa	15.22
16.	Alang-alang/Tall grass	Imperata cylindrica	10.85
17.	Jukut pait	Axonopus compressus	6.51
18.	Gelagah/Wild sugarcane	Saccharum spontaneum	6.51
19.	Mikania	Mikania sp	17.39
20.	Babadotan	Agaratum conyzoides	4.34
21.	Ferns	Nephrolepis exaltata	1.60
22.	Ferns	Pteris ensi formis	0.40
23.	Ferns	Stenochlaena palustris	0.40

*) IV (Important Value), counted on the basis of RF (=Relative Frequency) + RD (Relative Density)

a.6 Forest

Forest vegetation occupies the most extensive area, i.e. 17,412 ha (41,9%) of the area of the Kecamatan of Sumber Jaya. From the viewpoint of its function, the forest is sub-divided into two groups, i.e. the South Bukit Barisan National Park and Reserved Forest. The Reserved Forest is recorded in Register 45 B of Wai Tenung.

In the village of Tambak Jaya a private forest is found of about 300 ha and the people managing the forest has been given the Kalpataru Award (1987) for their outstanding performance in the preservation of the forest. The detailed data on the types of plant growing in the primary and secondary forest area in the area of study are presented respectively in Table 3.11 and 3.12.

Table 3.11. Types and Important value Index (IVI) of Forest Plant and Vegetation Indigenous in the Area of Study

No.	Name of Plant	Latin Name	IVI
Tree Level			
1.	Kayu Pasang	Quercus sp.	37.03
2.	Medang	Alseodaphne sp.	33.46
3.	Merawan	Hopea mangarawan	8.47
4.	Kruing	Dipterocarpus sp.	4.90
5.	Cemara/Casuariana tree	Casuarina sp.	21.41
6.	Tenan/Mersawa	Anisoptera sp.	28.11
7.	Meranti/Morantee	Shorea sp.	15.61
8.	Sungkai	Peronema canescens	4.90
9.	Balau	Shorea sumatrana	5.32
10.	H u r u	Schima sp.	13.88
11.	Durian	Durio sp.	5.58
12.	Kemuning/Yellow wood tree	Murraya paniculata	2.42
13.	Gisok	Shorea sp.	3.34
14.	Bayur	Pterospermum javanicum	6.69
15.	Nyamplung	Calophyllum sp.	4.46
16.	Bungur	Lagerstroemia sp.	12.55
17.	Kapur	Dryobalanops sp.	2.67
18.	Canari	Canarium sp.	4.46
19.	Matoa	Fometia sp.	2.42
20.	Gelam	Eugenia sp.	5.58
21.	Cengal	Hopea sp.	3.89
22.	Kecapi	Sondoricum koetjape	2.56
23.	Be'ingin/Banyan tree	Ficus benjamina	5.35
24.	Bendo	Ficus g.amerata	6.42
25.	Pulai	Alstonia scholaris	6.83
26.	Menteru	Schima wallichii	8.16
27.	Simpur	Dillenia sp.	4.67
28.	Laban	Vitex pubescens	6.91
29.	Lada/Pepper	Cinnamomum parthenoxylon	2.24
30.	Minyak	Dipterocarpus sp.	5.55
31.	Widara	Zizyphus sp.	2.67
32.	Klampeyan	Anthocephalus cadamba	4.00
33.	Merbau	Intsia calebannica	1.67
34.	Suren	Toona sureni	2.56
35.	Angrung	Trema orientalis	2.00
36.	Manggis/Mangosteen	Garcinia sp.	3.34
37.	Gondang	Ficus variegata	1.28
38.	Sawa	Calophyllum sp.	2.58
39.	Duku/Lanseh tree	Lanatum spp.	1.28
40.	Rengas	Glutha renghas	1.67
41.	Putat	Planchoria	0.55
Pole Level			
1.	Pasang	Quercus sp.	29.12
2.	Medang	Alseodaphne sp.	35.05
3.	Sungkai	Peronema canescens	10.52
4.	Keruing	Dipterocarpus sp.	6.88
5.	Laban	Vitex Pubescens	5.91
6.	Kayu Rimba	-	2.79
7.	Meranti/Morantee	Shorea sp.	8.24
8.	Bandetan	Polyalthia sp.	4.49
9.	Kopi-kopi	Plectrocarpa glabra	2.70
10.	Kiciat	Ficus sp.	2.06
11.	Simpur	Dillenia sp.	4.06
12.	Rengas	Gluta renghas	9.95
13.	Jambuan	Eugenia sp.	5.34
14.	Kemang	Magnifera sp.	5.69
15.	Salam	Eugenia sp.	7.35
16.	Klampeyan	Anthocephalus cadamba	4.19
17.	Huru	Schima sp.	18.44
18.	Mersawa	Anisoptera sp.	21.82
19.	Kandis	Garcinia sp.	8.07
20.	Gelam	Eugenia sp.	7.14

IVI = Important Value Index

Table 3.11. Types and Important value Index (IVI) of Forest Plant and Vegetation Indigenous in the Area of Study (continued)

No.	Name of Plant	Latin Name	IVI
Pole Level			
21.	Widora	Zizyphus jujuba	6.60
22.	Putat	Plachonia valida	5.74
23.	Gebang	Arthocarpus elasticus	4.44
24.	Bayur	Pterospermum javanicum	19.52
25.	Asem/Tamarind	Canarium denticulatum	10.48
26.	Duku/Lanseh tree	Lancium sp.	8.66
27.	Pulai	Alstonia scholaris	2.87
28.	Kecapi	Sondoricum Murraya paniculata	2.15
29.	Kemuning	Murraya paniculata	1.86
30.	Durian	Durio sp.	2.29
31.	Cemara/Casuarina tree	Casuarina sp.	28.70
32.	Merbau	Intsia palenbanica	4.22
33.	Pepper	Cinnamomum parthenoxylon	6.56
Pile Level			
1.	Gisok	Shorea sp.	11.74
2.	Meranti/Morantee	Shorea sp.	7.45
3.	Simpur	Dillenia sp.	6.56
4.	Keruing	Dipterocarpus sp.	4.88
5.	Kopian	Plectronia glabra	7.45
6.	Medang	Alseodhagne sp.	5.73
7.	Pasang	Quercus sp.	28.87
8.	Jambu/Rose-apple	Eugenis sp.	10.86
9.	Menteru	Schima sp.	1.01
10.	Merawan	Hopea Mangarawan	18.60
11.	Buni	Antidesma bumuis	6.29
12.	Kemuning	Murraya paniculata	5.25
13.	Klampeyan	Anthocephalus cadamba	13.57
14.	Laban	Vitex pubescens	8.37
15.	Rengas	Gluta Renghas	5.77
16.	Kiciat	Ficus sp.	4.46
17.	Sungkai	Peronema canescens	6.14
18.	Salam	Eugenia poliantha	4.24
19.	Bendo	Ficus glomerata	8.30
20.	Suren	Toona sureni	6.59
21.	Merbau	Intsia palenbanica	9.73
22.	kandis	Garcinia sp.	6.02
23.	Mersawa	Anisoptera sp.	5.30
24.	Bayur	Pterospermum sp.	4.02
25.	Gebang	Arthocarpus elasticus	20.30
26.	Saga	Adinathera sp.	4.87
27.	Gelam	Eugenia sp.	4.81
28.	Pulai	Alstonia scholaris	4.39
29.	Balau	Shorea sumatrana	6.45
30.	Mersawa	Anisoptera sp.	8.86
31.	Duku	Lancium sp.	5.62
32.	Klengkeng/Longan	Litchi chinensis	8.10
33.	Hampelas	Ficus ampelas	24.62
34.	Rattan	Calamus sp.	4.81
35.	Gondang	Ficus variegata	4.02

Table 3.11. Types and Important value Index (IVI) of Forest Plant and Vegetation indigenous in the Area of Study (continued)

No.	Name of Plant	Latin Name	IVI
Undergrowth Level			
1.	Meranti/Marante	Shorea sp.	15.54
2.	Kopias	Plectronia glabra	5.91
3.	Gisok	Shorea sp.	26.92
4.	Klanpeyan	Anthocephalus carlamba	2.79
5.	Merawan	Kopea Mangarawan	4.49
6.	Sempur	Dillenia sp.	4.22
7.	Kemuning	Murraya paniculata	5.69
8.	Jambuan	Eugenia sp.	28.70
9.	Medang	Alseochapne sp.	8.52
10.	Nuni	Antidesma bunius	5.52
11.	Sungkal	Peronema canescens	5.34
12.	Rattan	Calamus sp.	6.60
13.	Pulai	Alstonia scholaris	21.82
14.	Mersawa	Anisoptera sp.	6.56
15.	Ampelas	Ficus ampelas	2.70
16.	Menteru	Schima walichi	4.19
17.	Bayur	Pterospermum sp.	1.86
18.	Gebang	Anthocephalus	2.10
19.	Saga	Adinathera sp.	6.10
20.	Gelam	Eugenia sp.	2.29
21.	Balau	Shorea sumatrana	7.35
22.	Duku	Lancium sp.	5.74
23.	Kiciat	Ficus sp.	15.54
24.	Herbau	Intsia palembanica	4.45
25.	Salam	Eugenia poliantha	13.45
26.	Bendo	Ficus glomerata	18.44
27.	Keruing	Dipterocarpus sp.	19.51
28.	Cemara/Casuarina tree	Casuarina sp.	10.38
29.	Kecapi	Sondaricum kutjape	2.87
30.	Sirih hutan/Wild betel	Piper retrofactum *)	8.78
31.	Paku/Fern	Diplazium spp. *)	8.24
32.	Wild banana	Musa sp. *)	6.88
33.	Pacing	Costus speciosus *)	10.52

*) Undergrowth

Table 3.12. Types and Important value Index (IVI) of Secondary Forest Vegetation in the Area of Study

No.	Name of Plant	Latin Name	IVI
Tree Level			
1.	Sonokeling	Dalbergia latifolia	26.48
2.	Johar	Casia siamea	9.32
3.	Wild kedondong	Spondias dulcis	4.91
4.	Kemiri/Candlenut	Aleurites moluccana	21.39
5.	Sungkai	Peronema canescens	3.79
6.	Veru	Albizia procera	8.29
7.	Pulai	Alstonia scholaris	4.45
8.	Durian	Durio zibethinus	5.39
9.	Mersawa	Anisoptera sp.	5.64
10.	Dadap	Erythrina variegata	16.30
11.	Lantoro	Leucaena glauca	5.06
12.	Jengkot/Great pungent bean	Pithecollobium labatum	8.95
13.	Tisuk	Hibiscus macrophyllus	2.16
14.	Bungur	Lagerstroemia sp.	7.35
15.	Nangka/Jackfruit	Artocarpus integra	2.60
16.	Aren/Sugar palm	Arenga pinnata	9.19
17.	Medang	Alseodaphne sp.	13.44
18.	Merbau	Intsia palembanica	8.07
19.	Cinnamon	Cinnamomum sp.	8.08
20.	Sengon	Faraserianthes falcafaria	7.10
21.	Petai/Pungent bean	Parkia speciosa	6.64
22.	Randu/Silk-cotton tree	Ceiba pentandra	2.87
23.	Jabon	Anthocephalus chinensis	19.50
24.	Buni	Antidesma bunius	8.66
25.	Merawan	Hopea mengarawan	2.152
26.	Kluwih/Breadfruit	Artocarpus communica	1.82
27.	Meranti/Morantee	Shorea sp.	1.86
28.	Duku/Lanseh tree	Lancium sp.	1.49
29.	Jambu/Rose-apple	Eugenia jambolana	2.29
30.	Cemara/Casuarina tree	Casuarina sp.	15.46
31.	Bendo	Ficus glomerata	10.50
32.	Pangi	Pangium edule	13.46
33.	Kiara	Ficus globosa	5.69
34.	Wild rambutan	Nephelium sp.	8.56
Pole Level			
1.	Kaliandra	Caliandra callothirsus	10.73
2.	Sonokeling	Dalbergia latifolia	8.46
3.	Dadap	Erythrina variegata	20.37
4.	Medang	Alseodaphne sp.	6.68
5.	Laban	Vitex pubescens	4.78
6.	Tisuk	Hibiscus macrophyllus	7.43
7.	Coffee	Cofea sp.	26.48
8.	Sengon	Faraserianthes falcafaria	5.75
9.	Kiciat	Ficus septica	7.00
10.	Cinnamon	Cinnamomum sp.	6.29
11.	Pinang/Betel nut	Pinanga kuhli	5.25
12.	Kemiri/Candlenut	Aleurites moluccana	13.27
13.	Nangka/Jackfruit	Artocarpus integra	8.35
14.	Johar	Casia siamea	5.79
15.	Clove	Eugenia aromatica	4.80
16.	Duku/Lanseh tree	Lancium domesticum	5.45
17.	Teureup	Artocarpus elastica	6.15
18.	Kiara	Ficus globosa	5.23
19.	Kiendog	Xanthophyllum exelsum	7.31
20.	Gamal	Gliricidae sp.	9.82
21.	Jengkot/Greater pungent bean	Pithecollobium lobatum	6.50
22.	Petai/Pungent bean	Parkia speciosa	6.02
23.	Durian	Durio zibethinus	6.32
24.	Guava	Psidium guajava	3.00
25.	Meranti/Morantee	Shorea sp.	4.70
26.	Bamboo	Gigantochloa spp.	13.58
27.	Jambu/Rose-apple	Eugenia sp.	4.40
28.	Wild Harendong	Melastoma sp.	4.05
29.	Beringin/Banyan tree	Ficus benamina	6.43

Table 3.12. Types and Important value Index (IVI) of Secondary Forest Vegetation in the Area of Study (continued)

No.	Name of Plant	Latin Name	IVI
Pole Level			
30.	Mahogany	Swietenia sp.	8.88
31.	Cemara/Casuarina tree	Casuarina sp.	4.82
32.	Bamboo	Bambusa sp.	5.62
33.	Mampelos	Ficus ampelas	18.61
34.	Lamtoro	Leucaena glauca	4.01
35.	Rambutan	Nephelium lappaceum	4.05
36.	Waru	Hibiscus sp.	10.25
37.	Merawan	Hopea mangarawan	5.81
38.	Pulai	Alstonia scholaris	8.56
Pile Level			
1.	Kaliandra	Calliandra caliothirus	30.66
2.	Coffee	Cofea sp.	12.08
3.	Sonokeling	Dalbergia latifolia	36.61
4.	Laban	Vitex pubescens	8.44
5.	Wild Marendong	Melastoma sp.	7.45
6.	Kiciat	Ficus sp.	4.35
7.	Rattan	Calamus spp.	9.78
8.	Ficus	Ficus sp.	6.05
9.	Lamtoro	Leucaena glauca	4.24
10.	Cinnamon	Cinnamomum sp.	3.62
11.	Dadap	Erythrina variegata	5.60
12.	Tisuk	Hibiscus macrophyllus	11.51
13.	Bamboo	Bambusa sp.	6.88
14.	Jambu/Rose-apple	Eugenia jambolana	7.25
15.	Kemiri/Candlenut	Aleurites moluccana	8.89
16.	Rambutan	Nephelium lappaceum	5.75
17.	Bamboo	Gigatochloa sp.	23.38
18.	Beringin/Banyan tree	Ficus benjamina	9.61
19.	Meranti/Morantee	Shorea sp.	8.70
20.	Kiara	Ficus globosa	8.14
21.	Teureup	Arthocarpus	7.30
22.	Sengon	Faraserianthes falcataria	5.98
23.	Gamal	Glaricidae sp.	21.08
24.	Mahogany	Swietenia mahogani	12.02
25.	Kluwih/Breadfruit	Arthocarpus commune	41.43
26.	Bendo	Ficus Glomerata	4.10
27.	Jambu/Guava	Psidium sp.	19.98
28.	Casuarina tree	Casuarina sp.	6.12

Table 3.12. Types and Important value Index (IVI) of Secondary Forest Vegetation in the Area of Study (continued)

No.	Name of Plant	Latin Name	IVI
Undergrowth Level **)			
1.	Kaliandra	<i>Calliandra caliothris</i>	7.84
2.	Rattan	<i>Calamus</i> spp.	5.26
3.	Alang-alang/Tall grass *)	<i>Imperata cylindrica</i>	11.07
4.	Harendong *)	<i>Melastome malabathoricum</i>	14.29
5.	Harendong bulu *)	<i>Clidemia hirta</i>	3.33
6.	Kiciat	<i>Ficus</i> sp.	4.29
7.	Banana	<i>Musa</i> sp.	10.10
8.	Pacing	<i>Costus speciosus</i> *)	5.74
9.	Laban	<i>Vitex pubescens</i>	5.01
10.	Mikania	<i>Mikania</i> sp. *)	23.16
11.	Saliara	<i>Lantana camara</i> *)	3.20
12.	Kirinyuh	<i>Eupatorium inulifolium</i> *)	20.74
13.	Jambu/Guava	<i>Psidium guajava</i>	4.41
14.	Rumput pahit/Bitter grass	<i>Paspalum conjugatum</i> *)	4.11
15.	Gelagah *)	<i>Sacharum spontaneum</i> *)	4.65
16.	Harewos	<i>Melastoma</i> sp. *)	5.63
17.	Tapak liman	<i>Elephantopus scaber</i> *)	5.36
18.	Kakangkungan	<i>Impomea</i> sp. *)	5.80
19.	Pakis willis	<i>Diplazium</i> sp. *)	4.03
20.	Pulutan	<i>Urena lobata</i> *)	5.36
21.	Babadotan	<i>Ageratum conyzoides</i> *)	6.15
22.	Pandanus	<i>Pandanus</i> sp. *)	5.47
23.	Rumput janggut	<i>Digitaria lobata</i> *)	3.84
24.	Wild taro	<i>Colocasia</i> sp.	3.11
25.	Jukutriut	<i>Mimosa invisa</i> *)	4.82
26.	Kahawasan	<i>Axonopus compressus</i> *)	5.51
27.	Sonokeling	<i>Dalbergia latifolia</i>	4.13
28.	Bayam duri/Thorny spinach	<i>Amaranthus</i> sp. *)	1.94
29.	Sinrong	<i>Erechthites valerianifolia</i> *)	2.23
30.	Sembung	<i>Blumea</i> sp. *)	4.06
31.	Suweng	<i>Amorphophalus</i> sp.	6.34

*) Undergrowth

***) Counted according to RF + RD

b. Fauna

b.1 Wild animals

From the information collected, the wild animals of the area of the Kecamatan of Sumber Jaya consist of 20 species of mammals, 9 species of reptilians, and 10 species of birds (aves). These animals generally live in the forest, underbrush, agricultural field (ladang), and on the banks of Wai Besai. Among these animals some are protected by law. The wild animals found in the area of study can be seen in the Table 3.13 and those found in the planned location of the project on Table 3.14.

