Appendix II

IEE レポート

Likud Mini-hydropower Development Project

Initial Environmental Examination

Likud Mini-hydropower Development Project

Initial Environmental Examination

Table of Contents

List of Tables

List of Figures

Annex

Abbreviations

°C	Degree Celsius
ANSI	American National Standards Institute
B	Bill (horny projecting mouth of a bird)
BOD	Biological Oxygen Demand
C	Dominance Index
CAA	Clean Air Act
CAR	Cordillera Administrative Region
CIS	Communal Irrigation Systems
cm	Centimeter
DAO	DENR Administrative Order
dBA	A-weighted decibels
DBH	Diameter at breast height
DENR	Department of Environment and Natural Resources
DOE	Department of Energy
DO	Dissolved oxygen
e	Evenness index
E	Ear
e8	Emerging 8
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EL	Elevation
EMP	Environmental Management Plan
FA	Forearm for bats
FS	Feasibility Study
G	gape
H'	Shannon diversity index
H	hour
HF	Hind foot
HH	Household
IFELCO	Ifugao Electric Cooperative
IRTCHO	Ifugao Rice Terraces Cultural Heritage Office
ICOMOS	International Council for Monuments and Sites
IUCN	International Conservation Union
km	kilometer
km^2	Square kilometer
kW	Kilowatt
LGU	Local Government Unit
LTO	Land Transportation Office
m	meter
m^3	Cubic meter
masl	Meter above sea level
mg/L	Milligrams/liter
mL	milliliter
mm	Millimeter
m/s	Meter per second
MBN	Municipal Basic Need
MPN/100mL	Most probabale number per 100 milliliter
PET	Polyethylene terephthalate
MW	Megawatt
NAAQG	National Ambient Air Quality Guidelines
NO2	Nitrogen dioxide
NPCC	National Pollution Control Commission
PAC	Project-affected Community
PPE	Personal Protective Equipment

ppm	Parts per million
PWRC	Philippine Wildlife Resources Conservation (Act of 2001)
RA	Republic Act
SE	Southeast
SEP	Socio-economic Profile
SO2	Sulfur dioxide
T	Tarsus
TEPCO	Tokyo Electric Power Corporation
TL	total length
TV	tail-vent length
TSP	Total Solid Particulates
TSS	Total Suspended Solid
TWG	Technical Working Group
ug/NCM	Microgram per normal cubic meter
UNESCO	United Nations Educational, Scientific and Cultural Organization
UPLB-CFNR	University of the Philippines – College of Forestry and Natural Resources
WC	Wing cord
WT	Weight

1.0 Executive Summary

The project site is approximately 334 km away from Metro Manila. It is in Barangay Haliap, Municipaity of Asipulo and Province of Ifugao.

The components of the project include:

- Diversion weir
- Intake and Settling Basin
- Headrace
- Headtank
- Penstock and Spillway
- Powerhouse
- Switchyard
- New access road to the power house
- Distribution line

Ifugao Province is well known for its extensive rice terraces. In 1995, UNESCO had included the Cordillera rice terrace in their World Heritage List of Cultural Landscapes. However, in 2001, UNESCO included them on the List of World Heritage in Danger because of its continuous deterioration primarily due to the decline of the traditional balance as a result of out-migration, slow but continuous disappearance of the old culture and leadership, and indiscriminate deforestration. In addition, there is no effective and comprehensive rice terraces conservation plan.

This project is primarily being developed to create funds from the sales of electricity that will be generated. These funds will be used in the rehabilitation programs, conservation projects for the rice terraces in Ifugao Province. It also envisioned that the funds generated will help in improving the quality of lives of the people engaged in terrace farming and removal of the Rice Terrace from the List of the UNESCO World Heritage in Danger.

Brief Summary of Project's IEE Process

The Initial Environmental Examination (IEE) conducted for the 810kW Likud Mini Hydropower Plant Project is consistent with the Revised Procedural Manual for Department of Environment and Natural Resources (DENR) Administrative Order (DAO) 2003-30 of August 2007. The Terms of Reference used for this study was based on environmental impacts identified for a hydropower project.

The baseline environmental conditions were assessed through the conduct of rapid site assessments and field observations from February 2011 until June 2011. Supplemental secondary information was collected from government agencies and institutions.

Summary of Baseline Characterization

Ecosystem	Findings
Land	The project site falls under the classification alienable and disposable land with some locations outside the proposed facility falling under the forest/timber land classification. The municipality of Asipulo covers a land area of 29,043 hectares. Of this, 490 hectares is covered by barangay Haliap. Alienable and disposable land covers for the 98% of the total land area of barangay Haliap while the remaining 2% is forest and timber land. Previous studies and correlation with outcrops of the neighbouring mountain ranges indicate that the stratigraphy of the basin is largely composed of deep marine sediments and extrusive igneous

Ecosystem	Findings
	rocks (Hipol et al., 2001). There are four main vegetation communities within and along the immediate surroundings of the project. These are agricultural land (planted mainly to rice, winged beans, and sweet potato), shrubland/grassland (dominated by various species of grass and woody shrubs), tree plantation (planted to Gmelina), and patches of forest (secondary growth and original vegetation restricted to the very steep portions of the river stretch). A total of 12 bird species were observed and confirmed present along the entire stretch of project site. Except for the white-eared brown-dove (*Phapitreron leucotis*), Philippine bulbul (*Hypsipetes philippensis*), and Philippine coucal (*Centropus viridis*), all recorded species are resident breeding but are non-endemic. None are considered under any threat categories based on PWRC 2001 and IUCN Red List of Threatened Species 2010.
Water	The project has a catchment area of 44.02 km^2. There is no historical stream flow data available for the Lamut River. Probable flood discharges for various return periods for Lamut River is calculated using the Dimensionless Hydrograph. The Lamut River is identified in the DENR Memorandum Circular No. 07 series of 1993 Additional List of Classified Rivers and Bays (DMC 1993-07) as a Class C fresh surface water body. Based on the classification guidelines of DAO 1990-34, Class C waters are used for aquaculture, recreational activities such as boating, and industrial water supply. In terms of pH, samples from the two stations along Lamut River were both alkaline. The DO levels at the Intake and Powerhouse are above the minimum limit in the DAO 1990-34 for Class C waters. BOD levels in the two stations both passed the DAO 1990-34 maximum allowable limit for Class C. Surface water stations have undetected levels of TSS. Elevated levels of total and fecal coliform were noted in the Intake and Powerhouse stations. In general, the entire reach of the proposed project area is in good condition. Other than the man-made weir bridge at Station LH-8, the stream reach experiences no significant perturbation that would likely impact the freshwater habitats and organisms thriving in the area.
Air	The prevailing climate in the project area falls under Type II of the Modified Corona's Classification of the Philippines. Under this classification there is a very short dry season with pronounced maximum rain during summer months. Using DAO 2000-81 air quality indices, the air quality of the project area based on the 24-hour concentrations of TSP and SO2 can generally be classified under good condition.
People	The municipality of Asipulo has 12 barangays and a total land area of 29,043.1533 ha. It has a total population of 13,100 and population density of 2.18 hectares per person (CBMS, 2007). The project site is within the administrative area of Barangay Haliap. As of 2007, the National Statistics Office (NSO) reported a population of 1,013 for the barangay with an average household size is 4.7. According to the 2007 CBMS survey, the total population is 979 with a 1.84% population growth rate. Agriculture and forestry are the main sources of livelihood. Beans, tomato and palay are the major crops planted in the barangay primarily used for subsistence while the remaining harvests are for cash crops.

Summary of Impact Assessment and Environmental Management Plant

Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement
I. PRE- DEVELOPMENT PHASE			
Development of project facilities	Biological Resources	Various facilities may disturb vegetation.	• Vegetation along the project stretch is heavily disturbed and

Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement
			will only entail clearing of limited areas. • All clearing activities will be carried out in a manner such that damage or disruption to vegetation is minimized. • All trees that will be cut will be properly compensated. • Relevant permits will be secured from concerned agencies prior to cutting.
	Biological Resources	Disturbance of wildlife.	• A "No Hunting" policy from the contractor to minimize the potential increase for wildlife hunting and poaching due to temporary increase of workers in the area.
	Socio-economic Cultural Conditions	Displacement of agricultural and land properties may cause apprehension on the community regarding the acquisition of land as project site.	• Conduct IEC to explain the project in terms of land acquisition and land use.
	Socio-economic Cultural Conditions	Expectation of lower cost of electric service.	• Conduct IEC on effects of project on the cost of electric service to level-off expectations.
II. CONSTRUCTION PHASE			
Construction of the key project facilities	Physical Resources	Potential degradation of water quality due to the generation of wastes during the construction period.	• Proper housekeeping will be initiated by the proponent and contractors during the construction phase.
	Physical Resources	Possible soil erosion from digging activities and increased sedimentation.	• Establishment of sediment traps during the construction stage.
	Physical Resources	Construction of the hydropower plant will alter the natural landscape of the project site.	• The dimensions of the facilities indicates that with a small project its impact will not be of alarming proportions and can be managed through:
	Socio-economic Cultural Conditions	• Creation of employment (about 200 workers will be employed during the construction of the plant). • Increased local labor pool and skills base. • Pressure on existing public services. • Possible peace and order problems. • Possible informal settlements that could eventually become permanent settlement	• Priority will be given to qualified local residents; A "local first" hiring policy will be implemented. • Develop a clear, precise, and well-defined employment policy and transparent procedures as part of the workforce management strategy to make clear what the process for employment in the project will be, what opportunities are available, and what the minimum skills requirements are in due coordination with concerned LGUs.
Construction of the key project	Socio-economic Cultural		

Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement
facilities	Conditions	unless regulated.	• Adequate provision of company provided medical and health services. • Increase in community policing (e.g. barangay tanods or barangay security officer, etc.) and registration of workers for identification purposes with local authorities. • Workers will be provided with PPEs. • Noisy activities will be limited during the daytime to avoid annoyance to the community.
III. OPERATIONS PHASE			
General Operation	Physical Resources	Water pollution by domestic effluent from the administration building.	Effluent will be treated in a conventional septic system.
	Physical Resources	Potential increase of sedimentation.	Regular cleaning of the settling pond will be conducted to prevent siltation and to remove large organic debris before any incipient decomposition occurs.
	Physical Resources	There will be competition on water resource as a result of the plant operation.	• Water use for irrigation will be prioritized over power generation to avoid any water competition. The power plant will be shut down during summer months when the river flow is at its minimum to prioritize irrigation requirements.
	Socio-economic Cultural Conditions	Threat to public health if domestic solid waste generated from the operation will not be properly disposed of.	A Solid Waste Management Plan which includes recycling, proper housekeeping and waste disposal will be formulated and implemented.
	Socio-economic Cultural Conditions	• Six to seven operators will be hired for the plant operation • Potential to stimulate business as a result of improved supply of electricity. • Potential supply/enterprise development in relation to the project include: ➢ Supply of food for the project's	• Establish "local first" hiring policy for qualified applicants. • Provide a clear, precise, and well-defined employment policy and transparent procedures as part of the workforce management strategy. • Continue to implement enhancement measures to facilitate equity and fairness in access to employment and to maximize opportunities for local participation.
General Operation		➢ workforce and employees ➢ Building maintenance ➢ General consumables ➢ Transportation	

Project Phase / Environmental Aspect (Project Activity Which Will Likely Impact the Environmental Component)	Environmental Component Likely to be Affected	Potential Impact	Options for Prevention or Mitigation or Enhancement
		➢ Tourism	
	Socio-economic Cultural Conditions	The number of available jobs will decrease modestly but will remain above the expected number of jobs to be created. Each year, the number of jobs is directly tied to constructing the facility.	• Prioritize employment to qualified locals. • Carry out activities consistent with TEPSCO and Provincial Government of Ifugao commitment to equal and fair employment opportunity.
	Socio-economic Cultural Conditions	Host communities will receive benefits indicated in Sections 4 and 66 of EPIRA 2001 (The Generation Company and/or energy resource developer should set aside one centavo per kilowatt hour (P0.01/kWh) of the total electricity sales as financial benefits to host communities). This is in relation with Sec. 5(i) of R.A. 7638 which states that DOE shall devise ways and means of giving direct benefits to the province, city, or municipality, especially the community and people affected, and equitable preferential benefit to the region that hosts the energy resource and/or energy-generating facility provided, however, that the other provinces, cities, municipalities, or regions shall not be deprived of their energy requirements.	• Closely coordinate with the local govt. units to monitor the use of the allocated Funds generated from the EPIRA benefits.
General Operation	Socio-economic Cultural Conditions	The project will generate funds for conservation programs and projects.	• Proceeds of the project will be used to fund projects for the conservation of the terraces, thus maintaining heritage. • The additional budget generated from the project is a welcome contribution to achieve the UNESCO's recommendations to the conservation of the Rice Terraces and eventually removal of which from the List of World Heritage In-Danger.

2.0 Introduction

2.1 Terms of Reference of the IEE Study

The Terms of Reference of this study is consistent with the Revised Procedural Manual for DAO 2003-30 (August 2007), based on environmental impacts identified for renewable energy (hydro power plant) project. The Study Plan was circulated to the stakeholders for their comments prior to implementation.

2.2 The Study Team

Name	Role
Jess Bayrante	Project Director
Mike de Guia	Project Manager/ Wildlife Specialist
Rene Cruz	Hydrologist
Wilfrido Palarca	Sociologist/ Stakeholder Consultation Specialist/ Landscape/ Cultural/ Heritage Assessment Specialist
Kathy Hipol	Geologist
Abba Grace Sanchez	Vegetation Specialist
Larry Padilla	Freshwater Biota Specialist
Martin John Morales	Environmental Scientist
Sheryl Gutierrez	Water Quality Specialist
Michael Andrew Manalili	GIS Specialist
Llore Juanico	Environmental Assistant
Kathleen Anne Cruz	Peer Reviewer

2.3 The Project Schedule

The propose work program for the project study started from February until July 2011.

Activities	Feb.		March					April				May				June				July	
	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3
Notice to Proceed / Contract																						
Review of related literatures, laws, and regulations																						
Site visit and field investigations																						
Social Environmental Influence during Construction/Operation Phase																						
Identification of Mitigations and Monitoring Plan																						
Field Survey Reports																						
Draft Report																						
Final Report																						
Submission of IEE checklist																						
Barangay Consultation (reference)																						

2.4 Project Location

The proposed 810kW Mini-Hrydro Power Plant project is in the northern Philippine island of Luzon, under Cordillera Administrative Region (CAR). The Mini-Hydro Power Plant project is sited on the northern part of Luzon, province of Ifugao, in the municipality of Asipulo and falls within the Barangay of Haliap. Asipulo is in the lower Southern portion of the Cordillera Mountain range and is about 334 kilometers away from Manila (Figure 2-1). It is bounded on the north by Kiangan, south by Ambaguio, Nueva Vizcaya Province and east by Lamut.

Asipulo has 12 barangays. The proposed project is in Barangay Haliap. Haliap is bounded to the north by Barangay Duit, the south by Pula, the east by Panubtuban and Mappit and west by Amduntog (Figure 2-2) The host barangay is approximately nine kilometres away and is accessible by tricycles (a three-wheeled vehicle consisting of a motorcycle attached to a sidecar) via a one lane concrete-paved road.

The proposed intake along Lamut River is in Barangay Haliap. Access to the weir site is by foot, either through a 150m trail from an existing concrete bridge or through another paved trail about 100m long. Both trails are rarely travelled. The powerhouse in Barangay Haliap is about nine kilometres from the Poblacion and is accessible by tricycle. The open type headrace which will start near the intake will run parallel with the river following existing contours and will extend for 1.8 km up to the head-tank. From the head-tank, water will flow through a steel pipe all the way through the powerhouse.

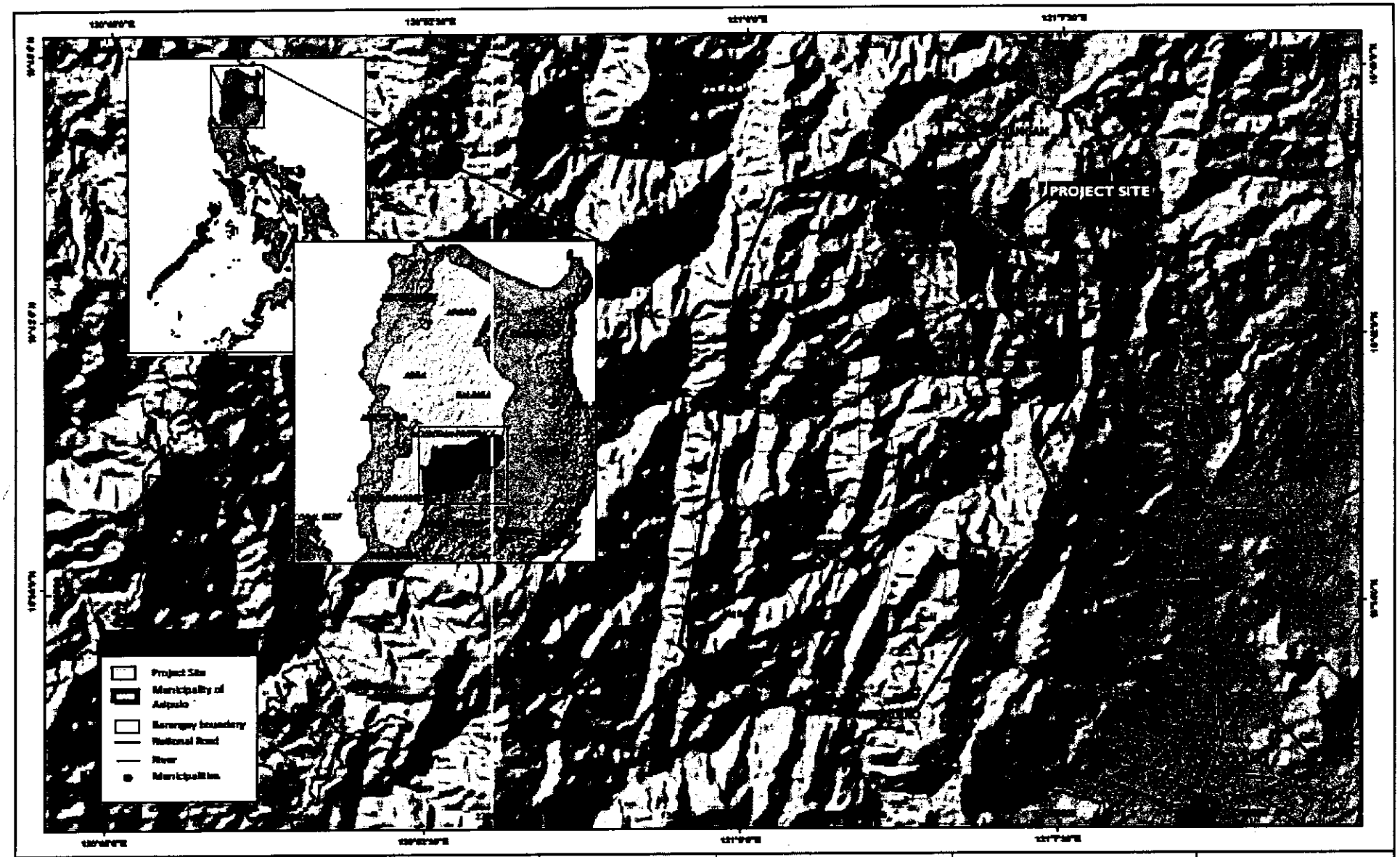


Figure 2-1

Location Map of Ifugao Province and Asipulo Municipality

TEPSCO	IEE - 810 kW Likad Mini Hydropower Plant Project	Rev 2	N
Tanay Hydro Power Solutions Co. Ltd	Barangay Halap, Municipality of Asipulo, Province of Ifugao	AECOM	ArcGIS

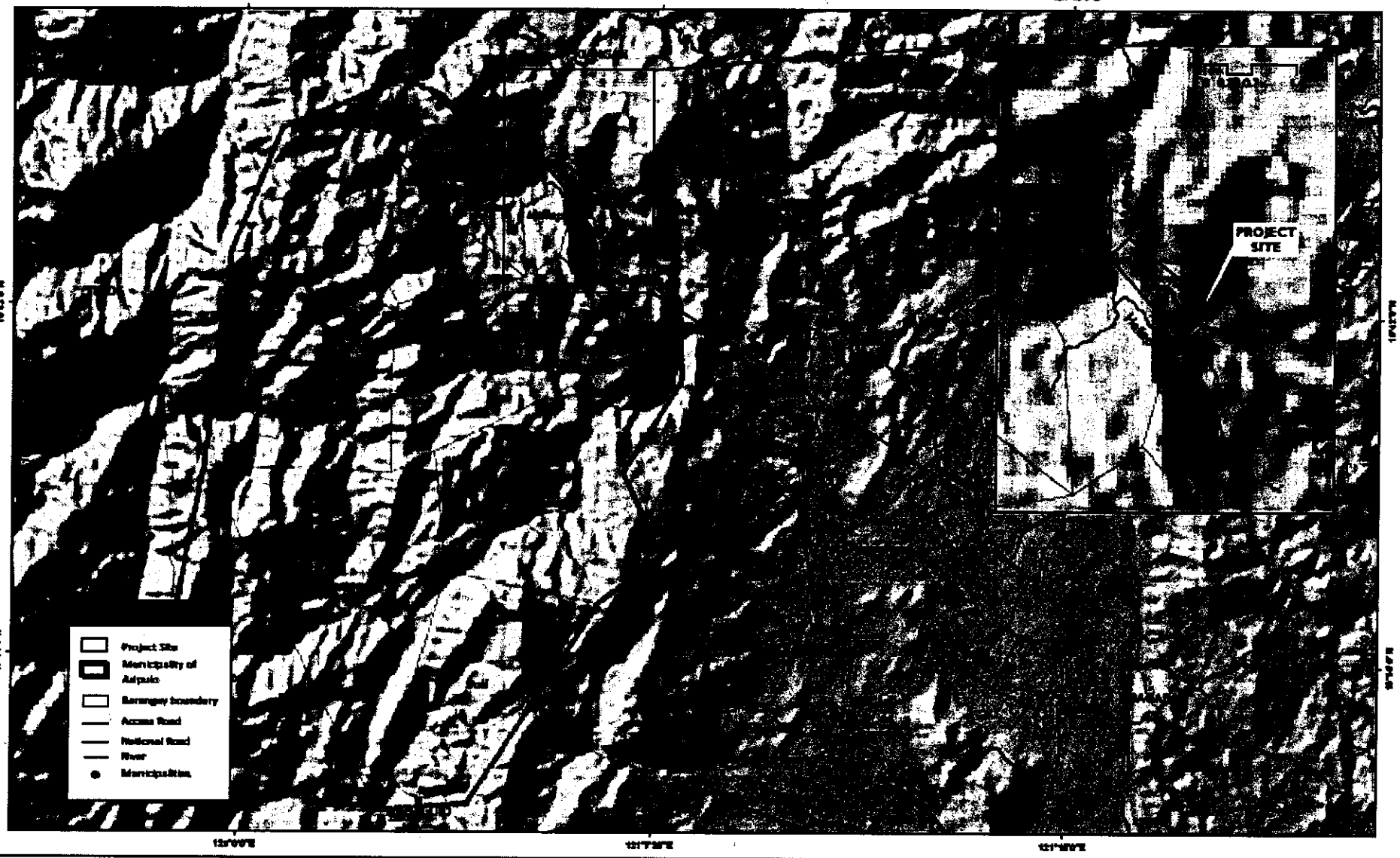


Figure 2-2

The Vicinity Map of the Project

Rev 2

IEE - 810 kW Likud Mini Hydropower Plant Project

Barangay Hellap, Municipality of Aslpato

Province of Bagio

2.5 Project Rationale

The Cordillera Mountain region of Northern Luzon is almost synonymous to the rice terraces. Rice terracing is practiced throughout the whole region of Pacific Asia but those found in the Cordilleras are said to be the most unique in the world. In 1995, UNESCO included the Cordillera rice terraces in their World Heritage List of cultural landscapes. However, the region is also considered as one of the poorest provinces in the country. The situation is made worse by a number of factors such as the deterioration of the traditional balance due to out-migration, slow but continuous disappearance of the old culture and leadership and indiscriminate deforestration. These factors together with the absence of an effective and comprehensive rice terraces conservation plan led to the slow but continuous degradation of the rice terraces. Hence in 2001, UNESCO included the Cordillera rice terraces on the List of World Heritage in Danger. The Cordillera rice terraces are one of the most unique in the world but also one of the most threatened.

In response to the above problem, the Philippine Government tapped the Provincial Government of Ifugao to lead the rice terraces conservation efforts. Thus, the Ifugao Cultural Heritage Office (ICHO) under the office of the Governor was created.

In 2009, the Tokyo Electric Power Company (TEPCO) implemented the 200KW mini-hydro power plant as a demonstration project providing a model of locally sustainable energy-based development, regional vitalization and promoting the development of sustainable mini-hydro power resources in the rural areas.

Currently, the Provincial Government of Ifugao is running the Ambangal power Plant and manages the Rice Terraces Conservation Fund (RTCF). Despite effort of the provincial government, the funds to conserve the Ifugao Rice Terraces is still not enough to accomplish its goal while the terraces remain in the Endanger List of UNESCO.

This project is developed, primarily, to create funds from the sales of the electricity. The funds will be utilized in the rehabilitation programs and conservation projects for the rice terraces and hopefully to improve the quality of lives of the people engaged in terrace farming.

2.6 Project Component

The proposed project features a run-of-river hydropower plant with a maximum capacity of 810kW and will tap the Lamut River traversing Barangay Haliap. The river system has a catchment area of 44.02 km^2. The project site has a total land area of 1.61ha. Figure 2-3 shows the location of the project main components.

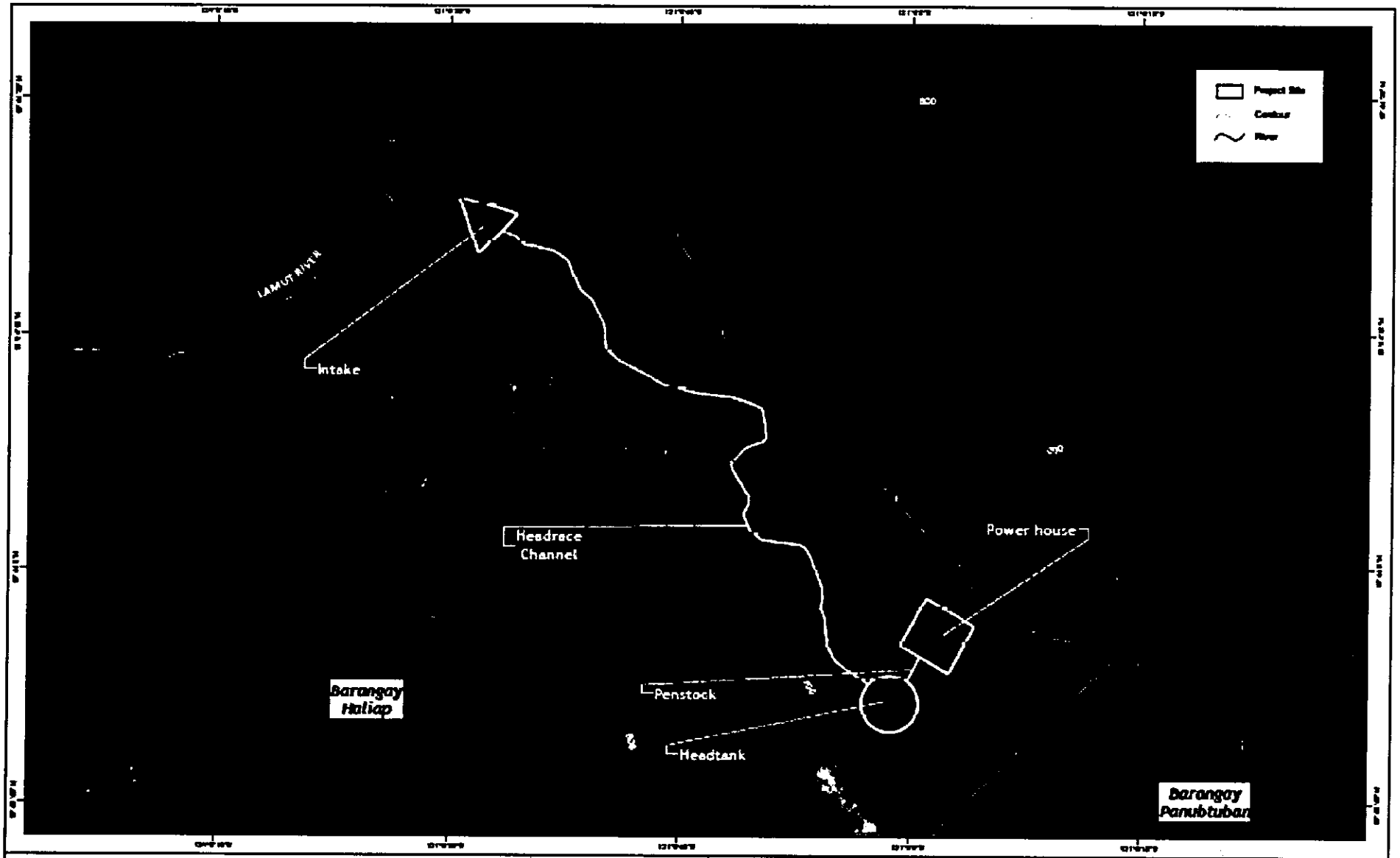


Figure 2-3

Location of the Main Project Component

IEE - 810 kW Likud Mini Hydropower Plant Project

Barangay Haliap, Municipality of Asipulo

Province of Ifugao

Rev 2

2.6.1 Diversion Weir

The intake weir will be constructed in Barangay Haliap. The intake weir is of the floating type which has a length of 20m, height of 3m and width of 0.8m. The body will be of the masonry concrete type while the surface will be covered with rain faced concrete. Access to the weir is by foot trail. Geographical and geological conditions on both sides of the river bank and river bed will be considered in constructing the structure along with the priority use of local raw materials and local manpower during construction.

2.6.2 Intake and Settling Basin

The intake is designed as the side intake type. The dimensions were designed to allow a smooth inflow of maximum discharge and irrigation water (Plate 2-1).

The settling basin is designed to ensure the capture of sediments with a diameter of 0.1mm (Figure2-4). A spillway will be installed to prevent the inflow of excess water from the intake into the headrace during floods (Plate 2-2).

There are two existing irrigation Communal Irrigation System (CIS) between the intake and the powerhouse, so a valve will be provided on the side wall of the settling basin for water diversion into the nearby irrigation systems, to comply with the Philippine Water Act, where irrigation water is a priority use over power.

2.6.3 Headrace

The headrace will be of the open channel type with the interior design to ensure a smooth flow of maximum discharge, with a dimension of 1.4m width by 1.2m depth (Figure 2-5). It will have a distance of 1.8 km from the intake to the head tank and an inclination of 1/500, following the contour line of the right bank of the Lamut River (Plate 2-3).

2.6.4 Head-tank

The head-tank will be an open type, with a dimension of 4.8 m width and 11.8m length (Figure 2-6). This project structure will ensure that the output capacity is stable even with fluctuations in power demand, compatibility with increase and decrease in the volume of the river water, ultimate removal of sediments and other foreign particles, and ability to discharge surplus water during a stop in the operation of the power station (Plate 2-4).

2.6.5 Penstock and Spillway

The penstock will facilitate the water transport from the head-tank to the powerhouse (Plate 2-5). Steel pipes will be used with a dimension of 0.85 m diameters and 118.5 m length (Figure 2-7). All of it will be constructed as an underground type in consideration of the existing landscape.

2.6.6 Powerhouse

The location of the powerhouse is 230 m upstream from the watershed-out concrete overflow crossing where it is relatively flat. . The structure has 12.7 length, 3.5 height and 6.9 width. The base of the powerhouse is 4 m up from the river basin (Figure 2-8). A new access road to the powerhouse with a total length of 230 m will be constructed.

Plate 2-1 Intake Weir[1]

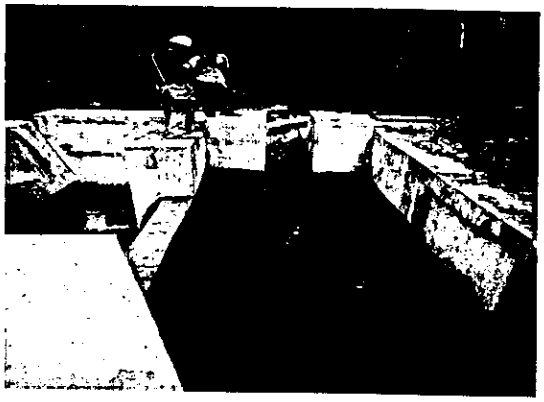


Plate 2-2 Settling and Basin[1]

Plate 2-3 Headrace[1]

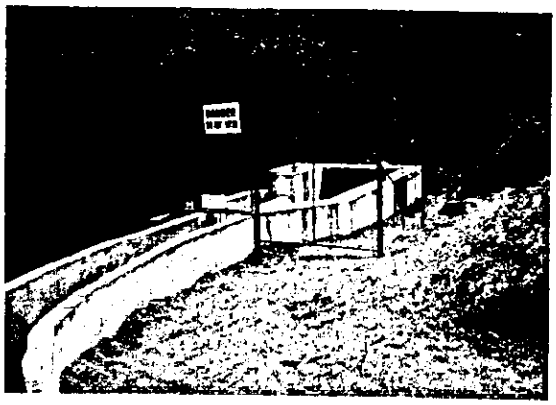


Plate 2-4 Headtank[1]

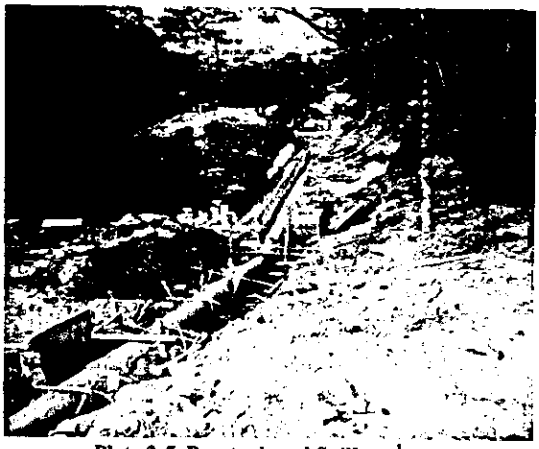
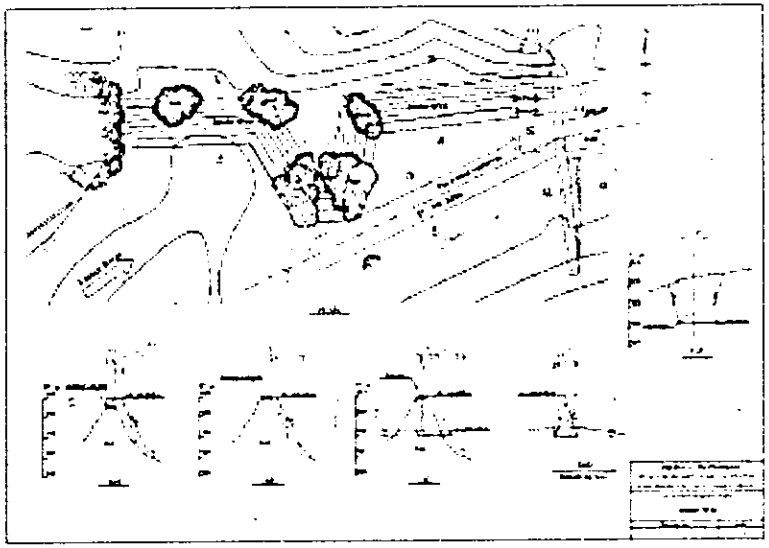


Plate 2-5 Penstock and Spillway[1]

[1] The image photos of the civil structure. All pictures, except Plate 2-1, are image picture of each civil structure. .