By comparing Table 3.13 with Table 3.14 and based on the formula of Sorensen, it is known that similarity index of mammals is 0.46, reptilians 1, and birds 0.66. Whereas the similarity index of all wild animal species in total is 0.7.

Table 3.13. Wild Animal Found in Kecamatan Sumber Jaya

No.	Name of Animal	Latin name	A b	Habitat
1.	Siamang/Gibbon	Hylobates syndactylus*	a	Fo, RB
2.	Monkey	Macaca sp.*	a	Fo, RB
3.	Hog/Wild boar	Sus sp.	b	Fo, Bu, Fi
4.	Tiger	Panthera tigris sumatrensis*	a	Fo
5.	Beruk/Macaque	Macaca sp.*	a	Fo, RB
6.	Kijang/Kind of small antelope	Mutiacus muncak	a	Bu, Th
7.	Deer	Cervus sp.	a	Fo, Th
8.	Wild goat	Capricornus sumatrensis*	a	Fo
9.	Kancil/Mouse deer	Tragulus javanicus*	a	Fo, Bu
10.	Tapir	Tapirus indicus*	a	Fo
11.	Bear	Helarctus malayanus*	a	Fo, Th
12.	Water civet	Cynogata bennetti*	a	RB
13.	Scaly anteater	Manis javanicus*	a	Fo, Bu, Th
14.	Sigung	Hydaus javanensis*	a	Fo, Bu, RB
15.	Porcupine	Histrix brachyura*	a	Fo, Bu, RB
16.	Macan akar	Neofelis nebulosa*	a	SF, Bu
17.	Otter		b	RB, Sa
18.	Ground squirrel	Lariscus insignis*	b	Fo, Es
19.	Flying squirrel	Ratufa bicolor*	a	Fo, Es
20.	Tree squirrel	Calloscirus notatus	b	Es
21.	Binuwak/Monitor lizard	Varanus salvator	a	RB
22.	Python	Python reticulatus*	a	RB
23.	Koros snake	Ptyas mucosus	a	Sw, RB
24.	Tree snake	Dryophis prasinus	a	Bu, Fo, RB
25.	Totog snake	Ophiophagus hannah*	a	Ft, RB
26.	Welang snake	Bungarus fasciatus*	a	RB
27.	Weling snake	Bungarus candidus*	a	RB
28.	Turtle		a	River
29.	Lizard	Mabouya multifasciata	b	RB, Sa
30.	Jungle fowl	Gallus gallus*	b	Bu, SF
31.	Rankong/Hornbill	Buceros sp.*	a	Fo
32.	Belib's/Teal		a	Sa
33.	Tekukur/Turtledove	Stroptopelia cinensistregina	b	SF, Fi
34.	Bincarung	Oriotus danensis	a	Fo, Th
35.	Titiran	Geopelia striata	a	Fo, Th
36.	Puyuh/Quail	Casturnix javanica	a	Bu, Fi
37.	Pipit/Sparrow	Lonchura leucogastroides	b	Sa, Bu, Es
38.	Elang/Eagle	Spilornis colapalindus*	a	Fo, Th
39.	Bondol	Hirundo tahitica	b	Sa, Bu, Es

* : Protected Fo : Forest Sa : Sawah RB : River Bank
 Ab : Abundance Bu : Bush Fi : Field SF : Secondary Forest
 a : scarce Th : Thicket Es : Estate FT : Forest Tree
 b : abundant

b.2 Domestic Animals

Domestic animals much raised by the local people are chicken (*Gallus sp.*), goat (*Capra hircus*), sheep (*Boven sp.*), and water buffalo (*Bubalus sp.*). Other domestic/pet animals are cat (*Felis sp.*), bird, and dog (*Cuon sp.*). Many of the population of Sumber Jaya keeps dogs as a "guard" when going to the field or as a helper when hunting.

Table 3.14. Wild Animal Found in around Project Location

No.	Name of Animal	Latin name	Ab	Habitat
1.	Siamang/Gibbon	<i>Hylobates syndactylus</i> *	a	Fo, RB
2.	Monkey	<i>Macaca sp.</i> *	a	Fo, RB
3.	Hog/Wild boar	<i>Sus sp.</i>	b	Fo, Sa, Fi
4.	Water civet	<i>Cynogata bennetti</i> *	a	RB
5.	Porcupine	<i>Histrix brachyura</i> *	a	Fo, Bu, RB
6.	Otter		b	Sa, RB
7.	Biawak/Monitor lizard	<i>Varanus salvator</i>	a	RB
8.	Python	<i>Python reticulatus</i> *	b	RB
9.	Koros snake	<i>Ptyas mucosus</i>	a	Sa, RB
10.	Totog snake	<i>Ophiophagus hannah</i> *	a	FT, RB
11.	Welang snake	<i>Bungarus fasciatus</i> *	a	RB
12.	Weling snake	<i>Bungarus candidus</i> *	a	RB
13.	Turtle		a	RB
14.	Lizard	<i>Mabouya multifasciata</i>	b	RB, Sa
15.	Jungle fowl	<i>Gallus gallus</i> *	b	SF, Bu
16.	Belibis/Teal		a	Sa
17.	Tekukur/Turtledove	<i>Streptopelia cinensis</i> stregina	b	SF, Fi
18.	Puyuh/Quail	<i>Casturnix javanica</i>	a	Sa, Fi
19.	Pipit/Sparrow	<i>Lonchura leucogastroides</i>	b	Sa, Bu, Es
20.	Bondol	<i>Hirundo tahitica</i>	b	Sa, Bu, Es

* : Protected Fo : Forest Sa : Sawah RB : River Bank
 Ab : Abundance Bu : Bush Fi : Field SF : Secondary Forest
 a : scarce Th : Thicket Es : Estate FT : Forest Tree
 b : abundant

(2) Aquatic Biota

a. Fish

Types of fish found in the Wai Besai, according to information from the people, are ikan semah (kind of goldfish), catfish (*Clarias batrachus*), gabus/snakehead (*Ophiocephalus gachua*), keting, baung, wader, sisili, gurami, goldsifh (*Cyprinus carpio*), tawes (*Ophintius javanicus*), mujair (*Tilapia mosambica*), and ikan nila (*Tilapia nilotica*). None of them are endanger nor of migratory spicies.

b. Aquatic Weeds

Some types of Aquatic weeds inventoried are: kayambang (*Salvinia molesta*), genjer (*Limnocharis flava*), eceng lembut (*Monochoria vaginalis*), semanggi (*Marsilea crenata*), and teki sawah (*Cyperus sp.*). These plants live as weeds in the sawah. Other plants are kangkung (*Ipomoea aquatica*) and kakangkungan (*I. fistulosa*) living on the shallow banks of calmly streaming rivers.

3.3 Socio-Economic and Socio-Cultural

3.3.1. Socio-Economic

(1) Demography

The population of the Kecamatan of Sumber Jaya are originated from West Java, Central Java, South Sumatra (Samendo and Ogan), and Lampung (from Krui and Liwa). In board outline, the population coming from West Java (Sundanese) are 55%, Central Java 12%, Samendo and Ogan 27%, and others 2% of the total population.

The number of population is 78,567. An agrarian density = $78,569/19,662 = 3,999$ population/ha (399.9 population/km²) and a geographical density = $78,567/41,500 = 1.89$ population/ha (189 population/km²). The number of population of each village can be seen in Table 3.15 and the number of population according to age group in the villages directly affected by the Project (Sukapura, Way Petai, and Dwikora) can be seen in Table 3.16.

Table 3.15. Number of Population of Kecamatan of Sumber Jaya

No.	Village	Population						Total
		< 12 yr		12-15 yr		> 55 yr		
		M	F	M	F	M	F	
1.	Purawiwitan	1,045	1,002	1,897	1,939	252	224	6,355.00
2.	Simpangsari	1,785	1,610	2,594	2,619	51	56	8,715.00
3.	Sukapura	265	352	760	705	122	141	2,345.00
4.	Puralaksana	564	592	615	967	148	151	3,037.00
5.	Muara Jaya *)	444	445	1,538	1,546	123	126	4,222.00
6.	Suka Menanti	427	324	1,445	1,437	32	42	3,707.00
7.	Suka Jaya	343	265	552	583	33	25	1,801.00
8.	Gunung Terang	264	249	434	434	64	59	1,504.00
9.	Suka Raja	196	183	722	557	41	44	1,743.00
10.	Way Petai	685	832	859	1,123	75	60	3,634.00
11.	Mutar Alam	753	733	1,537	1,435	8	5	4,471.00
12.	Pajar Bulan	278	377	1,337	1,663	187	134	3,976.00
13.	Pedang Tambak	174	199	1,313	1,529	29	71	3,315.00
14.	Tri Budi Syukur	609	450	676	686	64	54	2,539.00
15.	Karang Agung	250	331	735	601	28	32	1,977.00
16.	Tanjung Raya	240	226	634	795	20	27	1,942.00
17.	Sindang Raya	312	285	501	465	32	21	1,616.00
18.	Purajaya	1,214	1,273	1,424	1,944	71	49	6,025.00
19.	Pura Mekar	617	575	1,236	1,132	73	61	3,694.00
20.	Tambak Jaya	207	200	1,180	1,046	38	39	2,710.00
21.	Cipta Waras	283	267	451	430	31	13	1,475.00
22.	Tri Mulya	135	231	1,015	987	33	31	2,432.00
23.	Gedung Surian	231	232	478	371	29	49	1,390.00
24.	Sri Menanti	117	102	257	223	5	3	707.00
25.	Senarang Jaya	169	178	247	474	16	23	1,107.00
26.	Sidodadi	57	72	410	525	11	3	1,078.00
27.	Sumber Jaya	140	129	434	446	7	3	1,159.00
	Total	11,816	11,726	26,066	25,493	1,678	1,601	78,676

*) Village development: Muara Jaya Dua

Table 3.16. Number of Population According to Age group

Age Group (Year)	Name of village								
	Sukapura			Dwikora			Way Pital		
	M	F	Total	M	F	Total	M	F	Total
0 - 4	103	106	209	137	101	238	309	333	642
5 - 9	107	102	209	112	161	273	290	305	595
10 - 14	125	129	254	92	109	201	165	345	510
15 - 19	157	167	324	88	92	180	146	183	329
20 - 24	102	104	206	61	69	130	131	163	294
25 - 29	80	81	161	52	51	103	124	172	296
30 - 34	55	58	113	73	65	138	95	141	236
35 - 39	55	71	126	54	92	146	92	124	216
40 - 44	79	65	144	209	367	576	84	98	182
45 - 49	67	56	123	86	62	148	81	76	157
50 - 54	57	55	112	104	55	159	64	53	117
55	52	42	94	96	107	203	84	68	152
Total	1,039.0	1,030.0	2,069.0	1,164.0	1,331.0	2,495.0	1,663.0	2,061.0	3,726.0

Source: Potensi Desa (Village Potensial), 1989

The average rate of growth of the population in the area of study is 2.68 % (Table 3.17)

Table 3.17. Population Growth

No.	Year	Total	Growth (%)
1.	1981	65,255	
2.	1982	64,907	-0.53
3.	1983	66,131	1.9
4.	1984	67,055	1.4
5.	1985	70,779	5.5
6.	1986	75,589	6.7
7.	1987	76,519	1.2
8.	1988	78,567	2.6
Total			18.77
Average			2.68

(2) Education

The level of education in the area of study is depicted by the sample villages investigated (Table 3.18), as follows: no school-education (NS) 16.29%, not passing Elementary School (NES) 27.67%, Elementary School (ES) 35.68%, Junior High School (JHS) 5.88%, Senior High School (SHS) 3.51%, Higher Education (HE) 0.50%, and illiterate (IL) 10.37%.

Table 3.18. Level of Education each Villages

No.	Village	Education							Total	
		NS	NEB	ES	JHS	SHS	HE	IL	Population	HF *)
1.	Sukapura	378	423	726	215	67	13	247	2,069	419
2.	Way Petal	942	748	1,500	300	100	62	74	3,726	717
3.	Dwikora	244	17	868	159	63	7	1,137	2,495	479
4.	Tribudi Syukur	275	527	689	80	58	26	246	1,901	399
5.	Purawiwitan	879	2,560	1,836	431	229	-	383	6,318	1,460
6.	Tanjung Raya	375	769	600	40	18	3	152	1,957	391
7.	Suka Jaya	271	765	542	39	15	2	174	1,808	362
8.	Semarang Jaya	254	458	198	27	12	-	129	1,078	227
9.	Karang Agung	384	286	2,063	114	52	7	77	2,983	479
10.	Suka Raja	358	850	524	170	327	16	247	2,492	483
Total		4,360	7,403	9,546	1,575	941	136	2,866	26,827	5,416
Average		16.25	27.60	35.58	5.87	3.51	0.51	10.68	100	

*) HF = Head of Family

(3) Employment categories

The result of data collection in 10 villages show that the main occupation of the population is as follows: farmer (88.33%), trader (2.22%), laborer (2.22%), and others (workshop, civil servant, driver, and other service) (7.23%).

Whereas the secondary means of support, or side jobs are: farmer 13.21%, trader 22.64%, laborer 37.73%, and others 26.43% as can be seen in Table 3.19.

Table 3.19. Main and Secondary Occupation in Area of Study

Village	Type of Work occupation							
	Main				Secondary/Side			
	Farmer	Trader	Laborer	Others	Farmer	Trader	Laborer	Others
Sukapura	23	-	-	2	1	1	1	2
Way Petal	21	4	-	-	1	-	-	5
Dwikora	17	-	-	8	2	1	3	2
Tribudi Syukur	15	-	-	-	-	-	-	2
Purawiwitan	15	-	-	-	-	-	12	-
Tanjungraya	15	-	-	-	-	-	-	3
Sukajaya	13	-	2	-	-	3	3	-
Semarang Jaya	15	-	-	-	-	2	-	-
Karang Agung	10	-	2	3	3	3	1	-
Suka Raja	15	-	-	-	-	2	-	-
Total	159.00	4.00	4.00	13.00	7.00	12.00	20.00	14.00
Percentage	88.33	2.22	2.22	7.22	13.21	22.64	37.74	26.42

(4) Manpower Labor Potensial

The data on manpower are obtained by grouping the population according to age, i.e. productive manpower (age 10-55 years) and unproductive manpower (age less than 5 years and over 55 years). The data collected show that productive manpower accounts for 6.22% of the total population and unproductive manpower 32.78%. Unproductive manpower forms a burden for productive manpower with and average rate of dependability of 0.49 (as can be seen in Table 3.20).

Table 3.20. Ratio of Dependency According to Age of population

No.	Village	Number of Population According to Age			Rate of Dependability
		< 10 year	10-65 year	> 65 year	
1.	Sukapura	422	1541	105	0.34
2.	Way Petai	1235	2239	152	0.62
3.	Dwikora	502	1425	568	0.75
4.	Tribudi Syukur	480	1361	60	0.40
5.	Purawitan	1629	4216	476	0.50
6.	Tanjungraya	427	1393	137	0.40
7.	Suka Jaya	450	1300	58	0.39
8.	Semarang Jaya	327	709	42	0.52
9.	Karang Agung	537	2261	185	0.32
10.	Suka Raja	641	1473	303	0.64
Total		6,650	17,918	2,086	0.49 *)
Percentage		24.95	67.22	7.83	

Note : Dependency ratio =

*) Average

$$\text{Dependency ratio} = \frac{<10\text{yr} + >55\text{yr}}{10-54\text{yr}}$$

The dependency ratio is the number of unproductive population divided by the number of productive population. A ratio of 0.49 means that every 49 unproductive population become the dependents of 100 productive population. In the other words, one productive manpower assumes liability for 0.49 unproductive manpower.

(5) Settlement

In general, the settlement of the population is spread on the side of the (asphalted) highway, or at least can be reach by four-wheel motor vehicles.

The result of observation shows that no population settlement is found along the length of the river. This is and indication that the pollution of the Way Besai caused by domestic waste is relatively small. The condition of housing of the population in the area of study can be seen in Table 3.21.

(6) Transportation Network

The provincial road connecting the city of Liwa and the city of Kotabumi pass the Kecamatan Sumberjaya. All villages in the Kecamatan of Sumber jaya can already be reached by four-wheel motor vehicles, although some villages are difficult to be passed by four-wheel vehicles in the rainy season.

The length and condition of the roads can be seen in the Table 3.22 and the number of motor vehicles and the distance from the village to the Kecamatan capital in Table 3.23. The condition of the road leading to Bukit and Kotabumi (district's capital) is very good asphalted.

Table 3.21 Condition of Housing of the Population

No.	Village	Permanent	Semi-permanent	Simple	Others	Total
1.	Simpangsari	304	1,218	213	8	1,743.00
2.	Sukapura	57	47	126	238	468.00
3.	Way Petai	106	594	24	-	724.00
4.	Suka Jaya	25	124	68	144	361.00
5.	Sindang Pager	10	305	8	-	323.00
6.	Puralesana	20	587	28	-	635.00
7.	Pajar Bulan	76	536	147	-	759.00
8.	Karang Agung	10	111	310	-	431.00
9.	Mutar Alam	12	338	522	20	892.00
10.	Tanjung Raya	10	188	165	-	363.00
11.	Sukananti	12	468	256	-	736.00
12.	Suka Raja	4	323	-	-	327.00
13.	Padang Tambak	3	278	378	-	659.00
14.	Tambak Jaya	10	269	263	-	542.00
15.	Tri Budi Syukur	12	358	95	-	465.00
16.	Putra Jaya	40	828	318	-	1,186.00
17.	Purawitan	197	679	230	150	1,256.00
18.	Muara Jaya	2	519	98	-	619.00
19.	Muara Jaya Dua	3	154	59	-	216.00
20.	Pura Mekar	84	137	517	-	738.00
21.	Cipta Waras	5	202	79	-	286.00
22.	Tri Muiyo	6	241	249	-	496.00
23.	Sri Menanti	2	103	32	-	137.00
24.	Sido Dadi	2	184	33	-	219.00
25.	Gunung Terang	4	88	195	-	287.00
26.	Gedung Surian	3	186	82	-	271.00
27.	Sumber Alam	3	191	41	-	235.00
28.	Semarang Jaya	4	202	15	-	221.00
T o t a l		1,026.00	9,458.00	4,551.00	560.00	15,595.00
Percentage		6.58	60.65	29.18	3.59	100.00

Source: Data of Kecamatan of Sumber Jaya

Table 3.22. Length and Condition of Road

No.	Type of Road	Condition of Road			Length of Road (km)
		Fair (km)	Inadequate (km)	Very Poor (km)	
1.	Asphalted	15	19	8	42
2.	Gravel/Sub-stratum	-	-	15	15
3.	Earth	-	10	10	20
T o t a l		15.00	29.00	33.00	77.00

Table 3.23 Number of Motor Vehicles per Village and the Distance of Village to Kecamatan Capital

No.	Village	Jeep	Sedan	Pick-up	Bus	Truck	Motor-cycle	Distant Village-Capital
1.	Simpangari	3	4	25	4	18	42	0
2.	Sukapura	1	-	14	5	8	22	1
3.	Way Petal	-	-	17	1	6	19	2
4.	Suka Jaya	-	-	5	-	-	5	11
5.	Sidang Pagar	-	1	3	-	4	25	12
6.	Puralaksana	1	2	10	1	3	13	15
7.	Pajar Bulan	1	3	24	5	10	45	15
8.	Karang Agung	-	-	6	2	-	10	16
9.	Mutar Alam	-	-	15	1	1	32	17
10.	Tanjungraya	-	-	2	-	-	6	19
11.	Sukananti	-	-	58	-	8	22	20
12.	Suka Raja	-	-	11	-	1	21	20
13.	Padang Tambak	-	-	6	-	2	11	21
14.	Tambak Jaya	-	-	2	-	2	17	25
15.	Tribudi Syukur	-	-	1	-	-	18	7
16.	Pura Jaya	-	-	14	5	13	115	10
17.	Purawilitan	-	-	7	1	2	42	12
18.	Muara Jaya	-	-	6	-	-	15	17
19.	Muara Jaya Dua	-	-	2	-	-	6	15
20.	Pura Mekar	-	-	14	-	-	36	23
21.	Cipta Warna	-	-	3	-	-	12	25
22.	Tri Mulyo	-	-	4	-	-	16	26
23.	Sri Menanti	-	-	1	-	-	9	27
24.	Sido Dadi	-	-	2	-	-	5	25
25.	Gunung Terang	-	-	4	-	-	13	29
26.	Gedung Surian	-	-	2	-	-	14	24
27.	Sumber Alam	-	-	2	-	-	8	27
28.	Senarang Jaya	-	-	1	-	-	4	26
Total		6.00	10.00	261.00	25.00	78.00	603.00	

(7) Public's Health

Medical officials serving the population consist of 3 physicians, 16 medical aides/nurses, 2 midwives, and 199 traditional midwives.

The disease most striking the population is malaria (20.29%) and least the disease of the oral cavity (3.20%). The types of disease and the number of population stricken can be seen in Table 3.24 and types of disease according to age can be seen in Table 3.25.

Table 3.24 Types of Disease and Number of Population Stricken

No.	Disease	Number	Percentage
1.	Malaria	2,835	20.30
2.	Disease of the upper respiratory tract	1,480	10.60
3.	Disease of the skin and lower skin tissue	1,458	10.44
4.	Influenza	967	6.92
5.	Diarrhoea	753	5.39
6.	Side ulcer	703	5.03
7.	Disease of the bone muscle	624	4.47
8.	Infection of the intestine	575	4.12
9.	Disease of the oral cavity	448	3.21
10.	Mishap	354	2.53
11.	Others	3,769	26.99
Total		13,966.00	100.00

Source: Puskesmas (Community Health Center), Pajar Bulan.

Table 3.25. Types of Disease According to Age Group

No.	Age Group	Type of Disease
1.	0 - 4	Diarrhoea, Influenza, Aer and Mastoiditis
2.	5 - 9	Malaria, Diarrhoea, Influenza, Aer and Mastoiditis
3.	10 - 14	Influenza, Malaria and Rabies
4.	15 - 24	Influenza, Malaria and Rabies
5.	24 - 49	Malaria, Thyphoid Fever, Bronchitis, and Diarrhoea
	> 50	Malaria, Thyphoid Fever, Bronchitis, and Ear

Source: Puskesmas (Community Health Center), Fajar Bulan.

(8) Agricultural Production

Farmland in the area of study consists of home garden, sawah (wet rice cultivation), tegalan/ladang/field (unirrigated cultivated), and private plantation. In general, home garden and tegalan/ field are planted with plantation crops or food crops (palawija). In village of which the majority of the population originates from West Java (Sundanese), the yards are usually used for ponds to raise fish. Almost the whole land area is planted with coffee and small part is used as a mixed crop of coffee and clove or pepper.

The farming activity of the population is mainly focused on sawah rice and coffee with an average production of 4.04 ton unhulled riced per hectare and 0.90 ton coffee beans per hectare (Table 3.26) respectively.

Table 3.26. Average Rice and Coffee Production

No.	Village	Production (Ton/ha)	
		(Unhulled) Rice	Coffee (Beans)
1.	Sukapura	4.15	0.92
2.	Way Petai	4.24	0.90
3.	Dwikora	-	0.78
4.	Tribudi Syukur	4.12	0.96
5.	Purawiwitan	4.08	0.83
6.	Tanjungraya	3.62	0.79
7.	Suka Jaya	3.47	0.91
8.	Semarang Jaya	-	0.87
9.	Karang Agung	4.03	1.15
10.	Suka Raja	4.61	0.93
Total		32.32	9.04
Average		4.04	0.90

(9) Land Price

Land Price in the affected villages varies from Rp. 6 millions to Rp. 7 millions depends on the land type and the crop. The price of the land is depended on the distance to the road, kind and age of the crop.

Table: 3.26a Land Price in the affected village

No	Villages	Price of Land (x Rp. 1,000,000,-)		
		Ricefield (simple irrigation)	Plantation (Coffee, Clove etc.)	Dry Field
1.	Sukapura	7	7	1,5
2.	Waypetai	7	7	1,0
3.	Dwikora	6	6,5	1,0

3.3.2. Socio-Cultural

(1) Community perception

Social survey conducted in April 1993 to find out the perception of the people who live in the area. About hundred families were asked specific question by the consultant and findings are based on survey. These families included the PAP's and others. Almost the entire community (99.0%) came out strongly in support of the project. The only person who gave the "floating answer" said that he believed in whatever the Government would do, as shown in table 3.27.

Table 3.27. Community Perception in the Surrounding Besai HPP Project

Villages	Agree		Normal		Against		Total	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Dwikora	25	100.0	-	-	-	-	25	100.0
Sukapura	25	100.0	-	-	-	-	25	100.0
Way Petai	25	100.0	-	-	-	-	25	100.0
Suka Jaya	12	100.0	-	-	-	-	12	100.0
Simpang Sari	12	99.0	1	1.0	-	-	13	100.0

The existence of HPP will create positive impact in harmony with perception and expectation of community in the vicinity of project. The concerned people stated that it will bring a significant changes or life improvement in the life of the village community. The availability various infrastructure such as road, transportation, and electric energy would create new activities in agriculture sector and industrial sectors.

The expectation of community regarding the existence of HPP, and utilization of land compensation received from PLN will be utilized as a capital for productive activities. Table 3.28 indicated that 35 % stated that they would use the compensation money for buying land in other places and 33 % would run small or carry on business activities. There is no utilization for consumptive purposes, except only small portion approximately 4.0% for houses improvement, and another 18.0% will be utilized mostly for school expense and saving.

Another expectation of community in regard to project construction stage is the willingness of local community to get jobs in the project activity.

Table 3.28. Utilization of Land Compensation, Perception and Expectation of Community

Villages	Buy land		Build/improve house		Carry on trade		Buy consumptive product		Others *)		Total	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Dwikora												
Sukapura	9	36.0	2	8.0	14	56.0	-	-	-	-	25	100.0
Way Petai	10	40.0	1	4.0	11	44.0	-	-	3	12.0	25	100.0
Suka Jaya	8	32.0	1	4.0	11	44.0	-	-	5	20.0	25	100.0
Simpang Sari	4	33.0	-	-	4	33.0	-	-	4	33.0	12	100.0
	4	31.0	-	-	3	23.0	-	-	6	46.0	13	100.0
	35	35.0	4	4.0	43	43.0	-	-	18	18.0	100	100.0

*) School budget and saving

(2) Conflict

Surrounding Besai Project was forest which belong to State Land when the people gradually moved in from other places and converted the forest to be agriculture areas, it happened in early 1950's. When the Forestry Department conducted the reformation of the status of the forest category, this area was included into the category of protected area.

In 1985 the Forest Authority undertook the reforestation in the settlement of the population in the village of Sukapura, with an area of 350 ha to be reforested. Before implementation of reforestation was continued, the population lodged a protest and a physical clash almost occurred between the population and the reforestation officials. As a result of this protest, finally the reforestation has not been carried out until the present.

Out of 50,1 ha project affected forest there is 15,2 ha of planted land by about 40 people. Conflict will not be provoked by this project, since the Compensation Committee will give the fair compensation price on the affected land which planted by the people.

Ministry of Forestry, on August 31 1993, issued approval letter to use the protected area (*hutan lindung*). Based on this letter project proponent (PLN) should provide a Plan of Reforestation and Land Rehabilitation on upper catchment area. To response of this letter PLN will provide a fund for the study which will be carried out by the consultant. The consultant will prepare the plan which may be accepted by the both parties the people and the Forestry Agency.

(3) Public consultation

Public consultation has been held on September 14, 1993 at the project site. 125 people attended the meeting minutes of the meeting are enclosed at annexure and several questions expressed in the meeting. The local peoples who live around the

project, stated that they agree to the plan of government to develop the Besai Hydro Electric Power Plant Project.

The important questions asked in that meeting were as follows:

1. Explanation of the basic principle of compensation that will be fixed for the land, plants, and buildings.
2. When will the compensation be given ?.
3. The details of the area especially for Dwikora village which will be affected by the Besai HEPP Project.
4. What is the status of the land which will be affected by the construction activity of the project despite the fact that the land has not been acquired yet?
5. Can the acquired land be used by the people before it is inundated by the water.
6. Can the people who live around the project get work in the construction activities?
7. Someone just bought some bush land. Can he ask for the compensation of it?

The response of the project proponent (PLN and the members of the compensation committee were as follows to the above question:

1. The land acquisition for the Government/public services is according to Keppres (President Decree No. 55/1993) which provides deliberation between the land Acquisition Committee and the owner of land.
2. The compensation will be given after the stacking out, cadastral survey, and the inventory of the land, plants, and other temporary structures are done completely. The compensation will be on principle of replacement costs.
3. To know the exact area that will be affected by the project one must go through these following steps :
 - a. Stacking out : to define the area's border
 - b. Cadastral survey : to make the detailed border of each piece of land
 - c. Inventory : to Collect the data of all the land, plants, and buildings.

This activity has already started at the local level and a time-schedule in annexed

4. Once the acquisition proceeding has been initiated, land holder can continue to use the same but cannot sell it to others.
5. The acquired land will belong to the PLN, so it may not be used by the people anymore.
6. PLN will encourage the Contractor to employ as many eligible local workers as possible.
7. All types of land holdings, irrespective of legal ownership will get compensation. But it must follow the procedure such as the inventory of the land and its status, number of plants and the size and condition of temporary structures.
The presidential decree provides for full compensation at a replacement value.

IV. ENVIRONMENTAL IMPACT

1. Negative environmental effects of construction:

a). Air and water pollution from construction and waste disposal.

Air quality in the village might be affected by the construction traffic such as dust or noise. To overcome those problems, several measures will be applied. The dust from the access road will be suppressed by the water spraying especially during the dry season. Noise will be suppressed by enforcement to use noise abatement in every construction vehicles. The exhaust gas emitted by the construction vehicles will disperse and the ambient concentration can be neglected in the village. So the impact of construction on air quality is considered a minor one if those measures are taken properly

The waste produce from the project activities can be divided into two categories, i.e. domestic waste and construction waste.

The domestic waste will be collected and disposed in the special disposal area far from the village.

The construction activities will produce several type of waste such as metal, paper, wood, soil or concrete aggregate. Metal, paper and wood will be recycled (collected and sold or re-use) so no waste on this categories will be disposed. Soil and concrete aggregate will be used for land reclamation or disposed in the soil disposal area. Reclamation of soil disposal area will be conducted such as terracering and replanting of trees and grasses.

b). Soil Erosion

Land clearing, cut and fill and soil disposal area can increase the rate of soil erosion if not carefully managed.

The erosion rate will be suppressed by several measures:

- Soil trap such as land holes if applicable in such area will be developed to trap the soil transported by the run off.

The water embankment will be avoided to prevent mosquito breeding area.
- Terracering and land reclamation on soil disposal area and on bare land area will be adopted
- Grasses or trees will be planted on the bareland caused by construction activities and on disposal area after the work finished.

c). The impact of construction worker camps.

There is several base camps which will be develop for the construction labors and employees. PLN will develop the camps for the PLN Project's employees and for the project engineers. The contractors will develop their own camp after the design being approved by the project engineers. Project proponent will ask that the camps should be provided with the health care facilities, standard sanitation facilities and sport/entertainment facilities. The polyclinic develops by the project proponent and the health care facilities developed by the contractors will support with each other. The local people may use those facilities as emergency besides the Health Center (PUSKESMAS) which exists on that area.

There are also benefit opportunities for local people to get the contract of lodging facilities for the outside construction workers.

2. Dislocation of people living in inundation zone.

No families living in the inundation zone.

The project will pay the fair compensation of land, crop/vegetation and houses/building based on negotiation between the people and land compensation committee.

After the project they will get better access road and electricity. They may use the polyclinic developed by the project. Priority of employment in the project will also be given to the affected people.

3. Lost of agricultural and forest land by inundation to form reservoir.

Besai HEPP is a run off river type power plant, the reservoir is designed to hold water for daily power generation, so the acreage of land for reservoir is only 140 ha and the impact is considered medium.

The land which belong to the people (agriculture land) will be compensated according to the President Republic of Indonesia Decree No. 15 of June 17, 1993. The owner and the compensation committee will sit together to negotiate the compensation value. The compensation payment will account for land, building and vegetation (crops).

The land which belong to Forestry agency will be replaced with such kind of land to be reforested in ratio of replacement of 1 : 1. The area of replacement has not decided yet, the Forestry Agency will give the condition of replacement land. The compensation of the replacement land will be proceeded according the regulation and the procedure as well as above.

4. Loss of historic, cultural or aesthetic features by inundation.

No historic, cultural and aesthetic features in the reservoir area. So this project will give no impact on these objects.

5. Loss of wildlands and wildlife habitat.

The project will use part of agriculture converted land forest or bushes forest land. The acreage of forest land to be used will be small compared those the adjacent forest area. Most of the forest area used by the project has been converted into coffee plantation.

The impact on wildlands and wildlife habitat is not considered to be significantly adverse for the following reasons. Although there are several protected animals such as gibbon, Monkey, water civet, porcupine and several snake sometime reported show up in the proposed project area, the main habitat of those animals area in adjacent forest area. Construction activity might disturb those animals, but they will naturally avoid the construction area. The habitat will be insignificantly reduced, so the impact is considered insignificant.

6. Proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation, navigation and fisheries and increasing water loss through transpiration

Vegetation in the reservoir area prior inundation will be cleared to reduce the nutrient source for future aquatic weeds.

The area of reservoir is relatively small, so aquatic weeds ca be removed easily in regular basis so it will not grow out of control.

7. Deterioration of water quality in reservoir

The vegetation in reservoir area if it is let uncleared, when it is inundated, it might cause eutrophication.

The area of future reservoir consist of agriculture area and secondary forest (shrub, brush etc.) it relatively contains few trees. Total vegetation clearing will be conducted to avoid deterioration of water quality in future reservoir area.

8. Sedimentation of reservoir and loss of storage

Erosion in upper catchment area will affect the storage of reservoir. To overcome the problem several measures will be taken:

- The Agency for Soil Conservation and Rehabilitation will make extension information to the farmer for better agriculture practice. Regreening will also be conducted in the bare land area.
- Flushing of sediment in reservoir will be conducted regularly.

9. Formation of sediment deposit at reservoir entrance creating backwater effect and flooding and waterlogging upstream.

Besai HEPP is a run off river type power plant, the reservoir is designed to hold water for daily power generation, so the volume of reservoir is relatively small and the current of water is also relatively high. It is considered that it will not cause the formation of sediment deposit at reservoir so much. During the high discharge

scouring effect of sediment in reservoir will make the balance of it. There is no dwelling areas or agricultural area which might be affected by the back water of Besai HEPP.

10. Scouring of riverbed below dam

The power plant has been designed to overcome the potential scouring effect of the water release through the sluiceway. The horizontal stilling basin of 33.5 m wide and 16.0 m long is designed to dissipate the energy of design flood equivalent to 100 years probable peak discharge. The scouringway of 16.5 m wide and 25.4 m long is facilitated with each two numbers of upper and lower-scouring gates, for the purpose of flushing out bed loads through the lower scouring gates and suspended loads through the upper ones. each gate is 6.0 m wide and 1.5 high. The size of scouringway is designed so as to ensure at least the same scouring capacity as existing river.

The impact of scouring of riverbed below the dam is considered insignificant.

11. Decrease in floodplain (recession) agriculture

There is no irrigation downstream of the dam.

12. Salinization of floodplain lands

Besai River is small tributaries of Tulang Bawang River.

There is no anticipated impact of Besai HEPP on salinization of floodplain lands.

13. Salt water intrusion in estuary and upstream

There is no impact of Besai HEPP on salt water intrusion in estuary and upstream.

14. Disruption of riverine fisheries due to changes in flow, blocking migration, and changes in water quality and limnology.

River flow will be greatly reduced in the approximately 5 Km section of river between the diversion weir and the power station outlet, particularly during the dry season. This will reduce the available habitat for aquatic organisms in the following ways.