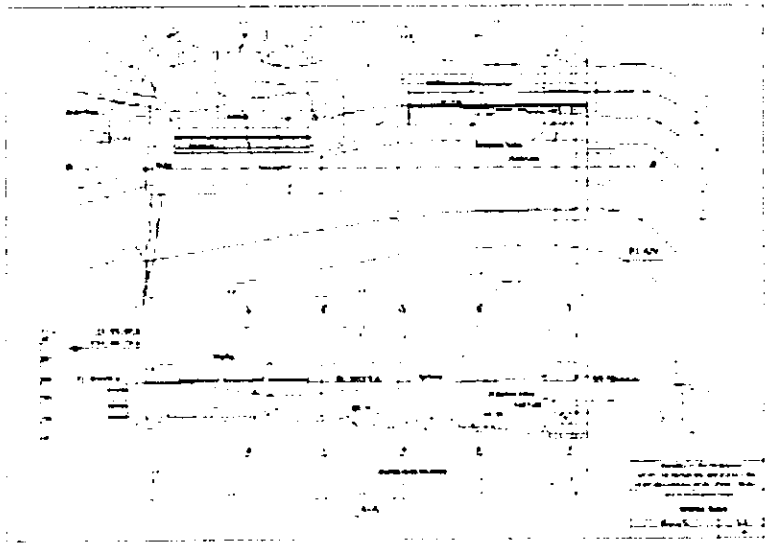


Figure 2-4

Lay-out of Intake and Settling Bacin

Rev 2	Not to scale	

EE - 810 kW Likud Mini Hydropower Plant Project
Barangay Halsip, Municipality of Asipulo
Province of Ifugao

AECOM

ArcGIS

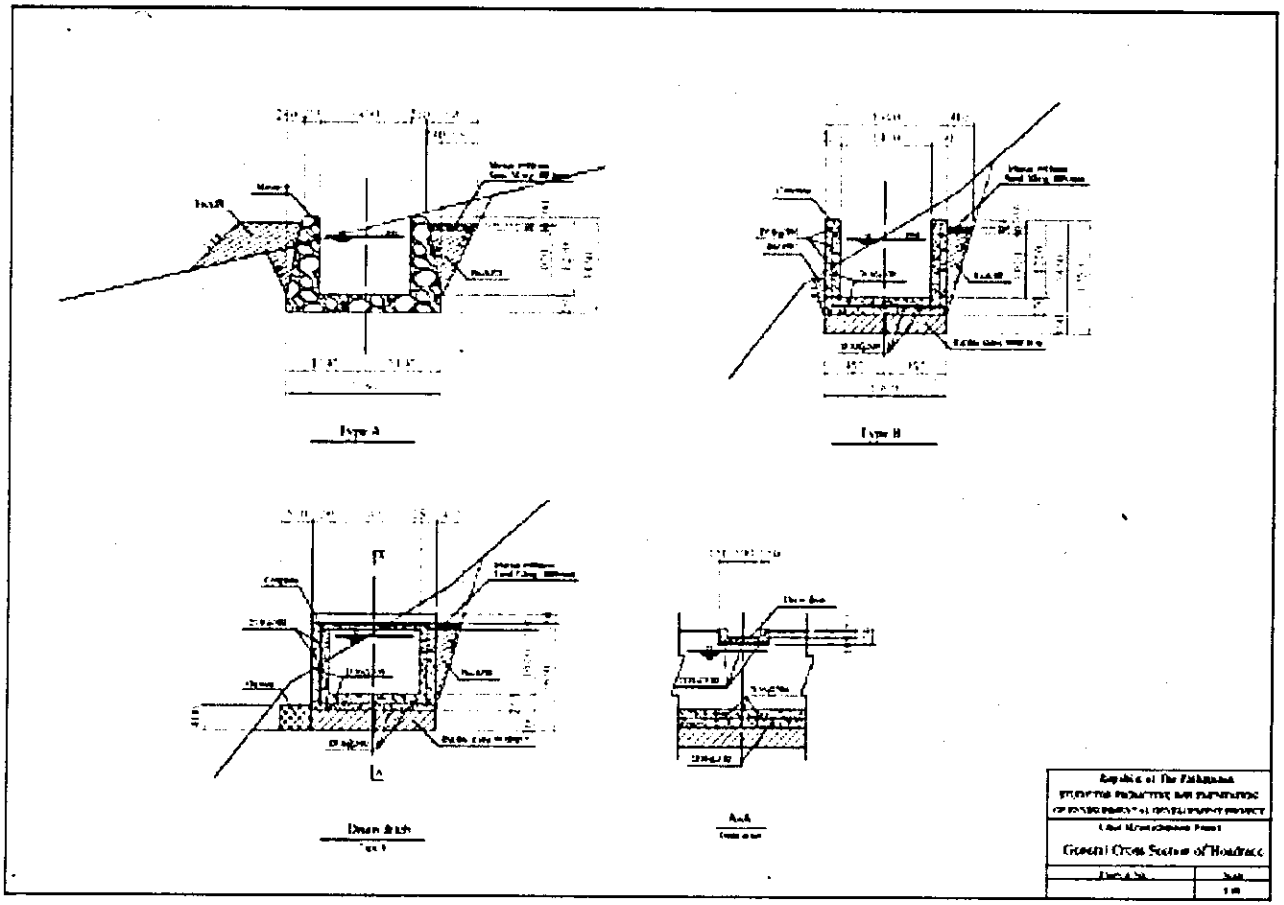


Figure 2-6

Layout of Headrace

IEE - 810 kW Liliud Mini Hydropower Plant Project
Barangay Hallap, Municipality of Asipulo
Province of Ifugao

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Not to scale

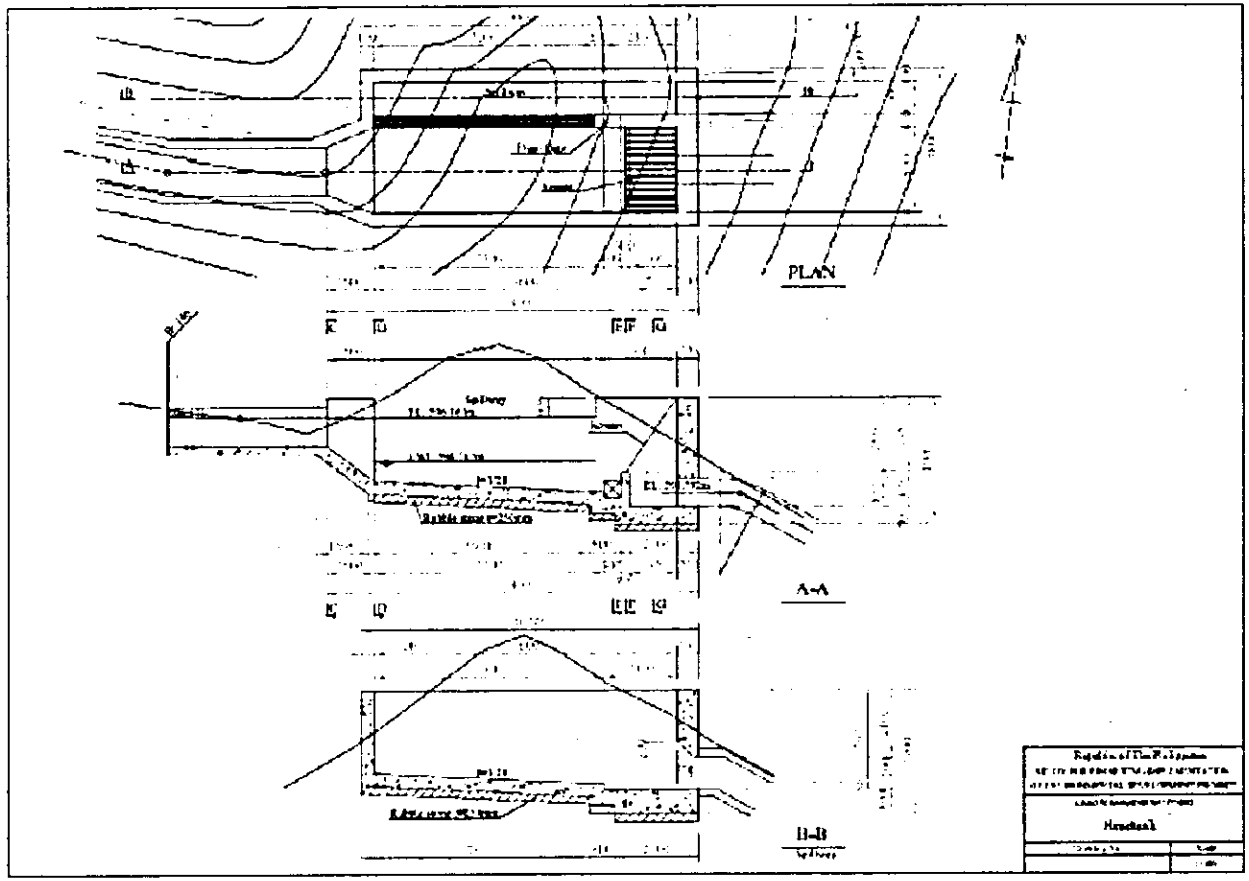

Figure 2-6

Lay-out of Headtank

Rev 2

Not to scale

IEE - 810 kW Likud Mini Hydropower Plant Project

Barangay Hatap, Municipality of Ampuin

Province of Ilugo

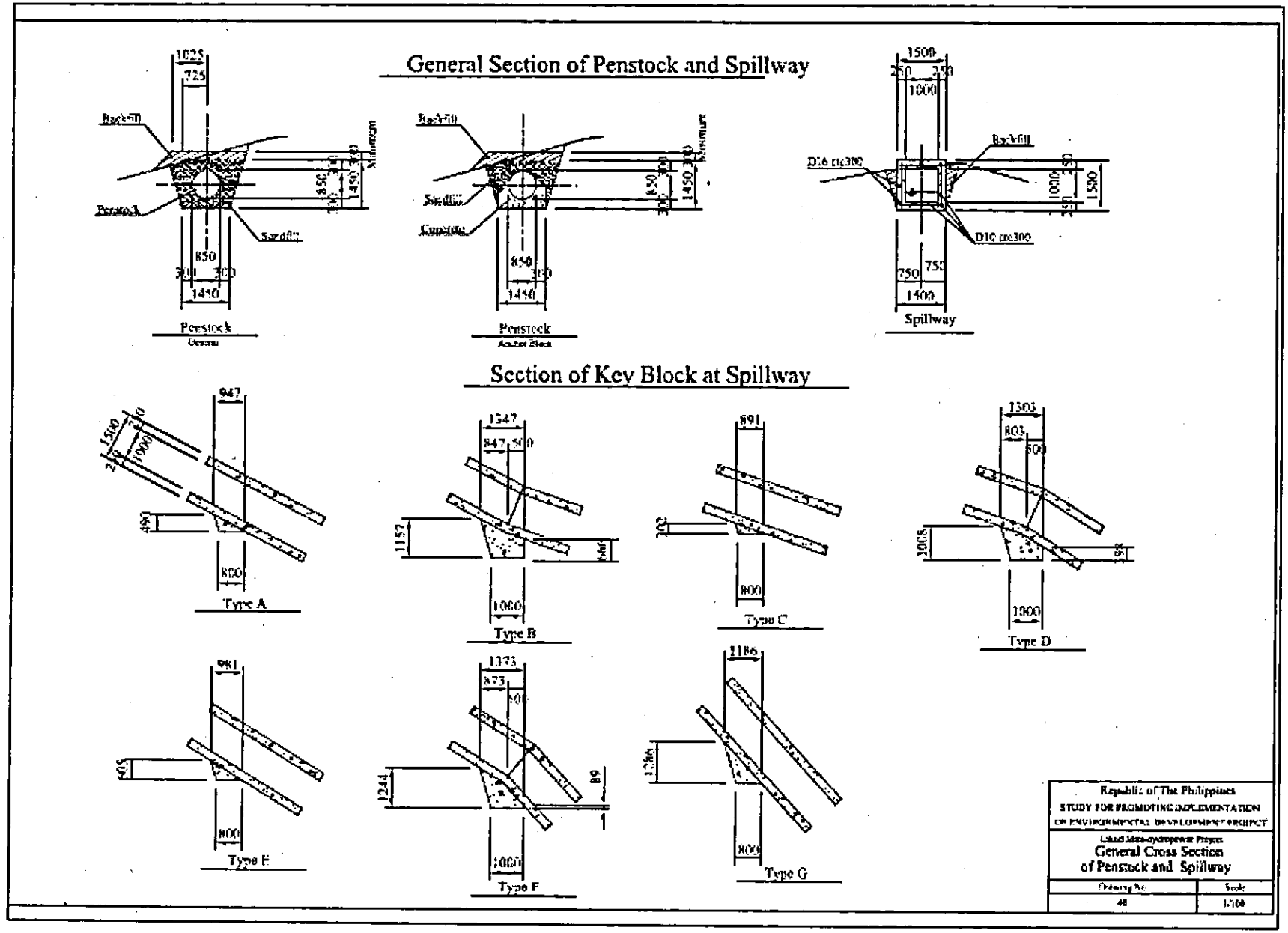

Figure 2-7 Lay-Out of Penstock and Spillway

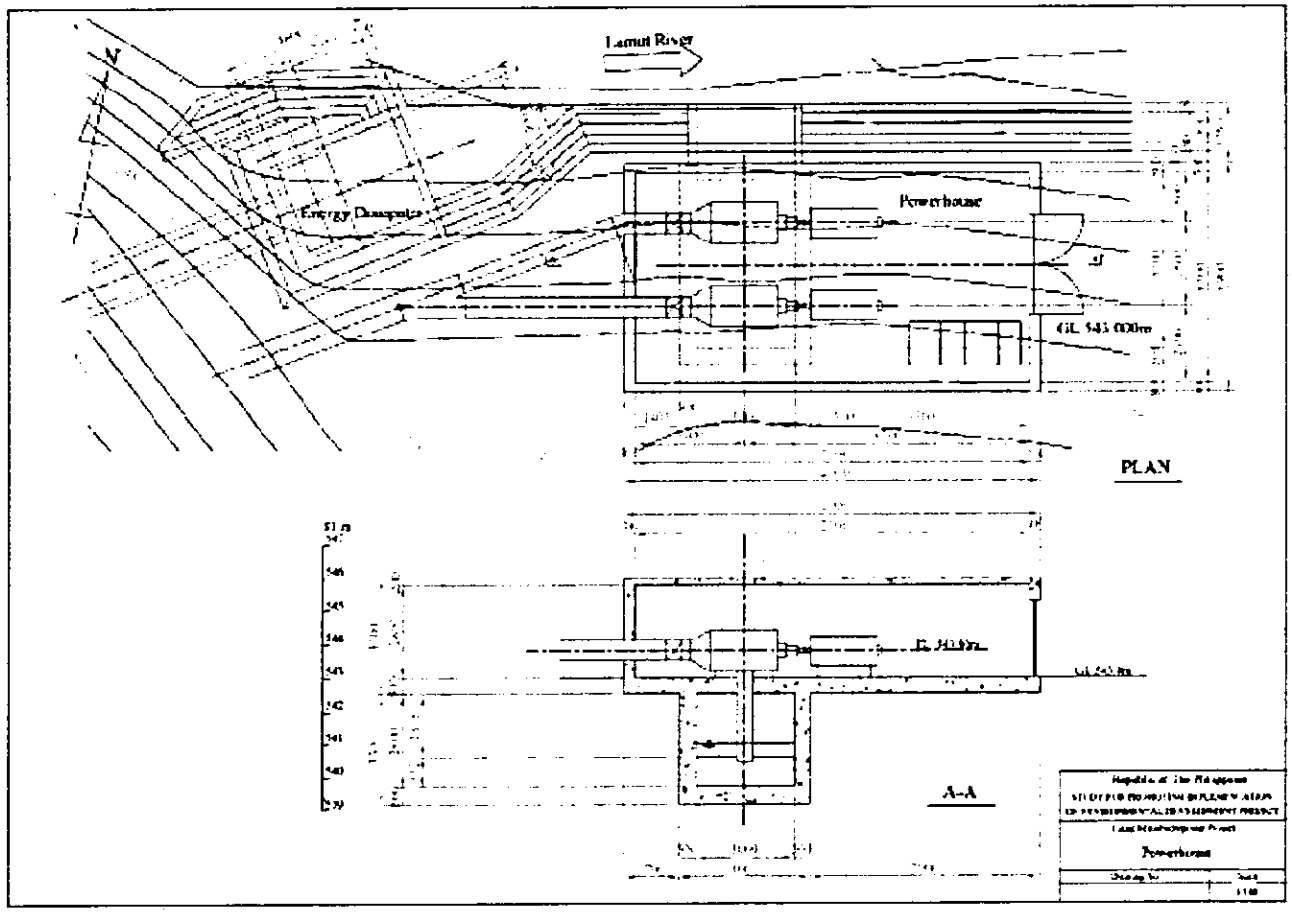

Figure 2-8

Lay-Out of Powerhouse

IEE - 810 kW Lilud Mini Hydropower Plant Project
Barangay Malico, Municipality of Alfonso
Province of Cavite

Rev 2

Not to scale

3.0 Survey Methodology

The approach and methodology were based on the Revised Procedural Manual of DAO 2003-30 specific to renewable energy projects. The study team conducted both primary and secondary data collection from February 2011 until June 2011. Published and unpublished information was supplemented with primary data obtained through actual field reconnaissance. The details of methodology used are discussed in each chapter of the report.

4.0 Administrative and Regulatory Framework in the Philippines

4.1 National Legal and Administrative Framework

The Philippine Government has enacted a number of Acts and Rules to safeguard the environment in the country. The details of these Acts and Rules and their applicability to the Mini-hydropower Project are provided below.

4.1.1 Legislation for the Development of the Project

4.1.1.1 Power and Energy Policies

The Philippines Electric Power Industry Reform Act of 2001 (RA 9136) declaration aims to ensure and accelerate the total electrification of the country and to ensure the quality, reliability, security and affordability of the supply of electric power. It also promotes the utilization of indigenous and new and renewable energy resources in power generation in order to reduce dependence on imported energy wherein details are covered in the Renewable Energy Act of 2008.

The Renewable Energy Act of 2008 (RA 9513) describes the framework for accelerated development and advancement of RE sources, and promotes the development of strategic programs to increase its utilization. It aims to attain the following:

- Accelerate the exploration and development of renewable resources to achieve energy self-reliance through the adoption of sustainable energy development strategies;
- Increase the utilization of renewable energy by institutionalizing the development of national and local capabilities in the use of renewable energy systems and promoting efficient and cost-effective commercial application; and
- Encourage the development and utilization of renewable energy resources to effectively prevent or reduce harmful emissions and thereby balance the goals of economic growth and development with the protection of health and environment.

4.1.2 Legislation for the Environmental Protection

This IEE has been prepared and in compliance to Presidential Decree 1586 (PD 1586) or the Philippine Environmental Impact Statement System which provides that no person, partnership or corporation shall undertake or operate any project declared as environmentally critical or is located within an environmentally critical area without first securing an Environmental Compliance Certificate (ECC) issued by the President or his duly authorized representative. This aims to balance the socio-economic growth that will be brought about by a project and the environmental protection for the benefit of the future generations. The DENR Administrative Order No. 2003-30 (DAO 2003-30), the implementing rules and regulations of PD 1586, defines the scope and guidelines of the EIS system.

Administrative Order No. 42 of 2002 streamlined the EIS processing system and delegated the ECC approving authority to the Secretary of the Department of Environment and Natural Resources

(DENR) and the Director and Regional Directors of the Environmental Management Bureau (EMB) of the DENR.

The IEE process is also guided by the following environmental legislations:

- Republic Act 9275, An Act Providing for a Comprehensive Water Quality Management and for Other Purposes (Philippine Clean Water Act of 2004);
- Republic Act 8749, An Act Providing for a Comprehensive Air Pollution Control Policy and for Other Purposes (Philippine Clean Air Act of 1999);
- Republic Act 9003, An Act Providing for an Ecological Solid Waste Management Program, Creating the Necessary Institutional Mechanisms and Incentives, Declaring Certain Acts Prohibited and Providing Penalties, Appropriating Funds Thereof, and for Other Purposes (Ecological Solid Waste Management Act of 2000); and
- Republic Act 6969, An Act to Control Toxic Substances and Hazardous and Nuclear Wastes Providing Penalties for Violations Thereof, and for Other Purposes (Toxic Substances and Hazardous and Nuclear Wastes Control Act of 1990).

4.1.3 Other Relevant legislation

4.1.3.1 National Integrated Protected Areas System (NIPAS)

Republic Act 7586 or the NIPAS Act of 1992 provides for the establishment and management of national protected areas, whether terrestrial, wetland or marine, protected areas, areas that shall encompass outstanding remarkable areas and biologically important public lands that are habitats of rare and endangered species of plants and animals, biogeographic zones and related ecosystems.

4.1.3.2 Indigenous People Rights Act (IPRA)

Another important legislation taken into consideration in this assessment is the Indigenous People Rights Act (IPRA) of 1997 (RA 8371). This act recognises and promotes the rights of indigenous peoples to ancestral domains and lands; the right to self-governance; economic and social rights; and cultural integrity, including indigenous culture, traditions and institutions.

5.0 Description of the Environment of the Project Site

5.1 Physical Resources

5.1.1 Land Use and Classification

This section describes the existing land classification and land uses within the project site, and includes mitigating measures that address identified impacts by the project. Under Philippine Law, the implementation of a project within a specific area is covered by an official declaration of land classification. Certain specific exclusions also exist as a matter of national interest, such as those under the Philippine Constitution (1987) or as local interest under the Philippine Local Government Code (1991), together with other associated laws. Since the project will involve a significant change to the current land use, it is important to determine and understand the existing land use, and compare this to what was legally classified both by the local and national government.

5.1.1.1 Methodology

The study of land use for the project involved a review of published literature and maps sourced primarily from the provincial, municipal, and barangay land use and development plans. Additional information was obtained from National Mapping Resources Information Agency (NAMRIA) maps for base referencing of key areas within the project site.

5.1.1.2 Baseline Environment

Land Classification

The project site falls under the classification alienable and disposable land with some locations outside the proposed facility falling under the forest/timber land classification. The distribution of these land classifications are presented in detail in Table 5-1 and illustrated in Figure 5-1.

Table 5-1 Barangay Haliap Land Classification

Land Classification	Area (ha)	Percent of Project Site
Alienable and Disposable Land	165	98%
Forest/Timber Land	3	2%
Total	168	100

Source: PPDO-Ifugao, 2010

Land Use

The distribution of actual land use/cover within Brgy.Haliap is presented in Table 5-2 and Figure 5-2. Agricultural land encompasses majority of the project site. Other uses include shrubland/grassland and built-up areas.

Table 5-2 Project Site Land Use Distribution

Land Use Category	Area (ha)	Percent of Barangay Land Area
Brushland	137	29
Agricultural	335	71%
Total	**472**	**100**

Source: PPDO-Ifugao, 2010

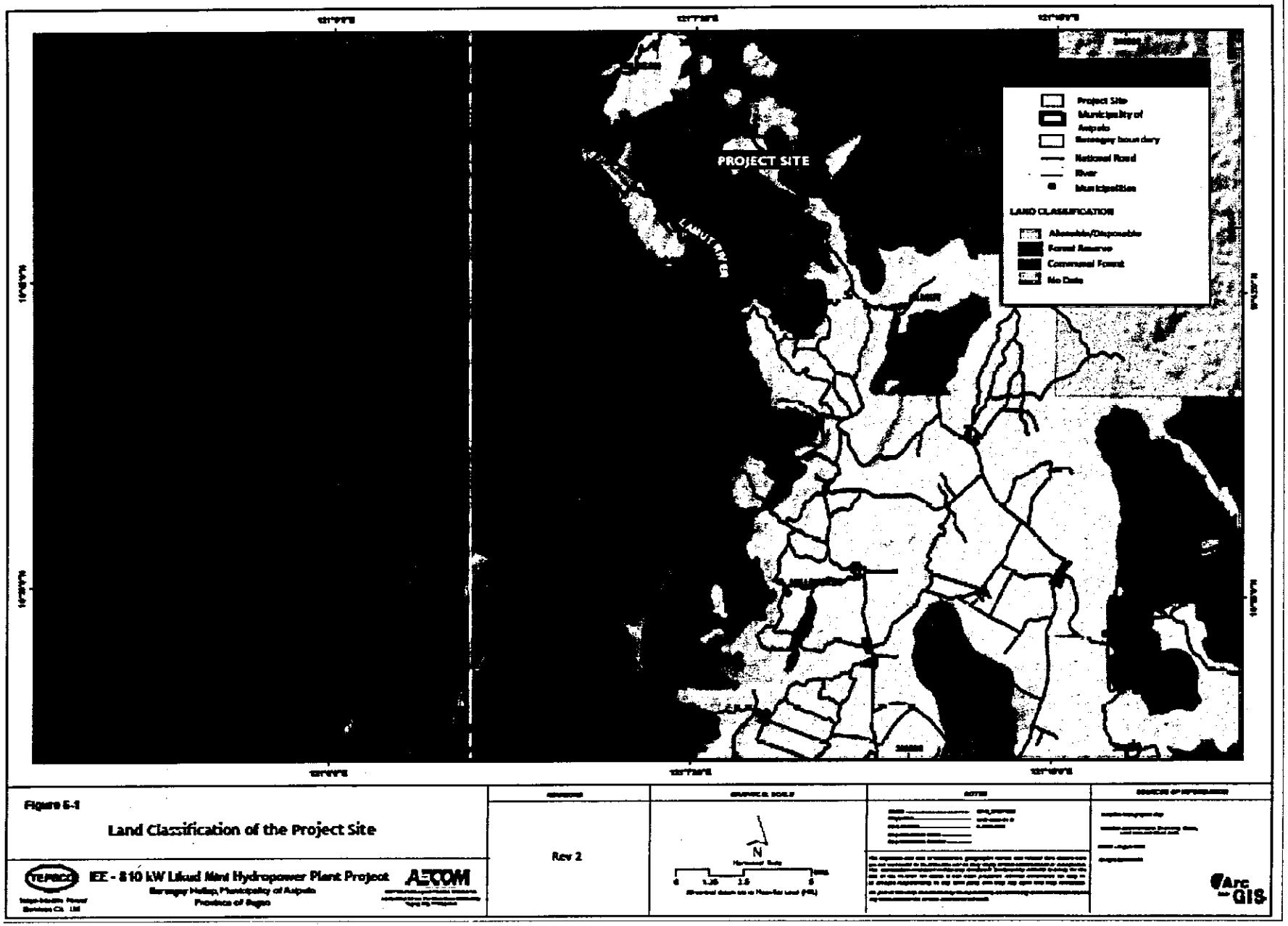

Figure 6-1

Land Classification of the Project Site

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IEE - 810 kW Liliud Mini Hydropower Plant Project

Barangay Hubay, Municipality of Aurora

Province of Aguin

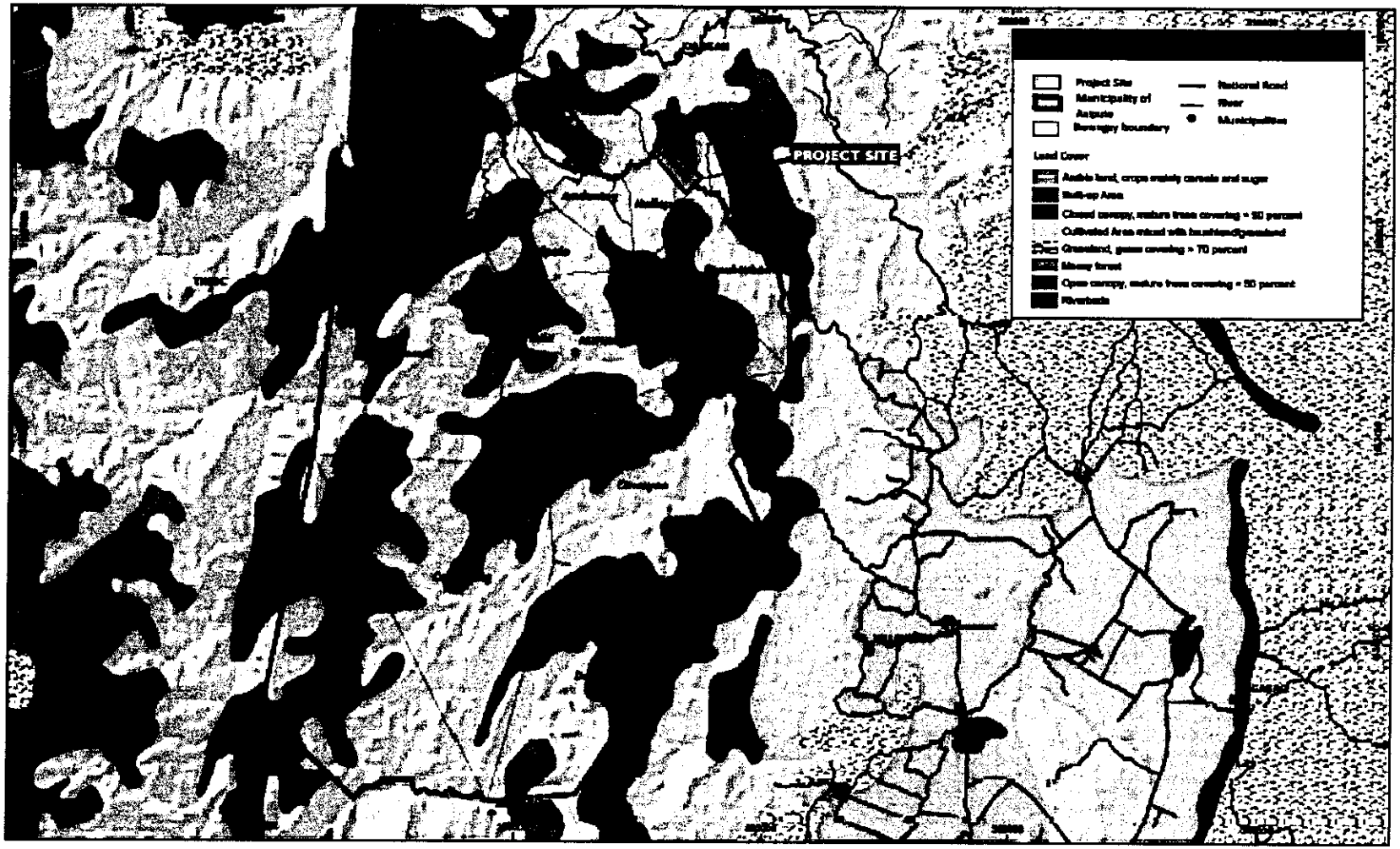

Figure 4-2

Existing Land Uses of the Project Site

IEE - 810 kW Lilud Mini Hydropower Plant Project

Barangay Poblag, Municipality of Aglipay
Province of Ilocos

Rev 2

5.1.2 Geology, Geomorphology and Geohazards

This section presents information on the baseline assessment of the geologic characteristics of the project site, focusing on the geo-structural conditions and natural geologic hazards that may potentially occur in the project site with or without project implementation.

5.1.2.1 Methodology

Discussions on geology, geomorphology, and geohazards are mainly based on the latest available geologic maps from the Mines and Geosciences Bureau (MGB) unit of the DENR and Philippine Institute of Volcanology and Seismology (PHIVOLCS). Published data on the province and the region were also used. Geomorphologic assessment was made using topographic maps from the National Mapping and Resource Information Authority (NAMRIA). In addition to the provision of basic geological and geomorphic information, interpretative maps generated from GIS post-processing were utilized in the evaluation of existing natural geological hazards at the project site.

5.1.2.2 Baseline Environment

5.1.2.2.1 Regional and Local Geology

The project site is located within the Cagayan Valley Basin which separates the Central Cordillera in the west and Sierra Madre mountain ranges to the east. The basin is bounded in the south by the Caraballo Range. The basin was formed from successive volcanism and uplift of the Central Cordillera from the Late Oligocene to Pleistocene (Caagusan, 1981). Previous studies and correlation with outcrops of the neighbouring mountain ranges indicate that the stratigraphy of the basin is largely composed of deep marine sediments and extrusive igneous rocks (Hipol et al., 2001).

The oldest units are represented by the Late Oligocene Dumatata Formation, equivalent to the Zigzag Formation, characterized by highly fractured and well indurated sandstone-mudstone interbeds and breccia inter-tonguing with volcanic breccia and andesite flow. Unconformably overlying this formation is the Early Miocene Ibulao Limestone composed of reefal limestones. It is generally massive to very thickly-bedded but becomes medium-bedded towards the top. The type locality is found in the Ibulao Gate. Conformably overlying the Ibulao Limestone is the Early Miocene Lubuagan Formation. This formation is composed mainly of sandstone-siltstone interbeds with alternating sequences of sandstones and conglomerates towards the top of the formation. The sandstone-siltstone sequence shows structures typical of turbidites indicating deposition in a subaqueous environment. The Lubuagan Formation is unconformably overlain by the Balbalan Formation. It is composed of andesite flows, fossiliferous sandstones, shales, conglomerates, alternating sandstones and conglomerates, and minor limestones. The Late Middle Miocene to Pliocene period is marked by a break in the rock record as no rocks of these ages are seen in the area. Unconformably resting on the older formations is the Pleistocene Tabuk Formation consisting of volcanic plugs in lower sections and tuffaceous sand deposits, autobreccia, lahar deposits, and terrace gravel deposits in upper sections. Recent alluvial deposits cap the deposits. The main exposures in the municipalities of Asipulo and Kiangan are characteristic of the sedimentary deposits of the Dumatata Formation and the Lubuagan Formation.

During the Early Miocene, NE-SW compression and extension directions are inferred based on fault array analysis. Strike-slip and reverse faults indicate that during the Middle Miocene, the primary stress direction slightly changed to the NNE-SSW direction. During the Quaternary, a NW-SE compressive stress is occurring. This force is associated with the movements along the left lateral strike-slip Philippine fault.

5.1.2.2.2 Geomorphology and Geologic Structures

The project site lies on rolling to steep terrain with elevations ranging from less than 450 m to 1935 m above sea level (masl) (Figure 5-3). The project site's terrain is steep characteristic of the mountainous area with river terraces and gorges bounding the headwaters. Near vertical slopes and gullies also run parallel to the river.

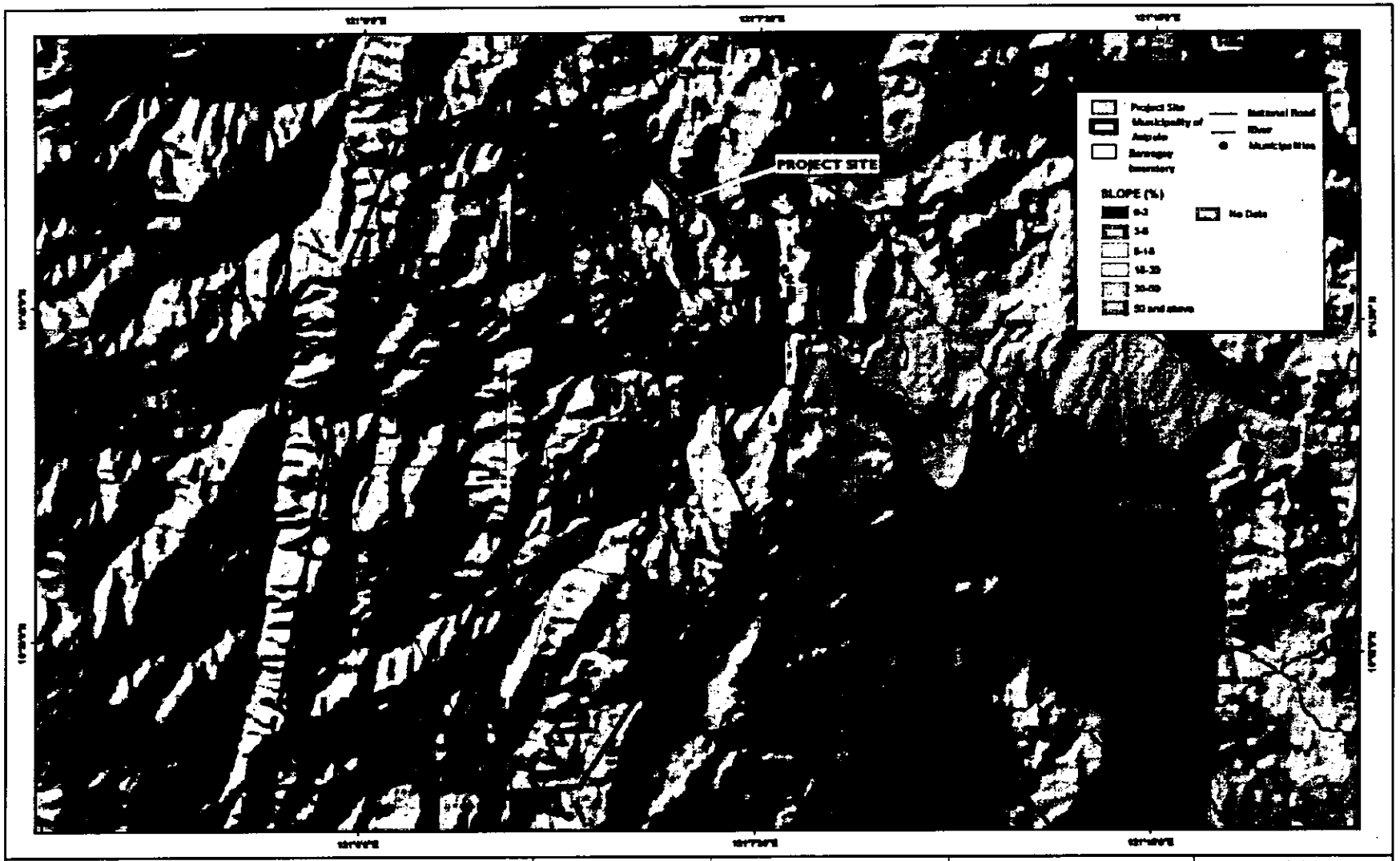

Figure 6-3

Slope Map of the Project Site

IEE - 810 kW Liliud Mini Hydropower Plant Project

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5.1.2.2.3 Geohazards

This section presents the assessment of various geological hazards that may affect the project. Hazards discussed are the natural hazards occurring as a consequence or part of the natural geological processes operating within the project site. The discussion also attempts to present useful information that can be included as part of the detailed design criteria that are both site and infrastructure-specific, to reduce, if not completely eliminate, the impact of natural environmental risks both to the proposed structures and their surroundings.

The influence of slope gradients on the generation of potential geologic hazards is presented in Table 5-3. The types of geohazards presented pertain only to surficial processes and excludes hazards in relation to seismicity. In addition, gradient values at 18% and above (usually characterized as steep) are subdivided further into three sub-categories to better characterize geohazard responses in each sub-category.

Table 5-3 Geohazard in Relation to Slopes and Percent Coverage of the Project Site

Slope Gradient	Geohazard	Soil Slope Class	Percent of Project Site	Area (ha)
Level to Nearly Level (0 to 3 %)	0	0	0	0
Nearly Level to Undulating (3 to 8%)	72%	341.791	72%	341.791
Undulating to Rolling (8 to 18 %)	Low susceptibility to slope failure and erosion			
Rolling to Moderately Steep (18 to 30%)	28%	129.39	28%	129.39
Very Steep (30 to 50%)	Highly susceptible to slope failure and erosion			
High Angle/Very Steep (>50%)	Highly susceptible to slope failure and erosion			
Total			**100**	**471.181**

A summary of identified geologic hazards that may affect the project site and proposed facilities is presented in Table 5-4. The table outlines the specific hazards, possibility/frequency of occurrence, and the potential impacts to the project as well as proposed mitigating measures to address the identified geohazard limitations.

Table 5-4 Geohazards, Corresponding Risks, and Mitigating Measures

Geohazard	Specific Hazards	Likelihood of Occurrence (prior to mitigation)	Potential Areas to be Affected	Risks to Project	Mitigating Measure
Seismic hazards	• Ground shaking	Possible	All areas within the project site	• Structural failure or collapse • Landslides and slope failure	• Detailed investigation of engineering, geological, and foundation properties for the structures • Appropriate design parameters to be taken into consideration in the design and reinforcement of the structures • Application of suitable ground preparation prior to erection of structures

Likelihood of occurrence are as follows: rare, unlikely, possible, likely, and probable; arranged from least occurring to most frequently occurring. The frequency/ probability rating for the geohazards is subject to change in the future as the Philippines has no officially established hazard rating matrix comparable to established frequency/ probability rating systems such those of FEMA and USGS. However, the probability rating presented is referenced from locally published literature and recognized by EMB and MGB as a sound rating system pending the establishment of a published local geohazard ratings guideline.

Seismic Hazards

Structures such as lineaments and joints indicate a NW-SE compressive stress within the general area of Ifugao as surveyed for the municipalities of Asipulo and Kiangan in 2001 (Hipol et al., 2001). This force is associated with the movements along the Philippine fault. The province of Ifugao is ranked by PHIVOLCS as 7th in terms of vulnerability to earthquakes and 1st in terms of earthquake-induced landslide among 10 provinces in the country. This was based on assessment of historic hazards within the province. Though Ifugao experiences less earthquakes than the eastern margin of Northern Luzon, the generally steep topography of the province and the project site make it susceptible to landslides and slope failures that may be induced by earthquakes of significant magnitude.

Based on the most recent regional active faults map defined by PHIVOLCS, the nearest known active faults are splays of the Philippine Fault Zone found 26 km south of Lagawe.

Ground Shaking

While the major earthquake-generating structures are outside the project site, the possible generation of a significant ground movement during an earthquake is the major concern for the project site. The actual ground acceleration g-values specific to the project site, as per relative distance from different earthquake generators in the region is calculated using the formula of Fukushima and Tanaka (August 1990, in Thenhaus, 1994) below,

$$\text{Log}_{10}A = 0.41M - \log_{10}(R + 0.032 \times 10^{0.41M}) - 0.0034R + 1.30$$

Where:

A = mean of the peak acceleration from two horizontal components at each site (cm/sec^2)
R = shortest distance between site and fault rupture (km)
M = surface wave magnitude

Ground acceleration values are represented as the unitless function g. The average g is calculated from the resulting mean of peak acceleration represented by A, divided by the computed acceleration due to gravity. The mean of peak acceleration generally decreases for a particular area as its distance increases from the potential epicenter of an earthquake which, for the purpose of this study, is treated as the project site's distance to the fault concerned. Variations in the mean value of g is calculated based on the type of subsurface material underlying a particular place or area, as different materials have different responses to the transmission of the earthquake energy. Four general categories, namely Rock, Hard Soil, Medium Soil and Soft Soil, are used to recalculate the g as presented in **Table 5-5**. The summarized table presents the fault defined by PHIVOLCS, all calculated from a theoretical maximum credible earthquake of 7.5 with pre-determined distance from the project site to the nearest contact with the identified fault.