- The volume of water and hence aquatic habitat, will be less.
- Reduce water velocity may render the river less suitable for species adapted to fast flowing waters.

These impacts will be long term and to a large extent irreversible, but it does not consider to be significant for the following reasons:

- The fish species and major invertebrate groups found in the affected river section are also found in abundance both upstream and downstream of project area.

- The river does not support an important economic, subsistence or recreational fishery.
- The fish species within the Besai River do not appear to be unique or endemic or migratory one to the Tulang Bawang river and are found throughout Sumatra.

15. Snagging of fishing nets in submerged vegetation in reservoir.

The area of future reservoir consist of agriculture area and secondary forest (shrub, brush etc.) it contains few trees.

Total vegetation clearing will be conducted to avoid snagging of fishing nets in submerged vegetation in reservoir area.

16. Increase of water related diseases.

The addition of water surface might provide the habitat of mosquito to breed, in other hand the rate of malaria incidence in the area is relatively high. So there is a potential of new habitat for malaria mosquito to breed.

Fortunately, reservoir of Besai HEPP is a daily pondage for daily generation, so the current of the reservoir will be too strong for the mosquito to breed. In case that the mosquito successfully breed in the reservoir, it will be overcome by restocking of fish that will eat mosquito larvae.

The Health center will elaborate to dismiss the rate of malaria prevalence and mosquito.

17. Conflicting demands for water use.

There is no conflicting demands for water use since there are no river water usages along the river down stream of the dam (riparian people, navigation, irrigation and other).

18. Social disruption and decrease in standard of living of resettled people.

Lost of agricultural land might result the decreasing of income and in turn it will decrease the standard of living as well.

For the Besai people, this condition will likely be happened for temporary basis. More than 78 % of affected people expressed their willingness that they will use their compensation money for productive use (purchase agriculture land, open new business etc.) and none of them will use their money to buy consumptive goods. To dismiss the using money unwisely, extension of information will be conducted by project proponent to affected people.

To minimize the negative impact and to enhance the positive impact the project proponent (PLN) will also initiate several measures, such as:

- a. To give priority to local people (affected people) to work on project.

- b. To provide services such as : electricity, access to polyclinic developed by the project.
- c. To provide the training on several skills such as:
 - Home industries
 - Carpenter, masonry, mechanical technicians etc.
 - Fisheries, animal husbandry
 - Small trading

19. Environmental degradation from increased pressure on land.

To overcome the problem the sectoral agency such Agricultural Agency, Plantation Agency and Soil Conservation and Rehabilitation Station and will elaborate to extend the information regarding better practice of agriculture work.

20. Disruption/destruction of tribal/indigenous groups.

There is no tribal/indigenous groups in the affected area of Besai HEPP.

21. Increase in humidity and fog locally, creating favorable habitat for insect disease vectors (mosquitos).

The climate in the surrounding Besai area is humid. Reservoir surface of Besai HEPP of 101 Ha is considered too small to change the humidity in the area. Reservoir of Besai HEPP is a daily pondage for daily generation, so the current of the reservoir will be too strong for the mosquito to breed. In case that the mosquito successfully breed in the reservoir, it will be overcome by restocking of fish that will eat mosquito larvae.

22. Impact of reservoir on drinking water pumped from shallow well.

Reservoir of Besai HEPP is relatively far from the dwelling area. Most of the dwelling area are located along the high way of Liwa - Kotabumi or along the village road. The people get the drinking water from the spring water or shallow water near their houses, so no impact of future reservoir on existing drinking water.

23. Impact of dry river bed between dam to the power house.

During the dry season the river bed between dam to the power house will be regularly dry for several days or weeks, especially when the incoming flow lower than the power generation outflow.

There are no people living in that area, since that area is very steep. There are no wild animal which will be affected by those condition. There is no migratory fish found in the river.

24. Impacts of earthquakes and floods

The project has been designed to accommodate the seismic acceleration for this area. The weir of Besai HEPP is only 8 m high and the surface area of the reservoir is only 101 Ha, so the induced seismic of the reservoir can be neglected and it will

not likely cause the hazard to environment.

The holding capacity of the reservoir to reduce the floods water from upstream will be small due to its capacity. Most of the floods will be passed through the sluiceway. The sluiceway is designed as a wholly gated concrete overflow weir of 33.5 m wide, 25.2 m long and 6.5 m high which is provided with four numbers of sluice gates. It is sufficiently to release not only 100 years probable peak discharge of 800 m³/sec but also 10,000 years probable peak discharge of 1,400 m³/sec.

25. Impact of waste lubricant oil

The waste of lubricant oil will come from several sources such as :

- Vehicles used for construction and operation activities
- Bearing of the movement part of the power plant.

The waste lubricant oil will be managed in environmentally acceptable manner, it will be collected in drums and will be sent to PERTAMIMA (the agency who have the authority to collect the waste lubricant oil).

26. Impact of transmission lines

The Electric power generated by this project will be transmitted through 150 KV high voltage to Bukit Kemuning Sub station. The distance of the Besai powerhouse to Bukit Kemuning is 16 Km. It pass the hushes and agriculture area, and no houses will be passed by the transmission lines. The impact of the transmission lines is considered insignificant.

I N D I R E C T

27. Uncontrolled migration of people into the area made possible by access roads and transmission lines.

The project area is located between the city of Liwa and Kotabumi, and have smooth surfaced asphalt high way, so this area is relatively an open area. The access road of the project is relatively short (2 Km) and it through agriculture area. The uncontrolled migration of people into the area will likely not be happened.

The transmission line will be built in parallel with the existing high way to Bukit Kemuning High way. Based on experience on the recent transmission that there is no uncontrolled migration of people along the transmission lines.

28. Environmental problems arising from development made possible by dam (irrigated agriculture, industries, municipal growth).

Due to topographic condition there is no possibility to develop irrigation in this area. Electric energy from Besai HEPP will stimulate the industrial growth in this region, especially near the city of Bandar Lampung, but it is unlikely in the surrounding of Besai HEPP.

EXTERNAL

- 29. Poor land use practices in catchment areas above reservoir resulting in increased siltation and changes in water quality.**

The agriculture practice in the catchment area that might share the major erosion rate is private coffee plantation. The habit of people to clear all of the weed under the coffee tree will increase the erosion rate.

To overcome the problem of erosion, the Agency for Soil Conservation and Rehabilitation and other involved agencies will make extension information to the farmer for better agriculture practice and greening in the critical land.

V. ANALYSIS OF ALTERNATIVES

5.1. Background

PLN's Region IV is the largest of its fourteen regions in terms of the geographic area covered. It includes four provinces in Sumatra, viz., South Sumatra, Bengkulu, Lampung and Jambi.

The total installed generating capacity in the region is 620 MW, of which 454 MW is in the South Sumatra and Lampung provinces. In addition to the central generating stations at Kramasan (2 x 12.5 MW oil fired steam turbines and 3 x 14.7 MW oil-fired gas turbines), Bukit Asam (2 x 65 MW coal-fired units), and the central plant at Tarahan (77.7 MW), there are about 400 diesel units, operating in over 150 independent generating centers. The Region IV has about 1,500 km of 150 kV and 70 kV Transmission lines, 4,800 km of medium voltage (20 kV and 12 kV) lines and about 6,400 km of low voltage lines.

In addition to PLN's generating facilities, there are about 487 captive generating installations totalling 790 MVA; none of them connected to the PLN network. Two major captive installations in Palembang are owned by Pusri Fertilizer (60 MW), and Pertamina (40 MW).

Bukit Asam coal-fired thermal power plant 2 x 65 MW units 3 and 4 are under construction at the unit 3 is due for commissioning in January 1994. Another 60 MW of gas turbines will be commissioned at Palembang in 1993/94.

5.1 Necessity of the Project

The population of the region is about 16 million, i.e., approximately 3.2 million households. The region has 5,734 villages. The total number of electrified households is about 690,000 (22%) and electrified villages is 1,749 (30.5%). Since 1991, the region has been declared as "critical" in terms of supply capacity and new industrial connections are not provided. Also, new residential consumers have to restrict their connected load under 2.2 kVA.

The major power sources planned to be developed by PLN for the system are as follows:

<u>Power source</u>	<u>Installed capacity (MW)</u>	<u>Accumulation (MW)</u>	<u>Remarks</u>
- Existing installation	483.3	483.3	Calculated up to the year of 1991
- Diesel	-3.9		Retirement in 1992
"	20.0	499.4	Installed in 1992
- Diesel	-5.0		Retirement 1993
- Mini hydro	0.2		Installed in 1993
- <u>Bukit Asam #3</u> (Coal fired-Steam power)	<u>65.0</u>	559.6	"
- Diesel	-4.4		Retirement in 1994
"	4.0		Installed in 1994
- <u>Bukit Asam #4</u> (Coal fired-Steam power)	<u>65.0</u>	624.2	"
- Mini hydro	1.1		Installed in 1995
- Diesel	-5.1		Retirement in 1995
"	21.0		Installed in 1995
- <u>Tarahan #1</u> (Steam power)	<u>65.0</u>	706.2	"
- Diesel	-5.7		Retirement in 1996
"	5.0		Installed in 1996
- Gas turbine	-15.0	690.5	Retirement in 1996
- Diesel	-7.1		Retirement in 1997
"	6.0		Installed in 1997
- <u>Tarahan #2</u> (Coal fired-Steam power)	<u>65.0</u>	754.4	"
- Diesel	-9.1		Retirement in 1998
"	8.5		Installed in 1998
- Gas turbine	-14.0		Retirement in 1998
- <u>Besai HEPP</u>	<u>90.0</u>	829.8	Installed in 1998

The integrated power supply systems of Lampung and South Sumatera provinces has been completed in 1992, connecting with each interconnected power supply system through a 150 kV transmission line. In order to send the produced electric power to the major load centers of Lampung and South Sumatera provinces, the Besai project has about 16 km long 150 kV transmission line to connect it with the 150 kV integrated transmission line system around Bukit Kemuning.

According to the power demand forecast made by PLN for the whole system of PLN Region-IV, the required energy production and the peak load demand will be 3,450 GWH and 650 MW in 1998, the expected commissioning year of the Project, as shown in tabel below.

Year	Required energy	Load factor		Peak load capacity factor	Reserved installed capacity	Required
	(GWH)	(%)	(MW)	(%)		(MW)
1988	1,170	67	230	30		330
1993	2,190	60	420	30		600
1998	3,450	61	650	30		930
2003	5,500	61	1,030	30		1,470

Judging from the power demand forecast and the planned power sources mentioned above, e.g. the required installed capacity of 930 MW and the planned installed capacity of 830 MW in 1998, it is recommended to implement the Besai Hydro electric Power Project as early as possible taking its construction period into consideration. The Project will be able to come on stream in 1998 due to a lead time necessary for design, tendering and construction.

Implementation of the project is also along the policy of the Indonesian government, namely, the oil resources would be preserved for improving balance of payment by developing hydropower potential with the highest development priority.

5.2 Optimization Development of Besai Scheme

5.2.1. Alternative scheme

In addition to the upstream reservoir scheme with a power plant of 90 MW installed capacity (Alternative 1), two more conceivable alternative schemes are newly prepared and compared respectively with the Alternative 1; the intermediate pondage scheme with a power plant of 90 MW installed capacity (Alternative 2) and the pumped storage scheme with a power plant of 180 MW installed capacity (Alternative 3), of which reservoir intake and intermediate pondage are connected by a free flow headrace tunnel or a pressurized headrace tunnel.

Alternative 1 :

Upstream reservoir scheme which is a run-of-river type development scheme with a daily regulation storage capacity in the upstream reservoir; with a power plant of installed capacity at 90 MW.

Alternative 2 :

Intermediate pondage scheme which is also a run-of-river type development scheme with a daily regulating capacity in the intermediate pondage instead of the upstream reservoir; with a power plant of installed capacity at 90 MW.

This scheme has two kinds of schemes as follows ;

The upstream reservoir intake and the intermediate pondage are connected with a free flow headrace tunnel

ii) Alternative 2-B

They are connected with a pressurized headrace tunnel

Alternative 3 :

Pumped storage scheme which is a multiple-use type pumped storage and is planned to double turbine flow from 48 m³/sec (equivalent to that of Alternatives 1 and 2) to 96 m³/sec by use of pumping back power water from the lower pondage to the upper pondage in the minimum power demand period; with a power plant of installed capacity at 180 MW.

This scheme has also two kinds of schemes as follows;

i) Alternative 3-A

The upstream reservoir intake and the upper pondage are connected with a free flow headrace tunnel.

ii) Alternative 3-B

They are connected with a pressurized head-race tunnel.

5.2.2. Examination on economic viability

The result of examination on economic viability for the five alternative schemes is summarized as follows :

	Upstream Reservoir Scheme Alternative 1 (Pressurized H/T)	Intermediate Pondage Scheme : Alternative 2-A (Free flow H/T)	Pumped Storage Scheme : Alternative 2-B (Pressurized H/T)	Alternative 3-A (Free flow H/T)	Alternative 3-B (Pressurized H/T)
i) Installed capacity (MW)	90(=45 MWx2 nos.)	90(=45 MWx2 nos.)	90(=45 MWx2 nos.)	180(=90 MWx2 nos.)	180(=90 MWx2 nos.)
ii) Generation mode (hrs.)	4.2	4.2	4.2	4.0	4.0
iii) Annual energy output (GWH)					
- Primary	136	136	136	263	263
- Secondary	233	246	254	0	130
Total	369	382	390	263	393
iv) Annual benefit (10 ⁶ US\$)	22.75	23.21	23.30	27.57	33.29
v) Annual cost (10 ⁶ US\$)	16.29	17.40	19.12	33.46	31.81
vi) Annual net benefit (10 ⁶ US\$)	5.46	5.81	4.38	-5.89	1.48
	"The Best"				

As seen in the table above, net benefit of the Alternative 1 (upstream reservoir scheme) is the biggest among the five alternatives.

As seen in the table above, net benefit of the Alternative 1 (upstream reservoir scheme) is the biggest among the five alternatives.

5.3 Conclusion

As stated above in Sections 5.2, the Alternative 1 of the upstream reservoir scheme with a plant of 90 MW installed capacity is the best in economical comparison among the five conceivable alternative schemes.

Judging from the power demand forecast and the required installed capacity, it is recommended to implement the Besai Hydro electric Power Project as early as possible taking its construction period into consideration.

VI. MITIGATION PLAN

1. Negative environmental effects of construction:

The construction impacts need to be mitigated are as follows:

a). **Impact on air quality such as dust, noise etc.**

Air quality in the village might be affected by the construction traffic such as dust or noise. To overcome those problems, several measures will be applied. The dust from the access road will be suppressed by the water spraying especially during the dry season. Noise will be suppressed by enforcement to use noise abatement in every construction vehicles. The exhaust gas emitted by the construction vehicles will disperse and the ambient concentration can be neglected in the village. So the impact of construction on air quality is considered a minor one if those measures are taken properly.

b). **Impact of waste disposal.**

The waste produce from the project activities can be divided into two categories, i.e. domestic waste and construction waste.

The domestic waste will be collected and disposed in the special disposal area far from the village.

The construction activities will produce several type of waste such as metal, paper, wood, soil or concrete aggregate. Metal, paper and wood will be recycled (collected and sold re-use) so no waste on this categories will be disposed. Soil and concrete aggregate will be used for land reclamation or disposed in the soil disposal area. Reclamation of soil disposal area will be conducted such as terracing and replanting of trees and grasses.

c). **Impact on soil erosion**

The erosion rate will be suppressed by several measures:

- Soil trap such as land holes if applicable in such area will be developed to trap the soil transported by the run off.

The water embankment will be avoided to prevent mosquito breeding area.

- Terracing and land reclamation on soil disposal area and on bare land area will be adopted
- Grasses or trees will be planted on the bareland caused by construction activities and on disposal area after the work finished.

d). The impact of construction worker camps.

There is several base camps which will be develop for the construction labors and employees. PLN will develop the camps for the PLN Project's employees and for the project engineers. The contractors will develop their own camp after the design being approved by the project engineers. Project proponent will ask that the camps should be provided with the health care facilities, standard sanitation facilities and sport/entertainment facilities. The polyclinic develops by the project proponent and the health care facilities developed by the contractors will support with each other. The local people may use those facilities as emergency besides the Health Center (PUSKESMAS) which exists on that area.

There are also benefit opportunities for local people to get the contract of lodging facilities for the outside construction workers.

Since most of the construction work will be carried out by the contractors, so most of the mitigation of construction impact will be conducted by the assigned contractor. PLN as project proponent will enforce the impact mitigation through development of several precautions such as:

- To develop the sound design and contracts to accommodate the necessity mitigation.
- To conduct regular coordination among Contractors, Consultants and Project Proponent.
- To conduct monitoring
- To enforce the sanction to the neglected contractors.

2. Dislocation of people living in construction area and inundation area.

No families living in the inundation zone and construction area. There are 129 families which will be affected because part of their land will be used for the construction and inundation areas.

The mitigation of the impact to the affected people is described on the resettlement plan as presented on chapter 7.

3. Lost of agricultural and forest land by inundation to form reservoir.

The land which belong to Forestry agency will be replaced with such kind of land to be reforested in ratio of replacement of 1 : 1. The area of replacement has not decided yet, the Forestry Agency will provide the condition of replacement land.

4. Loss of historic, cultural or aesthetic features by inundation.

No mitigation measures will be anticipated because there is no historic, cultural and aesthetic features in the reservoir area.

5. Loss of wildlands and wildlife habitat.

The restriction to disturb the wildlife if exist or show up will be enforced by the project proponent. The Sign Board and announcement will be provided by the project proponent. The project has been designed to use the forest land as efficient as possible.

6. Proliferation of aquatic weeds in reservoir and downstream impairing dam discharge, irrigation, navigation and fisheries and increasing water loss through transpiration

Vegetation in the reservoir area prior inundation will be cleared to reduce the nutrient source, the aquatic weeds grow less. This will be conducted by the project.

During the power plant operation period the aquatic weeds will be removed in regular basis by the Plant Operation Division in regular basis.

7. Deterioration of water quality in reservoir

Total vegetation clearing will be conducted by Project Proponent to avoid deterioration of water quality in future reservoir area.