Table 5-5 Calculated G-values for Defined Faults and Seismic Responses per Subsurface Material

Parameters	26 km north of the identified trace of the Philippine Fault Zone. (In this report, PHIVOLCS, 2010)
Radius (km)	26.000
Magnitude (M)	7.500
Acceleration (cm/sec^2)	302.136
Acceleration due to gravity (cm/sec^2)	981.000
Average g (ground acceleration)	0.308
Rock (60% of g)*	0.185
Hard Soil (107% of g)*	0.330

Parameters	26 km north of the identified trace of the Philippine Fault Zone. (In this report, PHIVOLCS, 2010)
Medium Soil (87% of g)*	0.268
Soft Soil (139% of g)*	0.428

* Based on Fukushima and Tanaka - Bulletin of Seismological Society of America, August 1990

5.1.3 Land Suitability Classification

In the absence of a detailed assessment involving actual sampling and analysis, land suitability within the project site is assessed with respect to specific uses.

The project site is suitable for cultivated crops and production forests as shown in Figure 5-4.

The area is also moderately to severely susceptible to erosion as shown in the Erosion Potential Map below. This is attributed to the steep topography of the area and the utilization of the land for agricultural use.

5.1.4 Surface Water Quality

5.1.5 Methodology

5.1.5.1 Sampling Stations

The water quality sampling was conducted in March 2011. Two stations were established in the areas that could possibly be affected by the project. Samples were collected along the upstream and downstream of Lamut River, covering the intake area and powerhouse of the proposed project site, respectively. Table 5-6 describes each water quality station, while Figure 5-5 and Plate 5-1 and Plate 5-1 illustrate the locations

Table 5-6 Surface Water Quality Stations

Station ID	Name of Water Body	Location of Water Body	Description of Station	Coordinates	Elevation
Intake	Upstream of Lamut River (*local name: Itum River*)	Sitio Lower Haliap, Brgy. Haliap, Asipulo	Station is located at the proposed intake area and downstream of Itum Bridge. This station is also downstream of the Lamut River and an unknown river confluence.	16°44'24.5" N 121°05'30.5" E	631 m
Powerhouse	Downstream of Lamut River (*local name: Guihinon River*)	Sitio Guihinon, Brgy. Makppit, Kiangan	Station is located at the proposed powerhouse, in-between Barangays Makppit and Panubtuban. It is downstream of Lamut River and its confluence with an unnamed river.	16°43'48.1" N 121°06'36.0" E	541 m

Plate 5-1 Water quality station at the intake area upstream of Lamut River

Plate 5-2 Water quality station at the proposed powerhouse downstream of Lamut River

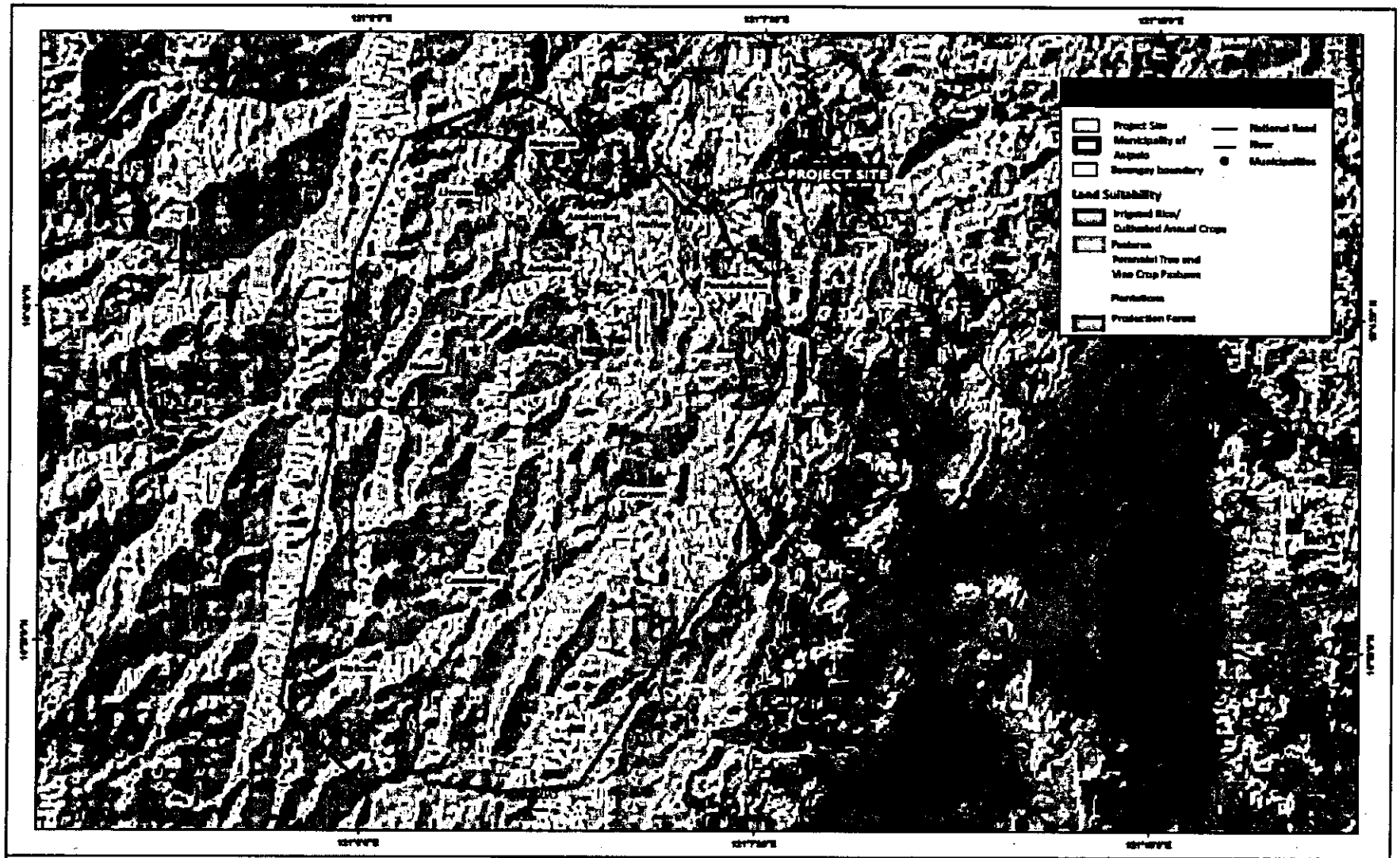

Figure 6-4

Land Suitability Classification

IEE - 810 kW Liliud Mini Hydropower Plant Project

Barangay Hidalgo, Municipality of Angadanan

Province of Isabela

Rev 2

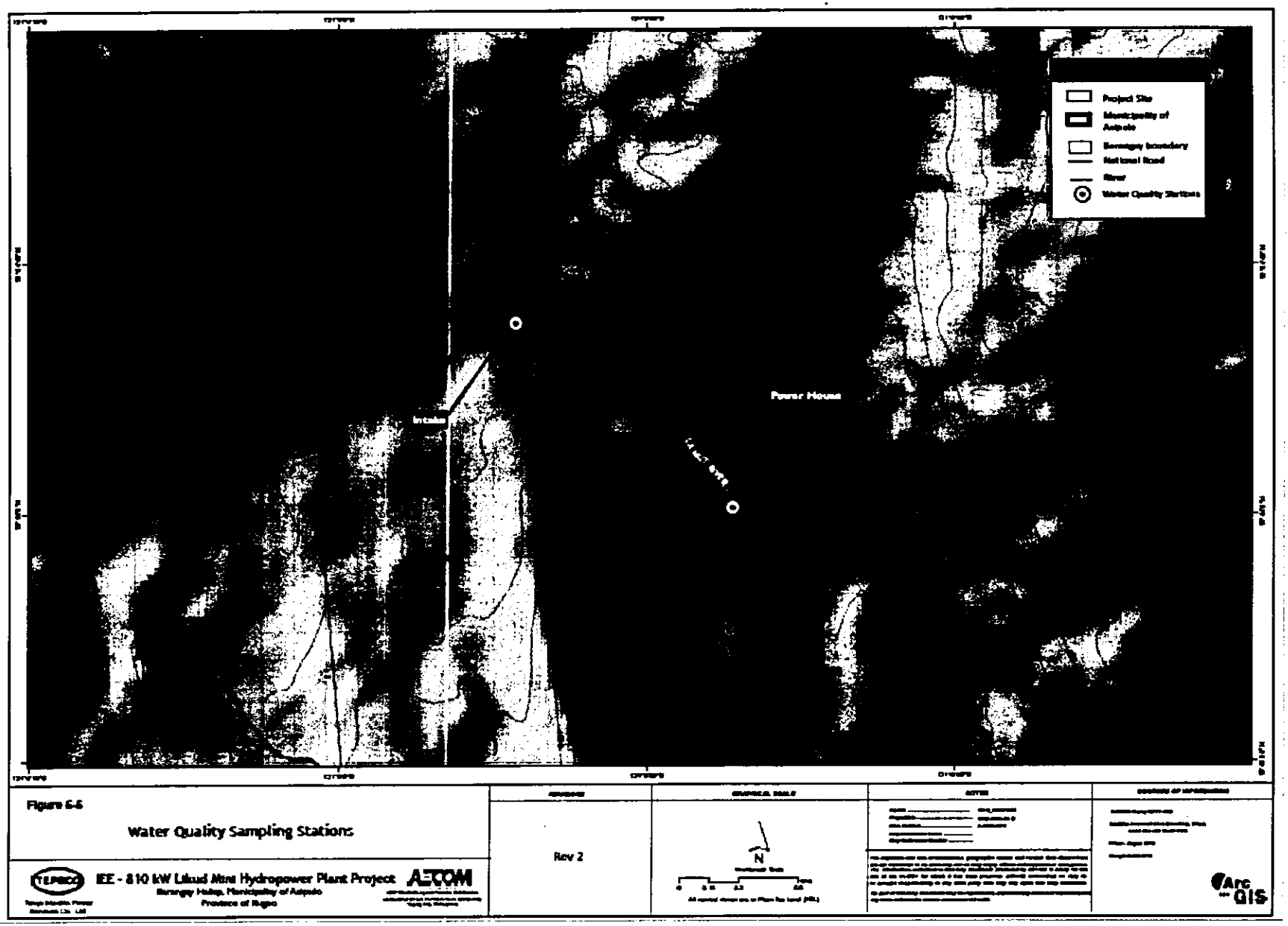

Figure 6-6

Water Quality Sampling Stations

IEE - 810 kW Lilud Mini Hydropower Plant Project

Barangay Hadap, Municipality of Aurora
Province of Ilgao

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5.1.5.2 Sampling and Analytical Procedures

The temperature and dissolved oxygen (DO) were measured in-situ using the WTW® Oxi 3210 DO meter, while the in-situ measurements of pH levels were determined using a pen type pH meter, Eutech® pH Testr 30. These equipment were calibrated prior to the sampling activity to confirm the validity and accuracy of the readings.

The sampling techniques, preservation and handling procedures were according to the *Australian/New Zealand Standard® Water Quality Sampling Guidance: AS/NZS 5667 series.* Grab samples were collected by submerging the containers against the flow or drift at a depth of 20 cm, as practicable or whenever the depth of the stream permits[2]. The samples were cool stored at approximately 4°C and were immediately brought to the accredited laboratory of OSTREA Mineral Laboratories, Inc. (OMLI) for analysis. Table 5-7 summarizes the parameters analyzed in the laboratory and their corresponding container, minimum volume, holding time, and preservation requirements. The analytical procedures used by OMLI are the approved methods described in the *DENR Administrative Order No. 34, series of 1990: Revised Water Usage and Classification/Water Quality Criteria Amending Section Nos. 68 and 69, Chapter III of the 1978 NPCC Rules and Regulations* (DAO 1990-34) *for water quality criteria* (Table 5-8).

Table 5-7 Water Quality Sampling Protocols

Parameter	Volume Required	Container	Preservation	Maximum Allowable Holding Time Prior to Analysis
pH, temperature, DO	Parameters measured *in-situ*			
Biological Oxygen Demand (BOD)	1 L	Polyethylene washed with phosphate-free detergent and distilled water	Cool stored at 1°C to 4°C	24 hours
Total Suspended Solids (TSS)	500 mL	Polyethylene washed with phosphate-free detergent and distilled water	Cool stored at 1°C to 4°C	24 hours
Total and Fecal Coliform	250 mL	Glass, sterilized	Cool stored at 1°C to 4°C	24 hours

Table 5-8 Methods of Analysis

Parameter	Method
Temperature	*In situ* measurement (Thermistor)
pH	*In situ* measurement (Glass Electrode)
DO	*In situ* measurement (Membrane Electrode)
BOD	Azide Modification (Dilution Technique)
TSS	Gravimetric (Filtration and Drying at 103°C -105°C)
Total coliform	Multiple Tube Fermentation Technique or Membrane Filter
Fecal coliform	Multiple Tube Fermentation Technique or Membrane Filter

[2] Grab sampling refers to collecting a water sample at one time from a single point. A grab sample represents only the composition of the water at the time and place the sample was collected (Environmental Management Bureau, Department of Environment and Natural Resources, 2008. Water Quality Monitoring Manual: Volume I Manual on Ambient Water Quality Monitoring).

5.1.6 Baseline Environment

The Lamut River is identified in the DENR Memorandum Circular No. 07 series of 1993 Additional List of Classified Rivers and Bays (DMC 1993-07) as a Class C fresh surface water body. Based on the classification guidelines of DAO 1990-34, Class C waters are used for aquaculture, recreational activities such as boating, and industrial water supply[3]. Table 5-9 presents the results of the baseline study covering the parameters that contribute to the aesthetic quality and oxygen demand in freshwaters, as well as their corresponding DAO 1990-34 Class C limits. Laboratory results are attached in Annex 1.

Table 5-9 Water Quality Sampling Results

Parameter	Water Quality Stations		DAO 1990-34 Class C limits[b]
	Intake *16 March 2011 10:01 am*[a]	Powerhouse *16 March 2011 1:24 pm*[a]	
Temperature (°C)	20.1	21.9	3C maximum rise
pH	8.5	8.4	6.5 to 8.5
DO (mg/L)	8.1	7.9	5.0
BOD (mg/L)	2	2	10
TSS (mg/L)	<1	<1	Not more than 30 mg/L increase
Total coliform (MPN/100mL)	5,400	16,000	5,000[c]
Fecal coliform (MPN/100mL)	3,500	9,200	-

a. Date and time of sampling;
b. Maximum limits unless otherwise specified;
c. The value refers to the geometric mean of the most probable number of coliform during a 3-month period, without exceeding in 20% of the samples taken during the same period.
- No prescribed limit

Temperature

The temperature levels during the time of sampling in the Lamut intake and powerhouse were 20.1°C and 21.9°C, respectively. The low temperature readings could be attributed to the cold climate in Kiangan, along with the cloudy to slightly rainy weather condition during the time of sampling. The shade provided by the large boulders surrounding the Intake station and the lush vegetation cover along the river banks of the Powerhouse station could have also contributed to the colder temperature measurements, at a lesser extent. Since there are no sources of thermal effluent in the area, the DAO 1990-34 Class C limit is no longer applicable for the purposes of this baseline study.

pH

Samples from the two stations along Lamut River were both alkaline, with values ranging from 8.4 to 8.5. Thus, both surface water stations conformed to the Class C range limit specified in the DAO 1990-34.

DO

The DO levels in the Intake and Powerhouse are above the minimum limit in the DAO 1990-34 for Class C waters. The high DO levels in the Intake (8.1 mg/L) and Powerhouse (7.9 mg/L) could have been influenced by the cold temperature and fast current flow of Lamut River, observed during the course of sampling. The low organic content of the river, which is reflected in the low BOD

[3] Beneficial use of Class C fresh waters include: (1) Fishery Water for the propagation and growth of fish and other aquatic resources; (2) Recreational Water Class II (Boatings, etc.); and Industrial Water Supply Class I for manufacturing processes after treatment (DAO 1990-34).

measurements of both stations, also contributed to the high DO levels, as these two parameters are inversely proportional.

BOD

BOD levels in the two stations both registered at 2 mg/L, which pass the DAO 1990-34 maximum allowable limit for Class C. This indicates that the surface water stations within the proposed project sites have low organic pollutant load, as BOD is the measurement of the amount of oxygen consumed by microorganisms in the process of biological degradation of organic matter in water.

TSS

Both surface water stations have undetected levels of TSS (<1 mg/L). Clear waters were collected from the upstream (Intake) and downstream (Powerhouse) sampling stations despite the partly raining weather condition during the time of sampling. The TSS concentration, for monitoring purposes, should not have an increase of more than 30mg/L.

Total and Fecal Coliform

Elevated levels of total and fecal coliform were noted in the Intake and Powerhouse stations. Measured values in the two surface water stations are higher compared to the 3-month geometric mean Class C limit for total coliform. The DAO 1990-34 has no specific guidelines for fecal coliform for Class C freshwaters. Possible sources of total and fecal coliform include human and animal wastes due to lack of domestic sewage and septage treatment facilities and widespread hog-raising activities in the area.

5.1.7 Hydrology

The project has a catchment area of 44.02 km^2. There is no historical stream flow data available for the Lamut River. Probable flood discharges for various return periods for Lamut River is calculated using the Dimensionless Hydrograph which is described below:

The Dimensionless Unit Hydrograph Method

The magnitude of flood from a catchment area depends on intensity, duration, and distribution in time and space of the rainfall over the catchment area and on the physiographic parameters that would affect the runoff viz. drainage basin area, its shape, slope, land use pattern, surface infiltration characteristics of the soil, vegetation cover and initial wetness of the soil. The problem of estimation of design flood actually reduces to selection of the minimum number of parameters that truly represent the drainage basin's response to the storm and to account for the complexities of the patterns of rainfall storms.

The magnitude of flood is the net result of all factors mentioned above acting individually and collectively, thereby suggesting the need to carry out probability and frequency analysis to calculate probable flood for a given return period. (a statistical parameter used in frequency analysis as a measure of most probable time interval between occurrence of a given event and that of an equal or greater event). With the availability of the RIDF data (Rainfall Intensity Duration Frequency) from PAGASA, the frequency analysis was simplified and the methodology as described in the DPWH Design Guidelines, Criteria and Standards, Vol. 2 was applied. The RIDF data of Baguio City was used in the calculation of probable flood discharge as it has similar climatological characteristics with Ifugao and being the nearest station of PAGASA. The RIDF of Baguio City is shown below.

Equations Used to Express the RIDF

The equation below was used to express the relationship between rainfall intensity and duration. The equation is expressed as:

$I_p = a*(t + b)^m$

Where: **Ip** = Rainfall Intensity

t_c = Rainfall Duration

a,b,m: are constants

Constants of the RIDF equation were estimated by least square regression analysis giving relationship between probable rainfall intensities and corresponding rainfall duration.

The dimensionless unit hydrograph shown in Figure 5- masks the effect of basin size and essentially eliminates the effect of shape, except as they are reflected in the estimate of basin lag t_p and runoff volume[4].

[4] Linsley, Kohler and Paulhaus, Hydrology for Engineers, 1988

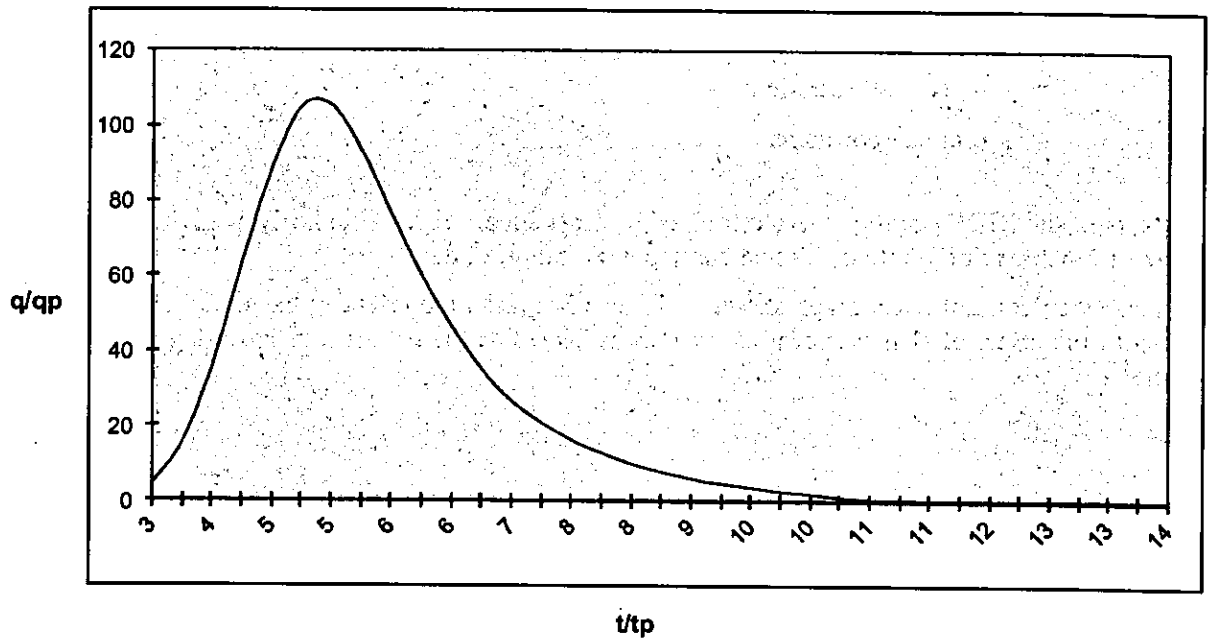


Figure 5-6 Dimensionless Unit Hydrograph

The general expression for basin lag used in the project take the following form:

$$t_p = C_t (LL_c / S^{1/2})^{0.38}$$

Where: t_p - lag time in hours

C_t = Coefficient varying from 0.35 to 1.2

L = Main stream distance from outlet to divide, in km.

L_c = Stream distance from outlet to a point perpendicular to the basin centroid, in km.

S = Average channel slope

The Model Hyetograph of each catchment area was created by the method of Soil Conservation Service (US-SCS).

The cumulative runoff is determined by the following equation:

$$Q = (P - I_a)^2 / (P - I_a + S)$$

Where: Q = cumulative runoff (mm)

P = Cumulative rainfall (mm)

F = Cumulative infiltration (mm)

I_a = Initial abstraction

S = Potential maximum abstraction

CN=Curve number. (Curve number used is for Antecedent Moisture Condition III).

The CN used is 80.

Calculated flood discharge at various return periods for Lamut River is shown in Table 5-10 below.

Table 5-10 Calculated Flood Discharge of Lamut River

Return Period	Calculated Discharge (cms)
2 years	165.85
5 years	367.45
10 Years	508.36
25 Years	698.55
50 Years	840.33
100 years	978.53

Weir Site

Access to the weir site is by foot, either through a 150 m trail from an existing concrete bridge or through another paved trail about 100 m long. Both trails are rarely travelled. The project site is at elevation 633 m from sea level with limestone rock outcrops at both sides of the riverbanks. Sheer vertical cliffs are at both sides, with moss and some small plants and trees that appear to be remnants of the original forest cover. The river at the weir site is about 8m wide with water flowing at a depth of about 500 mm. Locals describe flooding to occur after about two full days of continuous rain at the upstream part of the river and surrounding mountains. Floods usually makes the water level at the site rise to about 1 to 1.5 m high and also making the river flow wider to about 12 m. A flash flood was reported to have occurred in the past due to a dike collapse upstream of the project site after a fairly long downpour. Flow along the river was reported to have risen to about 3 to 4 m high (Annex 2).

Along the River

An irrigation weir was observed at about 50m from the proposed weir site. This was reported to have been constructed about 20 years ago to serve small rice paddies and vegetable orchards along the river. Access to the irrigation weir is through an existing paved footpath at the left side of the bank facing the downstream direction. There were signs of "kaingin" at some slopes not far from the river. Small slides and erosion have also been observed (Annex 3).

During the site visit, water levels at different river crossings were just above the knees (500-600 mm) with small boulders lining the river bed. There are four streams / gulleys that flow into the river along the stretch of the project area, some of which are also being used for irrigation. Three of these streams are on the left side of the river when facing the downstream direction, and one is on the other side of the river. These streams have well vegetated slopes. A washed-out concrete overflow crossing was also seen along the river. This structure reportedly collapsed during the onslaught of Ondoy – Pepeng storms.

Powerhouse

The site for the powerhouse is 230 m downstream from the washed-out concrete overflow crossing. The elevation of the river near the powerhouse was taken as 541m above sea level. The river width at the powerhouse site was about 16 m. Trees, shrubs and small plants abound on the site (Annex 4).

The elevated flat area near the river was considered for the powerhouse and appurtenant structures. Floodwater rises to about 2 m during flood events but local guides informed that the area has not been flooded from past storms.

5.1.8 Air Quality, Noise and Vibration

This section presents the results of the ambient air quality and noise assessments for the project. Secondary data were used to characterize the baseline conditions of the project site with regard to its climate, air quality and noise levels.

5.1.9 Methodology

The meteorological conditions in the project site were described using the long-term data obtained from the nearest Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) located in Baguio City.

The other relevant data and information gathered are contour map, climate map and typhoon frequency map. Contour maps were procured from the NAMRIA while the climate map and the typhoon frequency map of the whole Philippines were also sourced from PAGASA.

5.1.10 General Climate

The prevailing climate in the project area falls under Type II of the Modified Corona's Classification of the Philippines (Figure 5-7). The Type II climate is characterized by a very short dry season with pronounced maximum rain during summer months.

The threshold value which defines the dry and wet period is 50mm: value less than 50 mm represents the dry period while values greater 50 mm represents the wet period. The climatological normals (Annex 5) show that the dry period covers the month of January, February, March and December. The highest rainfall was recorded for the month of August at 905.0 mm. Further, climatological extremes (Annex 6) show that the highest daily rainfall occurred on July 4, 2001 at 1085.8 mm.

Southeasterly wind predominantly occurs at a rate of 2 m/s winds during the entire year. Climatological extremes show that the highest wind speed recorded was at 47 m/s in July 20, 1974, with wind direction of SE.

The monthly average temperature ranges from 18.1 to 20.8 °C while relative humidity, which factors in the amount of water vapour available in the atmosphere, ranges from and 83 to 93%. These parameters influence the moisture content of the ambient air which in effect affects the evaporation rate of the moisture content of the soil.

Typhoons also influence the climate and the weather of the country. Approximately 20 typhoons pass through the Philippine Area of Responsibility (PAR) each year. Figure 5-8 shows that the project site is within the area frequently visited by typhoon at an average annual incident of 5-7 typhoons.

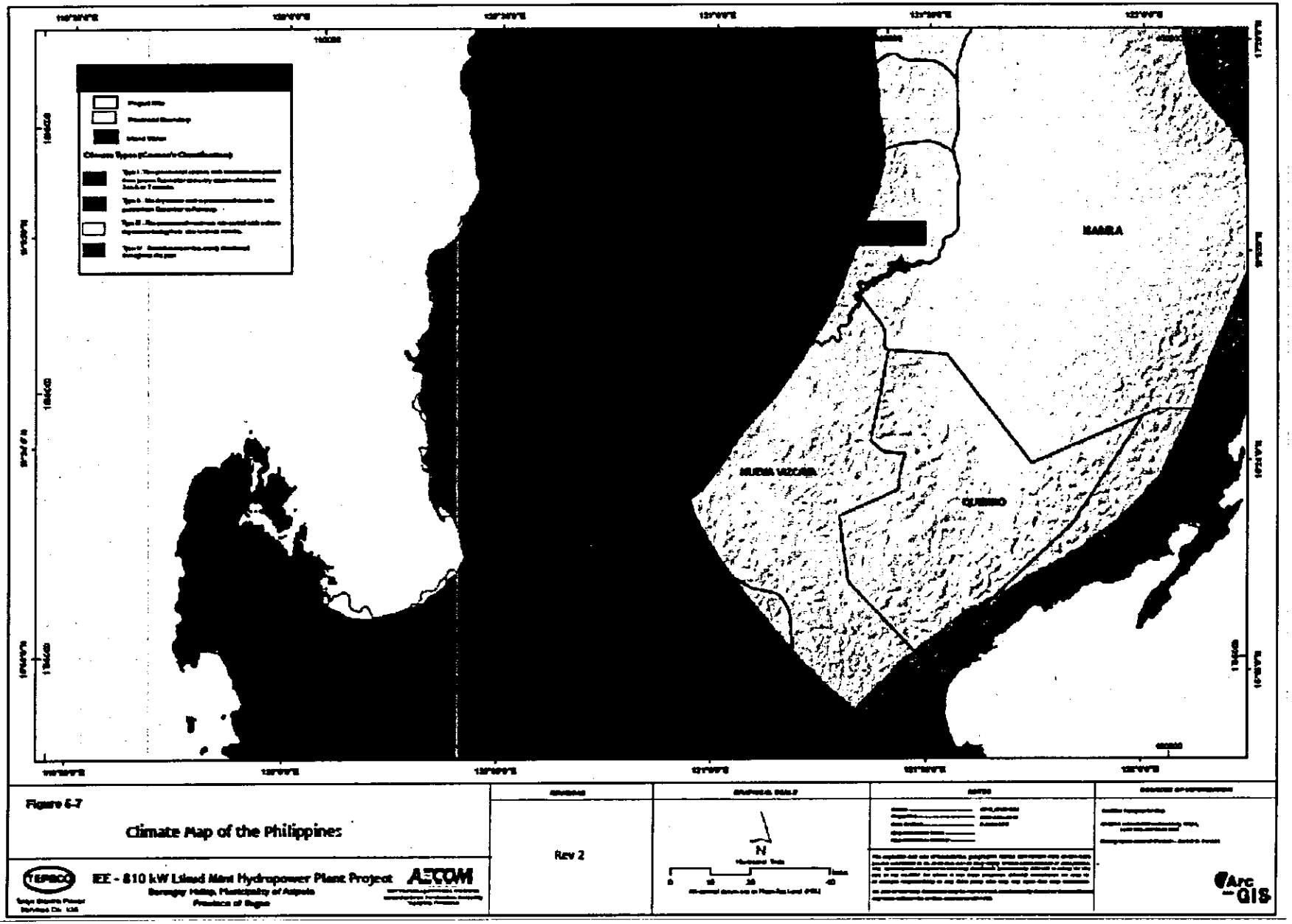


Figure 6-7

Climate Map of the Philippines

Rev 2

TEPSCO

EE - 810 kW Lilad Mini Hydropower Plant Project

Barangay Hidlip, Municipality of Asipulo

Province of Ifugao

AECOM

ArcGIS

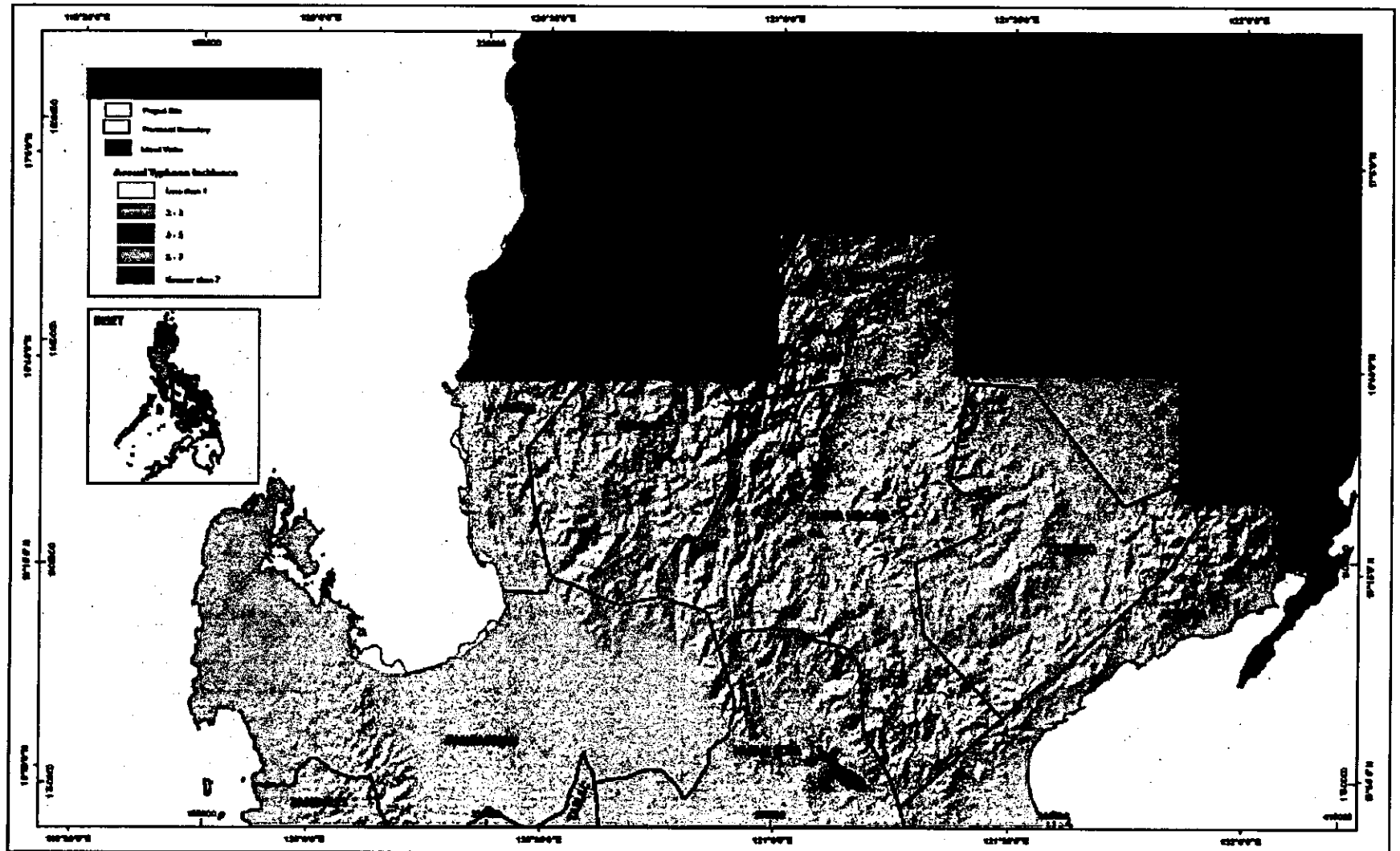


Figure 6-8

Typhoon Map of the Philippines

Rev 2

IEE - 810 kW Likud Mini Hydropower Plant Project

5.1.11 Ambient Air Quality

5.1.12 Methodology

The ambient air quality of the project area has been characterized using the data gathered in March 2008 by the Tokyo Electric power Company Inc. (TEPCO) in cooperation with the e8 group, the Department of Energy (DOE) and the Provincial Government of Ifugao for a 200kW mini hydropower project in Barangays Ambabag and Pindongan, Municipality of Kiangan, Province of Ifugao. The two stations used in the EIA of the 200kW mini hydropower project were adopted for the assessment of the air quality of the project site. Figure 5-9 shows the locations of these stations relative to the project site. The location of the sampling stations is about 5.7 km north of the project site. There is also a mountain range north of the project site, between Kiangan and Haliap, with elevation ranging from 902 to 1042 meters above sea level.

5.1.13 Baseline Environment

The analytical results of the 24-hour sampling are shown in Table 5-11. For the purpose of comparison, the prescribed limits, i.e., the National Ambient Air Quality Guidelines Values (NAAQGV), under the Philippine Clean Air Act (CAA) are shown in the last rows of the tables. The NAAQGV are the 24-hour air pollutant concentration limits published by the DENR intended for protection of public health, safety and general welfare. The NAAQGV are typically used in the assessment of the air quality of an airshed or a region/locale.

The TSP levels recorded at station AQ-1 and station AQ-2 are 7 µg/NCM and 12 µg/NCM, respectively. SO_2 concentrations in both stations are below the detection limit while NO2 concentrations were 1.6ug/Ncm for Station AQ-1 and below detection limit for Station AQ-2. All the pollutants levels recorded are way below their respective NAAQGV standards.

Table 5-11 Results of Ambient Air Quality Monitoring

Station ID	Location	Coordinates	TSP (µg/NCM)	SO_2 (µg/NCM)	NO_2 (µg/NCM)
Station AQ-1	Powerhouse of the 200 kW mini hydropower plant	N 16° 47' 29.6" E 121° 06' 22.32"	7	ND*	1.6
Station AQ-2	Community (Sitio Bae) near the Intake weir	N 16° 47'0.18" E121° 05' 28.38"	12	ND	ND
Detection Limit			-**	4	0.2
DENR NAAQGV			230	180	150

Note: * ND – not detected

**not specified by the laboratory

Compared with the DAO 2000-81 air quality indices, the air quality of the project area based on the 24-hour concentrations of TSP and SO2 can generally be classified under good condition (Table 5-12).

Table 5-12 Air Quality Indices (Source: Annex A of DAO 2000-81)

Type	TSP, µg/NCM (24-hour average)	SO_2, ppm* (24-hour average)	NO_2, ppm* (24-hour average)
Good	0 to 80	0.000 to 0.034 (0 to 88.8)	**
Fair	81 to 230	0.035 to 0.144 (91.4 to 376.2)	**
Unhealthy for sensitive groups	231 to 349	0.145 to 0.244 (378.8 to 637.4)	**
Very unhealthy	350 to 599	0.225 to 0.304 (587.8 to 794.2)	**
Acute unhealthy	600 to 899	0.305 to 0.604	0.65 to 1.24

Type	TSP, µg/NCM (24-hour average)	SO_2, ppm* (24-hour average)	NO_2, ppm* (24-hour average)
		(796.8 to 1577.9)	(1220.5 to 2328.3)
Emergency	900 and above	0.605 to 0.804 (1580.5 to 2100.3)	1.25 to 1.64 (2347.0 to 3079.3)

Note: * Values in parenthesis are expressed in units of µg/NCM, conversion factor for SO2: 1 ppm=2,612.4 µg/NCM; NO2=1877.6 µg/NCM.

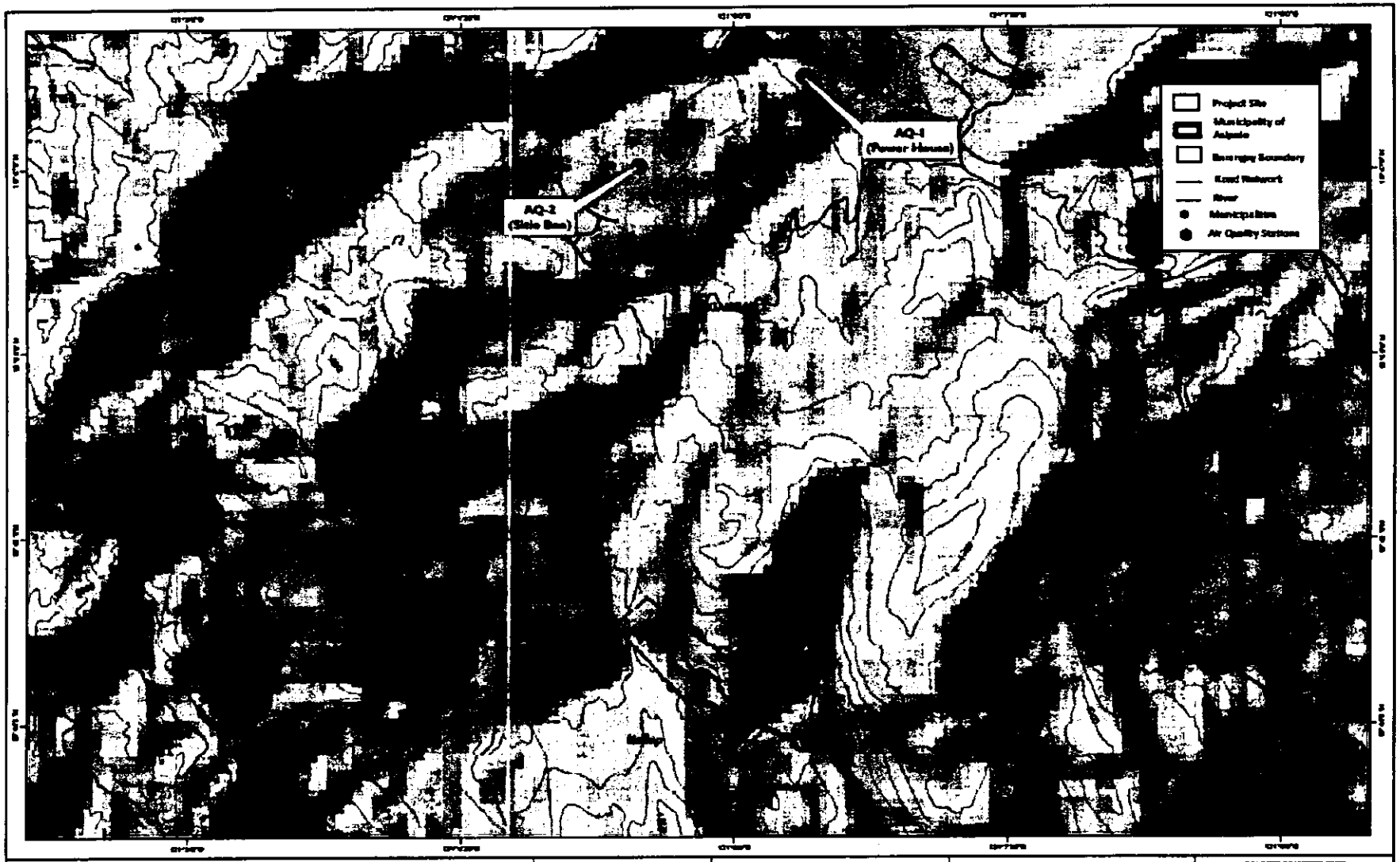


Figure 6-8

Air Quality Stations

Rev 2

TEPSCO

IEE - 810 kW Lilaud Mini Hydropower Plant Project

Barangay Hubay, Municipality of Aglubo
Province of Bukidnon

AECOM

ArcGIS

5.2 Biological Resources

5.2.1 Freshwater Ecology

The study was undertaken to assess the potential impacts of the project to the freshwater ecology and to identify appropriate mitigation measures needed to address these impacts. The findings of the baseline assessment, the identified potential impacts, and the mitigation measures proposed for the project are presented below and the following sections.

5.2.2 Methodology

Rapid freshwater habitat assessment through field observations was conducted on March 16, 2011 to characterize and assess the general condition of the instream habitats along the proposed project area. Ten observation points were established at irregular intervals along the stream and banks to represent the freshwater habitat condition for the entire reach of the freshwater stream. Table 5-13 shows the coordinates and details of the observation points established during the field survey.

Table 5-13 Instream habitat observation points

Station ID	Description	Coordinates (WGS 84)	
		Longitude	Latitude
LH-IN	Proposed Intake	121° 05' 30.4"	16° 44' 24.5"
LH-1	Small Waterfall	121° 05' 33.0"	16° 44' 26.3"
LH-2	Onhill-overview of the rice fields	121° 05' 39.8"	16° 44' 28.0"
LH-3	Onhill-overview of the stream	121° 05' 44.6"	16° 44' 23.6"
LH-4	Onhill-overview of the rice fields	121° 05' 47.5"	16° 44' 20.6"
LH-5	Midstream	121° 05' 47.3"	16° 44' 17.3"
LH-6	Cascade Stream	121° 05' 51.3"	16° 44' 12.0"
LH-7	On Hanging bridge	121° 05' 58.4"	16° 44' 07.0"
LH-8	Portion of midstream habitat	121° 06' 15.7"	16° 43' 54.6"
LH-PH	End of sampling point	121° 06' 35.9"	16° 43' 48.1"

The freshwater habitat assessment has been conducted in reference to the US-EPA Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers (Barbour et al. 1999). Characterization of freshwater habitats is important in defining the biological integrity and diversity of streams and other water bodies. Parameters considered in the habitat assessment were:

- Epifaunal substrate
- Embeddedness
- Pool substrate characterization
- Velocity/depth combination
- Pool variability
- Sediment deposition
- Channel flow status
- Channel alteration
- Frequency of riffles
- Channel sinuosity
- Bank stability
- Bank vegetative protection

5.2.3 Baseline Environment

In general, the entire reach of the proposed project area is in good condition. Other than the man-made weir bridge at Station LH-8, the stream reach experiences no significant perturbation that would likely impact the freshwater habitats and organisms thriving in the area. The entire reach of the surveyed section of the stream is characterized by various types of freshwater habitats (Figure 5-1). The habitat channel types vary from small waterfalls and cascades to riffles and glides lined and covered with boulders, cobbles, pebbles and sand. Substrate embeddedness in most areas was low with layered cobbles providing diversity of niche space. A variety of riparian vegetation ranging from sedges and tall grasses (e.g. Station LH-5) to shrubs and small trees (e.g. LH-3 and LH-7) comprised the reach of the proposed project area. Few aquatic plants, snags, plant and tree debris, however, was observed during the survey. Most sections of the stream was shallow (<1m depth) with relatively deep sections observed mostly at pooling areas. The entire reach of the stream appears to be clear and well-oxygenated thereby allowing freshwater organisms to thrive in the area. Freshwater fishes (i.e. catfishes and tilapia) and small crabs are reportedly caught upstream and in some midstream section of the surveyed area for sustenance and home consumption. Fishing is usually done via damming during summer months when water level is low. Aquatic insects that are likely to inhabit such instream habitat include pollution sensitive taxa such as mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera). Nematodes and oligochaetes (aquatic worms) are unlikely to be abundant in such areas because fine and organic-rich sediments were not that apparent in and along the stream. Nonetheless, high freshwater fauna biodiversity is expected in the area as the instream habitat features an array of good to optimal habitat characteristics. On a study conducted by Maunsell AECOM (2007) at Ambangal River in the municipality of Kiangan, Ifugao, the most common aquatic insects collected were mayflies and caddisflies which are indicative of a good instream habitat. Few fishes inhabit Ambangal River as attested by the interviewed locals in the area. Only two fishes (i.e. goby and halfbeak) were caught during the sampling. Other freshwater fishes reportedly caught in Ambangal River, and possibly in Itum River, are small-sized murrels (dalag), tilapia, freshwater catfishes (hito), and carps (karpa).

The stretch of freshwater stream where the project site will be established also has several agricultural farmlands cultivated for rice and crops. The local guide who assisted during the freshwater survey cited the use of fertilizers and pesticides in some of these farmlands. The use of these chemicals should be regulated and maintained to prevent contamination of the streams and other water resources. The water quality section summarizes the general water quality condition of the stream section where the proposed intake and powerhouse will be established. Detailed notations of the observations made during the site assessment are detailed below.

Station LH-IN (Proposed Intake)

Station LH-IN where the proposed intake of the project will be established is an upstream section of Itum River located at Sitio Lower Haliap, Barangay Haliap. The observation point was accessed by foot using the narrow trail near Itum Bridge some 150 meters upstream. Both banks in this area are characterized by fluvial slope landforms with relatively steep sides similar to ravines. Short intermittent bends of the outcrop wall indicating high degree of channel sinuosity bounds the upstream section of the stream. Optimal channel sinuosity provides diverse habitat for various aquatic fauna and allows better protection from water surges during storms and torrential rains. The vegetation protection in this area is located on top of the limestone outcrop with sparse cover of shrubs, herbs and small trees. Moss patches on the outcrop wall were also observed indicating a humid environment and possible flooding in this stream section due to continuous rain. The instream substrate and banks were composed mostly of bedrocks, cobbles and pebbles with minimal sediment deposition at the time of the sampling. Moderate stream flow rate characteristic of runs and glides along the stream gushes into the small waterfall located a few meters downstream. There was no apparent aquatic vegetation present in this area as the substrate appeared to be loose and possibly have low nutrient levels.

Freshwater fishes thrive in the upstream section of this observation point according to the locals who accompanied the team during the survey. Bank erosion was not evident during the survey but may possibly occur after heavy rainfall events. The municipalities of Kiangan and Asipulo where the stream traverses experiences slight erosion with few areas predicted to have moderate to severe erosion (PDPFP). Slash and burn was reported at the upstream section of the project area that may promote land erosion at the upstream section of Itum River.

Stations LH-1 to LH-8 (Midstream Habitats)

At least two sections of instream habitats are apportioned at the midstream section of the surveyed area. The first section runs from the view at Station LH-2 towards Station LH-5 and the other runs near Station LH-7 towards LH-8. The small waterfall at Station LH-1, a cascade at Station LH-6, and the weir bridge at Station LH-8 bisect these sections from the proposed intake, the midstream areas and the proposed location of the powerhouse, respectively.

The first section has several rice fields near both banks spanning from the downstream areas of the proposed intake and small waterfall at LH-2 and extending towards the proposed powerhouse station. Minimal use of fertilizer and pesticide has been reported in these fields but may still potentially contribute to organic and contaminant levels in the water resources around the area. Most portion of the stream section is generally shallow with cobbles and boulders distributed within the reach of the stream. The stream is generally narrow in some areas with widths spanning to ~3 meters that widens to as much as ~10 meters in several portions. Riparian vegetation including overhanging vegetation, shrubs and grasses are also common in the area. Other than mosses clinging to cobbles and boulders and few microalgal patches in entrained and pooled waters, aquatic vegetation such as submerged, floating, or emergent species were not observed in the area. Residual part of a cut tree was observed on one portion of the stream (Station LH-5). The channel flow status varied from slow to fast flowing waters with riffles present on stream sections creased with boulders and cobbles.

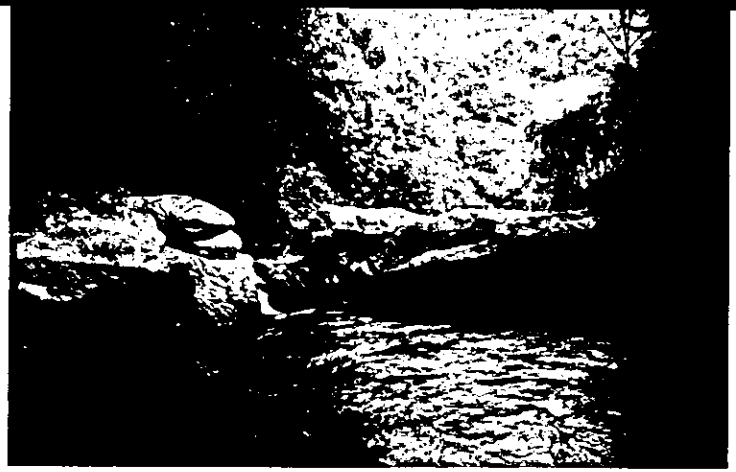
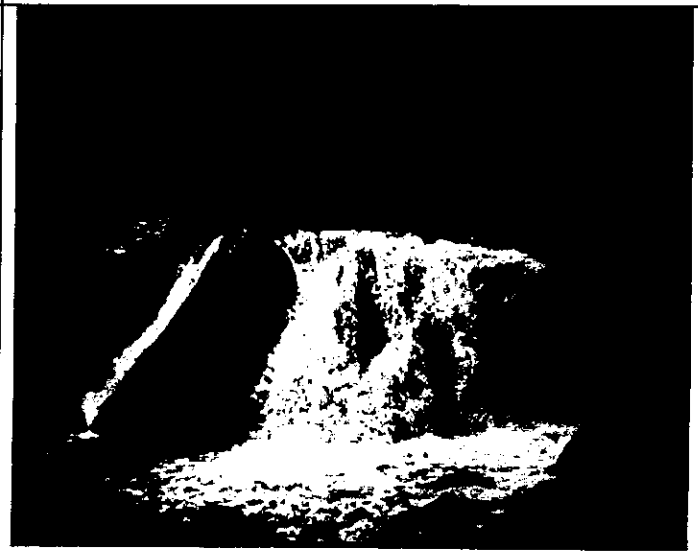
The second portion of the midstream section is lined with huge boulders on both banks and on instream areas (i.e. Station LH-7). Stream water depth varies from knee level in shallow areas (e.g. run and backwaters) to around a meter in pool areas. The water level may reach approximately one meter above the presently observed depth as indicated by the demarcation on the boulders at the banks (i.e. Station LH-7). Flooding has been reported in the area especially during frequent and strong rainfall events. A steel-cable hanging foot bridge approximately 5 meters above the water level has been constructed to replace the torn down wooden hanging foot bridge lying below. Several overhanging vegetation have been observed in the area. Further downstream of the observation point (Station LH-8), uniform distribution of cobbles and pebbles with few boulders were observed. There was no indication of aquatic vegetation throughout the observed portion of the stream. A dilapidated irrigation weir-bridge previously constructed obstructs water flow, thus modifying the instream habitat in these areas.

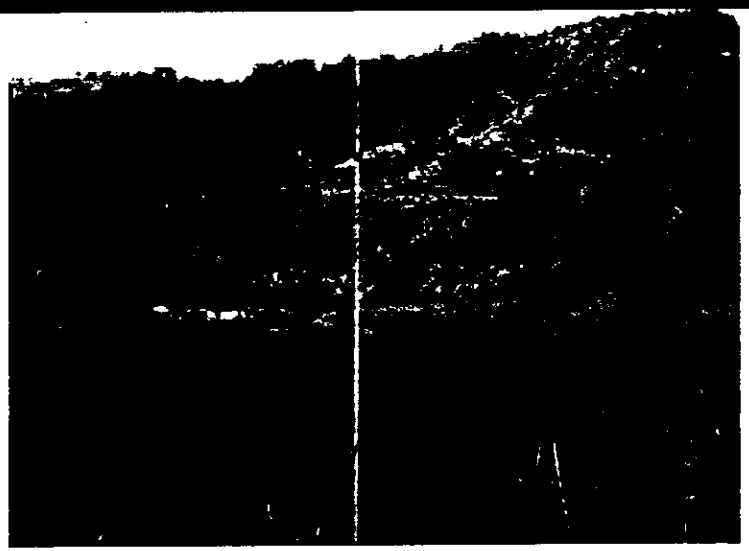
Station LH (End of Sampling Point)

The stream is characterized by several channel habitat types with rapids, riffles and runs interspersed within the reach of the observation point. Both banks appeared to have high stability with gently sloping banks and good riparian vegetation. The upstream section in lined with sedges, tall grasses, and shrubs on both banks whereas the downstream section have an assortment of woody shrubs, grasses and small trees that in some cases overhang the stream. A few snags and submerged aquatic plants at the instream habitat were also sited during the survey. The instream substrate had numerous boulders and cobbles with riffled fast flowing waters especially at the downstream section. An island bar bisecting the stream (where the observations was also done) composed variably from boulders to sand was formed. Although the stream water was clear, sediment deposition at certain section of the banks have also been observed. A temporary weir made up of cobbles was placed at the right

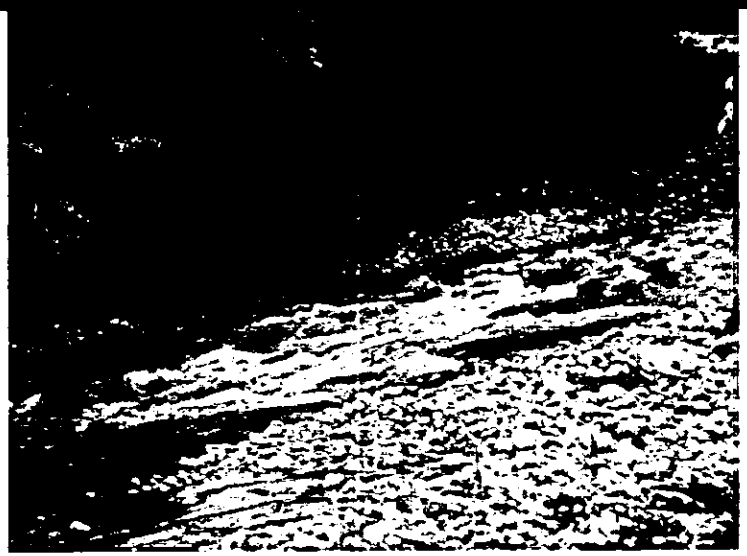
upstream section of the stream that results to flow impediment at the fork stream. Freshwater fauna likely to dominant such instream environments are aquatic insects clinging or burrowed under the substrate. Small fishes were seen around pooling areas of the stream at the time of the survey.

Figure 5-1 Photos of Observation Points

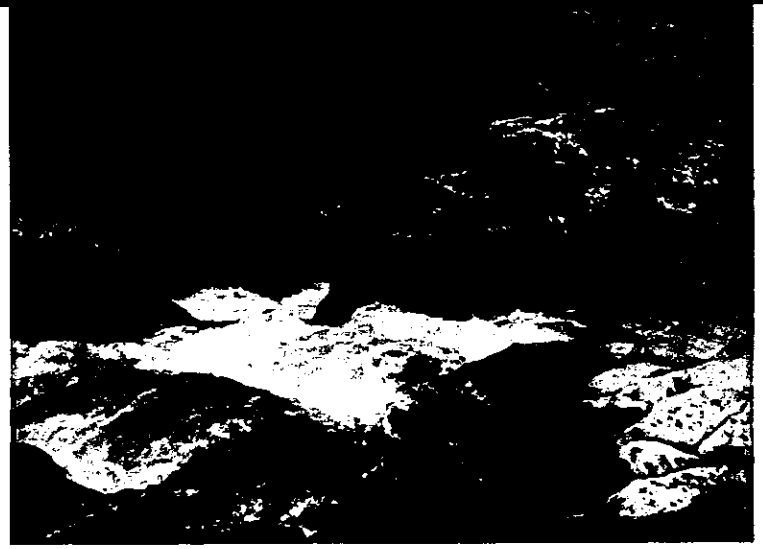
Station ID	Upstream View	Downstream View
LH-IN		
LH-1		

Station ID	Upstream View	Downstream View
Station ID	Upstream View	Downstream View
LH-2		

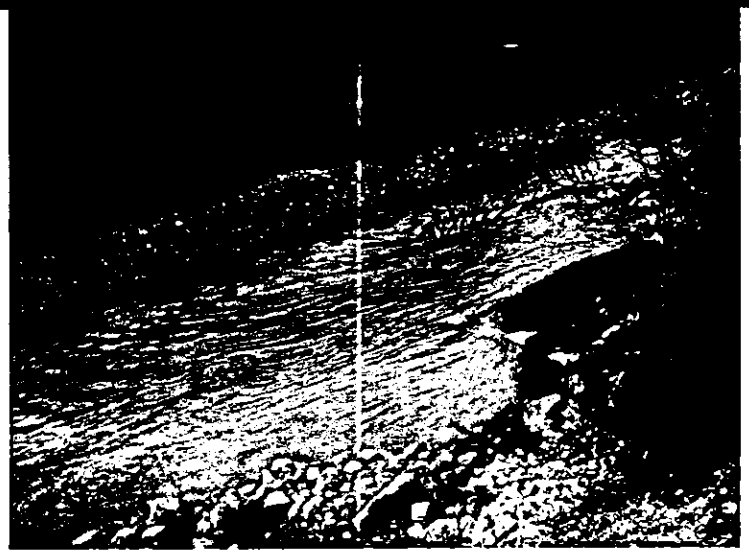
Station ID	Upstream View	Downstream View
LH-3	Upstream view covered with dense vegetation	
Station ID	Upstream View	Downstream View

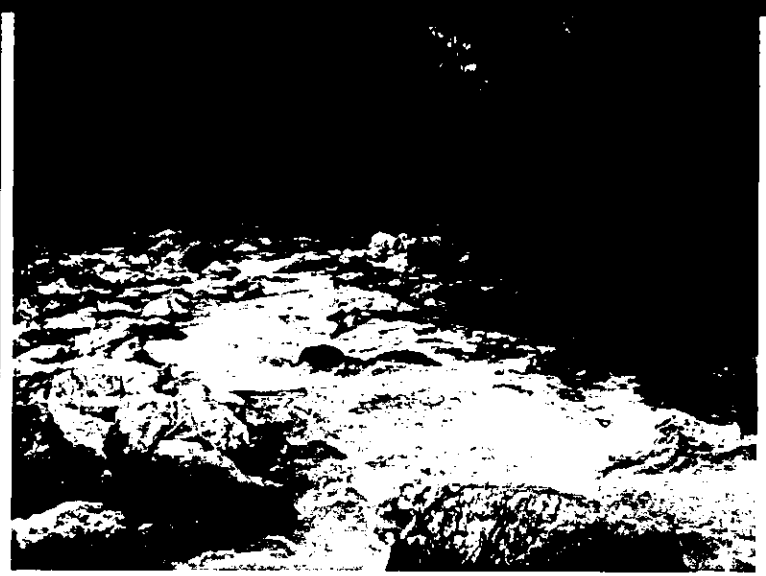
Station ID	Upstream View	Downstream View
LH-4		

Station ID	Upstream View	Downstream View
LH-5		

Station ID	Upstream View	Downstream View
LH-6		

Station ID	Upstream View	Downstream View
LH-7		

Station ID	Upstream View	Downstream View
LH-8		

Station ID	Upstream View	Downstream View
LH-PH		

5.2.4 Terrestrial Ecology

The study was undertaken to assess the potential impacts of the project to terrestrial vegetation and wildlife and to identify appropriate mitigation measures needed to address these impacts. The findings of the baseline assessment, the identified potential impacts, and the mitigation measures proposed for the project are presented below and the following sections.

5.2.5 Methodology

A rapid site assessment was undertaken to have a general picture of the vegetation and wildlife assemblage that will potentially be affected by the project. Methodology included walk-through survey, photo-documentation and interview of locals encountered during the site visit. Conservation status of each identified plant and wildlife species were determined from DENR Administrative Order (DAO) 2007-01 known as the "National List of Threatened Philippine Plants and their Categories, and the List of Other Wildlife Species" and International Union for Conservation Nature (IUCN). The IUCN's Red List of Threatened Species was also referred to since it provides the global assessment of the conservation status.

5.2.6 Baseline Environment

Based on the rapid site assessment, four vegetation communities within and along the immediate surroundings of the project site were identified. These are agricultural land (planted mainly to rice, winged beans, and sweet potato), shrubland/grassland (dominated by various species of grass and woody shrubs), tree plantation (planted to Gmelina), and patches of forest (secondary growth and original vegetation restricted to the very steep portions of the river stretch). More than 90% of the river stretch (about 10 m from both sides of the banks) is heavily disturbed as represented by the agricultural land, shrubland/grassland, and tree plantation. The remaining forest patches were most likely untouched either because of their very steep location and/or stunted structure rendering them without economic value. A general assessment was conducted to determine the suitability of these vegetation communities as a potential habitat for wildlife species.

A total of 12 bird species dominated by the yellow-vented bulbul (*Pycnonotus goiavier*), chestnut munia (*Lonchura malacca*), and Pacific swallow (*Hirundo tahitica*) were observed and confirmed present along the entire stretch of project site. Except for the white-eared brown-dove (*Phapitreron leucotis*), Philippine bulbul (*Hypsipetes philippensis*), and Philippine coucal (*Centropus viridis*), all recorded species are resident breeding but are non-endemic. None are considered under any threat categories based on PWRC Act of 2001 and IUCN Red List of Threatened Species 2010.

Table 5-14 presents the key findings and conclusions of the terrestrial ecology assessment.

Table 5-14 Key Findings and Conclusions - Terrestrial Ecology

Baseline Information *	Key Findings and Conclusion
Habitat	• The entire stretch of the project site is heavily disturbed and modified caused by past anthropogenic activities such as land clearing for agriculture. The host and neighbouring barangays have been utilized as agricultural land and settlement areas.
Vegetation communities	• There are four vegetation communities within the project site namely: agricultural land, shrubland/grassland, tree plantation, and forest patches.
Endemicity and conservation status of plant species identified	• None of the plant species recorded within the actual stretch of the project site is included within the DENR Administrative Order (DAO) 2007-01 list known as the "National List of Threatened Philippine Plants and their Categories" and the International Union for Conservation Nature (IUCN). Majority of the species recorded are introduced while some are native but non-endemic.
Wildlife species inventory and their conservation status	• A total of 12 bird species were recorded. Of which, only three species are considered endemic while the rest are resident breeding but non-endemic. This low species turn-out was expected due to the highly disturbed vegetation condition of the project area.None are

Baseline Information *	Key Findings and Conclusion
Habitat	• The entire stretch of the project site is heavily disturbed and modified caused by past anthropogenic activities such as land clearing for agriculture. The host and neighbouring barangays have been utilized as agricultural land and settlement areas.
	considered under any threat categories based on PWRC Act of 2001 and IUCN Red List of Threatened Species 2010.

5.3 Socio-Economic Cultural Conditions

5.3.1 Socio-Economic Profile

The project site is within the administrative area of Barangay Haliap in Asipulo Municipality. Formerly a part of Kiangan, Ifugao Province, Asipulo was created a separate jurisdiction by Republic Act 7173 in 1992. Asipulo covers a land area of 29,043 hectares with a total population of 13,100 and population density of 2.18 hectares per person (CBMS, 2007).

The following structures are envisioned to be constructed in Haliap.

Structure	Haliap
Diversion Weir	✓
Intake and Settling Basin	✓
Headrace	✓
Head-Tank	✓
Pension and Spillway	✓
Powerhouse	✓

Haliap is bounded to the north by Barangay Duit, the south by Pula, the east by Panubtuban and Mappit, and west by Amduntog. Haliap has nine sitios and a total land area of 490.0848 ha. According to the 2007 CBMS survey, the total population is 979 with a 1.84% population growth rate.

5.3.1.1 Household Composition and Structure

The average household size is 4.7. Haliap has 194 households, the largest being in Purok Lower Haliap, Gulun and Tangngadon (31 each) and the smallest in Taaw (2). Table 5-15 shows the population distribution, household population and number of families per sitio.

Table 5-15 Population Distribution by Purok (CBMS, 2007)

Purok	No. of HH	Population	No. of Males	No. of Females
Likud	23	137	73	64
Upper Haliap	26	136	69	67
Lower Haliap	31	151	78	73
Nadonglaan	5	37	21	16
Mayubba	29	121	62	58
Gulun	31	174	85	89
Taaw	2	11	6	5
Tangngadon	31	133	67	66
Panakligan	16	79	37	41
Total	**194**	**979**	**498**	**479**

5.3.1.2 Labor Force

Forty percent of the population (15-64 years old) is of working age. Household members who are working total 388. The employed labor force for males is at 230 compared to females at 158. Haliap has no record of unemployment rate as per 2007 CBMS. Table 5-16 shows the labor force 15 years and over by sex.

Table 5-16 Labor Force 15 years and over by Sex (CBMS, 2007)

Purok	Labor Force	Male	Female
Likud	51	32	19
Upper Haliap	45	25	20
Lower Haliap	58	36	22
Nadonglaan	13	9	4
Mayubba	61	35	26
Gulun	64	39	25
Taaw	3	2	1
Tangngadon	57	34	23
Panakligan	36	18	18
Total	**388**	**230**	**158**

5.3.1.3 School-Age and Educational Profile

Eighty-six percent of Haliap's population (10 years old and above) are literate. The illiteracy rate is almost equal for males and females at 12.81% and 12.08%, respectively. In 2007, 31% of the population is of school age (6-21years old). The participation rate for elementary is at 97.1% and high school at 87.23%. Table 5-17 demonstrates the school age population and enrolment rate.

Table 5-17 School Age Population and Enrolment Rate (CBMS, 2007)

Education Level	Number	Enrollment Rate
Elementary School-going age	186	181
Secondary School-going age	119	104

5.3.1.4 Ethnicity and Religion

The overwhelming majority of the population in Barangay Haliap is indigenous (Ayangan-Ifugao). Ayangan is one of the two ethno-linguistic subgroups in Ifugao province. Manuel Dulawan, local historian and noted authority on Ifugao culture, states that the Ayangan dialect are distinguished for the phonemes *ch, f, sh* and *j* which sounds are not uttered in Tuwali, another dialect in Ifugao that is spoken in the area surrounding Asipulo.Haliap barangay officials claim that more than half of the households are Roman Catholics followed by various Protestant denomination (United Methodist, Bible Methodist, Baptist and Evangelical).

5.3.1.5 Income and Livelihood

The main sources of livelihood and income in Haliap are agriculture and forestry. Key informants cited beans, tomato and palay as major crops in the barangay. Harvested crops from small land holdings are primarily for family consumption, while the remaining produce are marketed in Kiangan and Lagawe for additional income. Table 5-18 shows the income and livelihood source by sex.

Table 5-18 Income and Livelihood Source by Sex (CBMS, 2007)

Industry	Total	Male	Female
Agriculture mining and Forestry	300	179	121

Industry	Total	Male	Female
Fishing	2	2	0
Manufacturing	1	0	1
Electricity, Gas and Water Supply	1	1	0
Construction	8	8	0
Wholesale and Retail Trade, Vehicle Repair	14	4	10
Transportation, Storage & Communication	8	8	0
Financial Intermediation	1	1	0
Real Estate, Renting and Business Activities	3	2	1
Public Administration and Defense	12	11	1
Education	10	2	8
Health and Social Work	2	0	2
Other community, Social or Personal Activities	21	12	9
Private Households with Employed Persons	5	0	5
Number of Employed Persons	388	230	158

Asipulo is a 5th class municipality according to the Department of Finance classification in terms of fiscal revenues. This is reflected in the household incomes of the host barangays and the largely subsistence agricultural economy. Incomes are generally low and majority of people are dependent on subsistence farming. The range of household income in the barangay is approximately 3000Php-7,000Php per month, as per interview with the barangay officials. Table 5-19 demonstrates the number of households by quintile.

Table 5-19 Number of households (CBMS, 2007)

Quantile	Magnitude	Proportion
Poorest	38	19.59
Lower middle	38	19.59
Middle	38	19.59
Upper middle	38	19.59
Richest	42	21.65

Households augment incomes by taking out loans from local lenders, mostly cooperatives. The community is also characterized by strong family and affinity ties evidenced by neighbours willing to lend help, both monetary and in kind, in times of financial scarcity. Identified as one of the poorest in the province, Asipulo also started receiving aid from KALAHI-CIDDS since 2003. The government's poverty alleviation project provides interventions to host barangay, such as human development services.

5.3.1.6 Physical-Cultural Resources

5.3.1.7 Land Resources

The 490.0848 ha land area of Barangay Haliap will be classified to agricultural, industrial, commercial and residential areas. The agricultural area is mainly devoted to crop cultivation, livestock and grazing. Industrial and commercial areas are locations for non-agricultural employment and activities such as public markets and offices. The residential areas in Barangay Haliap are scattered and are found in relatively remote locations.

5.3.1.8 Water Resources

The Lamut River stretches on a southeast-northwest direction fed by two tributaries, the Pambingan River from the Asipulo side and the Bagnit River from the Kiangan area. Both tributaries emanate from thickly forested watersheds adjacent to each other. These watersheds ensure sufficient water volume on the Haliap River needed by the mini-hydro electric plant even during the dry months of the year. There are private and communal irrigation systems supplying irrigation water in all rice fields throughout the municipality. The systems, however, are easily destroyed during rainy seasons and calamities.

Almost all barangays in Asipulo have with Levels I (point source) and II (point source with public faucet) water systems. However, several households still fetch water from a distance beyond 250 meters, which is beyond the MBN (Minimum Basic Need) norm. The water sources are also reported to be poorly constructed often proned to contamination by wandering animals. Table 5-20 shows the type of source of drinking water.

Table 5-20 Types of Source of Drinking Water (CBMS, 2007)

Type of Source of Drinking Water	Magnitude	Proportion
Community water system-own	56	28.87
Community water system-shared	98	50.52
Deep well-own	2	1.03
Deep well-shared	1	0.52
Artesian well-own	2	1.03
River, stream, lake, spring	35	18.04
Number of Total Households	**194**	

5.3.1.9 Power

Ifugao Electric Cooperative (IFELCO) provides Haliap with electric service. Haliap is not completely energized. A still significant portion of the households is without electric service. The households without access to or could not afford the services of IFELCO use kerosene lamps, gas lanterns (petromax) and pinewood for their lighting needs. Alternative source of electricity, such as solar panel, are also offered by IFELCO.

5.3.1.10 Communication

Presently, wireless/mobile telecommunications service in Haliap is provided by the GLOBE and SMART. However, there are still selected portions of the barangay that are not accessible to mobile phone signals.

5.3.1.11 Historical and Cultural Value

Interviews with key informants and field observation suggest that there are no sites of historic, cultural, archaeological or religious significance. The testimonial of Manuel Dulawan, local historian and noted authority on Ifugao culture, also claimed that no site of cultural, historic, or religious significance will be negatively impacted by the hydro power plant project. Testimonial of Mr. Dulawan is appended in this report (Annex 7)

5.3.1.12 Settlement and Infrastructure

5.3.1.13 Land Acquisition and Settlement Pattern

Based on key local informants (land owners and organization heads) and barangay council, there are no settlements within the project site. The settlement and built-up areas are concentrated along the national highway and the low-lying puroks or sitios. However, a total of 1 ha of agricultural land will be converted for the project. Local owners with legal rights to land and assets within the vicinity of the

project site will be directly impacted by the proposal. The project will also affect the ability of the adjacent agricultural landowners to continue farming. The local land owners require monetary compensation in exchange of land and property. Potential right of way conflict is also expected within the project site.

The proponents will estimate the economic implications of the project proposal, including impacts to the agricultural sector in Haliap, productivity changes, impact on land values and property taxes and the potential effect on agricultural lease rents. The proponents will provide prompt and adequate monetary compensation for the change in land ownership within the project site.

5.3.1.14 Existing Infrastructures and Industries

Haliap has three government-owned schools, one each for day care, complete elementary and high school. The elementary school has a total of nine classrooms, seven other buildings and three makeshift latrines. The Haliap National High School is built with two to three classroom buildings; one Home Economics Building; one faculty building, teachers cottage, one Administration Building and a two-storey library building with three Latrines. The HNHS has two annexes located at Natcak and Camandag, Asipulo.

Retail trade and cooperative lending are the most common types of business establishments in Haliap. On the other hand, cottage industries include beans as product.

Haliap also has one barangay station accessible to all the households in need of medical and health assistance.

5.3.1.15 Health and Safety

5.3.1.16 Public Health and Sanitation

Sixty-eight households (35%) have no sanitary toilets (closed pit or water-sealed), while 35 households are without access to safe water. The barangay health center has no record of the illnesses caused by water borne diseases. On the other hand, total of 20 incidences of maternal mortality has been recorded per 2007 CBMS.

Colds and diarrhea are the most common illnesses in the barangay host. Irregular weather condition and cases of pollution are the leading causes of these illnesses. CBMS data, however, record, no cases of malnutrition Table 5-21 demonstrates the barangay's nutrition status by sex.

Table 5-21 Nutrition Status by Gender (CBMS, 2007)

	Total (Base: 117)	*Male (Base: 57)*	*Female (Base: 60)*
Above Normal	0.85	0	1.67
Normal	99.15	100	98.33
Below Normal (moderate)	0	0	0
Below Normal (severe)	0	0	0

5.3.1.17 Community Health and Safety

Haliap has one barangay station accessible to all the households in need of primary health care. A midwife is in charge of the health station. Small budget for medical supplies and health concerns are cited among the most common problems on community health.

The barangay has a single case of homicide based on 2007 CBMS. In general, however, the key informants (barangay officials) claim that Haliap is still a peaceful and safe community.

5.3.1.18 Social Protection

The largest membership among the community associations are Women's Organization and Religious Groups, with 25 members each. The Active Males Movement against Violence also ensures the prevention of violence against women and children in the community.

6.0 Land Compensation and Its Implementing Procedure

The Land Compensation section describes the principles, entitlement and implementation procedures on land acquisition and resettlement for I.2 MW Likud Mini-hydropower Plant Project. Relevant laws and regulation of the Philippine Constitution are detailed to ensure that (a) landownership concerns on the project site are addressed thru a legally binding land use agreement (b) the economic implications of the project proposal, including impacts on Haliap agricultural sector, productivity changes, impact on land values and property taxes and the potential effect on agricultural lease rents are accurately assessed (c) adequate funds are allocated, based on detailed valuation of properties and assets, for disbursement of compensation on impacted land properties.

6.1 The Policy Framework of Land Ownership

The policy framework of land ownership is based on the relevant laws and regulations of the Philippine Constitution. Specifically, Section 19 of RA 7160 (Local Government Code of 1991) and Section 17 of RA 6657 (Comprehensive Agrarian Reform Law of 1988) shall serve as the primary policy guidelines for the land compensation scheme of the project.

Section 19 (Eminent Domain) of RA 7160 acknowledges the inherent political right of a local government unit to exercise the power of eminent domain for public use upon payment of just compensation pursuant to the provisions of the Constitution provided however:

(i) That the power of eminent domain may not be exercised unless a valid and definite offer has been previously made to the owner, and such offer was not accepted
(ii) That the local government unit may immediately take possession of the property upon the filing of the expropriation proceedings and upon making a deposit with the proper court of at least fifteen percent (15%) of the fair market value of the property based on the current tax declaration of the property to be expropriated
(iii) That, the amount to be paid for the expropriated property shall be determined by the proper court, based on the fair market value at the time of the taking of the property.

In addition, Section 17 of RA 6657 or the Comprehensive Agrarian Reform Law of 1988, which is particularly relevant in the determination of just compensation, stated as follows:

> "In determining just compensation, the cost of acquisition of the land, the current value of like properties, its nature, actual use and income, the sworn valuation by the owner, the tax declarations, and the assessment made by government assessors shall be considered. The social and economic benefits contributed by the farmers and the farm-workers and by the Government to the property as well as the non-payment of taxes or loans secured from any government financing institution on the said land shall be considered as additional factors to determine its valuation."

Another important legislation taken into consideration in this assessment is the Indigenous People Rights Act (IPRA) of 1997 (RA 8371). This act recognises and promotes the rights of indigenous peoples to ancestral domains and lands; the right to self-governance; economic and social rights; and cultural integrity, including indigenous culture, traditions and institutions.