8. Sedimentation of reservoir and loss of storage

To overcome the problem of erosion several agencies will be involved:

- Ministry of Forestry on August 31 1993 issued approval letter to use the protected area (*hutan lindung*). Based on this letter project proponent (PLN) should provide a Plan of Reforestation and Land Rehabilitation on upper catchment area. To response of this letter PLN will provide a fund for the study which will be carried out by the consultant. Close collaboration will be conducted with the involved agencies such as Forestry Agency, The Agency for Soil Conservation and Rehabilitation, Plantation Agency, Food Crop Agency and Local Government.

- The plan of Reforestation and Land Rehabilitation on upper catchment area to be approved to BAPPEDA Lampung Province for erosion abatement in the Besai Catchment area. The basic plan will be used for several agencies such as Forestry Agency, Plantation Agency, Agriculture Agency, Public Work etc. to develop further plan.

Forestry Agency basically will be responsible in greening the critical areas belong to Forestry agency. Plantation agency will be responsible in providing extension information to the coffee farmer which abundant in the upstream catchment area. The Agriculture Agency will be responsible in the extension information on dry land farmer. The farmer will be taught on developing friendly soil conservation agriculture. The Public Work Agency will develop checks dam to control erosion, if necessary.

- The project has been designed to accommodate the high level of erosion, so the flushing of sediment in reservoir will be conducted regularly. This work will be carried out by the Power Plant Operation Division.

9. Formation of sediment deposit at reservoir entrance creating backwater effect and flooding and waterlogging upstream.

It is anticipated that this problem will not be significant, since no agricultural or dwelling area near the back water of reservoir. Relatively high flow of water in those area will prevent of sediment deposition and it also will provide natural scouring effect of the sediment deposited during low flow. The power plant has been designed to have the sediment trap and flushing facility. Flushing of sediment in reservoir will be conducted regularly. This work will be carried out by the Power Plant Operation Division.

10. Scouring of riverbed below dam

The power plant has been designed to overcome the potential scouring effect of the water release through the sluiceway.

11. Decrease in floodplain (recession) agriculture

There is no irrigation downstream of the dam. No mitigation will be conducted.

12. Salinization of floodplain lands

There is no anticipated impact of Besai HEPP on salinization of floodplain lands. No Mitigation will be conducted.

13. Salt water intrusion in estuary and upstream

There is no impact of Besai HEPP on salt water intrusion in estuary and upstream. No Mitigation will be conducted.

14. Disruption of riverine fisheries due to changes in flow, blocking migration, and changes in water quality and limnology.

Although the fisheries activities conducted by the people is insignificant, to enhance the positive impact, the fisheries agency will restock the fish in future reservoir.

15. Snagging of fishing nets in submerged vegetation in reservoir.

Total vegetation clearing will be conducted to avoid snagging of fishing nets in submerged vegetation in reservoir area. This will be conducted by the project.

16. Increase of water related diseases.

In case that the mosquito successfully breed in the reservoir, it will be overcome by restocking of fish that will eat mosquito larvae. This work will be conducted by Fisheries Agency.

The Public Health center will elaborate to dismiss the rate of malaria prevalence and educate the people how to control mosquito.

17. Conflicting demands for water use.

No mitigation is necessary since there is no conflicting demands for water use.

18. Social disruption and decrease in standard of living of resettled people.

To minimize the negative impact and to enhance the positive impact the project proponent (PLN) will also initiate several measures as discussed on chapter 7.

19. Environmental degradation from increased pressure on land.

To overcome the problem on possibility of environmental degradation such, the sectoral agency such Agricultural Agency, Plantation Agency and Soil Conservation & Rehabilitation Station and will elaborate to extend the information regarding better practice of agriculture work.

20. Disruption/destruction of tribal/indigenous groups.

There is no tribal/indigenous groups in the affected area of Besai HEPP. No mitigation will be conducted.

21. Increase in humidity and fog locally, creating favorable habitat for insect disease vectors (mosquitos).

In case that the mosquito successfully breed in the reservoir, it will be overcome by restocking of fish that will eat mosquito larvae. This kind of work will be conducted by the Fisheries Agency.

22. Impact of reservoir on drinking water pumped from shallow well.

Since no impact of future reservoir on existing drinking water, no mitigation is anticipated.

23. Impact of dry river bed between dam to the power house.

Since no impact is anticipated, so no mitigation will be conducted.

24. Impacts of earthquakes and floods

The induced seismic of the reservoir can be neglected and it will not likely cause the hazard to environment. No mitigation is anticipated.

The holding capacity of the reservoir to reduce the floods water from upstream will be small due to its capacity. Most of the floods will be passed through the sluiceway. No mitigation is anticipated.

25. Impact of waste lubricant oil

The waste lubricant oil will be managed in environmentally acceptable manner, it will be collected in drums and will be sent to PERTAMIMA (the agency who have the authority to collect the waste lubricant oil).

26. Impact of transmission lines

The Electric power generated by this project will be transmitted through 150 KV high voltage to Bukit Kemuning Sub station. The distance of the Besai powerhouse to Bukit Kemuning is 12,5 Km. It pass the bushes and agriculture area, and no houses will be passed by the transmission lines. Although the impact of the transmission lines is considered insignificant, the extension information will be conducted by the project proponent. The impact check list is presented on annex 1 & 2.

INDIRECT

27. Uncontrolled migration of people into the area made possible by access roads and transmission lines.

The project area is located between the city of Liwa and Kotabumi, and have smooth surfaced asphalt high way, so this area is relatively an open area. The access road of the project is relatively short (2 Km) and it through agriculture area.

The uncontrolled migration of people into the area will likely not be happened.

The transmission line will be built in parallel with the existing high way to Bukit Kemuning High way. Based on experience on the recent transmission that there is no uncontrolled migration of people along the transmission lines. No mitigation is anticipated.

28. Environmental problems arising from development made possible by dam (irrigated agriculture, industries, municipal growth).

Due to topographic condition there is no possibility to develop irrigation in this area. Electric energy from Besai HEPP will stimulate the industrial growth away of this region, especially near the city of Bandar Lampung. No mitigation measure is anticipated.

EXTERNAL

- 29. Poor land use practices in catchment areas above reservoir resulting in increased siltation and changes in water quality.**

The plan of Reforestation and Land Rehabilitation on upper catchment area prepared by the project proponent is to be approved by BAPPEDA Lampung Province for erosion abatement in the Besai Catchment area. The basic plan will be used for several agencies such as Forestry Agency, Plantation Agency, Agriculture Agency, Public Work etc. to develop further plan.

Forestry Agency basically will be responsible in regreening the critical areas belong to Forestry agency. Plantation agency will be responsible in providing extension information to the coffee farmer which abundant in the upstream catchment area. The Agriculture Agency will be responsible in the extension information on dry land farmer. The farmer will be taught on developing friendly soil conservation agriculture. The Public Work Agency will develop checks dam to control erosion, if necessary.

VII. RESETTLEMENT PLAN

1. OBJECTIVE

- a. The Resettlement plan of affected people at Besai HEPP will be useful for providing the input of parties involved :
 - To developed a timebound resettlement plan, based on the valuation and compensation principles of land and other assets affected by the project
 - To establish a budget and an implementation schedule
 - To identify organizational responsibilities for implementation
- b. To collate the people's desire and develop other alternatives which may be acceptable to the affected people, this can be developed by the project proponent and involved agencies.

2. THE AFFECTED PEOPLE

There are 129 families which will be affected by the Besai Project : 88 families will be affected by the inundation area and the rest (41 families) will be affected by the construction area. The construction area belongs to the Forestry Agency and several people have planted coffee trees on it.

The list of affected people is presented on Table 7.1 - 7.4.

3. RESETTLEMENT OPTIONS

The suggested options which may be chosen by the affected people:

- a). Purchase other agriculture land

The land compensation money may be used to buy other agriculture land in other locations, because the land compensation money is considered appropriate to buy other land in other location. So by this option, the affected people may still continue with agricultural activities. PLN will buy the alternative land, with the concurrence of PAPs who might exercise this option, and hand it over to them.

- b). Trading.

After receiving the compensation money, the people may use their money for the small trading capital as follows:

- Trade in agriculture commodity abundant in that area such as coffee bean, and other annual crops.
- Open small shop
- Open small restaurant

PLN will ensure appropriate counselling for those who want it on their endeavor.

c). **Small business**

Besides acting as farmer on the remaining land, the other option is to open small business. The land compensation money may be used as a capital for following business activities :

- Transportation business : Motor bike transportation, small vehicle transportation.
- Workshop
- Tailors
- Home industry such as: handicraft, coffee bean processing, other agriculture commodity processing.
- Catering.
- Animal husbandry: Chicken, goat, sheep, dairy cow.

PLN will ensure appropriate counselling is available for those who want it.

d). **Transmigration.**

This option will be given to the people who occupy the Forestry land who may wish to transmigrate. In case the people are willing to move to other location through local transmigration or even to other island, it may be implemented. The local government of Lampung province through the Department of Transmigration and Resettlement of Forest Encroacher has a program to resettle of 2000 families per year.

e). **Working at Besai HEPP Project**

If the affected/local people meet the qualification stated by the project, they are welcome to send the application to work on the Besai Project. There are three parties which would need/employees i.e.:

- PLN (Perusahaan Umum Listrik Negara) as project proponent consists of two parties.

- **PLN Besai Project** (Under the coordination of Project Principal of Generation and Transmission of Southern Part of Sumatra at Palembang). This PLN unit is responsible in the construction of Besai Project. There are few positions which may be available for the local people if they are qualified. Most of the PLN Besai project employees will come from other PLN offices.

- **PLN Besai Sector** (Under the coordination of PLN Region I at Palembang).

This PLN Unit will be responsible on operation and maintenance of Besai HEPP. There are few position which may be available to the local people if they are qualified. Most of the PLN Besai project employees will come from other PLN offices.

PLN of Besai Sector in operation and maintenance work will need cooperation of several maintenance contractors, supplier and cleaning service. Those companies will need the skilled, semiskilled and unskilled employees which may be recruited from the local people.

- **Contractors and suppliers of Besai HEPP project.**

All of the Besai project work will be entrusted to contractors. Various contractors of civil, electrical and mechanical works will need skilled, semiskilled and unskilled labor. The people may apply for positions according to their qualifications. Most of the work and positions will be provided by those contractors.

- **Consultant of Besai HEPP Project.**

Most of position of consultant employee will be dominated by the high education skill; in other word the position for the unskilled/semi-skilled employee will be very limited here.

f). **Education and training**

PLN encourages PAPs to improve their standard of living by learning new skills. Training for new skills in vocational training schools will be made available to these PAPs who might opt for such education and training. This effort will facilitate complete restoration of the income level PAPs. PLN will ensure this.

4. LAND COMPENSATION PLAN

4.1. Land Compensation Implementation

Land acquisition is implemented pursuant to the Regulation of the KEPPRES (President Decree) No. 55/1993 with the establishment of the Committee of Land Acquisition for the public uses. The amount of the payment of compensation for

land and plants will be decided during consultation between the Committee for Land Acquisition and the population whose land is affected by the project.

The land compensation will be implemented as per the following procedure:

- a. Extension of information to the affected people will be conducted prior to the payment of compensation. These activities will be conducted by the project proponent and the land compensation committee.
- b. The next step is conducting the stacking out of the boundary of the needed land. This activities are being conducted by the project proponent.
- c. The detailed mapping of the land holding, is being done. This activity will be conducted by the land compensation committee.
- d. After the maps are ready then the inventory of crop, vegetation, building or other asset will be conducted. These activities will be conducted by the land compensation committee.
- e. The next step is preparing the list of the acreage of land holding, lists of affected crops and temporary structures. These activities will be conducted by the land compensation committee.
- f. The last step is the payment of compensation. The payment will be given directly to the land owner through the Bank. Price negotiation will be conducted by the Land compensation Committee and will invite the project proponent and the affected people. Compensation payment will be conducted through the local Bank.

The implementation of the procedure stated above will be conducted in several stages. It depends on the priority of the land requirement or construction priorities. For example, the land for the access road and base camp will be the first priority and inundated area will be the last priority.

The compensation stages will be conducted as follows:

- a. Access road and Base camp
- b. Access road to Powerhouse
- c. Spoil bank No. 1 - 7
- d. Powerhouse, Surge tank, Intake dam
- e. Temporary building yard
- f. Access road to work audit No 1-3, Dam site and Surge Tank
- g. Inundated area
- h. Forestry replacement land.

4.2 Land compensation organization/supervision

The Land Compensation Committee has been established by The Governor of Lampung Province. The committee will be chaired by Bupati (Head of District) West Lampung and North Lampung. The committee consists of:

1. Bupati (Head of West Lampung and North Lampung District)
2. The Head of Agrarian Affairs
3. The Head of Land & Building Tax Services
4. The Agency of Local Government which responsible on Building aspects.
5. The Agency of Local Government which responsible on Agriculture services
6. The Head of Sub Districts
7. The Head of Villages

The secretary of the committee but not as a member :

1. The Head of Subdivision of District Administration
2. The Head of Agrarian Affairs Sections

4.3. Allocated budget for Land Compensation

The expenditures of land compensation budget can be divided into three categories:

a. Land compensation payment.

The compensation payment of the land asset will be three categories:

- Land.
- Vegetation/crop
- Building

The payment will follow the standard issued by the Bupati Decree.

The allocation money for this payment is approximately Rp. 2,261,510,000,-. This money will come from PLN.

b. Honorarium and expenditures of the Land Compensation Committee.

The allocation money for this expenditures is approximately Rp.73,005,000. This money will come from PLN.

c. Replacement land of the Forestry Land

The allocation money for this expenditures is approximately Rp.1,925,500,000. This money will come from PLN.

d. Land Boundary stacking out

The allocation money for this expenditures is approximately Rp.660,000,000. This money will come from PLN.

The semi detailed land compensation cost is presented in the end of this chapter.

4.4. Schedule of Land Compensation

The Land compensation schedule is presented in the following of this page (Figure 7.1).

Figure 7.1
LAND COMPENSATION SCHEDULE
BESAI HYDROELECTRIC POWER PROJECT

NO	ACTIVITIES	YEAR 1993						YEAR 1994		
		AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	
1	Mapping/cadastral survey									
2	Forest land area mapping									
3	Asset inventory (Crop and others)									
4	Land Negotiation									
5	Land Compensation payment									

5. RESETTLEMENT PLAN

The resettlement plan will help the affected people to improve the condition of their source of income which may be disturbed by the project because part of their land or even entire land in some cases will be compensated.

5.1. Implementation of the Resettlement Plan:

a). Purchase other agriculture land

The implementation of this option will be assisted by the Resettlement Implementation Team. Based on the last negotiation between the Land Compensation Committee and the PAP's, there is no PAP's who opt for land. All of the PAP's prefer to arrange the purchasing of the new land by them selves. But the project proponent through the Land compensation Committee will solve to entertaining such request of PAP's if anybody from them should change their mind and ask for land compensation.

b). Transmigration.

Transmigration will be encouraged to the affected people who belong to the category of *forest encroacher*. The implementation agency will be the Department of Transmigration and Forest Encroacher Resettlement and it will be coordinated by the Resettlement Implementation Team.

c). Training on several skills

The training will be encouraged to the people who lost partly or totally of their income, because of land compensation. The implementation agency will be conducted by the Department of Manpower (Industrial Training Station and Agricultural Training Station) and it will be coordinated by the Resettlement Implementation Team.

Implementation of the resettlement plan is already in progress. PLN will ensure that it is completed in a phased manner well ahead of the actual construction of the proposed hydroelectric project.

5.2. Resettlement organization/supervision.

The resettlement work will be implemented by The Resettlement Implementation Team. The team will chaired be by Bupati (Head of District) West Lampung and North Lampung. The team will consist of:

- 1. The Agrarian Affairs**
- 2. The Department of Transmigration and Resettlement of forest encroacher**

3. The Head of Subdivision of Governmentation
4. The Department of Man Power
5. The Industrial agency
6. The Food Crop Agency
7. The Plantation Agency
8. The Forestry Agency
9. The Department of Social
10. The Head of Sub Districts
11. The Head of Villages

Because the Resettlement Implementation Team will consist of two districts, it will be coordinated by the Provincial Authorities (Chief of Governor of Development Affairs) or Head of Planning Coordinating Board (BAPPEDA) of Lampung provinces.

5.3. The counselling/assistance and grievance mechanism

The implementation team will provide the counselling facilities for the PAP's. The sectoral agencies which involved in the Resettlement Implementation Team will assist the PAP's in developing of their desire program. The implementation team will provide the limited/emergency financial assistance for the PAP's. The credit assistance to get the capital to run the business will also be provided by the Resettlement Implementation Team.

The grievance of the PAP's will be channelled through the informal leader of the PAP's or the head of the village and it will be conveyed to the Resettlement Implementation Team and Land Compensation Committee. The committee will sit together with PLN as project proponent and discuss to solve the problem. If the Resettlement Implementation Team and Land Compensation Committee can not solve the problem, it will be handed over by the Provincial Government level (Governor of Lampung Province). If the result of the problem solving is not satisfactorily for the PAP's, it will be discuss in the interdepartmental level which will be coordinated by the National Coordinating Board (BAPPENAS).

5.4. Allocated budget for Resettlement

The allocated budget for resettlement will be as follows:

- a. Training cost for about 120 persons.

The allocation money for this expenditures is approximately Rp. 244,000,000,-. This money will be provided by PLN.

b. Transmigration cost

The allocation money for this expenditures is approximately Rp. 435,000,000,-. This money will be provided by Department of Transmigration and Forest Encroacher Resettlement.

c. Resettlement Implementation Team

Resettlement Implementation Team will be in duty for approximately 7 years (5 years during construction stages and 2 years during operation stage). The allocation money for this expenditures is approximately Rp. 518,000,000. This money will be provided by PLN.

d. Monitoring of Resettlement and Land Compensation implementation

Monitoring of Resettlement and Land Compensation Implementation will be carried out for approximately 7 years (5 years during construction stages and 2 years during operation stage).

The allocation money for this expenditures is approximately Rp. 75,000,000,-. This money will be provided by PLN.

The semi detailed resettlement cost is presented in the end of this chapter.

5.4. Resettlement Implementation Schedule

The resettlement implementation schedule is presented in the following of this page (Figure 7.2).

6. PLN's COMMITMENTS

To ensure that the former living standards, including the earning capacity of the PAPs are improved, PLN is committed to do the following:

- * Arrange for land compensation to those who opt for it before the start of actual construction. In case a suitable and acceptable land cannot be found before the land is required for construction, PLN will provide for adequate transition allowance;
- * Counselling and credit facilities will be made available to those wishing to engage in small business and other trade activities;
- * Education and training will be provided in vocational schools to those who may opt for such schemes.

7. MONITORING

Monitoring of the resettlement and land compensation processes and impacts will be carried out by independent agency, i.e. local university in cooperation with local Non Government Organization (NGO).

Reporting will be made twice a year during construction stage (5 years) and two years after the project completion. PLN should send the monitoring Reports to the World Bank, Washington (with copy to the Resident Mission of the Bank at Jakarta) within two weeks of the relevant period.

Figure 7.2

**RESETTLEMENT IMPLEMENTATION SCHEDULE
BESAI HYDROELECTRIC POWER PROJECT**

NO	ACTIVITIES	YEAR OF IMPLEMENTATION																				
		1993			1994			1995			1996			1997			1998			1999		
1	Land compensation payment																					
2	Purchase new agricultural land (if necessary)																					
3	Training of several skill																					
4	Open new bussiness																					
5	Transmigration/Forest encroacher resettlement																					
6	Monitoring																					
7	Resettlement committe activities																					

Table 7.1. Number of Owners and Area of Land for Access Road
Location : Dusun Dwikora Barat (Ds.5)

No.	Name of Head of Family	Affected (Ha)	Not Affected (Ha)	Total (Ha)
1	Masnan	0.70	1.70	2.40
2	Gunawan	0.28	0.72	1.00
3	Yazid	0.42	1.07	1.49
4	Suhaimi	0.07	0.17	0.24
5	Junaidi	0.42	1.07	1.49
6	Saini	0.14	0.37	0.51
7	Muis	0.02	0	0.02
8	Ramsi	0.70	1.70	2.40
Sub total		2.75	6.80	9.55

Location : Dusun Dwikora Barat (Ds.5)

No.	Name of Head of Family	Affected (Ha)	Not Affected (Ha)	Total (Ha)
9	Nurdin	0.84	2.16	3.00
10	Waluto	0.42	1.08	1.50
11	Polani	0.28	0.72	1.00
Sub. Total		1.54	3.96	5.50

Note: The acreage stated in this table is rough estimation not intended to be used for land compensation.

Location : Dusun Lubuk Laban

No.	Name of Head of Family	Affected (Ha)	Not Affected (Ha)	Total (Ha)
12	Supli	1.12	2.88	4.00
13	Rumayu	0.56	1.44	2.00
14	Tasan	0.28	0.72	1.00
15	Syahid	0.28	0.72	1.00
16	Hairin	0.84	2.16	3.00
17	Marroib	0.56	1.44	2.00
18	Hamni	0.84	2.16	3.00
19	Suparudin	0.84	2.16	3.00
20	Ajri	0.28	0.72	1.00
21	Sutan Suradi	0.56	1.44	2.00
22	Dariah	0.28	0.72	1.00
23	Sukamto	0.42	1.08	1.50
24	Nanja	0.28	0.72	1.00
25	Syahril	0.84	2.16	3.00
	Sub. Total	7.98	20.52	28.50
	Total	12.27	31.28	43.55

Note: The acreage stated in this table is rough estimation not intended to be used for land compensation.

**Table 7.2. List of affected people whose own land at
Power House & Spoil bank Besai HEPP
Dusun Dwikora Barat (Dusun 5 and Dusun I)**

No.	Name Head of Family	Estimation affected land (Ha)	Estimation non affected land (Ha)	Total (HA)
Dusun 5				
26	Mustar	1.00	1.00	2.00
27	Sogol	2.00	2.00	4.00
28	Burhasan	1.25	1.25	2.50
29	Kedul	2.00	2.00	4.00
30	Khun Maryono	2.00	2.00	4.00
31	Burhani	0.75	0.75	1.50
32	Salam	2.00	2.00	4.00
33	Perman	0.75	0.75	1.50
34	Sutrisno	1.00	1.00	2.00
35	Mukroni	0.50	0.50	1.00
	Sub-Total	13.25	13.25	26.50
Dusun I (Sinar Ogan)				
36	Slamet	1.50	1.50	3.00
37	Hamdan	2.00	2.00	4.00
38	Gimun	2.00	2.00	4.00
39	Man	2.00	2.00	4.00
40	Darno	1.00	1.00	2.00
41	Jenawi	1.50	1.50	3.00
	Sub-Total	10.00	10.00	20.00
	T o t a l	23.25	23.25	46.50

Note: Land acreage stated in this table is rough estimation not intended to be used for land compensation.

**Table 7.3. List of Land owners Affected by the Besai HPP Project,
Village of Sukapura, Sub-District (Kecamatan) of Sumber Jaya, West Lampung
(INUNDATED AREA)**

No	N A M E	TOTAL AREA TO BE INUNDATED (Ha)	LAND USE	NON AFFECTED LAND (Ha)
42	Fajri	0.75	Wet rice	0.50
43	Maman	0.50	Estate	0.00
44	Anjak	0.50	Estate	3.50
45	Julik	0.50	Wet rice	1.00
46	Cecek	0.50	Wet rice	1.00
47	Kasman	0.50	Wet rice	1.50
48	Ruhadi	0.25	Wet rice	1.75
49	Sarmad	0.125	Wet rice	1.68
50	Sadiman	1.00	Wet rice	6.00
		1.00	Estate	
51	Dadang	0.25	Wet rice	0.00
52	Jasmin	1.50	Bare land	1.50
53	Sahalk	4.00	Estate	0.00
54	Hamim	0.75	Wet rice	0.25
55	Julid	1.00	Wet rice	0.00
56	Men	1.00	Wet rice	0.50
57	Sayadi	1.00	Wet rice	0.50
58	Sulaiman	1.00	Estate	0.25
		0.50	Wet rice	
59	Subandi	0.75	Estate	0.00
60	Bahrudin	0.75	Bare land	0.00
61	Darman	0.25	Wet rice	1.00
62	Misman	0.25	Wet rice	2.75
63	Ipun Sulaeman	0.25	Dry Cultivation	0.75
64	Kadir	0.75	Estate	0.00
		0.75	Wet rice	
65	Suparmen	0.25	Estate	0.00
		0.75	Estate	
66	Sarkasih	1.00	Wet rice	1.00
67	Oon	0.25	Wet rice	2.25
68	Juhana	0.50	Wet rice	3.50
	Sub-Total	23.125		31.175

Note: The acreage stated in this table is rough estimation is not intended for land compensation.

**Table 7.3. List of Land owners Affected by the Besai HPP Project,
Village of Sukapura, Sub-District (Kecamatan) of Sumber Jaya, West Lampung
(INUNDATED AREA)**

No	N A M E	TOTAL AREA TO BE INUNDATED (Ha)	LAND USE	NON AFFECTED LAND (Ha)
69	Daryak	0.50	Wet rice	2.50
70	Panarman	0.50	Wet rice	1.00
71	Oji Rosidi	0.25	Wet rice	1.75
72	Taryan	0.50	Wet rice	0.25
73	Kholid	0.50	Wet rice	1.00
74	Jamad	0.50	Wet rice	2.00
75	Sajak	0.50	Wet rice	1.50
76	Somantri	0.75	Bare land	0.00
77	Saspan	0.125	Wet rice	0.88
78	Madnan	0.25	Wet rice	0.25
79	Jaman	0.25	Wet rice	0.00
		1.00	Dry Cultivation	
80	Odak	0.75	Wet rice	0.25
81	Wandi	1.00	Wet rice	0.00
82	Panji	1.25	Wet rice	0.00
83	Miharja	0.75	Wet rice	0.00
84	Rasman	0.50	Wet rice	0.00
		0.50	Estate	
85	Zainudin	0.50	Wet rice	0.50
86	Madnan	1.00	Wet rice	0.00
87	Ojiki	0.56	Wet rice	0.00
		0.25	Pond	0.00
88	Rahmad	0.25	Wet rice	0.50
		0.04	Pond	
89	Parjono	0.25	Wet rice	0.75
90	Rainan	0.125	Wet rice	0.38
91	Mang Wasjan	0.50	Wet rice	1.50
		0.50	Dry Cultivation	
92	Harli	0.25	Wet rice	0.25
93	Oma	0.50	Wet rice	0.00
94	Suladin	0.75	Wet rice	0.75
		0.75	Estate	
	Sub-Total	16.04		16.00

Note: The acreage stated in this table is rough estimation is not intended for land compensation.

**Table 7.3. List of Land owners Affected by the Besal HPP Project,
Village of Sukapura, Sub-District (Kecamatan) of Sumber Jaya, West Lampung
(INUNDATED AREA)**

No	N A M E	TOTAL AREA TO BE INUNDATED (Ha)	LAND USE	NON AFFECTED LAND (Ha)
95	Sarja	1.00	Wet rice	0.00
96	Ujuk	0.75	Wet rice	0.75
97	Ganda	0.75	Wet rice	0.00
		0.50	Estate	0.25
98	Zarkasih	0.75	Wet rice	0.00
99	Sarjan	0.50	Dry Cultivation	0.00
100	Sajar	0.50	Wet rice	0.00
		0.25	Wet rice	0.00
101	Nahrudin	0.25	Dry Cultivation	0.50
		0.25	Wet rice	
102	Tatak	0.50	Wet rice	0.00
103	Omin	0.25	Wet rice	0.00
		0.25	Dry Cultivation	
104	Sutarman	0.50	Wet rice	1.00
		0.50	Wet rice	
105	Sukiman	0.06	Wet rice	1.40
106	Sabar	0.125	Wet rice	0.38
107	Aljan	0.125	Wet rice	0.38
	Sub-Total	7.81		4.65

Note: The acreage stated in this table is rough estimation is not intended for land compensation.

**Table 7.4. List of Land owners Affected by the Besai HPP Project,
Village of Waypetal, Sub-District (Kecamatan) of Sumber Jaya, West Lampung
(INUNDATED AREA)**

No	N A M E	TOTAL AREA TO BE INUNDATED (Ha)	LAND USE	NON AFFECTED LAND (Ha)
108	Umar Nawi	1.00	Estate	1.00
		1.00	Wet rice	
109	H. Abdul Hanan	1.75	Wet rice	0.00
110	Nangsina	0.50	Wet rice	0.00
111	Ridl	0.50	Wet rice	1.00
112	Nurdik	0.50	Wet rice	1.00
113	H. Salam	0.50	Wet rice	0.50
114	H. Ibrahim	1.00	Wet rice	0.00
		1.00	Estate	
115	Sukardi	2.50	Wet rice	0.00
116	Cek Nani	0.50	Wet rice	1.00
117	Usman	1.00	Wet rice	1.00
118	Dakrun	1.25	Wet rice	0.00
119	Nuri	0.25	Wet rice	0.50
120	Bosrah	0.50	Wet rice	0.00
121	Sofyan	0.50	Wet rice	0.00
122	A. Azis	1.00	Wet rice	0.00
123	Mawi	0.75	Wet rice	0.00
124	Jaman	0.50	Wet rice	0.25
125	Said Aman	1.00	Wet rice	5.00
126	Idris	0.50	Estate	0.00
127	A. Budin	0.75	Estate	2.00
128	Sarjo	0.25	Wet rice	0.00
129	Urnen	0.25	Wet rice	0.00
	Sub-Total	19.25		13.25
	Total	66.23		65.08

Note: The acreage stated in this table is rough estimation is not intended for land compensation.

**ESTIMATION OF
LAND ACQUISITION, COMPENSATION AND RESETTLEMENT COST
BESAI HYDROELECTRIC POWER PROJECT**

I LAND ACQUISITION/COMPENSATION COST

I.1 PROJECT AREA

I.1.1. ACCESS ROAD AND BASE CAMP (15.11 HA COFFEE, 2 HA PADDY)

Crop	15.11 ha x Rp	5,000,000 = Rp	75,550,000
Crop	2.00 ha x Rp	6,500,000 = Rp	13,000,000
		Rp.	88,550,000

I.1.2. ACCESS ROAD TO POWER HOUSE

Crop	4.20 ha x Rp	5,000,000 = Rp	21,000,000
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I.1.3. SPOIL BANK NO 1 - 7

Crop	12.44 ha x Rp	5,000,000 = Rp	62,200,000
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I.1.4 POWER HOUSE, SURGE TANK, INTAKE DAM

Crop	12.55 ha x Rp	5,000,000 = Rp	62,750,000
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I.1.5 TEMPORARY BUILDING YARD

Crop	12.13 ha x Rp	5,000,000 = Rp	60,650,000
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I.1.6 ACCESS ROAD TO WORK ADIT NO. 1-3, DAM SITE AND SURGE TANK

Crop	16.71 ha x Rp	5,000,000 = Rp	83,550,000
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I.1.7 INUNDATED AREA

Land	85.34 ha x Rp	20,000,000 = Rp	1,706,800,000
Crop	85.34 ha x Rp	6,500,000 = Rp	554,710,000
		Rp.	2,261,510,000

TOTAL I.1.1 - I.1.7

Rp. 2,640,210,000

1.1.8	COMMITTEE HONORARIUM		Rp.	7,000,000
1.1.9	COMMITTEE ADMINISTRATION (1.5%)		Rp.	39,603,150
1.1.10	MAPPING AND ASSET INVENTORY (1%)		Rp.	26,402,100
	TOTAL 1.1.1 - 1.1.10		Rp.	2,713,215,250
1.2	FOREST REPLACEMENT LAND			
1.2.1	LAND COMPENSATION			
	Land	60 ha x Rp	15,000,000 = Rp	900,000,000
	Crop	60 ha x Rp	4,000,000 = Rp	240,000,000
			Rp.	1,140,000,000
1.2.2	REVEGETATION	10 ha x Rp	10,000,000 = Rp	600,000,000
1.2.3	STUDY OF REFORESTATION & LAND REHABILITATION		= Rp	150,000,000
1.2.4	COMMITTEE HONORARIUM		Rp.	7,000,000
1.2.5	COMMITTEE ADMINISTRATION		Rp.	17,100,000
1.2.6	MAPPING AND ASSET INVENTORY		Rp.	11,400,000
	TOTAL 1.2.1 - 1.2.6		Rp.	1,925,500,000
1.3	LAND BOUNDARY STACKING OUT			
1.3.1	PROJECT AREA	160 ha x Rp	3,000,000 = Rp	480,000,000
1.3.2	FORESTRY REPLACEMENT LAND	60 ha x Rp	3,000,000 = Rp	180,000,000
	TOTAL 1.3.1 - 1.3.2		Rp.	660,000,000
	TOTAL LAND COMPENSATION		Rp.	5,298,715,250

II.	RESETTLEMENT COST				
II.1	TRAINING (120 PERSONS)				
	Transportation			Rp.	10,000,000
	Living accommodation			Rp.	90,000,000
	Living allowance			Rp.	60,000,000
	Instructors			Rp.	24,000,000
	Training facilities			Rp.	50,000,000
	Hand outs			Rp.	10,000,000
	TOTAL II.1			Rp.	244,000,000
II. 2	TRANSMIGRATION (40 FAMILIES)				
	Recruitment			Rp.	10,000,000
	Site Visit			Rp.	25,000,000
	Living allowance & Moving cost				
	40	x Rp.	10,000,000	Rp.	400,000,000
	TOTAL II.2			Rp.	435,000,000
II. 3	RESETTLEMENT COMMITTEE				
	Operational cost (7 years)				
	7	x Rp.	50,000,000	Rp.	350,000,000
	Honorarium (7 years)				
	7	x Rp.	24,000,000	Rp.	168,000,000
	TOTAL II.3			Rp.	518,000,000
	TOTAL II.1 - II.3			Rp.	1,197,000,000

III MONITORING COST OF RESETTLEMENT AND LAND COMPENSATION

Monitoring by the local University & NGO (7 years)

7 x Rp. 50,000,000 Rp. 350,000,000

Monitoring by the local government (7 years)

7 x Rp. 30,000,000 Rp. 210,000,000

TOTAL III Rp. 560,000,000

TOTAL I + II + III Rp. 7,055,715,250

EQUIVALENT US \$ 3,345,526

Price level is October 01, 1993 (US \$ 1 = Rp. 2109 = 105.82 Yen)

VIII. MANAGEMENT AND TRAINING

I. MANAGEMENT INSTITUTIONAL

Project proponent of Besai Hydro Electric Power is Perusahaan Umum Listrik Negara (PLN) an Agency of Mines and Energy Ministry. There are two bodies in Mines and Energy Ministry which handle the Environmental Impact Assessment i.e. The first one is Central Commission of Environmental Impact Assessment Ministry of Mines and Energy (Komisi Pusat AMDAL). The commission consists of senior officials and environmental experts from various ministry involved and chaired by the General Secretary of Mines and Energy Ministry. The second one is Division of Environmental which is developed to handle daily environmental problem.

Under The Ministry of Mines and Energy, there is a Directorate General Electric and Energy Development which provide the authority to perform the supervision to the PLN. The Environmental Sub Division in this directorate provides assistance and to evaluate the environmental management and monitoring report of the project. Technical Team of Environmental Impact Assessment in this Directorate is developed to provide the technical assistance to the Central Commission. The Technical Team is chaired by the Director of Electricity planning.

The PLN head quarter which is responsible all of the Besai Project located in Jakarta a Capital City of Republic Indonesia, about 300 Km from the project site. There are several Divisions and Office in Head quarter will be involved in Project environmental related, namely:

1. System Planning Division (c.q. Survey Sub Division), under the Director of Planning is responsible on feasibility study of the project (including Environmental Impact Assessment).
2. Hydro Project Controlling and Supervision Division, under the Director of Development is responsible on controlling and supervision during project implementation.
3. Hydro operation Controlling and Supervision Division, under the Director of Operation is responsible on controlling and supervision during power plant generation and maintenance.
4. Engineering Service Center is responsible on engineering design of Besai Project, including the environmental management and monitoring plan.
5. PLN's AMDAL Team comprises senior officials and experts in environmental aspects, responsible on Environmental Impact assessment procedures.