6.2 Land Acquisition Procedure

The stretch of freshwater stream where the project site will be established has several agricultural farmlands cultivated for rice and crops. The impacted stakeholders of the Mini-hydropower Plant Project are agriculture landowners from Barangay Haliap for the construction of hydropower plant. The primary stakeholder's interests involve land acquisition procedure and the disbursement of just compensation for the affected properties. Other stakeholders are local residents of the host barangay and nearby communities, and local government units, whose interests are related to the implementation of the project and availability of reliable power at a reasonable cost.

Necessary data collection were undertaken to understand project's site development plan, project description, and related laws and regulations pertaining to land acquisition and just compensation.

Consultations for the project were conducted to inform landowners and institutional stakeholders (i.e. LGU's and other affected government agency) that a hydropower plant project has been chosen by the proponent to be established in Haliap. The objective of these consultations were to (i) discuss scope of the proposed hydro power plant; (ii) identify land users and landowners of the proposed site; and (iii) discuss guidelines and procedures on land acquisition and compensation scheme in accordance to customary and regulatory laws. The list of initial consultations conducted is shown in Table 6-1.

Table 6-1 Key Consultation Activities

Public/ Stakeholder Consultation	Date	Place	Participants	Topic of discussion
Public Consultation	February 22, 2011	Barangay Hall, Barangay Haliap, Asipulo	1. Barangay Council of Haliap 2. Barangay Council of Panubtuban 3. Provincial Planning and Development Office 4. TEPSCO 5. AECOM	Discussed project objectives, history and goal of the mini-hydro development in Ifugao, location of the project, schedule and items of the feasibility study and basic considerations in the planning and designing of the project.
Plant visit to Ambangal Dam	February 28, 2011	Ambangal, Kiangan	1. Barangay Council of Haliap 2. Barangay Council of Panubtuban 3. TEPSCO 4. Ambangal Dam operators	Discussion on the structures and the daily operations of the Ambangal Minihydro Power Plant.
Public Consultation	April 28, 2011	Barangay Hall, Barangay Haliap, Asipulo	1. Barangay Council of Haliap 2. Barangay Council of Panubtuban 3. Farmers	• Selection of the location of the main facilities. • Comparison study between waterway routes
Public/ Stakeholder Consultation	Date	Place	Participants	Topic of discussion

Key Informant Interview	June 23, 2011	Haliap Barangay Hall, Haliap, Asipulo	Kgd Rosemarie Doque	Discussed project background, their concerns and how they will benefit or experience negative impacts. (i.e. Opinion on the establishment of hydro power plant; Perceived Impacts on the establishment of hydro power).
Consultation with Haliap Barangay Council and Sector Leader	June 23, 2011	Haliap Barangay Hall, Haliap, Asipulo	1. Kgd Basilio Fedelito 2. Basilio Bayawna 3. Christina Ngabit 4. Nancy Addab	Discussed project background, their concerns and how they will benefit or experience negative impacts. (i.e. Opinion on the establishment of hydro power plant; Perceived Impacts on the establishment of hydro power).
Consultation with Panubtuban Barangay Council	June 23, 2011	Panubtuban Barangay Hall, Panubtuban, Asipulo	1. Brgy Captain 2. Kgd Josie 3. Brgy Treasurer 4. Brgy Secretary 5. Brgy Staff	Discussed project background, their concerns and how they will benefit or experience negative impacts. (i.e. Opinion on the establishment of hydro power plant; Perceived Impacts on the establishment of the hydropower plant)
Landowners' Focus Group Discussion	June 23, 2011	Haliap	Landowners	Discussed project background, their concerns specific to land ownership and how they will benefit or experience negative impacts. (i.e. Opinion on the establishment of hydro power plant; Perceived Impacts on the establishment of hydro power).
Public Consultation	July 1, 2011	Barangay Hall, Barangay Haliap, Asipulo	1. Barangay Council of Haliap 2. Barangay Captain of Haliap	• General Lay-out of the hydropower plant • Development Scale • Outline of civil structure • The result of parceally survey to identify potential affected landowners

6.3 Social Acceptability

The level of social acceptability of this project was assessed through a series of consultations and focus group discussions conducted in the project affected community and the lot owners. The barangay council of Barangay Haliap gave their approval upon presenting the primary objectives of the projects and its positive impacts to the community and the entire province as well (Annex 8).

Whereas, the most cited reason of lot owners for objecting to the project is "might affect the flow of water for irrigation." Upon thorough presentation of the project vis-a-vis their objection, the lot owners approved of the project.

6.4 Land Ownership of the Potentially Project- Affected Area

Based on key local informants (land owners and organization heads) and barangay council, there are no settlements within the project site. The settlement and built-up areas are concentrated along the

national highway and the low-lying puroks or sitios. The project does not require displacement of community host residents. There are no physical structures on the proposed site (historic, cultural, archaeological or religious site). The project will however need to acquire a total of 1 ha of land.

Local owners with legal rights to land and assets within the vicinity of the project site will be directly impacted by the project. The project site covers 22 land owners from Barangay Haliap. The acquisition of land is also expected to affect the livelihoods and income of the adjacent agricultural landowners.

Affected landowners have been consulted during feasibility study. They are generally supportive of the project, but are also concerned of the land acquisition and compensation procedure. The local land owners require monetary compensation for affected land and assets including right of way conflicts. The stakeholders also cited concerns on activities during construction with potential negative impacts on proposed project site. This includes apprehensions on the removal of vegetative cover and trees and fear of the excavation and drilling of land for the installation of facilities.

6.5 Land Acquisition for the Project

The proponent will estimate the implications of the project proposal, including impacts to the agricultural sector in Haliap, productivity changes, impact on land values and property taxes and the potential effect on agricultural lease rents. The proponents will provide prompt and adequate monetary compensation for the change in land ownership within the project site.

Discussion with the landowners will continue, to reach a legally binding land use agreement on land acquisition. The landowner clan leaders will be informed of the policies and implementation procedures regarding compensation for land and assets. This will include specific details on compensation rates and entitlements with careful details on the mode and schedule of compensation payment.

A model for land compensation is presented in Annex 9. This model is applied in a similar project in Ambangal mini-hydro power project.

7.0 Impacts due to the Project and Mitigation Measures

7.1 Soil

There is a potential for topsoil loss during construction. As mitigation, topsoil that will be disturbed during construction will be gathered and properly stockpiled. Gathered topsoil will be used for revegetation of cleared or affected areas. These cleared or affected areas will include but not limited to areas used for temporary storage of construction materials and campsite.

7.2 Water Quality and Wastes

During construction, possible soil erosion from digging/excavation activities may result to increased sedimentation particularly at the intake weir and the headrace area. Furthermore, potential degradation of water quality due to the generation of wastes that may indiscriminately be disposed of by the workers may eventually find its way into the water body. As mitigation, the contractor will be required to adhere to best construction practices including proper housekeeping and this will be stipulated in their contract. Non-adherence to the said provisions will render non-payment of their fees. If practicable, the weir will be constructed during the dry season when the water level is low. Sediment traps will be placed along the headrace alignment to prevent, if not to minimize, the transport of the excavation spoils to Lamut River. The temporary camps for workers will be positioned away from the river. This will be provided with adequate and properly maintained sanitation systems. Good housekeeping measures (including waste segregation and proper disposal) will be strictly enforced.

7.3 Hydrology

The project requires for a 2.0 m^3 maximum discharge and a 0.4 m^3 minimum discharge to able to operate. As such, lower than this amount, the Plant will stop operation.

Potential impact might be the non-priority of the irrigation requirements. Based on the Water Code of the Philippines (PD 1067), priority of water use is given to irrigation prior to power generation energy.

7.4 Air Quality

Potential air quality impacts will be exhibited during construction and operation stages. During construction, there will be generation of particulate matters from excavation works and movement of vehicles. Furthermore, nitrogen oxides and sulfur oxides from fuel combustion of vehicles and engine/generator set will be generated. There will be no big equipment to be used but manual labor will be extensive, thus, sources of dust will be limited from excavation works and vehicular movements of delivery trucks. To mitigate exposure to increased level of dusts, proper Personal Protective Equipment (PPE), such as mask will be provided to workers, when applicable. Most of the barangay roads, although very narrow are cemented, thus build up of dust will also be negligible.

During the operational phase, there will be generation of nitrogen oxides and sulfur oxides from fuel combustion of back-up generator. This will be mitigated by employment of regular maintenance.

7.5 Noise

During construction, noise and vibration will be generated from vehicular movements, sand and aggregates processing, excavation and other construction noise including workers. The main potential impact of the increased noise levels and vibration will be to the construction workers since there are no communities within the immediate environ of the construction sites. Mitigation will include standard occupational health and safety practices such as use of ear mufflers and enforcement of exposure duration restrictions. Construction activities will also be limited during daytime (if practical) to contain noise during daytime and assure a quiet and peaceful night in the area.

During operational phase, there will be generation of noise from operation of turbine and back-up generator set. This will be mitigated by regular maintenance and enclosure of the powerhouse to minimize noise.

7.6 Vegetation

The construction of the different facilities will require vegetation clearing. The vegetation following the entire stretch of the project site is already heavily disturbed (more than 90%) due to past anthropogenic activities represented by the agricultural land, shrubland/grassland, and tree plantation. The remaining forest are restricted to small patches that were most likely untouched either because of their very steep location and/or stunted structure rendering them without economic value.

Vegetation clearing activities of the project will adhere to all Philippine statutory requirements. Harvesting of timber and timber products require a tree cutting permit issued by the Department of Environment and Natural Resources (DENR). A Private Land Timber Permit (PLTP) is issued to harvesting of naturally grown forest while a Special Private Land Timber Permit (SPLTP) is issued to harvesting of premium hardwood species. This permit is issued by the DENR Regional Director if volume is less than 10m3, while it goes up to the DENR Secretary if more than 10m3(DAO 2000-21).

As mitigation, reforestation/revegetation areas will be at least equivalent to the area cleared to give way to the project's facilities. Reforestation/revegetation areas will be located in the immediate vicinity of the project site.

7.7 Wildlife

The main group of vertebrate fauna that will be potentially susceptible to the impacts of the project will be the amphibians and reptiles due to their limited and localized mobility. The construction of the headrace will affect the movement of these groups specifically, those that are distributed along its entire length since this would act as a barrier for individuals trying to move perpendicularly across the river. Their regular movement patterns (i.e., foraging, breeding, etc.) might be affected. A possible solution is to put a covering on strategic locations to serve as a bridge which would facilitate their crossings. Simultaneously, these coverings would also prevent the entry of too much litter into the headrace.

Neither birds nor mammals are expected to be negatively impacted by the different facilities of the project. Vegetation clearing will be mainly limited to the already disturbed habitats; birds and mammals could easily migrate to similar nearby areas. The foreseeable negative effect is during the construction phase specifically when workers and other personnel will be present in the area. Noise and other disturbances brought by their presence will definitely drive them away but they are expected to slowly return as soon as the disturbance source is eliminated. Hunting will also be strictly prohibited and enforced among the workers as some of them might resort to this activity which could result to further decrease of already limited species.

7.8 Freshwater Ecology

The project will cause minimal impacts on the freshwater ecology of the project site. This will be experienced during the construction of the intake and headrace only. The potential increase in sedimentation/erosion, due to clearing and digging activities may smother the benthic organisms thriving in the river. This can have similar effect to fisheries.

Mitigating measures to minimize erosion/sedimentation in the river will include the establishment of protection wall in the intake area, which will also prevent flooding in the nearby farm, use of riprap/stonewall in strategic locations, and re-vegetation of cleared areas.

The maintenance of the minimum river flow during the dry season would also maintain aquatic life in the river.

7.9 Socio-Cultural and Heritage

The project is expected to bring positive economic benefits to the host community. Jobs will be created as a result of the construction and operation of the project. About 200 local residents will be hired at the peak of construction. During operations, seven local residents will be employed to manage and maintain the mini-hydro power plant. The host communities will receive benefits indicated in Sections 4 and 66 of EPIRA 2001 (The Generation Company and/or energy resource developer should set aside one centavo per kilowatt hour (P0.01/kWh) of the total electricity sales as financial benefits to host communities). The project will also generate funds for the conservation programs of the Ifugao rice terraces.

Mr. Manuel Dulawan, a noted local historian and cultural worker in Ifugao, states that given the scale of the mini-hydro power plant project in Barangay Haliap, no site of cultural, historical or religious significance will be negatively impacted. He also concluded that no intangible aspects such as cultural practices, rituals, taboos of Ifugao culture will be affected. Moreover, the proposed mini-hydro power plant project in Barangay Haliap, will promote cultural significance of harnessing water for progress and this resonates with age-old Ifugao traditions that venerate water as a primary life force. Water is a natural resource used by Ifugao for agriculture and also had been used as an engineering tool in building terraces, dams and move larger rocks.

8.0 Environmental Monitoring Plan (EMoP)

8.1 Self- Monitoring Plan

The framework for environmental compliance monitoring and environmental performance indicators is described in this section. The primary purpose of the self-monitoring plan is to ensure that the project complies with relevant regulatory requirements through the proposed management measures identified to address project impacts. There will be two types of monitoring report that will be submitted to EMB.

- ECC Compliance Monitoring Report– A semi-annual report of the project's compliance with the ECC conditionalities; and
- Self-Monitoring Report – A quarterly report of the project's compliance to environmental standards and other requirements specific to four environmental laws under the direct mandate of the EMB on air quality (Republic Act (RA) 8749), water quality (RA 9275), toxic substances and hazardous waste management (RA 6969), and solid waste management (RA 9003).

Table 8-1 presents the Monitoring Plan that will be undertaken by the Provincial Government of Ifugao and ECC Compliance Monitoring Report will be submitted to EMB-CAR. A notarized completed Project Environmental Monitoring and Audit Prioritization Scheme Questionnaire is presented in Annex 10. The questionnaire serves as a guide for EMB to determine the monitoring strategy and to rank/classify projects based on their priority in terms of monitoring.

Table 8-1 Environmental Monitoring Plan (EMoP)

Key Environmental Aspects per Project Phase	Potential Impacts Per Envt'l Sector	Parameter to be Monitored	Sampling & Measurement Plan			Lead Person	Estimated Cost (PhP)	EQPL Management Scheme			
			Method	Frequency	Location			EQPL Range		Management Measure	
								Action	Limit	Action	Limit
Construction Phase											
Water	Water Pollution	TSS, TDS, coliform, BOD, COD	AS/NZS 5667.1	Semi-Annual	Four water stations in Lamut River	Environmental Officer	50,000/ sampling		DAO 1990-34		
Air	Generation of dust and gaseous pollutants	TSP, NO_2, SO_2	USEPA 40 CFR, Part 50	Semi-Annual	Two stations within the project site	Environmental Officer	50,000/ sampling		NAAQS		
Noise	Increase in noise levels	Noise levels	AS 1055.1-1998	Semi-Annual	Concurrent with the Air Quality Stations	Environmental Officer	5,000/ sampling		NPCC Guidelines		
Health and Safety	Exposure of employees and to some degree, the local community to health and safety risks as a result of construction activities	Safety and health committee meeting agreements; accident investigations/ reports; and periodic hazards assessment with the corresponding remedial measures/ action for each hazard.	Included in the Health and Safety Plan of the proponent	Daily	Project site	Health and Safety Officer	50,000/monthl y reporting			DOLE DO 13 of 1998	
Operation Phase											
Water	Water Pollution	TSS, TDS, coliform, BOD, COD	AS/NZS 5667.1	Quarterly for the first year; will be adjusted as necessary	Four water stations in Lamut River	Environmental Officer	50,000/ sampling		DAO 1990-34		
Aquatic Biota	Loss of habitat and		Scientifically	Quarterly for		Environmental	100,000/				

Key Environmental Aspects per Project Phase	Potential Impacts Per Envt'l Sector	Parameter to be Monitored	Sampling & Measurement Plan			Lead Person	Estimated Cost (PhP)	EQPL Management Scheme			
			Method	Frequency	Location			EQPL Range		Management Measure	
								Action	Limit	Action	Limit
	aquatic biota.		accepted methodologies; photo transect and visual census	the first year; will be adjusted as necessary especially if there's no perceived impacts after a year		Officer	sampling				
Air	Generation of dust and gaseous pollutants	TSP, NO_2, SO_2	USEPA 40 CFR, Part 50	Quarterly	Two stations within the project site	Environmental Officer	40,000/ sampling		NAAQS		
Noise	Increase noise levels	Noise levels	AS 1055.1-1998	Quarterly	Two stations within the project site	Environmental Officer	5,000/ sampling		NPCC Guideline		
Health and Safety	Exposure of employees and to some degree, the local community to health and safety risks as a result of operations activities	Safety and health committee meeting agreements; accident investigations/ reports; and periodic hazards assessment with the corresponding remedial measures/ action for each hazard.	Included in the Health and Safety Plan of the proponent	Daily	Project site	Health and Safety Officer	50,000/monthl y reporting			DOLE DO 13 of 1998	

9.0 Conclusion and recommendations for the Initial Environmental Assessment

It is expected that given the scale of the proposed mini hydro-electric power plant project, the limited facilities proposed to be established, the already heavily disturbed vegetation in the area, and the strategic mitigations provided, that negative impacts to the environment will be very minimal. Proposed mitigation for the different modules will minimize if not totally eliminate negative impacts to the surrounding environment of the project site. With the proper implementation of the different mitigation, the project is considered unlikely to pose major impacts to the environment of the project site. Benefits to the host communities in the form of a fund which will conserve and protect the rice terraces will heavily outweigh possible impacts.

10.0 Annexes

11.0 References

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AECOM

Annex

Annex 1 Laboratory Results

OSTREA MINERAL LABORATORIES, INC.
Assaying and Environmental Testing Specialist
Barangay Road, Bo. Mamplasan, Biñan, Laguna, Philippines 4024
Tels. : (02) 889-9058; (049) 539-0102; (02) 848-6951
Fax : (02) 520-9189
Email : omlione@yahoo.com / omlimarketing@yahoo.com

№ **59705**

AECOM
23rd Floor, Fort Legend Towers, 3rd Ave. corner 31st St.
Bonifacio Global City, Fort Bonifacio, Taguig City
Attention: MS. SHERYL JOY ANNE GUTIERREZ / MR. LARRY PADILLA

DATE March 24, 2011
R.A. № 57664
INVOICE №
PAGE 1 OF 2 PAGES

CERTIFICATE OF ANALYSIS

Date received : March 17, 2011
Date analyzed : March 17 – 22, 2011

	Cot. Intake	Cot. Powerhouse	Method/Technique
BOD, mg/L	2	2	Azide Modification (Dilution Technique)
TSS, mg/L	<1	<1	Gravimetric (dried at 103-105^{0}C)

**** O V E R ****

Total Samples : 2 **Total Analysis :** 8

Reference/Remarks :
Standard Methods for the Examination of Water and Wastewater, 21st ed.

Certified Correct by: LUISITA GRESILDA V. MENDOZA, PRC № 0006312
Approved Signatory: GINA B. MARITAN, Environmental Section Head
Noted by: LORNA G. SY, President

OSTREA MINERAL LABORATORIES, INC.
Assaying and Environmental Testing Specialist
Barangay Road, Bo. Mamplasan, Biñan, Laguna, Philippines 4024
Tels. : (02) 889-9058; (049) 539-0102; (02) 848-6951
Fax : (02) 520-9189
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AECOM
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Attention: MS. SHERYL JOY ANNE GUTIERREZ / MR. LARRY PADILLA

DATE March 24, 2011
R.A. № 57664
INVOICE №
PAGE 2 OF 2 PAGES

CERTIFICATE OF ANALYSIS

Date received : March 17, 2011
Date analyzed : March 17 – 22, 2011

	Cot. Intake	Cot. Powerhouse	Method/Technique
Total Coliform, MPN/100ml	54×10^2	16×10^3	Multiple Tube Fermentation
Fecal Coliform, MPN/100ml	35×10^2	92×10^2	Multiple Tube Fermentation

**** NOTHING FOLLOWS ****

The test results pertain only to the samples submitted by the customer.

Total Samples : 2 **Total Analysis :** 8

Reference/Remarks :
Standard Methods for the Examination of Water and Wastewater, 21st ed.

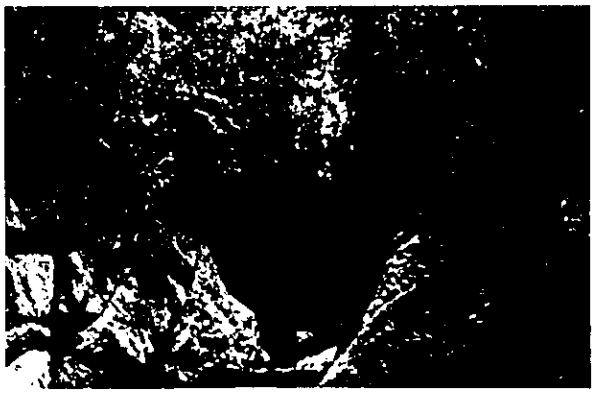
Certified Correct by: LUISITA GRESILDA V. MENDOZA, PRC № 0006312
Approved Signatory: GINA G. MARITAN, Environmental Section Head
Noted by: LORNA G. SY, President

DENR ACCREDITED
Source Emission Testing Firm
SAT № 2006-13
SAT № 2009-21-T2

DOH Accredited
Water Testing Laboratory
Accreditation № 117

Uninterrupted Total Quality Service
Since 1976

Annex 2 Photos of Observation at Weir Intake



Looking upstream at weir site

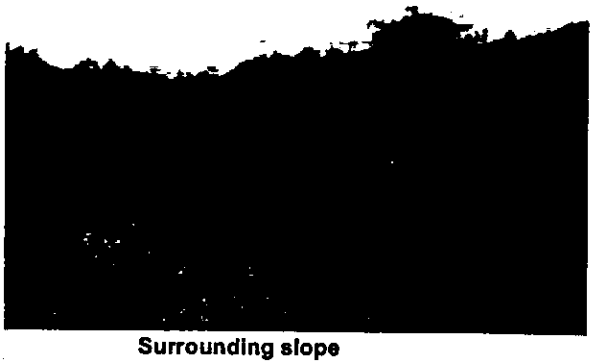
Looking upstream at weir site

Looking downstream at weir site

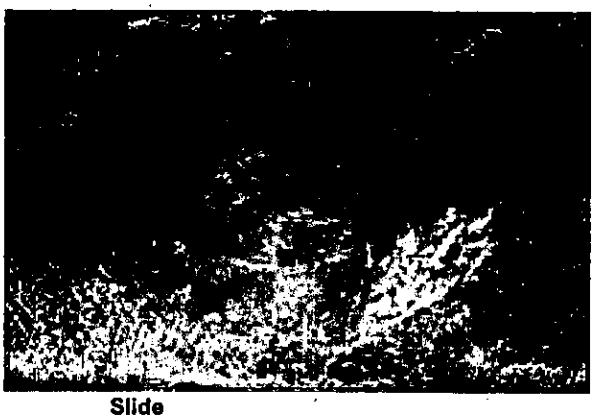
Looking downstream at weir site

Annex 3 Photos of Observation Along the River

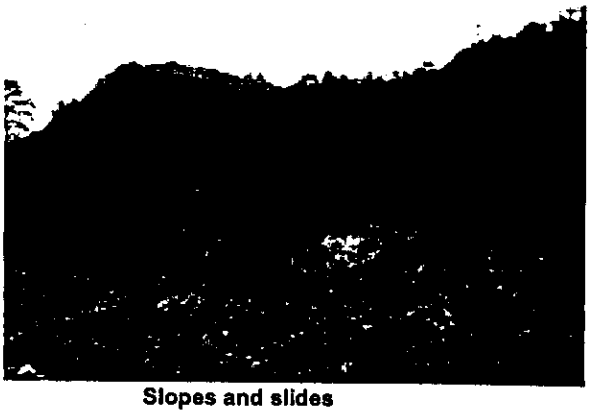
Stream flowing into Lamut River



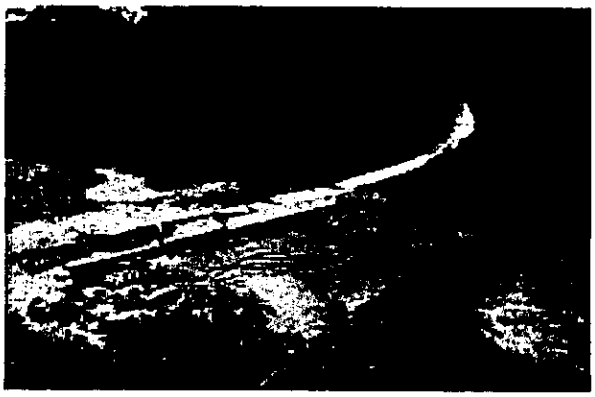
Surrounding slope



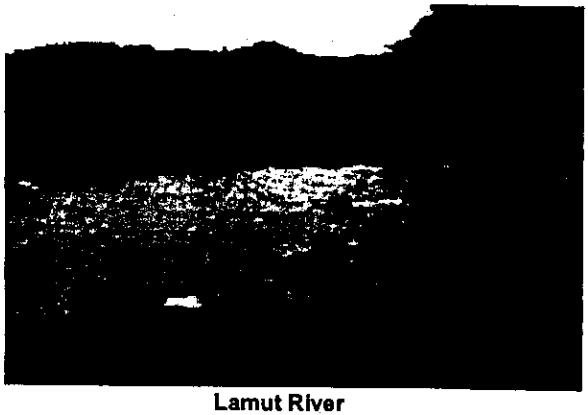
Slide



Slopes and slides



Washed out bridge



Lamut River

Annex 4 Photos of Observation in the Powerhouse

River near Powerhouse

River near powerhouse

River near powerhouse

River near powerhouse

Annex 5 Climatological Normals

NORMAL VALUES

Station Name : BAGUIO CITY, BENGUET
Period : 1981 - 2010

Latitude : 16°24'36" N
Longtitude: 120°36'00" E

Elevation: 1500 m

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	
	Rainfall		Temperature									Wind			No. Days w/	
Month	Amount	No. of	Max	Min	Mean	Dry Bulb	Wet Bulb	Dew Pt.	Vapor Pressure	Rel. Hum.	MSLP	DIR	SPD	Cloud Amount	TSTM	LTNG
	(mm)	RD	(°C)	(°C)	(°C)	(°C)	(°C)	(°C)	(mbs)	%	(MBS)	(16 pt)	(mps)	(okta)		
JAN	15.2	3	23.3	12.9	18.1	17.1	15.5	14.5	16.5	85	1011.7	SE	2	5	0	0
FEB	23.4	3	24.1	13.4	18.7	17.7	16.0	15.0	17.0	84	1011.3	SE	2	5	1	0
MAR	46.0	5	25.2	14.5	19.9	18.9	17.0	15.9	18.1	83	1010.3	SE	2	5	3	1
APR	104.1	9	25.8	15.9	20.8	20.0	18.2	17.3	19.7	84	1008.9	SE	2	5	9	4
MAY	341.1	20	25.0	16.4	20.7	19.8	18.4	17.7	20.2	88	1007.7	SE	2	6	17	12
JUN	475.8	22	24.4	16.5	20.5	19.6	18.4	17.8	20.3	89	1007.0	SE	2	7	16	12
JUL	781.9	26	23.4	16.3	19.8	19.0	18.1	17.6	20.2	92	1006.6	SE	2	7	15	10
AUG	905.0	27	22.6	16.2	19.4	18.7	17.9	17.5	20.0	93	1006.3	SE	2	7	13	7
SEP	570.9	24	23.4	16.0	19.7	18.9	17.9	17.3	19.8	91	1007.1	SE	2	7	13	7
OCT	454.3	17	23.9	15.7	19.8	19.0	17.8	17.1	19.6	89	1008.0	SE	2	6	8	6
NOV	97.4	8	24.1	15.1	19.6	18.7	17.2	16.4	18.6	86	1009.3	SE	2	5	3	2
DEC	26.2	4	23.5	13.7	18.6	17.7	16.0	15.0	17.0	84	1011.0	SE	2	5	0	0
ANNUAL	3841.4	168	24.0	15.2	19.6	18.8	17.4	16.6	18.9	87	1008.8	SE	2	6	98	61

Definition of Terms:

Climatological Normals ——— Period averages computed for a uniform and relative long period comprising at least three (3) consecutive 10-year period.

Rainfall (mm) (column 2) ——— The amount of precipitation (rain, hail, etc.) expressed in millimeters depth, of the layer of the water which has fallen.

Rainy days (RD) (column 3) ——— A rainy day is defined as a period of 24 hours beginning at 8AM to 8 AM of the next day during which 0.1 mm of rain is recorded.

Maximum Temperature (°C) (column 4) ——— The maximum temperature in °C recorded for the day, usually occurring in the early afternoon.

Minimum Temperature (°C) (column 5) ——— The minimum temperature in °C recorded for the day, usually occuring during early hours of the morning (before sunrise)

Mean Temperature (°C) (column 6) ——— Mean Temp. = Maximum + Minimum / 2

Dry Bulb Temperature (°C) (column 7) ——— It gives the air temperature in °C at the time of observation.

Wet Bulb Temperature (°C) (column 8) ——— It gives the temperature in °C that an air parcel would have if cooled adiabatically to saturation at constant pressure by evaporating water in it.

Dew Point Temperature (°C) (column 9) ——— The temperature in °C at a given pressure, to which the air must be cooled to become saturated. It is the temperature when atmospheric moisture begins to condense to liquid forming "dew" upon objects.

Vapor Pressure (mbs) (column 10) ——— Denotes the partial pressure of water vapor in atmosphere. As the water evaporates, additional water vapor is introduced into space above and pressure increases slightly as the new vapor is added. The increasing pressure is due to an increase in the partial pressure of water vapor.

Relative Humidity (column 11) ——— The ratio of the amount of water vapor actually in the air to the maximum amount the air can hold at that temperature.

Mean Sea Level Pressure (mbs) (column 12) ——— The force exerted by the weight of the atmosphere on a unit area at the mean sea level. It is also the atmospheric pressure at mean sea level.

Prevailing Winds (mps) (column 13 & 14) ——— The prevailing wind direction most frequently observed during a given period while the average wind speed in meters per second is the arithmetic average of the observed wind speed.

Cloud (oktas) (column 15) ——— The amount of cloud present in the sky, expressed in oktas of the sky cover.(Okta is the function used in denoting cloud amount and is equal to 1/8 of the whole sky.

Days with Thunderstorm (column 16a) ——— A thunderstorm day is defined as an observational day during which thunder is at station.

Annex 6 Climatological Extremes

Republic of the Philippines
Department of Sicence and Technology
Philippine Atmospheric, Geophysical and Astronomical Services Administration
Climatology and Agrometeorology Branch
CLIMATE DATA SECTION
PAGASA Science Garden Complex, Agham Road, Diliman Quezon City, Philippines
Telefax: (632)-434-2698

CLIMATOLOGICAL EXTREMES

STATION: BAGUIO CITY
YEAR: AS OF 2009

	TEMPERATURE (°C)				GREATEST DAILY RAINFALL (MM)		HIGHEST WIND (MPS)			SEA LEVEL PRESSURES (MBS)			
MONTH	HIGH	DATE	LOW	DATE	AMOUNT	DATE	SPD	DIR	DATE	HIGH	DATE	LOW	DATE
JAN	29.7	01-31-1978	6.3	01-18-1961	107.4	01-25-2006	20	SE	01-25-1975	1021.7	01-18-1959	1001.9	01-01-1950
FEB	28.7	02-10-1978	6.7	02-01-1963	58.4	02-26-2008	15	ESE	02-13-1974	1020.6	02-01-1962	1002.3	02-07-1985
MAR	30.4	03-15-1988	7.4	03-01-1963	80.6	03-27-2001	17	ESE	03-28-1996	1019.6	03-07-2006	1000.6	03-05-1999
APR	29.3	04-28-1995	10.0	04-01-1923	147.7	04-08-1967	25	SW	04-25-1976	1018.0	04-05-1998	992.4	04-21-1956
MAY	29.4	05-09-2003	7.7	05-30-1989	730.3	05-15-1980	32	ESE	05-07-2009	1014.0	05-02-1978	987.8	05-23-1976
JUNE	28.7	06-03-1991	11.8	06-20-2014	538.4	06-29-2004	35	WNW	06-26-1993	1014.0	06-27-1993	985.9	06-10-1974
JULY	27.9	07-04-1983	12.5	07-08-1925	1085.8	07-04-2001	47	SE	07-20-1974	1012.8	07-12-1979	981.0	07-04-2001
AUG	27.7	08-30-1988	12.8	08-12-1936	969.8	08-04-2008	31	S	08-07-1964	1014.0	08-18-1963	985.3	08-06-1964
SEP	28.0	09-04-1981	12.6	09-01-1990	799.8	09-27-1911	38	S	09-11-1970	1013.8	09-28-1982	988.7	09-23-1955
OCT	27.7	10-08-1980	11.3	10-26-1913	994.6	10-14-1998	41	WNW	10-27-1974	1015.8	10-26-2008	978.9	10-24-1988
NOV	28.2	11-19-1987	9.2	11-30-1989	698.7	11-05-1980	41	SE	11-04-1967	1018.2	11-30-1978	978.4	11-08-1954
DEC	28.2	12-28-1929	7.6	12-13-1991	148.8	12-04-1936	30	SSE	12-02-2004	1019.7	12-19-1994	974.1	12-14-1964
ANNUAL	30.4	03-15-1988	6.3	01-18-1961	1085.8	07-04-2001	47	SE	07-20-1974	1021.7	01-18-1959	974.1	12-14-1964
Period of Record	1909-2009				1902-2009		1950-2009			1949-2009			

PREPARED BY: CADS/CAD/PAGASA

Annex 7 Testimonial of Mr. Manuel Dulawan

A Write-up for the Mini-hydro Electric Plant to be Constructed at Sicu on the Haliap River

Asipulo was once a part of Kiangan. By virtue of R.A. 7178 signed into law by then Pres. Corazon Aquino on January 13, 1992, the nine barangays of southern Kiangan (Haliap, Pamabtuban, Nungawa, Amduntog, Antipolo, Pula, Cawayan, Nanal and Camandeg) were separated from the mother municipality to constitute the new municipality of Asipulo.

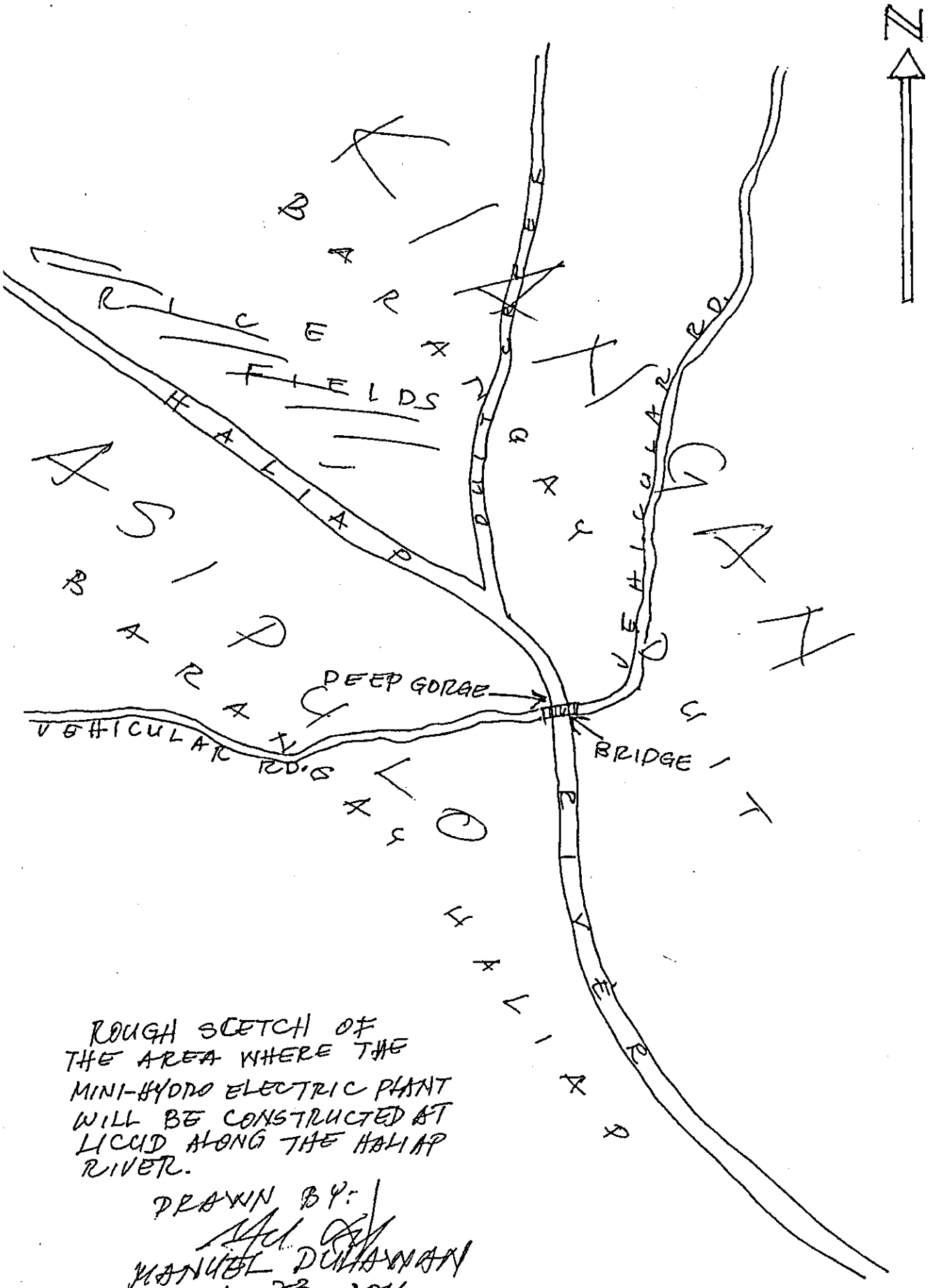
The boundary separating the two municipalities is the Haliap River stretching on a southeast-northwest direction. The Haliap River is fed by two main tributaries, the Pamhingan river from the Asipulo side and the Bagnit River from the Kiangan area. Both tributaries emanate from thickly forested watersheds adjacent to each other. These watersheds ensure sufficient water volume of the Haliap river needed by the mini-hydro electric plant even during the dry months of the year.

The site of the mini-hydro dam has to be at least 100 meters below the ~~the~~ location of the bridge. This will prevent the possible inundation of the rice fields above the bridge even when the river gets swollen

during heavy rains

As far below as a kilometer from the bridge on both sides of the banks of the river, there are no places that may pose any problem. There are no sacred places nor properties either on the Asipulo or Kiangan side that may be damaged in the course of the construction of the mini-hydro electric plant.

written by Manuel Dulawan
6-23-2011



ROUGH SCETCH OF THE AREA WHERE THE MINI-HYDRO ELECTRIC PLANT WILL BE CONSTRUCTED AT LICUD ALONG THE HALIAP RIVER.

DRAWN BY:

MANUEL DUMAMAN

6-23-2011

The Ayangan*

The Ifugao ethnic group (not tribe) is composed of two subgroups, the Ayangan and the Tuwali. The Ayangan subgroup occupies a wider area of the province of Ifugao and its members are more than that of the Tuwali.