The PLN units which will be responsible to coordinate daily implementation of the project is Principal project of Generation and Transmission of South part of Sumatra, which located in Palembang about 500 Km from the site. The daily implementation will be conducted by Besai Hydro Electric Power Project office located in Besai site. The environmental management and monitoring during construction will be conducted by the Public Relation and Environmental Sub Division.

After the project completed the management of power plant will be shifted to PLN Region IV which cover Lampung, Bengkulu, South Sumatra and Jambi Provinces. The management office at site will be formed namely PLN Sector Besai. The environmental management and monitoring during power plant operation will be conducted by the Environmental Section.

According to law and Government regulation, PLN as a project proponent has specific authority in dealing with environmental aspect of project related. Several environmental impact mitigation and management should be conducted by the involved sectoral agencies, although it is project impact related such as:

- Management of Impact on Fisheries Should be conducted by Fisheries Agencies
- Erosion control in the upper catchment area will be conducted by several agencies such as:
 - * Department of Forestry to rehabilitate the bald/critical area of land under their jurisdiction.
 - * Department of Agriculture (Food Crop Agency) to supervise and provide information extension to the farmer to develop better soil conservation on food crop land
 - * Department of Agriculture (Plantation Crop Agency) to supervise and provide information extension to the farmer to develop better soil conservation on private plantation land.
- Land compensation and associated problem of it will be conducted by Land Compensation Committee developed by the Governor of Lampung Province etc.
-

II. TRAINING

1. PLN PRINCIPAL PROJECT OF GENERATION AND TRANSMISSION OF SOUTH PART OF SUMATRA AND BESAI PROJECT.

Training of personnel of Public Relation and Environmental sub division at PLN PRINCIPAL PROJECT OF GENERATION AND TRANSMISSION OF SOUTH PART OF SUMATRA on environmental management and monitoring will be needed. Comparative study to similar project will also be conducted.

Personnel of Civil sub division at PLN Besai Project will also be trained to handle the project in environmentally manner.

2. PLN REGION IV AND PLN BESAI SECTOR.

Personnel of Environmental subsection who will handle the environmental management and monitoring of Besai Project will be trained on its aspects.

IX. MONITORING

1. PUBLIC HEALTH AND DISEASE VECTOR

Monitoring of public health will be conducted through the PUSKESMAS (Public Health Center) and at Polyclinic at construction camp. The malaria, and infection of intestine disease will be the main attention to be monitored. The monitoring will be carried out during construction and during the operation stage.

Mosquito is a malaria disease vector will be monitored in the adult stage as well in larvae stage. The reservoir will be monitored whether it will be a good new habitat for the mosquito larvae.

2. EROSION RATE AND SEDIMENT DEPOSITION

Monitoring of erosion rate will be conducted at the upstream river discharge. This will be conducted each month, especially during the rainy season.

Sediment deposition monitoring at reservoir will be conducted yearly.

3. WATER DISCHARGE

Monitoring of water discharge will be conducted by continuous automatic monitor equipment at dam site.

4. WATER QUALITY

Water quality will be monitored quarterly at reservoir.

5. AQUATIC WEED

The spreading area of floating and submerged aquatic weed at reservoir will be monitored each month.

6. WILDLIFE

The possibility disturbance of construction activity will be monitored.

7. CONSTRUCTION WORKER

The number of construction worker will be monitored each month, consist of local worker and migration worker.

8. SOCIO-ECONOMIC OF AFFECTED PEOPLE

The socio-economic condition of the affected people will be monitored each year.

9. WATERSHED CONDITION

Monitoring of watershed condition will be conducted by the Land Rehabilitation and Conservation Station each year.

10. FISHERY

Fish production, fish species, number of people dealing with fisheries will be monitored by the Fisheries Agency.

**IMPACT CHECKLIST FOR
BESAI-BUKIT KEMUNING TRANSMISSION LINE PROJECTS
(150 KV, 12.5 KMS)**

Actions Affecting Environmental Resources	Potential Environmental Impact	Initial Environmental Examination			
		No significant Impact	Significant Impact		
			Small	Moderate	Major
A. Project siting	1. Ecologically - sensitive areas	v			
	2. Historical/cultural features	v			
	3. Settlements	v			
	4. Land value/use changes		v		
	5. Land form/drainage alternation	v			
B. Project Design	1. Critical environmental areas	v			
	2. Historical/cultural features	v			
	3. Settlement/resettlement	v			
	4. Land values/uses		v		
	5. Landform/drainage alterations	v			
	6. Safety: Explosion/hazardous spill	v			
	7. Noise/Vibration/Pollution	v			
	8. Worker health & safety		v		
	9. Access roads	v			
C. Construction	1. Construction methods	v			
	2. Hunting/poaching/woodcutting	v			
	3. Construction camps	v			
D. Operation	1. Project maintenance	v			
	2. Access control	v			
	3. Land management		v		

**PRELIMINARY IMPACT ASSESSMENT OF
BESAI-BUKIT KEMUNING TRANSMISSION LINE PROJECTS
(150 KV, 12.5 KMS)**

A. Project sitting

1. Ecologically - sensitive areas

The transmission will not go through the ecologically sensitive area. It will go through the bushes, agriculture area (coffee, annual crop etc.). There is no forest, swamp, parks or other ecologically sensitive area which will be affected by the project.

2. Historical/cultural features

There is no historical and cultural features will be affected by the transmission lines. The project will not likely affect the tourism activities.

3. Settlements

There is no houses should be relocated, and no houses will be passing over by the transmission lines.

4. Land value/use changes

Most of the land use passed over by the transmission lines are bushes and agricultural land. The crops grow on those land will not be disturbed, except the crop or vegetation on the tower site. The farmer may allow to grow the existing crop or similar one on the affected land. So, there will be no depreciation on the value of the land anticipated.

5. Landform/drainage alterations

There will be no topographic features changes caused by this project. The transmission lines will not affect the passageways for the communities and the wildlife pattern nor the drainage pattern as well.

B. Project Design

1. Critical environmental areas

The route design has considered not to pass the settlement areas and other sensitive environmental areas.

2. Historical/cultural features

There is no historical and cultural features will be affected by the transmission lines. The project will not likely affect the tourism activities.

3. Settlement/resettlement

There is no houses should be relocated, and no houses will be passing over. Compensation payment will be given to the people whose land affected by the tower of the transmission lines and the trees/crops affected by the project activities.

4. Land values/uses

Most of the land passed over the transmission lines area bushes and agricultural land. The tall trees which will exceed the safety clearance of the transmission lines will be cut and the trees owner will be given compensation.

5. Landform/drainage alterations

The transmission lines will pass over the bushes and agricultural land (coffee, seasonal crop etc.). Most of the crop and bushes will be let uncleared and it will be very few tall trees been cut. The safety clearance has accommodated this matter, so the impact of the project on the land form and drainage alterations can be neglected.

6. Risk of Explosion/hazardous spill

The transmission line has been designed to prevent the accidental failure of power lines caused by storm, strong wind, earthquake, lightening, air pollution etc. The design has accommodated the risk of explosion as well. There is no hazardous spill anticipated since no hazardous liquid will be used such as oil containing PCB in the transformer.

7. Noise/Vibration/Pollution

During construction phase, the noise, vibration generated by construction activities will be low. There is insignificant pollution of exhaust gas and dust generated by the construction and supply vehicle. During operation there is no vibration and pollution generated by the transmission lines. Transmission lines will be designed to meet the environmental standard of noise level.

8. Worker health & safety

During construction phase, there is a risk of the worker to fall down from the tower. To prevent the accident, the worker will be provided with the safety measures such as safety belts, gloves, shoes, helmet etc. Construction of tower and stringing activities of the line will also consider the safety for the community and the traffic.

9. Access roads

The transmission lines will almost in parallel with the existing highway connecting the Bukit kemuning through Besai to Liwa. There are also several village road and pathway across the right of way. The right of way is considered an open area and the access is relatively easy to carry the construction material such as the tower material and the cable of the line. In this regard there will be no special access road necessary.

C. Construction

1. Construction methods

The construction methods will consider the prevention of soil erosion. There will be insignificant noise and dust generated by the construction activities. The total clear and cut of the vegetation will be happened only on the tower sites. Cut and fill of the soil will be kept to minimum to prevent soil erosion.

2. Hunting/poaching/woodcutting

There is no potential wildlife or valuable vegetation exist along the right of way which may be hunt/collected/cut by the worker or the surrounding people.

3. Construction camps

Since the transmission is relatively short (12.5 Km), the worker of construction activities will be small, so the construction camp will also small. The demand of water supply and sanitation will not disturb the balance in the chosen area. The impact of the worker on the public health of the local communities will be small.

D. Operation

1. Project maintenance

The transmission line has been designed to prevent the accidental failure of power lines caused by storm, strong wind, earthquake, lightening, air pollution, fire hazard etc. The design has accommodate the risk of explosion and line failure as well. If the line fail, the safety mechanism in the substation will disconnect the power current less than a second, so the broken lines will harmless to the people/wildlife.

2. Access control

There is no special natural resources along the right of way which may be threatened, so no access control is necessary.

3. Land management

The monitoring of the right of way will be carried out regularly to monitor the possible land slide on the surrounding tower and the trees which may grow taller than the clearance zone which may be dangerous.

PROJECT FEATURES

The Besai Hydroelectric Power Project is located in the upper reach of the Besai river, a tributary of the Tulangbawang river which is one of three major rivers in the Lampung province off Sumatera, draining into the Java Sea as shown Drawing No.1.

The Project is formulated as a run-of-river type development with a daily regulating storage capacity.

Harnessing available 95% dependable firm discharge of 8.3 m³/sec and water head of about 245 m, the project is planned to produce an annual energy of 402 GWh consisting of 144 GWh for primary energy and 258 GWh for secondary energy, with an installed capacity of 90 MW. It aims to supply the electric power to the public in the PLN Region IV system so as to cope with the rapid increasing power demand of the system so as to cope with the policy of the Indonesian government, i.e. preservation of the oil resources by developing hydro power potential with the highest development priority.

The principal features of the Project are summarized below :

Operation features of the Project

i)	Water levels		
	Intake water level	:	FSL EL. 722.0 m LOL EL. 720.9 m MOL EL. 719.0 m RWL EL. 721.6 m
	Tail water level	:	TWL EL. 477.0 m (for Q = 45.6 m ³ /sec, 2 units operation) TWL EL. 476.8 m (for Q = 22.8 m ³ /sec, 1 unit operation)
	Gross head	:	244.6 m (for 2 units operation) 243.8 mm (for 1 unit operation)
	Net head	:	231.3 m (for 2 units operation) 240.0 m (for 1 unit operation)
ii)	Discharges		
	95% dependable firm discharge	:	8.3 m ³ /sec.
	Plant discharge	:	45.6 m ³ /se. (for 2 units operation)

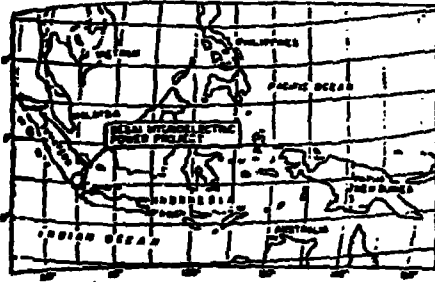
iii)	Power generation and energy output	
	Installed capacity	: 90 MW (45.0 MW x 2 = 90 MW)
	Power generation, peak	: 90 MW
	Annual energy, primary	: 144 GWh
	Annual energy, secondary	: 258 Gwh

Major structural features of the Project

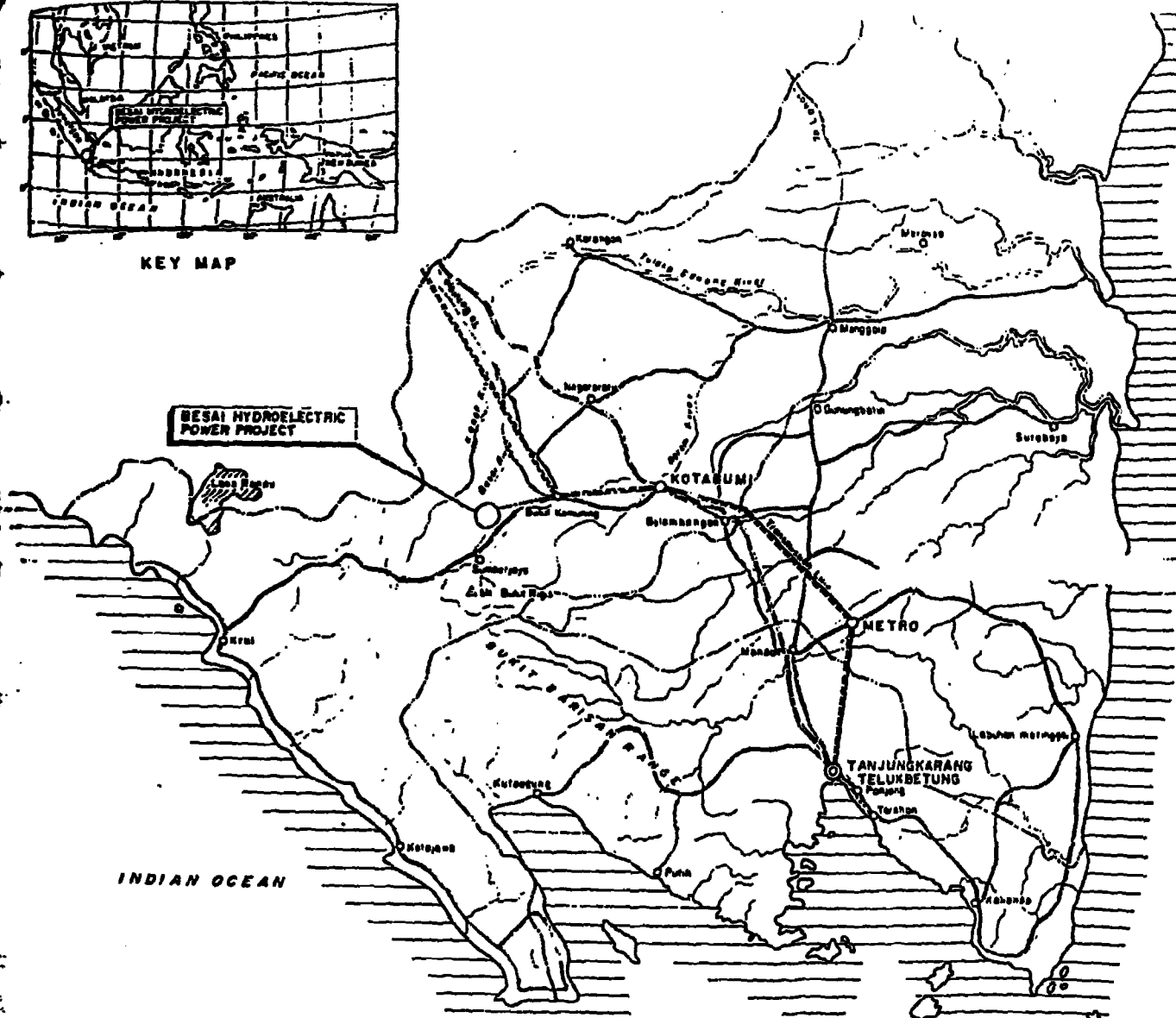
i)	Intake pondage	
	Catchment area	: 415 km ²
	Annual average runoff	: 24.3 m ³ /sec.
	Water level	: Extra-ordinary FWL 725.8 m Design FWL 723.0 m FSL 722.0 m LOL 720.9 m MOL 719.0 m
	Pondage surface area	: 0.7 km ²
	Storage capacity, gross	: 1,200,000 m ³
	, active	: 1,047,000 m ³
ii)	Intake Dam	
	Type	Gated concrete weir
	Dam crest elevation	EL. 726.3 m
	Weir crest elevation	EL. 714.5 m
	Sill elevation	EL. 713.0 m
	Sluiceway	26.0 m wide
	Sluice gate	6.5 m wide x 7.95 m high x nos.
	Scouringway	12.0 m wide
	Scouring gate	6.0 m wide x 1.5 m high x nos.
	Stoplogs	6.5 m wide x 7.8 m total high x 1 no. for sluiceway 6.0 m wide x 3.9 m total high x 1 no. for scouringway
iii)	Intake	
	Inlet dimension	13.8 m wide x 10.1 m high
	Sill elevation	EL. 716.2 m
	Intake gate	3.8 m wide x 6.1 m high x 2 nos
	Trashracks	6.0 m wide x 10.1 m high x 2 nos
	Trash ranking system	1 set

iv)	Sand Trap basin	
	Width	17.3 m x 2 nos.
	Length	60.3 m
	Width of side spillway	40.1 m
	Crest elevation of	
	Side spillway	EL. 722.0 m
	Sand flush gate	1.0 m wide x 1.0 m high x 2 nos.
v)	Inlet of Headrace Tunnel	
	Inlet dimension	7.6 m wide x 10.1 m high
	Sill elevation	EL. 716.2 m
	Trashracks	7.6 m wide x 10.1 m high x 1 no.
	Inlet gate	7.0 m wide x 6.1 m high x 1 no.
vi)	Headrace Tunnel	
	Type	Concrete lined circular tunnel
	Diameter	4.3 m
	Length	4,893.2 m
	Sand drainage facilities	600 mm ϕ hollow jet valve x i no., 600 mm ϕ steel conduit, 40 m in length x i lane
vii)	Surge Tank	
	Tank	Restricted orifice type, prestressed concrete with reinforced concrete shaft
	Up-surgng water level	EL. 733.4 m
	Down-surgng water level	EL. 702.8 m
	Diameter	13.0 m in Chamber 2.5 m in riser shaft
	Height above headrace tunnel ceiling	94.7 m
viii)	Penstock	
	Type	Inclined/horizontal pressure shaft, steel lined
	Diameter	3.8 m to 1.8 m (3.4 m on an average)
ix)	Powerhouse	
	Type	Surface type
	Main building dimension	28.0 m wide x 44.0 m long x 36.0 m high
	Office and control building dimension	10.0 m wide x 32.0 m long x 8.0 m high
	Draft tube gate	2.4 m wide x 2.3 m high x 2 nos.
x)	Generating Equipment	
	- Turbine	
	Type	Vertical shaft Francis type
	Number of units	2 units
	Rated output	46,400 kW
	Rated head	231.3 m

	Rated speed	500 rpm
-	Generator Type	3-phase, vertical shaft, synchronous type
	Number of units	2 units
	Rated capacity	53,000 kVA
	Rated voltage	11 kV
	Frequency	50 Hz
	Power factor	0.85 lagging
-	Main transformer Type	3-phase oil immersed, forced-oil-circulation and forced air cooled, outdoor use type
	Number of units	2 units
	Voltage	11/150 kV
	Capacity	53,000 kVA
xi)	Transmission Line	
-	Transmission line route	Power station-Existing Transmission line between Baturaja and Kotabumi around Bukit Kemuning
	Length	16 km
	Number of circuit	Double circuit
	Voltage	150 kV
	Conductor	ACSR 240 mm²
	Tower	Double circuit steel towers



KEY MAP



JAVA SEA

INDIAN OCEAN

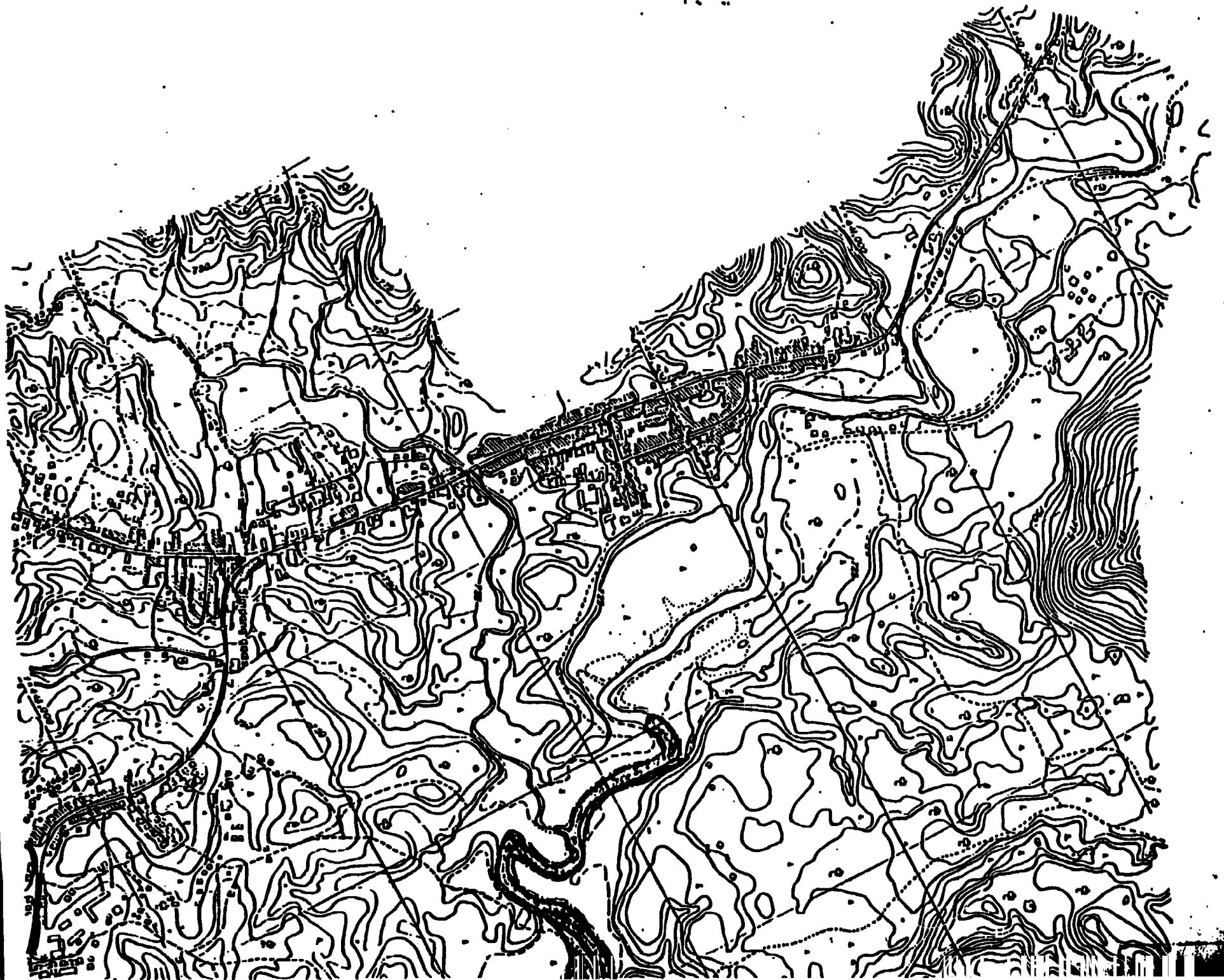
Drawing 1

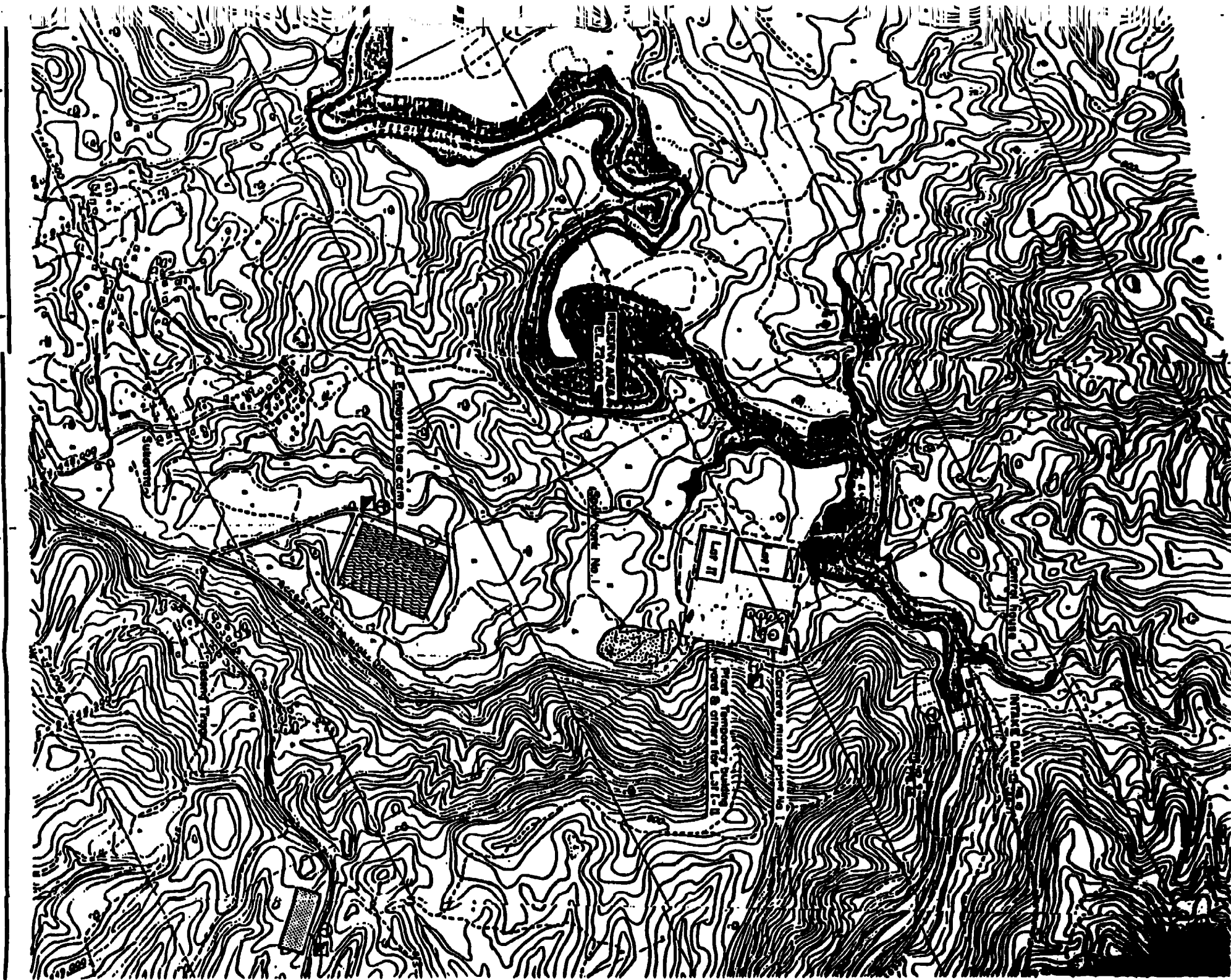
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TITLE BESAI HYDROELECTRIC POWER PROJECT			
DRAWING TITLE GENERAL LOCATION MAP			
APPROVED BY		DATE	
APPROVED BY		DATE	
APPROVED BY		DATE	
DATE	APPROVED BY	DATE	APPROVED BY

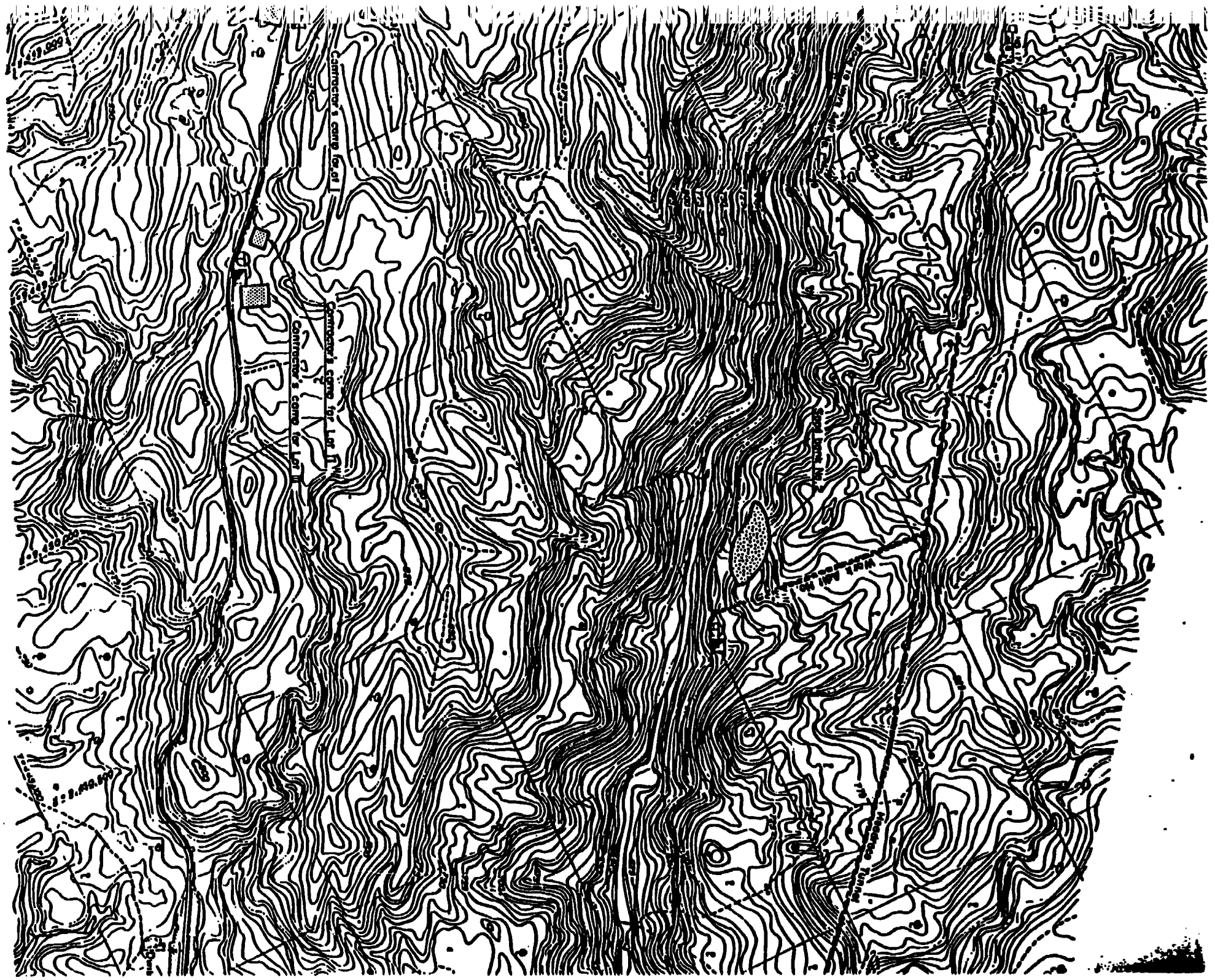
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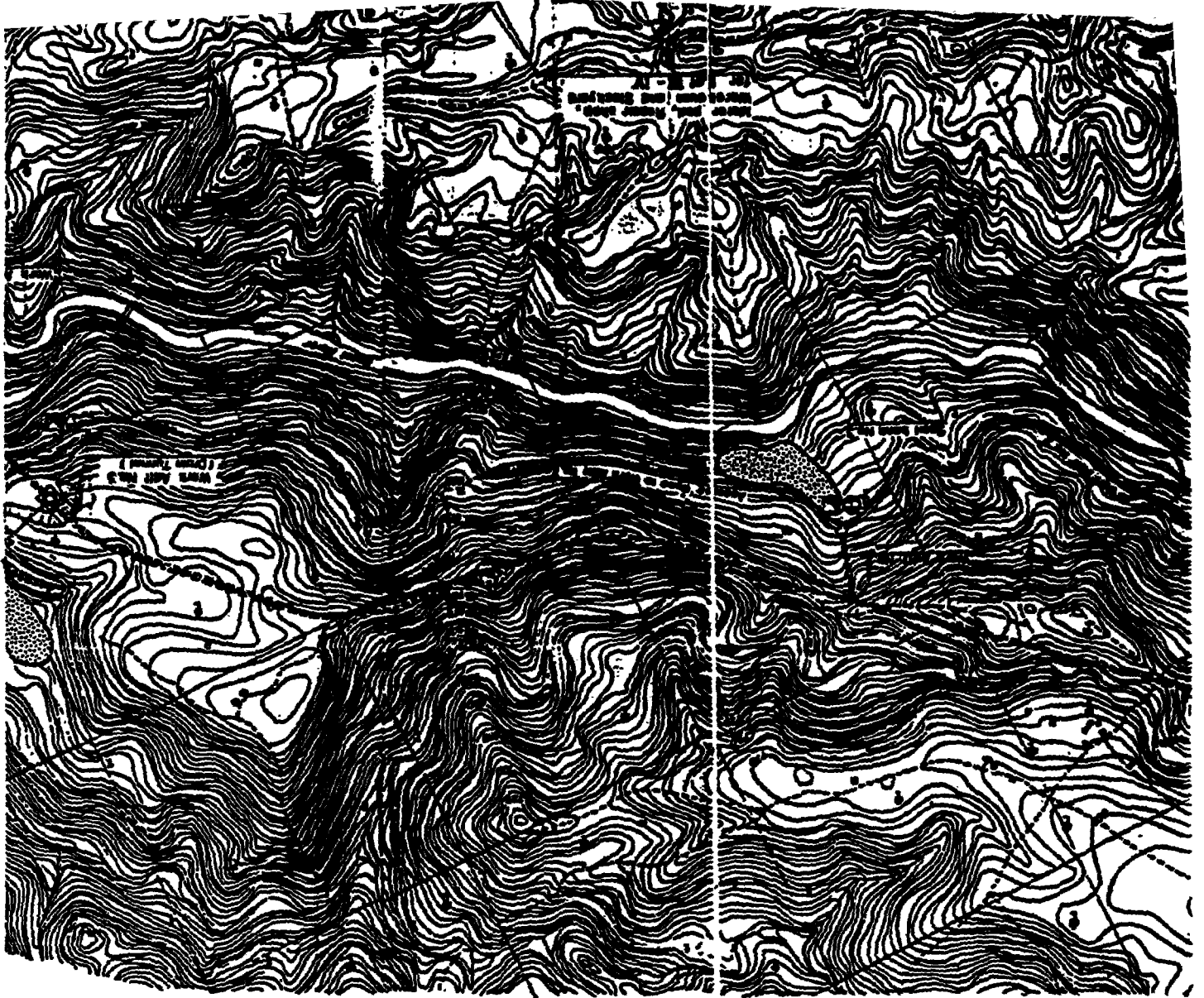
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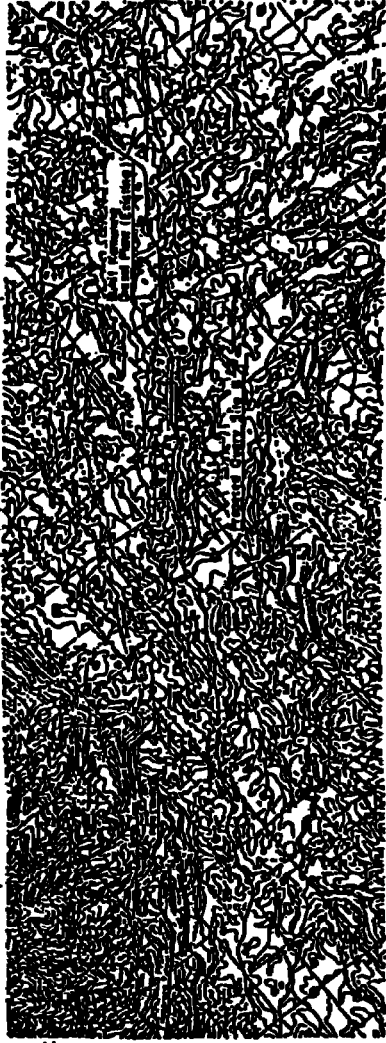
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LEGEND:

- Low voltage terminal of Transformer
- ⊙ Terminal box of Telephone System

Drawing II

NO. 1	PERUSAHAAN UMUM LISTRIK NEGARA
NO. 2	AGENCY OF THE MINISTER OF WORKS AND ENERGY OF THE GOVERNMENT OF THE REPUBLIC INDONESIA
NO. 3	ENGINEERING SERVICES CENTER (PPE)
NO. 4	PT. BINA SARYA & ANGGKA SIA PERTAMA 1960 CO. LTD.
NO. 5	RESMI HYDROELECTRIC POWER PROJECT
NO. 6	GENERAL
NO. 7	ALLOTTED AREA AND CONSTRUCTION FACILITIES
NO. 8	PROJECT NO. 10.01/1967/100
NO. 9	DESIGNED BY: [Signature]
NO. 10	CHECKED BY: [Signature]
NO. 11	DATE: [Blank]
NO. 12	SCALE: [Blank]