The Ayangan occupy the whole municipalities of Aguinaldo and Hingyon and they are found in several barangays in Banaue, Lagawe, Lamut, Kiangan and Asipulo and a few places in Hingyon and Alfonso Lista. It is only in Tinoc and Hungduan where no Ayangan community is found.

What distinguish the Ayangan* and the Tuwali subgroups are: (1) the way members of each speak the Ifugao language—the Ayangan dialect has the phonemes ch, f, sh and j which sounds are not uttered in Tuwali; (2) the slight variation in the design and preference in color scheme of woven costumes; and (3) a slight difference in socioreligious rites.

At present permanent Ayangan and Tuwali Ifugao migrant communities are found in the provinces of Nueva Vizcaya, Quirino, Benguet as well as Baguio City. In Quirino the Ifugao (Ayangan and Tuwali) make up a significant number of the total population of the province. A number of barangays in the municipalities of Cabarroguis and Maddela, in fact, are inhabited wholly by Ifugao.

* Based on the book An Ethnographic Mapping of the Ifugao Ethnolinguistic Subgroups by M. Dulawan, 1996.

Annex 8 Minutes of Focus Group Discussion with Barangay Hallap and Panubtuban

Public/Stakeholder Consultation	Date	Place	Participants	Consultation Minutes
Key Informant Interview	June 23, 2011	Haliap Barangay Hall, Haliap, Asipulo	Kgd Rosemarie Doque	Topic of Discussion: i. Demographic data, sources of livelihood and household income; Sources and consumption of electricity and water; ii. Opinion on the establishment of hydro power plant; iii. Perceived Impacts on the establishment of hydro power Details: Major Sources of Livelihood and Income in the community: ▪ Farming - Major crops include rice, beans, tomato, squash, pepper - Majority of the households are into subsistence farming - Only sells excess harvest to Kiangan, Haliap and Bangbang kompradors ▪ Kaingin ▪ Poultry and Livestock - Encounters difficulty in water sourcing Average Family Income 3000PHP-7000PHP Expenses: 1. Food 2. Children's School Allowance 3. Electric Bill 4. Poultry Supplies 5. Medicine Knowledge of the Hydro electric Power Plant ▪ Use of water to generate electricity Gained support from Kgd Duque on the proposed hydro power plant Cited the positive impacts in terms of energy supply and rice field irrigation.
FGD	June 23, 2011	Haliap Barangay Hall, Haliap,	1. Kgd Basilio Fedelito	Demographic data, sources of livelihood and household income; Sources and consumption of electricity and water;

Public/Stakeholder Consultation	Date	Place	Participants	Consultation Minutes
		Asipulo	2. Basilio Bayawna 3. Christina Ngabit 4. Nancy Addab	Opinion on the establishment of hydro power plant; Perceived Impacts on the establishment of hydro power Major Sources of Livelihood and Income in the community: ▪ Farming - Major crops include beans, squash, rice, tomatoes - Subsistence farming - Sells excess produce but there are also some households who purposely farm to market their harvest ▪ Employed - Around 5% of labor force ▪ Poultry and Livestock *Government Assistance in the form of KALAHI-CIDDS (MSWDO) *Cooperative loan, but mostly help are received from neighbors Average Family Income ▪ 3000PHP-10000PHP - Income is not stable, based on harvest Peace and Order - Generally peaceful, no recorded crime - Active Males Movement against violence (on women) Main source of Water ▪ Spring - Problem arises during dry season - Likud – continuous water flow Ethnicity ▪ 90-95% are Ayangan ▪ 5% - Tuwali (intermarriage) ▪ Haliap is Ayangan's ancestral land Community Health

Public/Stakeholder Consultation	Date	Place	Participants	Consultation Minutes
				▪ Health center with midwife ▪ Common illnesses are cold and diarrhea ▪ Small budget for medical supplies and health concerns Perceived Impacts on the establishment of hydro power Gained support from the Barangay Council on the proposed hydro power plant Cited the positive impacts in terms of energy supply and reiterated that the project should push through. Based on the results of Ambangal project, the respondents perceived the project to be beneficial to the community as well. Initial concerns on flooding, but has proven otherwise. Again, based on experience on Ambangal Dam. One major concern is the proponent's interest on the "hidden treasure." Others claimed however, that could be acceptable so long as the project is set
FGD	June 23, 2011	Panubtuban Barangay Hall, Panubtuban, Asipulo	1. Brgy Captain 2. Kgd Josie 3. Brgy Treasurer 4. Brgy Secretary 5. Brgy Staff	Raised concern on the project site. Inquired on the benefits for the barangay. Also claimed that the access road will not be part of the Panubtuban. Major Sources of Livelihood and Income in the community: ▪ Farming - Major crops include beans, squash, rice, coffee, corn - Subsistence farming - Sells excess produce but there are also some households who purposely farm to market their harvest - Market to Kiangan, Lagawe, Bagabang ▪ Kaingin - To plant corn ▪ Work abroad Average Family Income ▪ 3000PHP-10000PHP - Income is not stable, based on harvest *Government Assistance in the form of KALAHI-CIDDS (MSWDO)

Public/Stakeholder Consultation	Date	Place	Participants	Consultation Minutes
				*Cooperative loan Expenses: 1. Education 2. Health 3. Water 4. Electricity 5. Medicine Peace and Order - Theft Transportation ▪ Jeepney (one trip a day), Motor Concerns Raised by the respondents: • Perceived interest of the proponents (gold) • Employment opportunities for barangay Panubtuban during construction • Health Impact • Effect on the water flow (water diversion) • Share of benefits with the host community
FGD	June 23, 2011	Haliap	Haliap Landowners	Issues and Concerns: • Effect on the flow of water for irrigation • Attention to Irrigation Source • Land Excavation • Compensation on Damages and Right of Way • Where to stock the Soil • Damages on Vegetation • During construction, increase in employment opportunities In favor of the project but Claimant and Proponent negotiation on Compensation should be clear and just.

Attendance

Focus Group Discussion: Licud Mini-Hydro Power Plant Project

June 22, 2011 ; Barangay Council Haliap

Facilitator:

Name	Designation	Signature	Fone
1). Rosemarie Dagud	Brgy. Haliap		
2). Basilio Bayaona	Haliap	Bayaona	
3) Fedelito Rendon	"		09262709(
4. Christina Ngalbit	Haliap	Ngalbit	0926989164

Landowners Consultation (June 23, 2011)

Name	Signature	Contact #
1. Constancio Catama		09265656922
2. CHRISTOPHER Catama		09262866460
3. CALIXTO CATAMA		09069711899
4. Rogelio Catama		09269163028
5. Pablo Bittuwon		
6. Joseph Otana		09066047428

June 29, 2011

Lot owner

1. Estelito Pajica

Attendance

Name	Position	Signature	Contact
1) Donato Khablinan	Brgy Kagawad		0905821
2) Mary Lah. ao T.	brgy. Treasurer		
3) Josephine n. Bital	Brgy Kagawad		0911685
4) Oscar D. Lacs-o	" Capt.		
5) Feliza K. Pahgod	Brgy. Secretary		0906455

Attendance

Focus Group Discussion: Licud Mini-Hydro Power Plant Project

June 22, 201_ ; Barangay Council Haliap

Facilitator:

Name	Designation	Signature	Favor
1. Rosemarie Dagud	Brgy. Hslap		
2. Basilio Bayaona	Haliap	Bayaona	
Fedelito Reindos	"		09262709077
Christina Ngalbit	Haliap		09269891698

Lotowners Consultation (June 23, 2011)

Name	Signature	Contact #
1. Constancio Catama		09265656922
2. CHRISTOPHER Catama		09262866460
3. CALIXTO CATAMA		09069711899
4. Rogelio catama		09269163028
5. Pablo Bittuwon		
6. Joseph Otero		09066047435

June 29, 2011

Lot owner

1. Eduardo Padjic

Annex 9 Land Compensation Procedures for Ambangal Mini-Hydro Power Plant

Land Acquisition Process for the e8 Ambangal mini-hydro power project

1. The Provincial Government of Ifugao (the PGI, the proponent) together with DENR staff and the Provincial Engineering Office staff identified the potential affected area based on the result of topographic survey.

2. The PGI and the affected landowners went through along the proposed headrace and penstock for verifying. The PGI made the inventory list.

3. The PGI and the affected land owners took Memorandum of Agreement (MOA) for the land compensation.

4. Payment of the land area shall be made on cash basis before actual implementation of the project. Price of the land shall be based on the following table.

Land Classification	Agreed Price
Muyung (Forest)	Php 30.00
Rice field = idle	Php 60.00
Rice filed = cultivated	Php 75.00
Coffee Plantation	Php 30.00
Corn Plantation	Php 30.00

5. Payment of damaged trees, plants and other vegetation by reason of project implementation which shall be given on cash basis after construction based on actual damaged to be determined after the post inventory report to be conducted in the presence of the landowners. Price of vegetation shall be determined by the price quotation as follows.

(A) Forest Trees:

Common Name of Existing Vegetation	Price per tree (per board foot)
1) Dogwe, 2) Laglabong, 3) Alimit, 4) Binwa, 5) Kakawate, and 6) Madre de Cacao	Php 5.00
1) Tagisang Bayawak, 2) Dapadap, 3) Anattap, 4) Calcalpo, 5) Tuwol, 6) Anonang, 7) Saraisa, 8) Balanti, 9) Bunot, 10) Kurdodannum, 11) Upla, 12) Baccuwog, 13) Tagacalo, 14) Alagge, 15) Ilhit, 16) Hupok, 17) Pau,	Php 10.00

18) Tupngag, 19) Bini, 20) Ludping(Lubting), 21) Hanung, 22) Ppole, 23) Analdong, 24) Polallay, 25) Latbang, 26) Kalabakab, 27) Ipil0pil, 28) Takang, and 29) Dulnuan	
1) G-melino, 2) Acacia, 3) Bakan, 4) Paguringaon(Aliguyon), 5) Dalakan, 6) Halong, and 7) Mahogany	Php 15.00
1) Narra, 2) Kultib, 3) Tabak, 4) Putukan, 5) Pakak and 6) Banolan	Php 20.00

(B) Fruit Bearing Trees:

Name of Fruit Bearing Trees	Yield/Tree	Unit Cost
1) Excetsa Coffee		Php 100.00 /tree
2) Robusta Coffee		Php 100.00 /tree
3) Santol	150 pcs. Or 25 kgs / tree per year	Php 10.00 /tree
4) Betel Nut	Half can / tree per year	Php 300.00 / can
5) Avocado	150 pcs. or 38kgs / tree per year	Php 10.00 / kg
6) Lychee	7 kgs / tree per year	Php 35.00 / kg
7) Banana	7 bunches / tree per season	Php 24.00 /bunch
8) Cacao	20 pcs. / tree per year	Php 50.00 / pc.
9) Pomelo	80 pcs. / tree per season	Php 4.00 / pc.
10) Coconut		Php 300.00 / tree
11) Rattan	20kgs / vine	Php 20.00 / kg.
12) Papaya	20 fruits or 32 kgs / tree	Php 10.00 / kg.
13) Rambutan	7 kgs / tree	Php 35.00 / kg.
14) Chesa	50 pcs. Or 10 kgs / tree	Php 10.00 / kg.
15) Gayunan	80 pcs. Or 16 kgs / tree	Php 12.00 / kg

6. Immediate restoration of damages to rice and corn plantations

   If immediate restoration is not possible, compensation shall be paid by the PGI which will be based on the actual produce per season. The basis for the computation for rice plantations shall be sixty five (65) cavans per hectare for the first cropping and forty five (45) cavans for the second cropping computed at twenty five (25) kilograms palay per canvan at Ten Pesos (Php 10.00) per kilogram and 0.35 kilogram per square meter at Five Pesos (Php 5.00) per kilogram for corm plantation.

(A) Rice.....yield/harvest

Average yield/harvest:

1st cropping= 65 cavans / hectare @ 25kgs/cavan@Php10.00/kg

2nd cropping= 45 cavans / hectare @ 25kgs/cavan@Php10.00/kg

(B) Corn.....yield/harvest

0.35 kg/m2 @ Php 5.00 / kg

Annex 10 Project Environmental Monitoring and Audit Prioritization Scheme questionnaire

ANNEX 2-7d

PROJECT ENVIRONMENTAL MONITORING AND AUDIT PRIORITIZATION SCHEME (PEMAPS) QUESTIONNAIRE

Project Name	:	**810kW Likud MiniHydropower Plant Project**
Project Location	:	**Sitio Likud, Barangay Haliap, Asipulo, Ifugao**
ECC Reference No.	:	
Proponent	:	**Tokyo Electric Power Service Co., Ltd.**
Pollution Control Officer	:	
Tel. No./Fax No./Email	:	
Project Type	:	**Hydro Power Project (Renewable Energy)**
Project Status	:	

I. PROJECT CONSIDERATIONS

Size and Type

Size based on number of employees

Specify number of employees:	200 workers during construction and 6-7 employees during operation

Type

ECP (in either ECA or Non-ECA)	
Non-ECP but in ECA	
Non-ECP and Non-ECA	✓

Waste Generation and Management

Enumerate Waste Type and Specify Quantity of Wastes generated in your facility. (Identify /Enumerate)

Category	Waste	Type		Quantity (Mt/yr)
		Hazardous	Non-Hazardous	
Air	Emissions[1]		TSP	Quantities were not estimated
			PM_{10}	
			NO_x	
			SO_x	
Liquid	Effluent[2]			
Solid	Domestic Waste[3]			

Pollution Control System (PCS)
Enumerate PCS or Waste Management Method Used in your facility.
(Identify /Enumerate)

Category	PCS/Waste Management Method Used	Remarks
Air	Main source of emissions are the mobile vehicles to be used onsite; proper maintenance will be employed periodically	RA 8749
Liquid	Conventional Sewage Treatment Plant	DAO 35 effluent requirements
Solid	Segregation will be employed (biodegradable, residual, hazardous, recyclable); Disposal through DENR accredited haulers	RA 9003 and RA 6969 requirements

II. PATHWAYS

Prevailing wind towards barrio or city? (mark the corresponding point) Yes ____ No ✓

Rainfall (impacts surface & groundwater pathways)

Average annual net rainfall:

Specify amount: 905 mm to 1085.8 mm

Maximum 24-hour rainfall:

Specify amount: 11 mm

Terrain (select one and mark) Flat ___ Steep ✓

Is the facility located in a flood-prone area? (select one and mark) Yes ✓ No ____

Ground Water

Depth of groundwater table (meter)	(select one and mark)
0 to less than 3	
3 to 10	✓
Greater than 10	

III. RECEIVING MEDIA/RECEPTORS

Air (Distance to nearest community)	(select one and mark)
0 to less than 0.5 km	
0.5 to 1 km	
Greater than 1 km	✓

Receiving Surface Water Body -- Lamut River (Freshwater)

Distance to receiving surface water:	(select one and mark)
0 to less than 0.5 km	
0.5 to 1 km	
Greater than 1 km	✓

Size of population using receiving surface water

Specify number: _____

Fresh Water

Classification of fresh water (select one and mark)

AA	
A	
B	
C	✓
D	

Size of fresh water body

Specify size: W = 17.7
L = 1.7kms
(within the
project area)

Economic value of water use (may select more than one of the criteria below)

Drinking	
Domestic	
Recreational	✓
Fishery	✓
Industrial	✓
Agricultural	✓

Salt water

Classification of salt water (select one and mark)

SA	
SB	
SC	
SD	

Economic value of water use (may select more than one of the criteria below)

Fishery	
Tourist zone or park	
Recreational	
Industrial	

Ground Water

Distance to nearest recharge area (select one and mark)

0 to less than 0.5 km	
0.5 to 1 km	
Greater than 1 km	

Distance to nearest well used (select one and mark)

0 to less than 0.5 km	
0.5 to 1 km	
Greater than 1 km	

Groundwater use within the nearest well (may select more than one of the criteria below)

Drinking	
Industrial	
Agricultural	

Land

Indicate current/actual land uses within 0.5 km radius: (may select more than one of the criteria below)

Residential	✓
Commercial/Institutional	
Industrial	✓
Agricultural/Recreational	✓
Protected Area	

Potential/proposed land uses within 0.5 km (may select more than one of the criteria below)

Residential	
Commercial/Institutional	
Industrial	✓
Agricultural/Recreational	✓
Protected Area	

Number of affected Environmentally Critical Areas within 1 km:

Specify number: 0

Distance to nearest ECA (select one and mark)

0 to less than 0.5km	
0.5 to 1 km	
Greater than 1 km	✓

IV. ENVIRONMENTAL PERFORMANCE

Compliance (pls. take note that this will be double-checked with PCD files)

Law	Violation (check if any)	Type (pls. specify number of times committed) STANDARD				Type of Admin Violation	Additional Remarks/Status of Compliance
		Emission/Effluent/ Discharge	Ambient	Human Impact	Admin/ ECC		
RA 8749	NA						
RA 9275	NA						
RA 6969	NA						
PD 1586	NA						
RA 9003	NA						

Number of Valid Complaints

Citizen and NGOs

Specify number:

Others (other Govt. Agencies, Private Institutions)
Specify number:

(To be filled up by EMB Personnel)
RECOMMENDATION/S:

_____
_____
_____

Assessed By: _____

Noted By: _____

Annex 11 IEE Checklist

810kW Likud Mini-hydropower Development Project

Initial Environmental Examination Checklist

810kW Likud Mini-hydropower Development Project

Initial Environmental Examination Checklist

Prepared by

AECOM Philippines Consultants Corporation
23/F Fort Legend Towers, 3rd Avenue Corner 31st Street,, Bonifacio Global City,, Fort Bonifacio,Taguig City, Philippines 1634
T +63 2 478 3266 F +63 2 478 3270 www.aecom.com

4 August 2011

Table of Contents

1.0 GENERAL INFORMATION

1.1 Project Name/Title:

810kW Likud Mini- Hydropower Development Project

1.2 Proponent/Company:

The Provincial Government of Ifugao
Provincial Capitol
Lagawe, Ifugao

1.3 Project Location:

Barangay Haliap, Asipulo, Ifugao

1.4 Scheme of Hydro Development :

[√] Run-of-water Scheme ☐ Storage Scheme

1.5 Project Objective/s

Ifugao Province is well known for its extensive rice terraces. In 1995, UNESCO had included the Cordillera rice terrace in their World Heritage List of Cultural Landscapes. However, in 2001, UNESCO included them on the List of World Heritage in Danger because of its continuous deterioration primarily due to the decline of the traditional balance as a result of out-migration, slow but continuous disappearance of the old culture and leadership, and indiscriminate deforestration. In addition, there is no effective and comprehensive rice terraces conservation plan.

This project is primarily being developed to create funds from the sales of electricity that will be generated. These funds will be used in the rehabilitation programs, conservation projects for the rice terraces in Ifugao Province. It also envisioned that the funds generated will help in improving the quality of lives of the people engaged in terrace farming and removal of the Rice Terrace from the List of the UNESCO World Heritage in Danger.

1.6 Project Ownership:

Type of Owner(s): ■ Single Proprietorship ☐ Corporation

☐ Partnership/Joint Venture ☐ Cooperative

☐ Others, pls. Specify: Local Government Unit

1.7 List of Owners (in case of partnership/corporation) : N/A

1.8 Project Cost:

Total Project Cost: PhP120, 300,000.00

2.0 PROJECT AREA DESCRIPTION

2.1 Project Area Coverage:

Watershed area (ha):

Above weir/ intake: 43.31 ha
Total watershed area of river: 4538.1899

Area of project sites (m2 or ha): 4538.1899

Total area: 94.111ha
Structures: 28.381ha
- Intake Weir: 60m^2
- Settling Basin: 47.95m^2
- Headrace: 2,250m^2
- Head-tank: 46.02m^2
- Powerhouse: 44.45m^2

Others, please specify:
- Tailrace: 20.13m^2

See **Annex 2 Design of the project structures**

2.2 General Water Appropriation:

[ ] Domestic [ ] Municipal [√] Irrigation [ ] Power Generation

[√] Fisheries [ ] Livestock [ ] Industrial [ ] Recreational

[ ] Others, pls. specify: _____

2.3 General Land Classification of project areas:

[√] Public Land (ha): 4538ha
[ ] A (applicable), (ha): ___ [√] D (disposable), (ha) : 165ha

2.4 Present Land Use Classification

[√] Agriculture [ ] Residential [ ] Tourism
[ ] Industrial [ ] Forest Land [ ] Institutional
[ ] Commercial [ ] Open Spaces
[ ] Others, pls. Specify:

3.0 PROJECT COMPONENTS

3.1 Relevant Dimensions

Plant Capacity	kW	810
Max. Plant Discharge	m3/s	2
Min Plant Discharge	m3/s	0.4
Max. Headwater Level	m.a.s.l	601,750 (flood)
Min. Operating Headwater Level	m.a.s.l	600,000
Tailrace Water Level	m.a.s.l	541,000
Estimated Net Head	m.a.s.l	59.000
Total Storage Volume	M3	

3.2 Structures and Buildings

3.2.1 Description

Weir	Floating type with stop log for flushing	60	20	3
Intake Settling and Basin	Side intake type	47.95	13.7	3.5
Headrace	Open channel	2,250	1,875	1.2
Head tank		46.02	11.8	3.9
Penstock	Steel pipe (diameter 5cm)		118.5	
Powerhouse	Grand type	44.45	12.7	3.5
Tailrace	Open channel	20.13	6.1	3.3
Turbine and Generator	Inline Francis type turbine; induction type generator			
Switchyard	Outdoor	40.05	4.5	8.9

3.2.2 Access

Weir	Trail	170m			
Headrace	Trail	260m			
Surge Tank	Trail	1414m			
Penstock	Trail	1444m			
Powerhouse	Trail	1460m			
Other structures, pls. specify					

3.3 Transmission Line

Location of next Substation/Tapping Point	Voltage [V]	Length [km]	Right-of-way [m]
From powerhouse to existing IFELCO distribution line No. 24	13.2	1	n/a
From existing IFELCO distribution line No. 24 to Kiangan Tapping Point	13.2	5.46	n/a

3.4 Resource Requirements

Water Demand:

	Maximum	**2.0 m3/s**
	Minimum	0.4 m^3/s
		2 litter/ha
		0.136 m^3/s

3.5 Water Treatment and Sewage Disposal

Is water used for other purpose than energy generation?
[ ] No [√] Yes, pls. specify: agricultural

If yes, is there provision for water treatment?
[ ] No [ ] Yes, pls. describe: _____
[√] N/A

If sewage disposal is required, what system is used?
[√] Individual Septic Tank [ ] communal Septic Tank
[ ] N/A

3.6 Handling and Disposal of Dangerous Substances

What kind of dangerous substances (e.g. oil, lubricants, chemicals; pls. Specify) are used during:

- Pre)Construction Phase:
  None; No use of machineries,
  Very small fuel oil for vehicles;
  Very small Paints and Thinners

- Operation/Maintenance Phase:
  None; Oil-less facilities will be used

Is an oil water separator installed?

[√] No [ ] Yes, Location: _____

What oil/Lubricants Collection and Disposal System are used?

Collection System: Volume of storage containers(l):
Storage Location:

Disposal System:

[ ] Recycled [ ] Sold to Re-cyclers
[ ] Others, pls. Specify: _____

3.7 Solid Waste Disposal System

Collection System:

[ ] Association/project-maintained garbage collection system
[√] integrated into municipal garbage collection system
[ ] Others, pls. Specify: _____

Disposal System :
[ ] Burning at open dumpsite [ ] Open dumpsite in project site
[ ] Sludge cleaning [√] Municipality/City landfill site
[ ] Others, pls. Specify: _____

Location of waste disposal site:
_____

3.8 Manpower and Employment

How many people will be employed by the proposed Mini Hydro Power Plant during:

- (Pre)Construction Phase: 200
- Operation and Maintenance Phase: 7

3.9 Project Schedule

3.10 Pictures of Project sites

See **Annex a.** Photo documentation

4.0 BASELINE ENVIRONEMTAL CONDITIONS

4.1 Natural and Physical Environment

River characteristics (length of river between intake and tailrace, slope, waterfall, typical flow depths), pls. describe and attach maps/photographs:

Weir Site

Access to the weir site is by foot, either through a 150 m trail from an existing concrete bridge or through another paved trail about 100 m long. Both trails are rarely travelled. The project site is at elevation 633 m from sea level with limestone rock outcrops at both sides of the riverbanks. Sheer vertical cliffs are at both sides, with moss and some small plants and trees that appear to be remnants of the original forest cover. The river at the weir site is about 8m wide with water flowing at a depth of about 500 mm. Locals describe flooding to occur after about two full days of continuous rain at the upstream part of the river and surrounding mountains. Floods usually makes the water level at the site rise to about 1 to 1.5 m high and also making the river flow wider to about 12 m. A flash flood was reported to have occurred in the past due to a dike collapse upstream of the project site after a fairly long downpour. Flow along the river was reported to have risen to about 3 to 4 m high (**Annex a**).

Along the River

An irrigation weir was observed at about 50m from the proposed weir site. This was reported to have been constructed about 20 years ago to serve small rice paddies and vegetable orchards along the river. Access to the irrigation weir is through an existing paved footpath at the left side of the bank facing the downstream direction. There were signs of "kaingin" at some slopes not far from the river. Small slides and erosion have also been observed (**Annex b**).

During the site visit, water levels at different river crossings were just above the knees (500-600 mm) with small boulders lining the river bed. There are four streams / gulleys that flow into the river along the stretch of the project area, some of which are also being used for irrigation. Three of these streams are on the left side of the river when facing the downstream direction and one is on the other side of the river. These streams have well vegetated slopes. A washed-out concrete overflow crossing was also seen along the river. This structure reportedly collapsed during the onslaught of Ondoy – Pepeng storms.

Length of river: 1.7kms

Flood characteristics of the river:

[Years]	[m^3/s]
2	165.85
5	367.45
10	508.36
25	698.55
50	840.33
100	978.53

Are there areas in the site where indication of soil erosion occur?
[ ] No
[√] Yes, pls. specify and/or attach pictures: See **Annex b**.

If yes, what causes the erosion? Pls. specify:
Kaingin, loose top soil.

Have any landslide occurred or still are occurring in the project area?
[ ] No
[√] Yes, pls. Specify and/or attach picture: See **Annex b.**

What are the present uses of water bodies (ground water surface water) in the watershed of the proposed project area?

[ ] Washing [ ] Recreation (swimming, boating. Etc.)
[ ] Source of drinking water (body/ location / demand [l/s]):

Sanitation (body/location / demand [l/s]):
None

[√] Irrigation (body/location / demand [l/s]): Agricultural land adjacent to river banks.
[ ] Fishing(body/location / demand [l/s]):
[ ] Others, pls. Specify:

What is the present land use of the project wherein the structures and buildings of the proposed mini hydro power plant will be located?

	[m2]or[ha]	*Categories see below*
Weir/Intake		Others (forest)
Headrace		Agricultural / Others (forest)
Surge Tank		Agricultural / Others (forest)
Forebay		Agricultural / Others (forest)
Penstock		Agricultural / Others (forest)
Powerhouse		Agricultural / Others (forest)
Tailrace		River
Switchyard		
Others, pls. specify		

Categories:
(1) Prime agricultural land (productive/irrigated); (2) Prime agricultural land (idle/abandoned);
(3) Grassland; (4) Build-up; (5) Orchard; (6) Marshal/Mangrove; (7) Fishpond;
(8) Others (pls. Specify)

Was the present water quality in the river assessed?

[ ] No
[√] Yes, pls. Insert results in table:

pH			8.5	8.4
Total Suspended Solids	ppm		<1	<1
Total Coliform	MPN/100ml		5400	16000
Oil and Grease	Mg/l Temp (Celsius)		20.1	21.9
Chlorides	Mg/l DO (mg/L)		8.1	7.9
Copper	Ppm BOC (mg/L)		2	2
Lead	Ppm			

Iron	Ppm Fecaliform (mpn/100ml)		3500	9200
Manganese	Ppm			
Total Hardness	Mg /l			
Alkalinity	Mg/l as CaCo3			
Pesticides, pls. Specify:				

Pls. Describe methods and locations of sampling and attach chemical attests:

The water quality sampling was conducted in March 2011. Two stations were established in the areas that could possibly be affected by the project. Samples were collected along the upstream and downstream of Lamut River, covering the intake area and powerhouse of the proposed project site, respectively. **Table 4-1**describes each water quality stations. See **Annex c** for illustration of locations.

Table 4.1 Water Quality Stations

Station ID	Name of Water Body	Location of Water Body	Description of Station	Coordinates	Elevation
Intake	Upstream of Lamut River (*local name: Itum River*)	Sitio Lower Haliap, Brgy. Haliap, Asipulo	Station is located at the proposed intake area and downstream of Itum Bridge. This station is also downstream of the Lamut River and an unknown river confluence.	16°44'24.5" N 121°05'30.5" E	631 m
Powerhouse	Downstream of Lamut River (*local name: Guihinon River*)	Sitio Guihinon, Brgy. Makppit, Kiangan	Station is located at the proposed powerhouse, in-between Barangays Makppit and Panubtuban. It is downstream of Lamut River and its confluence with an unnamed river.	16°43'48.1" N 121°06'36.0" E	541 m

4.2 Biological Environment

Are there flora and/or fauna of ecological or commercial significance to be found in the water bodies near within the project area that might be affected by the proposed project?

[√] No, pls. discuss probable reasons:

Based on the rapid site assessment, four vegetation communities within and along the immediate surroundings of the project site were identified. These are agricultural land (planted mainly to rice, winged beans, and sweet potato), shrubland/grassland (dominated by various species of grass and woody shrubs), tree plantation (planted to Gmelina), and patches of forest (secondary growth and original vegetation restricted to the very steep portions of the river stretch). More than 90% of the river stretch (about 10 m from both sides of the banks) is heavily disturbed as represented by the agricultural land, shrubland/grassland, and tree plantation. The remaining forest patches were most likely untouched either because of their very steep location and/or stunted structure rendering them without economic value. A general assessment was conducted to determine the suitability of these vegetation communities as a potential habitat for wildlife species.

A total of 12 bird species dominated by the yellow-vented bulbul (*Pycnonotus goiavier*), chestnut munia (*Lonchura malacca*), and Pacific swallow (*Hirundo tahitica*) were observed and confirmed present along the entire stretch of project site. Except for the white-eared brown-dove (*Phapitreron leucotis*), Philippine bulbul (*Hypsipetes philippensis*), and Philippine coucal (*Centropus viridis*), all recorded species are resident breeding but are non-endemic. None are considered under any threat categories based on PWRC Act of 2001 and IUCN Red List of Threatened Species 2010

[ ] Yes, pls. specify (water body/location/species/significance of the population):

What methods and data sources were used to assess the flora and fauna in the water bodies? Pls. describe and/or attach documents:

A rapid site assessment was undertaken to have a general picture of the vegetation and wildlife assemblage that will potentially be affected by the project. Methodology included walk-through survey, photo-documentation and interview of locals encountered during the site visit. Conservation status of each identified plant and wildlife species were determined from DENR Administrative Order (DAO) 2007-01 known as the "National List of Threatened Philippine Plants and their Categories, and the List of Other Wildlife Species" and International Union for Conservation Nature (IUCN). The IUCN's Red List of Threatened Species was also referred to since it provides the global assessment of the conservation status.

Is there flora and/or fauna of ecological or commercial significance to be found outside the water bodies near within the project area that might be affected by the proposed project?

[√] No. A similar type of vegetation (mixed of secondary forest and orchard) is found outside the project jurisdiction, however, no vegetation will be affected by the hydropower plant. For the fauna, these will be temporarily disturbed and would be displaced during the construction stage due to increased activity in the area. Once construction is finished, the displaced wildlife will slowly turn up in the area.

[ ] Yes, pls. specify (location/location/significance):

4.3 Socio-Cultural, Economic and Political Environment

Are there existing settlements in the watershed area of the proposed project?
[√] No
[ ] Yes, pls. specify(location/number of households. families and population):

What methods and data sources were used to gain information on the existing settlements? Pls. describe and/or attach documents:

Occular Survey
Data Source: Community- Based Monitoring System
Methods Used: Key Informant Interviews and Focus Group Discussion (landowners, barangay council, community organization heads)

What social infrastructures are located in or near the project area? Pls. describe.

School(s)	1 Elementary School and 1 High School in Barangay Haliap	181 (elementary) 104 (high school)	Yes

Health Center(s)/Clinic(s)	1 Rural Health Unit in Nanduntog, Antipolo 1 Barangay Health Station (Haliap)	1 doctor 1 nurse 1 sanitary inspector 7 permanent 4 casual public health midwives.	Yes
Hospital(s)	Ifugao Provincial Hospital		
Others, pls. specify			

Is the political situation (peace and order) stable in the near the project area?

[√] Yes
[ ] No, pls. describe:

What are the major employment and income sources in and around the project area?

Farming	77%
Fishing	.5%
Backyard poultry and piggery	
Vending/Buy and Sell	3.6%
Sari-sari store	
Others, pls. specify:Real Estate, Education, Community and Social activities, etc.	18.9%

Are there existing local non-governmental organizations in or around the project area?

[ ] No
[√] Yes, pls. identify:

a. Irrigator's association
b. Women's association
c. Cooperative
d. Senior Citizen's Club

Social acceptability of the project assessed(community, government, non-governmental organizations)?

[ ] No
[√] Yes, pls. describe and/ or attach documents:

Focus group discussions/ key informant interviews in the affected barangay of Haliap, indicate general acceptance of the project. Kindly refer to Annex 8 of IEE report for minutes of the meeting and attendance sheets.

5.0 IMPACT ASSESSMENT / MITIGATION MEASURES

5.1 Project Location and Design

Loss of species due to obstructions to movement of aquatic life	Height of the weir(m):3m	[√] none [ ] low [ ] moderate [ ] high	[x] No mitigation measure [ ] Fish way or by-pass planned. Pls. Describe design and arrangement of the proposed mitigation facility and attach plans: [ ] Further measures, pls. specify.	
Fish injuries due to passing through turbine or across sharp edged weir	Width of openings of screen or rack at intake (mm) : 1.6mm Design of weir spillway (Intake weir is over-flow type on the weir crest because it is utilized for the existing irrigation weir).	[√] none [ ] low [ ] moderate [ ] high	[√] No mitigation measure: No project structure will be constructed within the river channel [ ] Planned measures, pls. Specify:	
Dying out of the riverbed between the intake and the outlet	Minimum residual flow with proposed project: -In m3/s or l/s: ___ In % of mean annual flow without proposed project: ___	[√] none [ ] low [ ] moderate [ ] high	How is the residual flow provided? [ ] With a residual flow section in the weir [ ] By-pass pipeline [ ] Other, pls. Specify [ ] Other measures, pls. specify:	
Downstream Erosion due to reduction or inhibition of bed load transport	Design and arrangement of the weir and the intake	[√] none [ ] low [ ] moderate [ ] high	Design and arrangement of the weir and the intake? Pls. Attach drawing or plan: Project Component Main Section	
Sludge alluvial deposits, increased growth of algae, Reduction of capacity for self-cleaning of the water due to the transformation of a stream into an impoundment	Tot. storage volume (m3): 0 Tot. surface area of the impoundment (m2): 0	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure [ ] Planned measures, pls. Specify:	

Impairment on aesthetics or cultural heritage due to protruding structures	Architecture, size and construction materials of buildings and structures:	[√] none [ ] low [ ] moderate [ ] high	Architecture, size and construction materials of major buildings? Pls. describe and attach plans:	
Erosion due to building of roads and/or structures on steep slopes	Maximum slope at construction site (%, N/A if tunnel): -Weir and intake structure: ___ -Headrace____ -Surge tank/Forebay:____ -Penstock:____ -Powerhouse:____ -Tailrace:___ -Others, pls. Specify: _____ _____ ____	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure [ ] Slope stabilization with methods of bio-engineering, pls. Specify : [x] Other slope stabilization measures, pls. Specify [ ] Other measures, pls. Specify: Refer to IEE Report	
Construction Phase				
Construction work in sensitive environment	Estimated duration of noisy and dust provoking activities during construction at all major project sites (days or months)? Estimated duration and volume of major transport traffic to construction sites (days and trucks per day)? Kind and number of machinery used at major construction sites? Truck	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure [ ] General guidelines for construction work (safety, health, and environment). Pls. Attach guidelines and implementing procedures. [ ] Restricting of hours during which the offending activities are carried out. Pls. Specify: [ ] Use of blast mats [ ] Maintenance of equipment exhaust system [ ] Removing and disposal of trees and any vegetation pushed or felled into watercourses [ ] Inhibition of illegal settlement and housing of wild animals as well as logging around the construction work [ ] Introduction of speed limits on access roads [ ] Other measures, pls. Specify:	TEPSCO, Provincial Government of Ifugao and Contractor
Contamination of soil and water due	Storage, handling and disposal of	[ ] none [√] low	[√] following of the regulation of RA 6969	

to spilling of dangerous substances (fuel, oil, lubricants, chemicals)	dangerous substances	[ ] moderate [ ] high	[√] Other measures, pls. Specify: Regular maintenance of construction heavy equipment will be observed.	
Loss of habitat due to excavation work in watercourses	Volume of excavation in or at watercourses (m3): 10,190m^3; there will be no excavation of existing watercourses.	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure. [ ] Erosion control measures with methods of bio-engineering, pls. Specify: [ ] Other erosion control measures, pls. Specify: [ ] Protection measures for fish populations, pls. Specify: [ ] Other measures, pls. Specify:	
Erosion and sedimentation due to disposal of spoil from excavation work	Estimated volumes of spoil from excavation work at construction sites (m3): 5,382m^3	[ ] none [√] low [ ] moderate [ ] high	[ ] No mitigation measure [ ] Disposal of spoil from excavation works at dedicated spoil and stockpile location, pls. Specify location(s): [ ] Related measures (drainage, re-vegetation)at stockpile location, pls. Specify: [√] Other measures, pls. Specify. Disposal site will be identified. Excavated spoils may be used as fill materials and may be given out free to interested individuals.	
Operation and Maintenance				
Obstruction to movement of aquatic life due to insufficient functionality of the migration facility	Functionality of mitigation facilities	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure [ ] Frequent maintenance of fishway or by-pass, pls. Describe measures: [ ] Other measures, pls. Specify:	
Loss of aquatic life due to surges as a consequence of	Estimated maximum variation of downstream	[√] none [ ] low [ ]	[ ] No mitigation measure [ ] operation guidelines	

intermittent operation of the hydro scheme	discharge (m3/s) during normal plant operation within a period of 5 Minutes: ____ 10 Minutes:___ 60 Minutes:___	moderate [ ] high	to limit surges, pls. describe: [ ] Other measures, pls. specify:	
Loss of aquatic life due to flushing of the impoundment	Volume of life storage, that will be maintained during plant operation phase (m3/s):____	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure [ ] Flushing during natural floods [ ] Provision and Implementation of flushing guidelines, pls. specify or attach flushing guidelines: If flushing during natural floods is not successful, what other strategies are planned to maintain the live storage? [ ] Dredging [ ] Flushing outside natural floods [ ] Others, pls. specify:	
Accumulation of floating debris at the intake	Design of intake	[ ] none [√] low [ ] moderate [ ] high	[ ] No mitigation measure [√] Measures to reduce or avoid accumulations of floating debris at the intake, pls. describe: Regular cleaning of the settling pond will be conducted to prevent siltation and to remove large organic debris before any incipient decomposition occurs.	
Loss of habitats due to de-watering of basins and channels during revision and maintenance work		[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure [ ] Relocation of fish population prior to de-watering of basins and channels [ ] Other measures, pls. specify:	
Abandonment and Rehabilitation Phase				
Contamination of soil and water due to abandoned equipment	Abandonment of plant facilities including all equipment	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure [ ] Abandonment plan including cost	

	(machinery, electro-mechanical equipment)		estimate, pls. describe and attach plan: [ ] Other measures, pls. specify:	
Flooding due to blocking of abandoned dam or weir				

5.2 Risk Assessment

Downstream flooding due to failure of the dam or weir	Dam or weir stability	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure necessary [ ] Monitoring of dam or weir stability; pls. include monitoring plan (refer to paragraph 6.3.) [ ] Other measures, pls. specify:	
Upstream flooding due to high head water level	Maximum flood water level in impoundment if sluice gate is blocked (m.a.s.l.): ——	[√] none [ ] low [ ] moderate [ ] high	[ ] No mitigation measure necessary [ ] Restricting activities near impoundment, pls. specify: [ ] Other measures, pls. specify:	

6.0 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

6.1 Environmental Management and Protection Plan

Watershed Management and Protection	The community and the entire Ifugao practice a communal forest system called *muyong*. This system somehow effectively controlled swidden (*kaingin*) farming, which largely the cause of forest degradation in the Cordillera region. Integration of this practice in the watershed management and protection plan will assure the preservation of the forest. A detailed watershed management plan will also be prepared during the implementation of the project.
Protection of significant flora and fauna in or near the project area	Protection of significant flora and fauna will be incorporated in the Watershed Management Plan to be established

6.2 Disaster Preparedness Plan

Flood Alarm System	Alarm System provided? [√] Not necessary [ ] Yes, please describe or attach plan:
Evacuation Plan	Evacuation Plan provided? [√] Not necessary [ ] Yes, please describe or attach plan:
Others, pls. specify:	

6.3 Monitoring Plan

Water Quality	The 2 baseline stations can be assigned as monitoring stations. Monitoring will be conducted quarterly. Monitoring parameters include ph; temperature; DO; BOD;TSS; Total and Fecal Coliform; Oil and Grease; Chlorides;	Proponent	PhP 50,000.00 per quarter

	Copper; Lead; Iron; Manganese; Total Hardness; Alkalinity and Pesticides		
Fish Mitigation	None		
Soil Erosion	Restoration of vegetation within the vicinity of the structures (i.e. headrace)	Proponent	-
Dam or weir stability	N/A Dam weir is only		
Waste disposal	none	Proponent	-
Others, pls. specify:			

Annex a. Photo documentation (Weir Site)

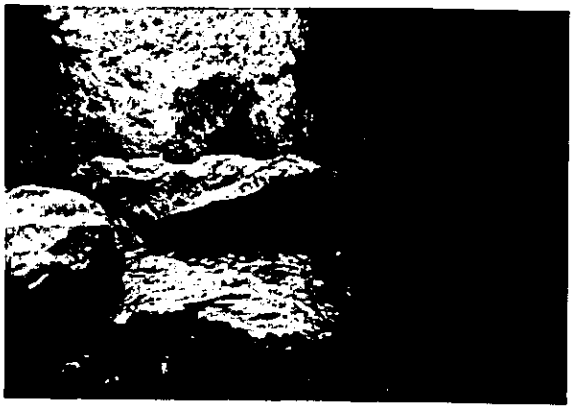
Stream flowing into Lamut River

Surrounding Slope

Looking upstream at weir site

Looking upstream at weir site

Looking downstream at weir site



Looking downstream at weir site

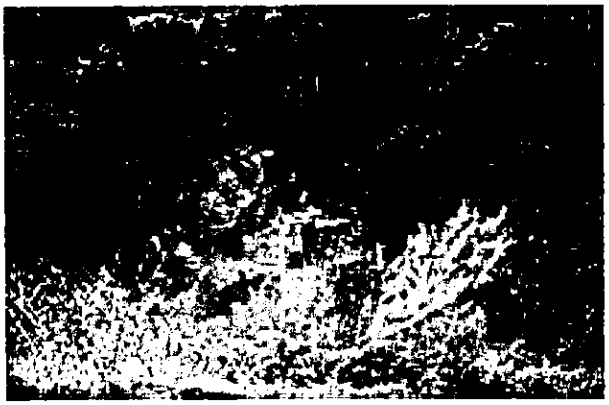
Annex b. Photo documentation- Along the River and Eroded Area

Lamut River

River near powerhouse

River near powerhouse

Washed out bridge



Erosion

Slopes

Annex c. Water Quality Stations

Water quality station at the intake area upstream of Lamut River

Water quality station at the proposed downstream of Lamut River

Appendix III

建設コスト積算書・数量計算書

Construction Cost of Likud Mini-hydropower Project

Contents	Quantity	Unit	Cost (Peso)	Remark
Direct Cost				
Civil Works				
Intake Weir	1.0	Ls	421,000	
Settling Basin	1.0	Ls	1,191,000	
Headrace	1.0	Ls	22,479,000	
Headtank	1.0	Ls	1,110,000	
Penstock, Spillway	1.0	Ls	4,921,000	
Powerhouse	1.0	Ls	1,730,000	
Access road	1.0	Ls	945,000	
Sub total			32,797,000	
Architectural Works				
Powerhouse	1.0	Ls	449,000	
Sub total			449,000	
Electro-mechanical Works				
Turbine	1.0	Ls	33,984,000	
Generator	1.0	Ls	16,461,000	
Controller	1.0	Ls	12,744,000	
Transformer	1.0	Ls	3,880,000	
Others	1.0	Ls	7,530,000	Water level Gauge, etc
Sub total			74,599,000	
Transmission				
Transmission Line	1.0	Ls	5,370,000	
Reinforcement of Substation	1.0	Ls	210,000	Lagawe S/S
Sub total			5,580,000	
Direct Cost Total	1.0	Ls	113,425,000	
Indirect Cost				
Engineering Cost	1.0	Ls	2,624,000	8% of Civil Works
Administration	1.0	Ls	328,000	1% of Civil Works
Contingency	1.0	Ls	3,280,000	10% of Civil Works
Indirect Cost Total	1.0	Ls	6,232,000	
Others				
Right of Way	1.0	Ls	659,000	
Total			120,316,000	

Exchange rate as of June 2011	JPY	USD	Peso
JPY (1.0 Yen)	1.000	0.012	0.531
USD (1.0 US$)	81.300	1.000	43.170
Peso (1.0 Peso)	1.883	0.023	1.000

1.1 Intake Weir 421,000 Php

Contents	Specification	Quantity	Unit	Unit cost (Php)	Cost (Php)	Remarks
1 Clearing and Grubbing		0.00	m^2	15		
Excavation						
2 Clay-Sand-Cobbles		0.00	m^3	110		
3 Boulder		68.42	m^3	230	15,737	
4 Rock		15.74	m^3	960	15,106	
5 Backfill		0.00	m^3	84		
6 Concrete		47.60	m^3	5,074	241,514	
7 Reinforce Bar		1,079.22	kg	59	63,674	
8 Form Work		134.61	m^2	357	48,055	
9 Stoplog		2.16	m^2	441	953	
10 Stone Masonry		4.76	m^3	3,150	14,993	
11 Others					20,968	5% of above
Total					421,000	

1.2 Settling Basin 1,191,000 Php

Contents	Specification	Quantity	Unit	Unit cost (Php)	Cost (Php)	Remarks
1 Clearing and Grubbing		199.51	m^2	15	2,993	
Excavation						
2 Clay-Sand-Cobbles		141.43	m^3	110	15,558	
3 Boulder		113.15	m^3	230	26,024	
4 Rock		28.29	m^3	960	27,155	
5 Backfill		49.89	m^3	84	4,191	
6 Concrete		101.09	m^3	5,074	512,919	
7 Reinforce Bar		4,457.25	kg	59	262,978	
8 Form Work		270.65	m^2	357	96,623	
9 Gabion		7.64	m^3	1,190	9,096	
10 Stoplog		3.90	m^2	441	1,720	
11 Rubble Stone		30.49	m^3	670	20,431	
12 Steel Pipe (D=250mm)		1.00	m	1,310	1,310	
13 Irregation Valve		1.00	unit	26,500	26,500	
14 Sand Flush Gate		1.00	unit	126,000	126,000	
15 Others					57,503	5% of above
Total					1,191,000	

1.3 Headrace 22,479,000 Php

Contents	Specification	Quantity	Unit	Unit cost (Php)	Cost (Php)	Remarks
1 Clearing and Grubbing		10,494.53	m^2	15	157,418	
Excavation						
2 Clay-Sand-Cobbles		4,145.75	m^3	110	456,033	
3 Boulder		3,316.60	m^3	230	762,818	
4 Rock		829.15	m^3	960	795,984	
5 Backfill		1,492.15	m^3	84	125,341	
6 Stone Masonry		1,892.74	m^3	3,360	6,359,615	
7 Concrete		1,000.88	m^3	5,074	5,078,480	
8 Reinforce Bar		29,329.22	kg	59	1,730,424	
9 Form Work		5,383.71	m^2	357	1,921,983	
10 Gabion		12.52	m^3	1,190	14,899	
11 Rubble Stone		509.75	m^3	1,750	892,064	
12 Sand Filling		53.67	m^3	1,334	71,601	
13 Mortar		33.36	m^3	290	9,675	
14 Plastering		7,126.16	m^2	290	2,066,585	
15 Guard Fence for Rock		934.93	m	100	93,493	
16 Guard for Excavation		934.93	m	210	196,335	
17 Top Board		934.93	m	722	675,225	
18 Others					1,071,028	5% of above
Total					22,479,000	

1.4 Headtank 1,110,000 Php

Contents	Specification	Quantity	Unit	Unit cost (Php)	Cost (Php)	Remarks
1 Clearing and Grubbing		72.79	m^2	15	1,092	
Excavation						
2 Clay-Sand-Cobbles		131.38	m^3	110	14,452	
3 Boulder		65.69	m^3	230	15,109	
4 Rock		21.90	m^3	960	21,021	
5 Backfill		37.92	m^3	84	3,185	
6 Concrete		69.40	m^3	5,074	352,149	
7 Reinforce Bar		4,033.64	kg	59	237,985	
8 Form Work		238.95	m^2	357	85,305	
9 Rubble Stone		13.81	m^3	1,750	24,173	
10 Sand Flush Gate		1.00	unit	126,000	126,000	
11 Screen		1.00	unit	176,000	176,000	
12 Others					53,529	5% of above
Total					1,110,000	

1.5 Penstock, Spillway 4,921,000 Php

Contents	Specification	Quantity	Unit	Unit cost (Php)	Cost (Php)	Remarks
1 Clearing and Grubbing		786.08	m^2	15	11,791	
Excavation						
2 Clay-Sand-Cobbles		454.58	m^3	140	63,641	
3 Boulder		363.66	m^3	390	141,828	
4 Rock		90.92	m^3	960	87,279	
5 Backfill		298.84	m^3	84	25,102	
6 Stone Masonry		5.37	m^3	2,220	11,916	
7 Concrete		193.48	m^3	5,074	981,742	
8 Reinforce Bar		5,437.52	kg	59	320,813	
9 Form Work		859.45	m^2	357	306,825	
10 Gabion		3.49	m^3	1,190	4,149	
11 Sand Filling		225.94	m^3	1,334	301,409	
12 Penstock Steel Pipe		14,908.20	kg		1,158,000	
13 Steel Pipe (D=200mm)		6.60	m	1,048	6,919	
14 Installation of Pipe		127.20	m	660	83,953	
15 Packing of Pipe		1.00	ls		610,500	
16 Transportation of Pipe		1.00	ls		570,000	
17 Others					235,133	5% of above
Total					4,921,000	

1.6 Powerhouse 2,179,000 Php

Contents	Specification	Quantity	Unit	Unit cost (Php)	Cost (Php)	Remarks
1 Clearing and Grubbing		359.16	m^2	15	5,387	
Excavation						
2 Clay-Sand-Cobbles		71.68	m^3	140	10,035	
3 Boulder		119.47	m^3	390	46,593	
4 Rock		47.79	m^3	960	45,876	
5 Backfill		103.73	m^3	84	8,713	
6 Stone Masonry		101.13	m^3	2,220	224,508	
7 Concrete		120.84	m^3	5,074	613,122	
8 Reinforce Bar		8,798.69	kg	59	519,123	
9 Form Work		438.30	m^2	357	156,472	
10 Rubble Stone		26.29	m^3	670	17,614	
11 Others					82,557	5% of above
Sub-total of Civil Works					1,730,000	
12 Steel Door		1.00	unit	120,400	120,400	
13 Steel Window		2.00	unit	14,000	28,000	
14 Others					30,600	20% of above
15 Operation house		1.00	ls		270,000	
Sub-total of Architectural Works					449,000	
Total					2,179,000	

1.7 Access Road 945,000 Php

Contents	Specification	Quantity	Unit	Unit cost (Php)	Cost (Php)	Remarks
1 Clearing and Grubbing		1,453.14	m^2	15	21,797	
Excavation						
2 Clay-Sand-Cobbles		131.49	m^3	140	18,408	
3 Boulder		32.87	m^3	390	12,820	
4 Rock		0.00	m^3	960		
5 Backfill		421.82	m^3	84	35,433	
6 Stone Masonry		105.41	m^3	2,220	234,010	
7 Concrete		3.92	m^3	5,074	19,890	
8 Reinforce Bar		161.77	kg	59	9,544	
9 Form Work		25.12	m^2	357	8,968	
10 Rubble Stone		93.54	m^3	670	62,674	
11 Others					21,456	5% of above
Sub-total of Access Road					445,000	
12 Reper and Maintenance Works					500,000	for Barangay Road
Total					945,000	

Unit Cost

(1) Excavation Cut/Clay-Sand-Cobbles

Unit 10 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.300	255	587	
Foreman	man-day	0.230	452	104	
Tools	ls	1.000	200	200	
Sub-total				890	
VAT				107	12%
Others				103	
Total				1,100	
Unit cost/m^3				110	

(2) Excavation Clay-Sand-Cobbles

Unit 10 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	3.900	255	995	
Foreman	man-day	0.390	452	176	
Tools	ls	1.000	25	25	
Sub-total				1,196	
VAT				143	12%
Others				61	
Total				1,400	
Unit cost/m^3				140	

(3) Excavation Cut/Boulders

Unit 10 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	4.000	255	1,020	
Mason	man-day	2.000	362	724	
Foreman	man-day	0.400	452	181	
Tools	ls	1.000	50	50	
Sub-total				1,975	
VAT				237	12%
Others				88	
Total				2,300	
Unit cost/m^3				230	

(4) Excavation Rock

Unit 10 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	12.000	255	3,060	
Mason	man-day	8.000	362	2,896	
Foreman	man-day	5.000	452	2,260	
Tools	ls	1.000	300	300	
Sub-total				8,516	
VAT				1,022	12%
Others				62	
Total				9,600	
Unit cost/m^3				960	

(5) Excavation Boulders

Unit 10 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	8.000	255	2,040	
Mason	man-day	3.000	362	1,086	
Foreman	man-day	0.600	452	271	
Tools	ls	1.000	50	50	
Sub-total				3,447	
VAT				414	12%
Others				39	
Total				3,900	
Unit cost/m^3				390	

(6) Backfill Excavated Soil

Unit 10 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.300	255	587	
Foreman	man-day	0.230	452	104	
Tools	ls	1.000	50	50	
Sub-total				740	
VAT				89	12%
Others				11	
Total				840	
Unit cost/m^3				84	

(7) Sandfill

Unit 10 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.300	255	587	
Unskilled Labor (Carry 150m)	man-day	4.000	255	1,020	
Foreman	man-day	0.230	452	104	
Sand	m^3	10.000	400	4,000	S1
Houling (Dump Truck 1127p/hr) 0.5hr	m^3	10.000	564	5,635	
Tools	ls	1.000	500	500	
Sub-total				11,845	
VAT				1,421	12%
Others				73	
Total				13,340	
Unit cost/m^3				1,334	

(8) Rubble Stone Purchase (Headrace, Headtank)

Unit 100 m^2

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.110	255	538	
Unskilled Labor (Carry 300m)	man-day	20.000	255	5,100	1.7m3/man
Skilled Labor	man-day	0.750	362	272	
Foreman	man-day	0.430	452	194	
Stone	m^3	34.200	500	17,100	G2
Houling (Dump Truck 1127p/hr) 0.5hr	m^3	34.200	564	19,272	
Tools	ls	1.000	4,000	4,000	
Sub-total				46,476	
VAT				5,577	12%
Others				447	
Total				52,500	
Unit cost/m^2				525	
Unit cost/m^3				1,750	t=30cm

(9) Rubble Stone Excavated Stone (Settling Basin, Powerhouse, Access)

Unit 100 m^2

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.110	255	538	
Unskilled Labor (Carry 300m)	man-day	20.000	255	5,100	
Skilled Labor	man-day	0.750	362	272	
Foreman	man-day	0.430	452	194	
Stone	m^3	41.040	230	9,439	(3)
Tools	ls	1.000	2,000	2,000	
Sub-total				17,543	
VAT				2,105	12%
Others				452	
Total				20,100	
Unit cost/m^2				201	
Unit cost/m^3				670	t=30cm

(10) Stone Masonry 1:2 Excaveted Stone + Purchase

Unit 1 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.250	255	574	
Unskilled Labor (Carry 300m)	man-day	0.588	255	150	
Skilled Labor	man-day	1.125	362	407	
Mason	man-day	0.113	362	41	
Foreman	man-day	0.017	452	8	
Rubbles (Excavated x 1.2+Purchase)/2	m^3	1.000	338	338	((3)x1.2+Boulder)/2
Sand and Gravel Mix	m^3	0.380	500	190	Sand (S1)+Gravel (G1)
Portland Cement	bags	3.520	226	796	
Houling (Dump Truck 1127p/hr) 0.5hr	m^3	0.880	564	496	
Houling (4ton Truck 593p/hr) 1.0hr Cement	bags	3.520	10	35	
Tools	ls	1.000	100	100	
Sub-total				3,134	
VAT				376	12%
Others				10	
Total				3,520	
Unit cost/m^3				3,520	

(11) Stone Masonry 1:2 Excaveted Stone

Unit 1 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.250	255	574	
Unskilled Labor (Carry 300m)	man-day	0.588	255	150	
Skilled Labor	man-day	1.125	362	407	
Mason	man-day	0.113	362	41	
Foreman	man-day	0.017	452	8	
Rubbles (Excavated)	m^3	1.200	230	276	(3)
Sand and Gravel Mix	m^3	0.400	500	200	Sand (S1)+Gravel (G1)
Portland Cement	bags	3.520	226	796	
Houling (Dump Truck 1127p/hr) 0.5hr	m^3	0.400	564	225	
Houling (4ton Truck 593p/hr) 1.0hr Cement	bags	3.520	10	35	
Tools	ls	1.000	100	100	
Sub-total				2,812	
VAT				337	12%
Others				1	
Total				3,150	
Unit cost/m^3				3,150	

(12) Stone Masonry 1:3 Excaveted Stone + Purchase

Unit 1 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.250	255	574	
Unskilled Labor (Carry 300m)	man-day	0.588	255	150	
Skilled Labor	man-day	1.125	362	407	
Mason	man-day	0.113	362	41	
Foreman	man-day	0.017	452	8	
Rubbles (Excavated x 1.2+Purchase)/2	m^3	1.000	338	338	((3)x1.2+Boulder)/2
Sand and Gravel Mix	m^3	0.400	500	200	Sand (S1)+Gravel (G1)
Portland Cement	bags	2.840	226	642	
Houling (Dump Truck 1127p/hr) 0.5hr	m^3	0.900	564	507	
Houling (4ton Truck 593p/hr) 1.0hr Cement	bags	2.840	10	28	
Tools	ls	1.000	100	100	
Sub-total				2,995	
VAT				359	12%
Others				6	
Total				3,360	
Unit cost/m^3				3,360	

(13) Stone Masonry 1:5 Excaveted Stone + Purchase

Unit 1 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	2.250	255	574	
Skilled Labor	man-day	1.125	362	407	
Mason	man-day	0.113	362	41	
Foreman	man-day	0.017	452	8	
Rubbles (Excavated)	m^3	1.200	0	0	
Sand and Gravel Mix	m^3	0.400	500	200	Sand (S1)+Gravel (G1)
Portland Cement	bags	1.800	226	407	
Houling (Dump Truck 1127p/hr) 0.5hr	m^3	0.400	564	225	
Houling (4ton Truck 593p/hr) 1.0hr Cement	bags	1.800	10	18	
Tools	ls	1.000	100	100	
Sub-total				1,980	
VAT				238	12%
Others				3	
Total				2,220	
Unit cost/m^3				2,220	

(14) Plastering

Unit 1 m^2

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	0.286	255	73	
Skilled Labor	man-day	0.214	362	77	
Foreman	man-day	0.020	452	9	
Sand	m^3	0.030	400	12	S1
Portland Cement	bags	0.250	226	57	
Houling (Dump Truck 1127p/hr) 0.5hr	m^3	0.030	564	17	
Houling (4ton Truck 593p/hr) 1.0hr Cement	bags	0.250	10	3	
Tools	ls	1.000	10	10	
Sub-total				257	
VAT				31	12%
Others				2	
Total				290	
Unit cost/m^2				290	

(15) Gabion

Unit 1 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	0.450	255	115	
Skilled Labor	man-day	0.200	362	72	
Foreman	man-day	0.020	452	9	
Rubbles (Excavated)	m^3	1.400	230	322	(3)
Wire Cage	kg	3.500	150	525	
Houling (4ton Truck 593p/hr) 1.0hr Cement	kg	3.500	0.519	2	
Tools	ls	1.000	10	10	
Sub-total				1,055	
VAT				127	12%
Others				8	
Total				1,190	
Unit cost/m^3				1,190	

(16) Concrete

Unit 10 m^3

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	25.000	255	6,375	
Unskilled Labor (Carry 300m)	man-day	6.000	255	1,530	
Skilled Labor	man-day	2.500	362	905	
Foreman	man-day	1.110	452	502	
Portland Cement	bags	80.000	226	18,080	
Sand	m^3	4.900	400	1,960	Sand (S1)
Gravel	m^3	8.100	600	4,860	Gravel (G1)
Houling (Dump Truck 1127p/hr) 0.5hr	m^3	13.000	564	7,326	
Houling (4ton Truck 593p/hr) 1.0hr Cement	bags	80.000	10	800	
Tools	ls	1.000	2,964	2,964	7% of above
Sub-total				45,301	
VAT				5,436	12%
Others				3	
Total				50,740	
Unit cost/m^3				5,074	

(17) Reinforce Bar

Unit 1,000 kg

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Steel Man	man-day	12.000	362	4,344	
Foreman Steel Man	man-day	1.200	452	542	
Steel Bar	kg	1000.000	40	40,000	
Tie Wire	kg	20.000	75	1,500	
Houling (4ton Truck 593p/hr) 1.0hr Cement	kg	1000.000	0.148	148	
Tools	ls	1.000	5,000	5,000	
Sub-total				51,535	
VAT				6,184	12%
Others				1,281	
Total				59,000	
Unit cost/kg				59	

(18) Form Work

Unit 100 m^2

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Carpenter	man-day	25.000	362	9,050	
Carpenter Forman	man-day	2.500	452	1,130	
Form Plywood	pcs	34.722	315	10,937	
Form Lumbers	bd ft	196.000	27	5,292	
CW Nails	kgs	20.000	75	1,500	
Hauling	ls	1.000	1,773	1,773	10% of Material Cost
Tools	ls	1.000	2,000	2,000	
Sub-total				31,682	
VAT				3,802	12%
Others				216	
Total				35,700	
Unit cost/m^2				357	

(19) Stoplog

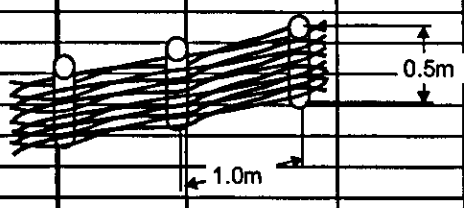
Unit 3 m^2

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Carpenter	man-day	1.000	362	362	
Form Plywood	pcs	1.042	570	594	Nara
Tools	ls	1.000	200	200	
Sub-total				1,156	
VAT				139	12%
Others				26	
Total				1,321	
Unit cost/m^2				441	

(20) Guard Fence for Rock

Unit 10 m

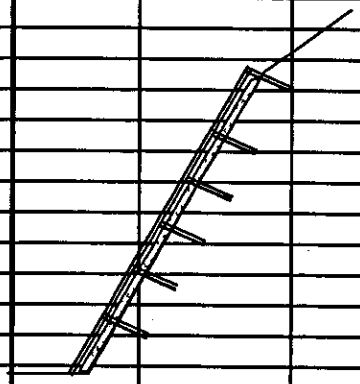
Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Carpenter	man-day	1.000	362	362	
Unskilled Labor	man-day	2.000	255	510	
Material	ls	1.000	0	0	Cut trees and twigs
Tools	ls	1.000	20	20	
Sub-total				892	
VAT				107	12%
Others				1	
Total				1,000	
Unit cost/m				100	



(21) Guard for Excavation

Unit 100 m^2

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Carpenter	man-day	5.000	362	1,810	
Unskilled Labor	man-day	20.000	255	5,100	
Foreman	man-day	2.000	452	904	
Material	ls	1.000	0	0	Cut trees and twigs
Form Lumbers	bdft	120.000	27	3,240	
Reinforce Bar	kg	101.596	40	4,064	10mm
Tools	ls	1.000	3,000	3,000	
Sub-total				18,118	
VAT				2,174	12%
Others				608	
Total				20,900	
Unit cost/m^2				210	



(22) Top Board

Unit 1.8 m

Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Carpenter	man-day	0.200	362	72	
Unskilled Labor	man-day	1.000	255	255	
Form Plywood	pcs	1.000	570	570	Nara
Hauling	ls	1.000	57	57	10% of Material Cost
Tools	ls	1.000	200	200	
Sub-total				1,154	
VAT				139	12%
Others				7	
Total				1,300	
Unit cost/m				722	

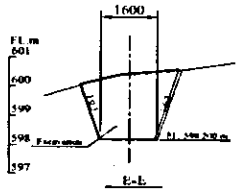
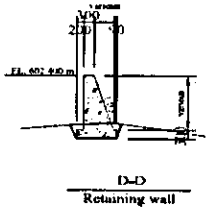
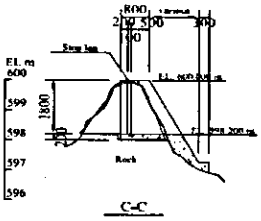
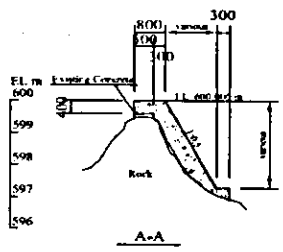
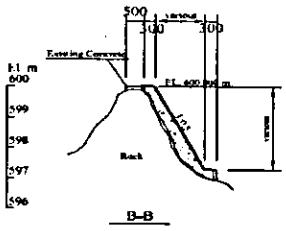
(23) Installation of Penstock Pipe

Unit 1.0 unit

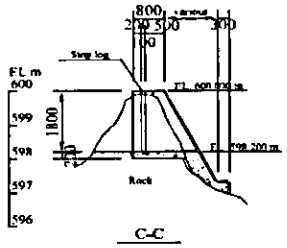
Work Item	Unit	Coefficient	Price	Unit Cost	Remark
Unskilled Labor	man-day	4.000	255	1,020	
Foreman	man-day	1.000	452	452	
Tools	ls	1.000	500	500	
Sub-total				1,972	
VAT				237	12%
Others				431	
Total				2,640	
Unit cost/unit				2,640	
Unit cost/m				660	L=4m

Bill of Quantity

	Unit	Intake Weir	Settling Basin	Headrace	Headtank	Penstock Spillway	Power house	Access Road	Total
(1) Clearing and Grubbing	m^2	0.00	199.51	10,494.53	72.79	786.08	359.16	1,453.14	13,365.21
Excavation									
(2) Clay-Sand-Cobbles	m^3		141.43	4,145.75	131.38	454.58	71.68	131.49	5,076.31
(3) Boulder	m^3	68.42	113.15	3,316.60	65.69	363.66	119.47	32.87	4,079.86
(4) Rock	m^3	15.74	28.29	829.15	21.90	90.92	47.79	0.00	1,033.77
(5) Backfill	m^3	0.00	49.89	1,492.15	37.92	298.84	103.73	421.82	2,404.34
(6) Stone Masonry	m^3			1,892.74		5.37	101.13	105.41	2,104.65
(7) Concrete	m^3	47.60	101.09	1,000.88	69.40	193.48	120.84	3.92	1,537.21
(8) Reinforce Bar	kg	1,079.22	4,457.25	29,329.22	4,033.64	5,437.52	8,798.69	161.77	53,297.31
(9) Form Work	m^2	134.61	270.65	5,383.71	238.95	859.45	438.30	25.12	7,350.79
(10) Gabion	m^3		7.64	12.52		3.49			23.65
(11) Stoplog	m^2	2.16	3.90						6.06
(12) Rubble Stone	m^3		30.49	509.75	13.81		26.29	93.54	673.89
(13) Sand Filling	m^3			53.67		225.94			279.62
(14) Mortar	m^3			33.36					33.36
(15) Plastering	m^2			7,126.16					7,126.16
(16) Guard Fence for Rock	m			934.93					934.93
(17) Guard for Excavation	m			934.93					934.93
(18) Top Board	m			934.93					934.93
(19) Penstock Steel Pipe	kg					14,908.20			14,908.20
(20) Steel Pipe (D=250mm)	m		1.00						1.00
(21) Steel Pipe (D=200mm)	m					6.60			6.60
(22) Irregation Valve	unit		1.00						1.00
(23) Sand Flush Gate	unit		1.00		1.00				2.00
(24) Screen	unit				1.00				1.00
(25) Steel Door	unit						1.00		1.00
(26) Steel Window	unit						2.00		2.00

Contents	Calculation					Quantities
1. Intake Weir						
1.1 Clean and Grubbing						0.00 m²
1.2 Excavation (Boulder)	Section E-E: Excavated waterway					
			A=	4.935 m²		
			L=	14.000 m		
			V=AL=	69.09 m³		
	Section D-D: Retainng Wal					
			A=	0.648 m²		
			L=	10.700 m		
			V=AL=	6.93 m³		
	V=	69.09	+	6.93 =	76.02 m³	
	Excavation Boulder					
	Vb=	76.02	x	90% =	68.42 m³	68.42 m³
1.3 Excavation (Rock)	Excavation Rock					
	Vr=	76.02	x	10% =	7.60 m³	
	Section C-C: Sand flush wa					
			A=	2.711 m²		
			B=	3.000 m		
			V=	8.13 m³		
	Excavation Rock					
	Vr=	7.60	+	8.13 =	15.74 m³	15.74 m³
1.4 Backfill						0.00 m³
1.5 Concrete	Section A-A					
			A=	1.704 m²		
			B=	11.220 m		
			V=	19.12 m³		
	Section B-B					
			A=	1.172 m²		
			B=	11.880 m		
			V=	13.92 m³		

Section C-C

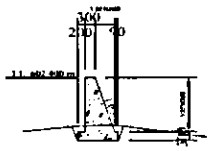


C-C

A= 2.250 m^2
B= 1.000 m
V= 2.25 m^3

A= 0.792 m^2
B= 1.000 m
V= 0.79 m^3

Section D-D



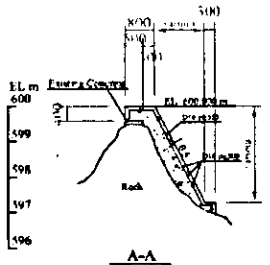
D-D
Retaining wall

A= 1.387 m^2
B= 8.300 m
V= 11.52 m^3

Concrete Total
Vc= 47.60 m^3 47.60 m^3

1.6 Reinforce bar

Section A-A

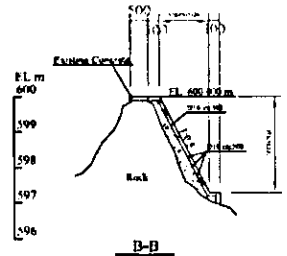


A-A

D16
w =4.4x1.0/0.3xπ x0.016²/4x7850
= 23.149 kg/m
L = 11.220 m
W16 = 259.731 kg

D10
w 16x π x0.010²/4x7850
= 9.865 kg/m
L = 11.220 m
W10 = 110.681 kg

Section B-B

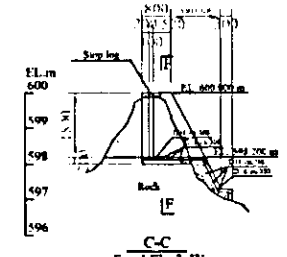


B-B

D16
w =3.7x1.0/0.3xπ x0.016²/4x7850
= 19.466 kg/m
L = 11.880 m
W16 = 231.258 kg

D10
w 14x π x0.010²/4x7850
= 8.632 kg/m
L = 11.880 m
W10 = 102.543 kg

Section C-C

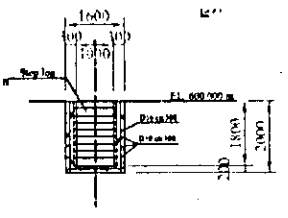


C-C
Sand Flush Way

D16
w =1.5x1.0/0.3xπ x0.016²/4x7850
= 7.892 kg/m
L = 1.600 m
W16 = 12.627 kg

D10
w 6x π x0.010²/4x7850
= 3.699 kg/m
L = 1.600 m
W10 = 5.919 kg

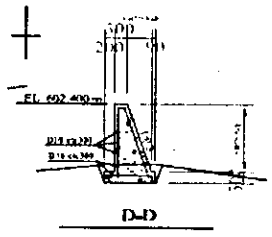
Section



D16
w =(1.9x2+1.5)x1.0/0.3xπ x0.016²/4x7850
= 27.884 kg/m
L = 1.200 m
W16 = 33.461 kg

D10
w 19x π x0.010²/4x7850
= 11.714 kg/m
L = 1.200 m
W10 = 14.057 kg

Section D-D



D-D

D16

w =5.2x1.0/0.3xπ x0.016²/4x7850

= 27.358 kg/m

L = 8.300 m

W16 = 227.070 kg

D10

w 16x π x0.010²/4x7850

= 9.865 kg/m

L = 8.300 m

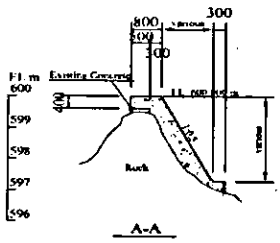
W10 = 81.876 kg

Reinforce bar Total

Wr= 1079.22 kg | 1079.22 kg

1.7 Form work

Section A-A



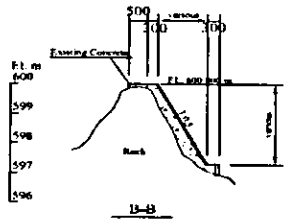
A-A

A= 3.900 m

B= 11.220 m

V= 43.76 m²

Section B-B



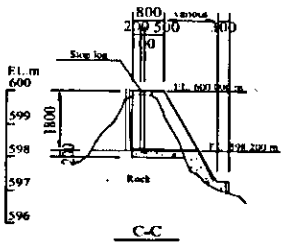
B-B

A= 3.500 m

B= 11.880 m

V= 41.58 m²

Section C-C



C-C

Sand flash way

A= 2.250 m

Both side

V= 4.50 m²

Stoplog

A= 0.540 m

Both side

V= 1.08 m²

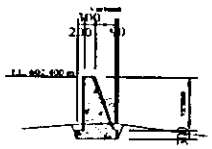
Upstream & downstream side

A= 3.200 m

B= 2.500 m

V= 8.00 m²

Section D-D



D-D

Retaining wall

A= 4.300 m

B= 8.300 m

V= 35.69 m²

Form work Total

Vf= 134.61 m² | 134.61 m²

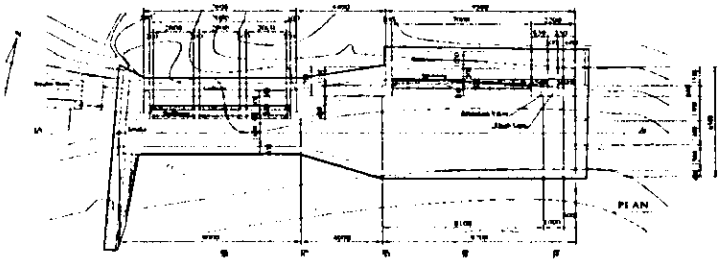
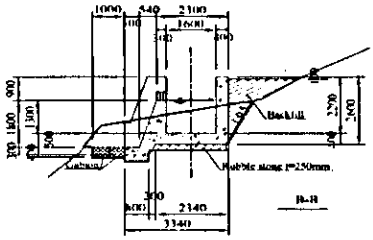
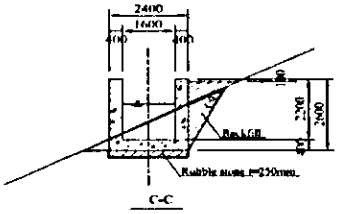
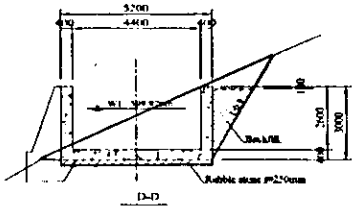
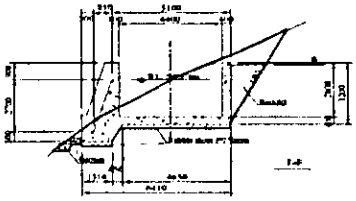
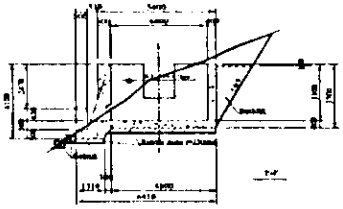
1.8 Stoplog

As= 1.80 x 1.20 = 2.16 m² | 2.16 m²

1.9 Stone Masonry

Filling between unevenness of rock surface and weir concre

10% of concrete volume V = 4.76 m³ | 4.76 m³

Contents	Calculation	Quantities
2. Settling Basin		
2.1 Clean and Grubbing		
	Ac= 166.26 x 1.2 = 199.51	199.51 m^2
2.2 Excavation (Clay-Sand-Cobbles)	Section B-B	
	 A= 7.059 m^2	
	Section C-C	
	 A= 4.141 m^2	
	Section D-D	
	 A= 14.140 m^2	
	Section E-E	
	 A= 19.220 m^2	
	Section F-F	
	 A= 21.385 m^2	

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
	7.059			
B-B	7.059	7.059	5.100	35.998
C-C	4.141	5.600	4.000	22.398
D-D	14.140	9.140	4.000	36.561
E-E	19.220	16.680	4.000	66.719
F-F	21.385	20.302	4.600	93.391
	21.385	21.385	1.300	27.801
total				282.868

Excavation Clay-Sand- Cobble

Vc= 282.87 x 50% = 141.43 m^3 — 141.43 m^3

2.3 Excavation (Boulder)

Excavation Boulder

Vb= 282.87 x 40% = 113.15 m^3 — 113.15 m^3

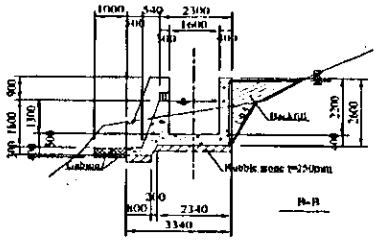
2.4 Excavation (Rock)

Excavation Rock

Vr= 282.87 x 10% = 28.29 m^3 — 28.29 m^3

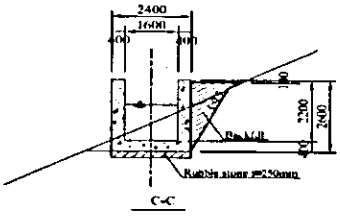
2.5 Backfill

Section B-B



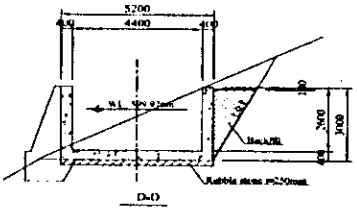
A= 2.027 m^2

Section C-C



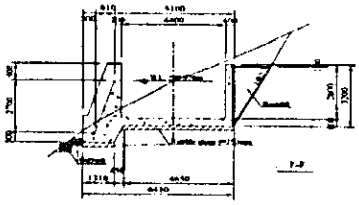
A= 1.587 m^2

Section D-D



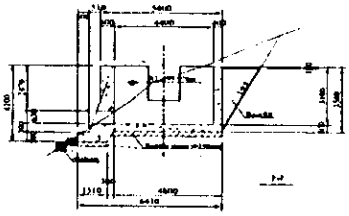
A= 2.103 m^2

Section E-E



A= 2.403 m^2

Section F-F

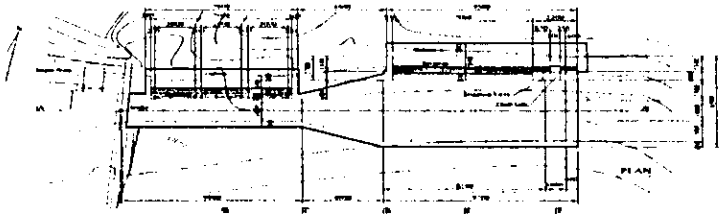


A= 2.890 m^2

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
	2.027			
B-B	2.027	2.027	5.100	10.339
C-C	1.587	1.807	4.000	7.229
D-D	2.103	1.845	4.000	7.379
E-E	2.403	2.253	4.000	9.010
F-F	2.890	2.646	4.600	12.173
	2.890	2.890	1.300	3.757
total				49.887

49.89 m^3

2.6 Rubble stone



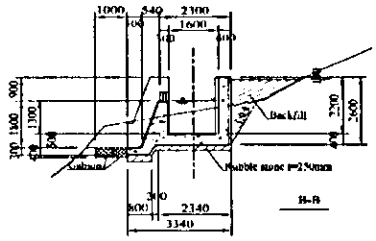
V= 121.97 x 0.25 = 30.49

(thickness:250mm)

30.49 m^3

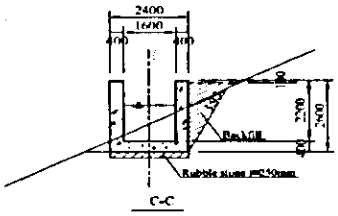
2.7 Concrete

Section B-B



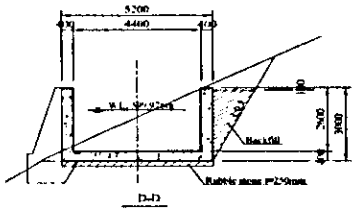
A= 2.932 m^2

Section C-C



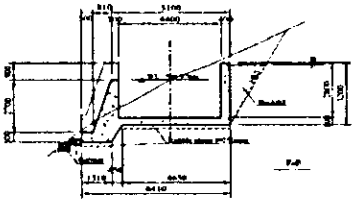
A= 2.720 m^2

Section D-D



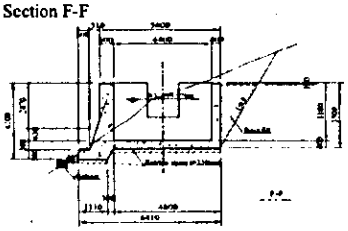
A= 4.160 m^2

Section E-E



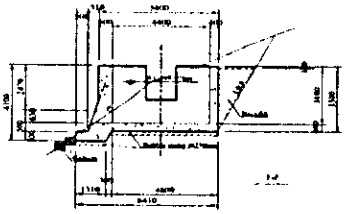
A= 5.681 m^2

Section F-F



A= 6.469 m^2

Section F-F+0.5



A= 17.506 m^2

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
	2.932			
B-B	2.932	2.932	5.000	14.660
C-C	2.720	2.826	4.000	11.304
D-D	4.160	3.440	4.000	13.760
E-E	5.681	4.921	4.000	19.682
F-F	6.469	6.075	4.600	27.944
F-F+0.5	6.469	6.469	0.500	3.234
F-F+0.5	17.506	11.987	0.000	0.000
F-F+1.1	17.506	17.506	0.600	10.504
total				101.088

101.09 m^3

2.8 Reinforce bar

Section B-B

D20

w =12.016x1.0/0.25xπ x0.020²/4x7850
= 118.533 kg/m
L = 9.000 m
W20 = 1066.797 kg

D10

w 39xπ x0.010²/4x7850
= 24.045 kg/m
L = 9.000 m
W10 = 216.405 kg

Section C-C - Section D-D

D20

wcc =12.2x1.0/0.25xπ x0.020²/4x7850
= 120.348 kg/m
wdd =16.6x1.0/0.25xπ x0.020²/4x7850
= 163.752 kg/m
wav = 142.050 kg/m
L = 4.000 m
W20 = 568.201 kg

D10

w (41+55)/2xπ x0.010²/4x7850
= 29.594 kg/m
L = 4.000 m
W10 = 118.375 kg

Section D-D - Section E-E

D20

wdd = 163.752 kg/m
wee =19.13x1.0/0.25xπ x0.020²/4x7850
= 188.710 kg/m
wav = 176.231 kg/m
L = 4.000 m
W20 = 704.924 kg

D10

w (55+58)/2xπ x0.010²/4x7850
= 34.834 kg/m
L = 4.000 m
W10 = 139.337 kg

Section E-E - Section F-F+0.5

D20

wee = 188.710 kg/m
wff =21.221x1.0/0.25xπ x0.020²/4x7850
= 209.337 kg/m
wav = 199.023 kg/m
L = 5.100 m
W20 = 1015.019 kg

D10

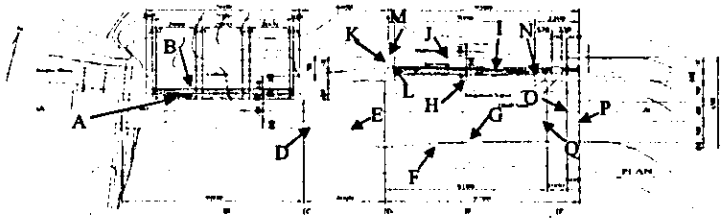
w (58+63)/2xπ x0.010²/4x7850
= 37.301 kg/m
L = 4.000 m
W10 = 149.202 kg

Downstream wall

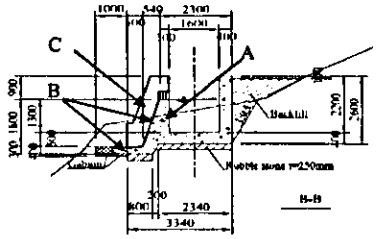
D20

w =7.0x1.0/0.25xπ x0.020²/4x7850
= 69.052 kg/m

		L	=	5.400	m	
		W20	=	372.882	kg	
		D10				
		w	24xπ x0.010^2/4x7850			
			=	14.797	kg/m	
		L	=	5.400	m	
		W10	=	79.903	kg	
	Inlet wall					
		D10				
		w	(2.024x1.0/3+8)xπ x0.010^2/4x7850			
			=	5.348	kg/m	
		L	=	4.900	m	
		W10	=	26.206	kg	
				Wr=	4,457.25 kg	4,457.25 kg
2.9	Form work	Inlet - Basin				
		Right-outside				
			2.600 x	8.718	= 22.667	m^2
		Right-inside				
			2.200 x	8.757	= 19.265	m^2
		Light-inside				
				A	= 13.587	m^2



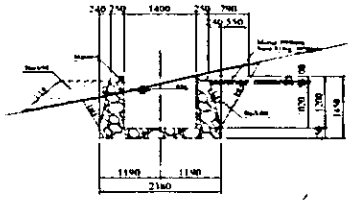
		Light-outside	Spillway			
				B	= 15.253	m^2
			Side wall	C		
			1.656 m2 x	4	side = 6.624	m^2



		Stoplog			= 1.200	m^2
		Front of Baisn				
			Outside	D	= 23.733	m^2
			Inside	E	= 20.342	m^2
		Basin				
			Right-outside	F	= 31.622	m^2
			Right-inside	G	= 25.800	m^2
			Left-inside	H	= 19.185	m^2
		Spillway				
			Spillway	I	= 27.489	m^2
			Foundation	J	= 6.005	m^2
			Flush gate		= 1.476	m^2
			Side wall			
			upstream	K	= 3.378	m^2
			downstream	L	= 2.259	m^2
			edge of wall	M	= 1.116	m^2
			gate side	N	= 0.690	m^2
		End of basin				
			Inside	O	= 11.037	m^2
			Outside	P	= 17.506	m^2
		Sand flush way		Q	= 0.418	m^2
		Form work Total				
		Vf=			270.65	m^2 270.65 m^2

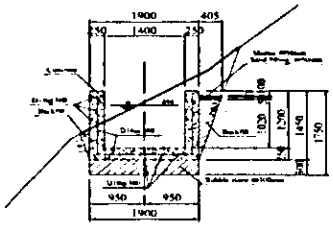
2.10 Gabion								
	B x H =	0.40x0..50	=		0.20	m2 x 2 sets		
	Length =	7.6+9.5+2.01	=		19.11	m		
	Vg=	0.20	x		19.11	x 2 sets	=	7.64 m^3	7.64 m^3
2.11 Stoplog	Inlet - Basin							
		Width =		2.20				
		Height =		0.30				
		Unit =		3.00		A	=	1.98 m^2
	End of Basin							
		Width =		1.60				
		Height =		1.20				
		Unit =		1.00		A	=	1.92 m^2
	As=	1.98	+		1.92		=	3.90 m^2	3.90 m^2
2.12 Steel Pipe	L =	1.00 m							1.00 m
	Diameter =	0.25 m							
2.13 Irregation Valve	Diameter =	0.25 m							1.00 unit
2.14 Sand Flush Gate	63cm x 50cm								1.00 unit

Contents	Calculation	Quantities
3. Headrace		
3.1 Clean and Grubbing		



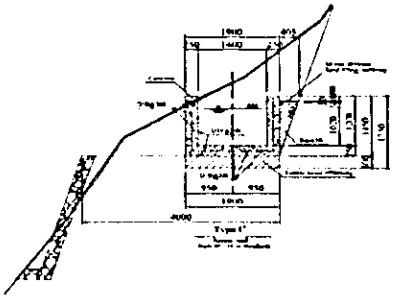
Type A

Area = 4.778 m^2/m
Length = 1,005.603 m
A= 4.804.771 m^2



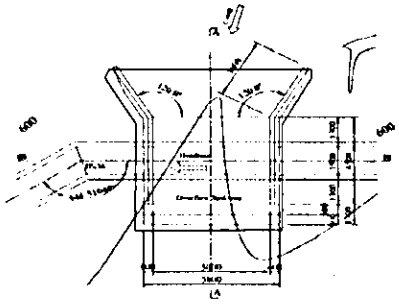
Type B

Area = 3.314 m^2/m
Length = 430.740 m
A= 1.427.472 m^2



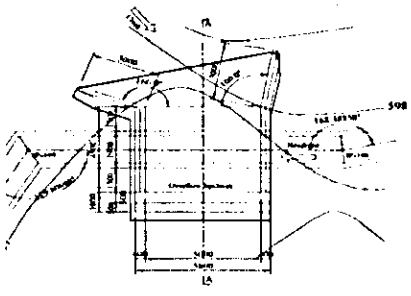
Type C

Area = 9.465 m^2/m
Length = 438.960 m
A= 4.154.756 m^2



Overflow Spillway IP-35+20.0n

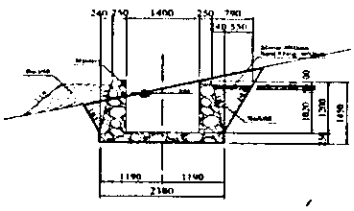
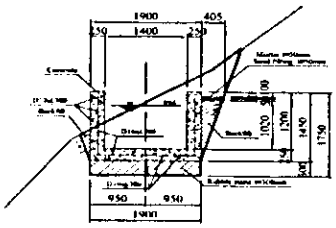
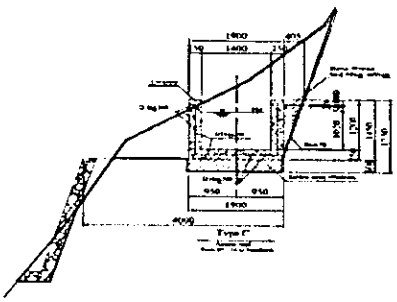
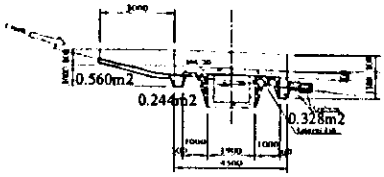
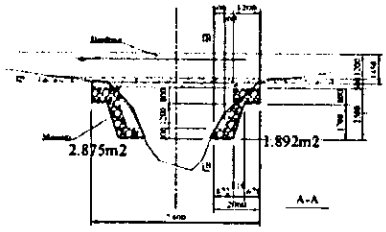
A = 54.512 m^2

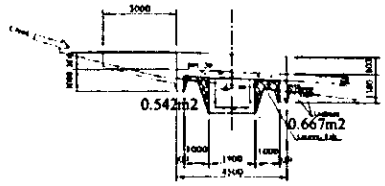
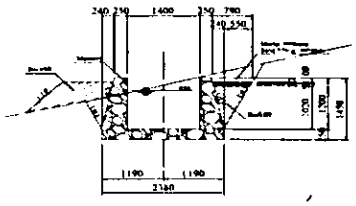
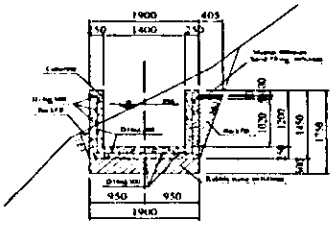
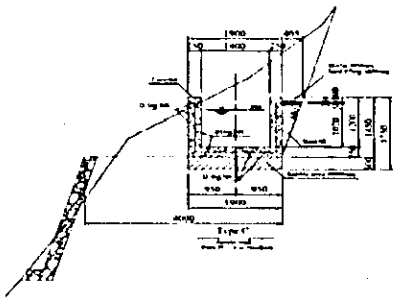
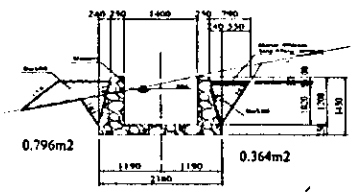


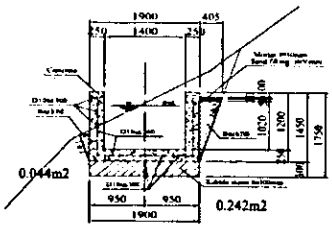
Overflow Spillway IP-108+6.0n

A = 53.021 m^2

Ac= 10,494.53 m^2 | 10,494.53 m^2

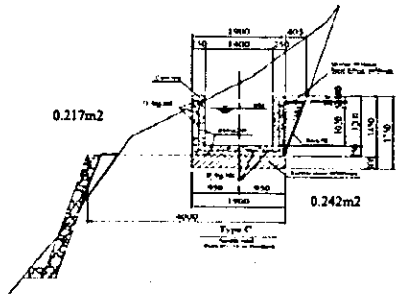
3.2	Excavation (Clay-Sand-Cobbles)	Type A					
				Area = 3.661 m^2/m Length = 1,005.603 m A= 3,681.950 m^2			
		Type B					
				Area = 3.546 m^2/m Length = 430.740 m A= 1,527.504 m^2			
		Type C					
				Area = 6.922 m^2/m Length = 438.960 m A= 3,038.647 m^2			
				Overflow Spillway IP-35+20.0m IP-108+6.0m Area = 0.572 m^2/m Width = 5.80 m unit = 2 A= 6.633 m^2 Retainning wall Area = 0.561 m^2/m Width = 3.00 m unit = 4 A= 6.732 m^2			
				Flume IP-15&16, IP-115&116, IP-130&131 Area = 4.768 m^2/m Width = 2.10 m unit = 3 A= 30.037 m^2			
		Excavation Clay-Sand- Cobble					
		Vc=	8,291.50	x	50% =	4145.75 m^3	4,145.75 m^3
3.3	Excavation (Boulder)	Excavation Boulder					
		Vb=	8,291.50	x	40% =	3316.60 m^3	3,316.60 m^3
3.4	Excavation (Rock)	Excavation Rock					
		Vr=	8,291.50	x	10% =	829.15 m^3	829.15 m^3
3.5	Rubble stone	Width = 1.90 m Thickness = 0.30 m Length Type B 430.740 m Type C 438.960 m Total 869.700 m V = 495.73 m^3					

		Overflow Spillway			
			Area = 1.209 m^2/m Width = 5.80 m unit = 2 A= 14.022 m^2		
				V = 509.75 m^3	509.75 m^3
3.6	Sand Filling	Type A			
			Area = 0.037 m^2/m Length = 1,005.603 m A= 36.780 m^2		
		Type B			
			Area = 0.019 m^2/m Length = 430.740 m A= 8.367 m^2		
		Type C			
			Area = 0.019 m^2/m Length = 438.960 m A= 8.527 m^2		
				Vs = 53.67 m^3	53.67 m^3
3.7	Mortar	Type A			
			Area = 0.023 m^2/m Length = 1,005.603 m A= 22.913 m^2		
		Type B			
			Area = 0.012 m^2/m Length = 430.740 m A= 5.175 m^2		
		Type C			
			Area = 0.012 m^2/m Length = 438.960 m A= 5.274 m^2		
				Vm= 33.36 m^3	33.36 m^3
3.8	Backfill		Type A Area = 1.161 m^2/m Length = 1,005.603 m A= 1,167.588 m^2		



Type B

Area =	0.286	m^2/m
Length =	430.740	m
A=	123.224	m^2

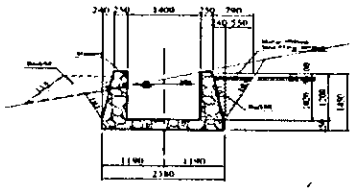


Type C

Area =	0.459	m^2/m
Length =	438.960	m
A=	201.337	m^2

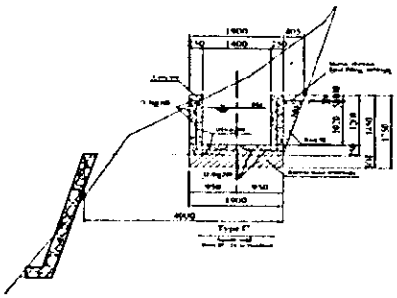
Vb =	1,492.15	m^2	1,492.15 m^2

3.9 Stone Masonry



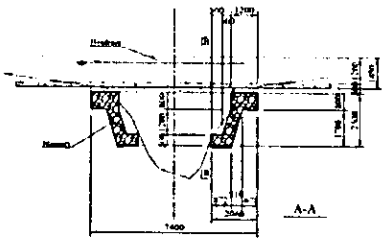
Type A

Area =	1.483	m^3/m
Length =	1,005.603	m
A=	1,491.309	m^3



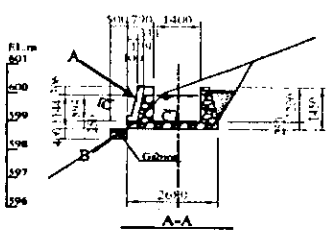
Type C

Area =	0.855	m^3/m
Length =	438.960	m
A=	375.266	m^3



Flume IP-15&16, IP-115&116, IP-130&131

Area =	4.120	m^3/m
Width =	2.10	m
unit =	3	
A=	25.955	m^3



Discharge Controll Spillway IP-1+2.5m

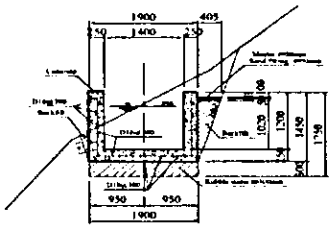
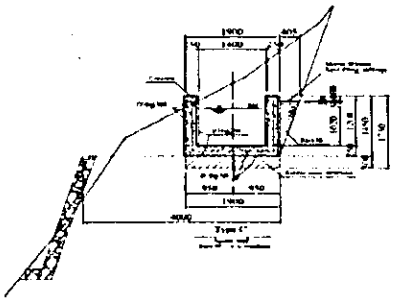
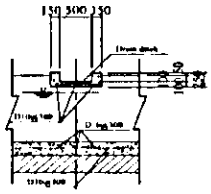
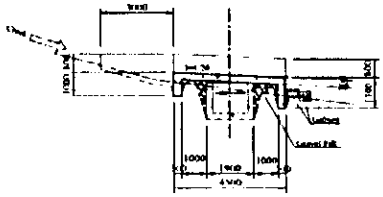
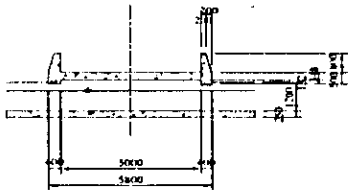
A

Area =	0.268	m^3/m
Width =	0.200	
unit	2	
V=	0.107	m^3

B

Area =	0.075	m^3/m
Width =	1.400	
V=	0.105	m^3

Vs =	1,892.74	m^3	1,892.74 m^3

3.10 Plastering	Inside of Channel A = 1.20m x 2 side + 1.40m = 3.80 m Length = = 1,875.304 m Area = = 7,126.155 m^2	7,126.16 m^2
3.11 Concrete	 Type B Area = 1.075 m^2 Length = 430.740 m A= 463.046 m^3	
	 Type C Area = 1.075 m^2 Length = 438.960 m A= 471.882 m^3	
	 Drain Area = 0.125 m^2 Width = 1.900 m each 50m unit = 38 A= 9.025 m^3	
	  Overflow Spillway IP-35+20.0m IP-108+6.0m Area = 1.952 m^3/m Width = 5.80 m unit = 2 A= 22.640 m^3 Retainning wall Area = 0.440 m^3/m Width = 7.50 m unit = 4 A= 13.200 m^3	
	Flume IP-15&16, IP-115&116, IP-130&131 Area = 3.700 m^3/m Width = 1.90 m unit = 3 A= 21.090 m^3	
	Vc = 1,000.88 m^3	1,000.88 m^3
3.12 Reinforce bar	Type B, C D16 w =(1.25x2+1.70)x1.0/0.3xπ x0.016^2/4x7850 = 22.097 kg/m L = 869.700 m W16 = 19217.505 kg D10 w =15x π x0.010^2/4x7850 = 9.248 kg/m L = 869.700 m W10 = 8043.041 kg	

Drain

D10

w	=(0.70x5+1.70x3)xπ x0.010²/4x7850				
	=	5.302	kg/unit		
unit	=	38	unit	each 50m	
W10	=	201.484	kg		

Flume

D20

w	=2x7x7.20xπ x0.020²/4x7850				
	=	248.588	kg/unit		
unit	=	3	unit		
W20	=	745.764	kg		

D10

w	=25x1.70xπ x0.010²/4x7850				
	=	26.203	kg/unit		
unit	=	3	unit		
W10	=	78.609	kg		

Overflow Spillway

Basement

D16

w	=20x5.60xπ x0.016²/4x7850				
	=	176.774	kg/unit		
unit	=	2	unit		
W16	=	353.547	kg		

D10

w	=21x(0.795+4.305+1.105)xπ x0.010²/4x7850				
	=	76.512	kg/unit		
unit	=	3	unit		
W10	=	229.537	kg		

Wall

D16

w	=2x(0.022+0.734+0.388+0.20+1.10)*1/0.3xπ x0.016²/4x7850				
	=	25.716	kg/m		
L	=	15	m		
W16	=	385.745	kg		

D10

w	=8x1.00xπ x0.010²/4x7850				
	=	4.932	kg/m		
unit	=	15	m		
W10	=	73.985	kg		

	Wr=	29,329.22	kg	29,329.22 kg

3.13 Form work

Type B & C

Inside	1.20	x	2 sides	=	2.40		
Outside	1.45	x	2 sides	=	2.90		
			total	=	5.30	m^2/m	
Length				=	934.928	m	
			A	=	4,955.12	m^2	

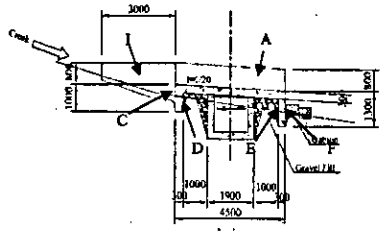
Drain

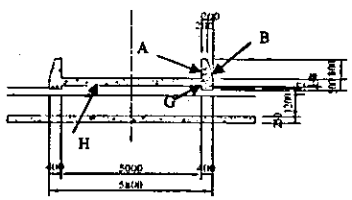
Area =	3.040	m^2/unit	
unit =	38		
A =		115.52	m^2

Overflow Spillway

IP-35+20.0m

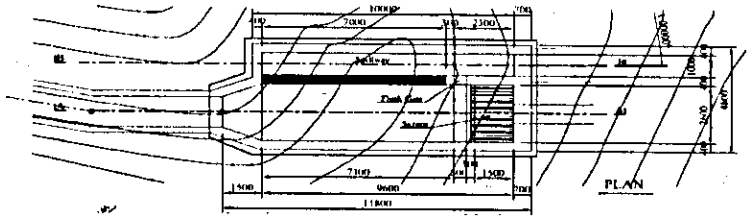
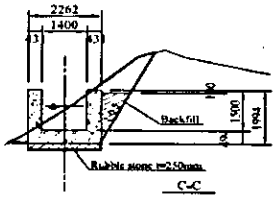
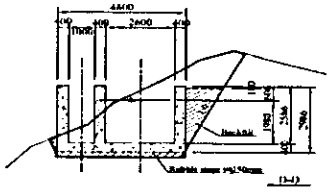
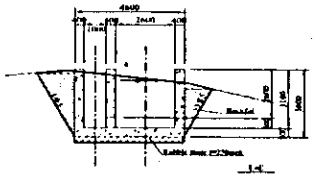
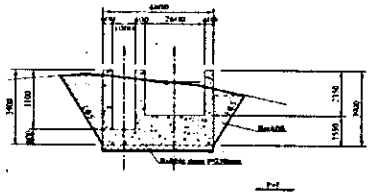
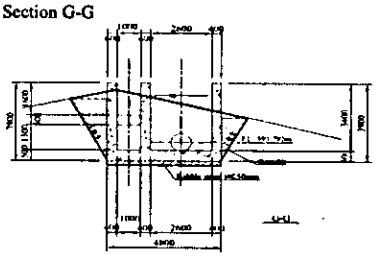
IP-108+6.0m



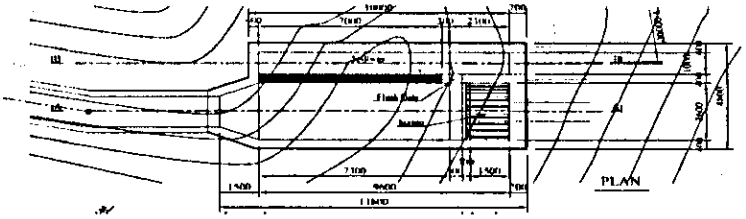
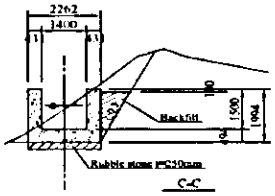
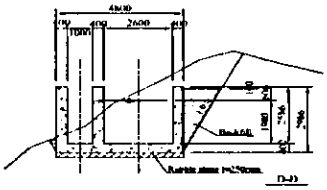
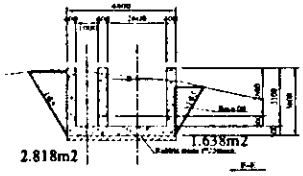
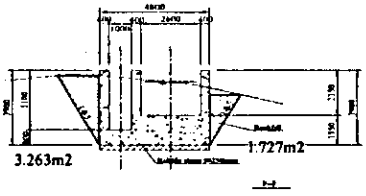
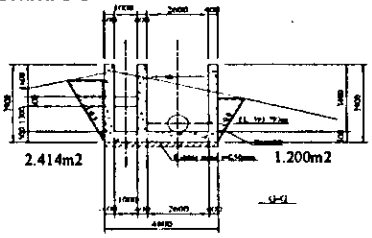


A	72.000	
B	11.925	
C	5.800	
D	3.973	
E	5.887	
F	7.540	
G	1.368	
H	9.500	
I	13.192	
sub total	131.185	m^2
unit	2.0	
A =	262.370	m^2

		Flume	IP-15&16, IP-115&116, IP-130&131					
			Area =	16.900 m^2				
			unit =	3				
			A=	50.700 m^2				
						Af =	5,383.71 m^2	5,383.71 m^2
3.14	Guard Fence for Rock	Type B & C						
					L	=	934.928 m	934.93 m
3.15	Guard for Excavation	Type B & C						
					L	=	934.928 m	934.93 m
3.16	Top Board	Type B & C						
					L	=	934.928 m	934.93 m
3.17	Gabion	Drain						
			Volume =	0.200 m^3/unit				
			unit =	38				
			V =	7.60 m^3				
		Overflow Spillway						
			Volume =	2.320 m^3/unit				
			unit =	2				
			V =	4.64 m^3				
		Discharge Controll Spillway						
			V =	0.280 m^3				
						Vg =	12.52 m^3	12.52 m^3

Contents	Calculation	Quantities
4. Headtank		
4.1 Clean and Grubbing		
	Ac= 60.66 x 1.2 = 72.79	72.79 m^2
4.2 Excavation (Clay-Sand-Cobbles)	Section C-C	
	 A= 5.517 m^2	
	Section D-D	
	 A= 16.747 m^2	
	Section E-E	
	 A= 21.242 m^2	
	Section F-F	
	 A= 22.617 m^2	
	Section G-G	
	 A= 20.013 m^2	

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
C-C	5.517			
D-D	16.747	11.132	1.500	16.698
E-E-0.75	21.242	18.995	6.800	129.163
E-E	21.242	21.242	0.750	15.931
E-E+0.05	21.242	21.242	0.050	1.062
F-F-0.35	22.617	21.929	0.000	0.000
F-F	22.617	22.617	0.350	7.916
G-G	20.013	21.315	0.900	19.184
G-G+1.45	20.013	20.013	1.450	29.019
total				218.974

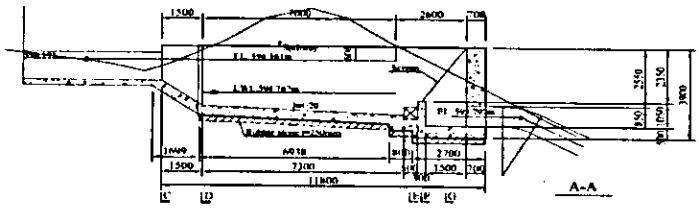
		Excavation Clay-Sand- Cobble					
		Vc=	218.97	x	60% =	131.38 m^3	131.38 m^3
4.3	Excavation (Boulder)	Excavation Boulder					
		Vb=	218.97	x	30% =	65.69 m^3	65.69 m^3
4.4	Excavation (Rock)	Excavation Rock					
		Vr=	218.97	x	10% =	21.90 m^3	21.90 m^3
4.5	Rubble stone						
		V=	55.25	x	0.25 = (thickness:250mm)	13.81	13.81 m^3
4.6	Backfill	Section C-C					
					A=	0.897 m^2	
		Section D-D					
					A=	2.082 m^2	
		Section E-E					
					A=	4.456 m^2	
		Section F-F					
					A=	4.991 m^2	
		Section G-G					
					A=	3.614 m^2	

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
C-C	0.897			
D-D	2.082	1.490	1.500	2.234
E-E	4.456	3.269	7.550	24.682
F-F	4.991	4.723	0.400	1.889
G-G	3.614	4.302	0.900	3.872
G-G+1.45	3.614	3.614	1.450	5.240
total				37.918

Vb = 37.92 m^2 | 37.92 m^2

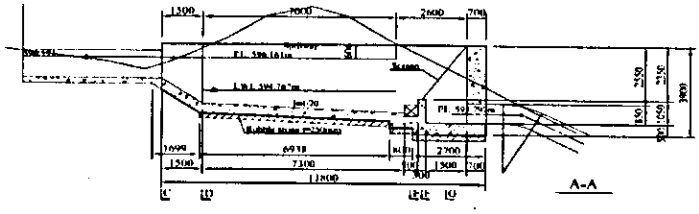
4.7 Concrete

Section A-A-1.70m



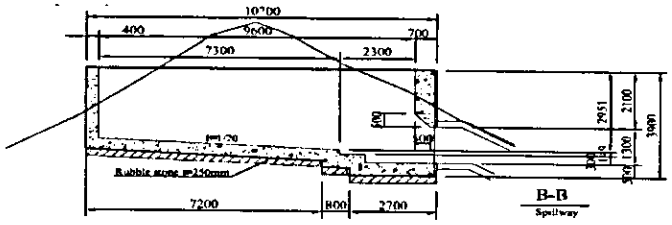
A= 35.081 m^2

Section A-A-0.70m & Section A-A+0.70m



A= 38.673 m^2

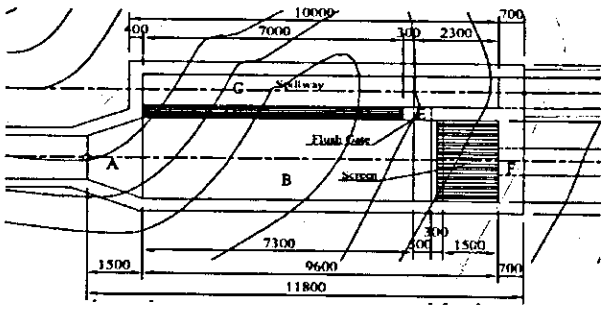
Section B-B-0.50m & Section B-B+0.90m



A= 36.065 m^2

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
A-A-1.70	35.081			
A-A-0.70	38.673	36.877	1.000	36.877
A-A+0.70	38.673	38.673	1.400	54.142
B-B-0.50	36.065	37.369	1.000	37.369
B-B+0.90	36.065	36.065	1.400	50.491
sub-total				178.879

Exclusion



A	1/2x(1.40x1.50+2.60x2.586)x1.5=	6.618
B	27.565x2.60=	71.669
C	28.825x1.0=	28.825
D	0.606x7.00x0.40=	1.697
E	0.50x0.50x0.40=	0.100
F	π x0.85^2/4=	0.567
	sub-total	-109.476

Vc = 178.879 + -109.476 = 69.40 m^3 | 69.40 m^3

4.8 Reinforce bar

Section C-C - Section D-D-0.4

D20

wcc	=9.7x1.0/0.20xπ x0.020²/4x7850		
	=	119.608	kg/m
wdd	=14.744x1.0/0.20xπ x0.020²/4x7850		
	=	181.805	kg/m
wav	=	150.706	kg/m
L	=	1.100	m
W20	=	165.777	kg

D10

w	(29+49)/2xπ x0.010²/4x7850		
	=	24.045	kg/m
L	=	1.100	m
W10	=	26.449	kg

Section D-D-0.4 - Section D-E

D20

wdd	=20.504x1.0/0.20xπ x0.020²/4x7850		
	=	252.830	kg/m
L	=	0.400	m
W20	=	101.132	kg

D10

w	66xπ x0.010²/4x7850		
	=	40.691	kg/m
L	=	0.400	m
W10	=	16.277	kg

Spillway wall

D20

wdd	=5.572x1.0/0.20xπ x0.020²/4x7850		
	=	68.707	kg/m
L	=	1.000	m
W20	=	68.707	kg

D10

w	20xπ x0.010²/4x7850		
	=	40.691	kg/m
L	=	1.000	m
W10	=	40.691	kg

Section D-D - Section E-E

D20

wdd	=	252.830	kg/m
wcc	=23.8x1.0/0.20xπ x0.020²/4x7850		
	=	293.472	kg/m
wav	=	273.151	kg/m
L	=	7.550	m
W20	=	2062.289	kg

D10

w	(66+80)/2xπ x0.010²/4x7850		
	=	45.007	kg/m
L	=	7.550	m
W10	=	339.805	kg

Section E-E - Section F-F

D20

wcc	=	293.472	kg/m
wff	=25.0x1.0/0.20xπ x0.020²/4x7850		
	=	308.269	kg/m
wav	=	300.870	kg/m
L	=	0.400	m
W20	=	120.348	kg

D10

w	(80+83)/2xπ x0.010²/4x7850		
	=	50.248	kg/m
L	=	0.400	m
W10	=	20.099	kg

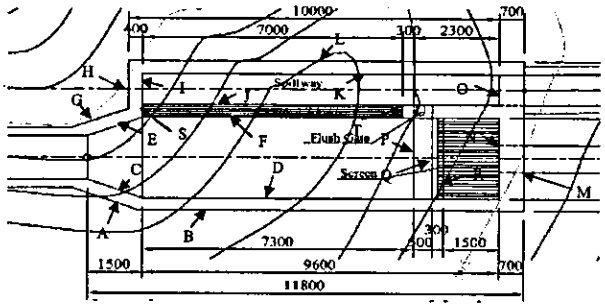
Section F-F - Section G-G+0.7

D20

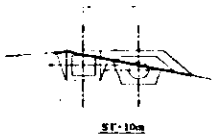
wff	=	308.269	kg/m
wgg	=27.4x1.0/0.20xπ x0.020²/4x7850		
	=	337.863	kg/m
wav	=	323.066	kg/m
L	=	1.650	m
W20	=	533.058	kg

D10

w	(83+90)/2xπ x0.010²/4x7850		
	=	53.330	kg/m
L	=	1.650	m
W10	=	87.995	kg

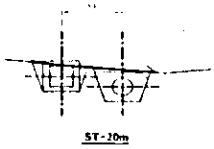
	Downstream wall D20 w =7.9x1.0/0.25xπ x0.020^2/4x7850 = 77.930 kg/m L = 4.800 m W20 = 374.066 kg D10 w 26x π x0.010^2/4x7850 = 16.030 kg/m L = 4.800 m W10 = 76.944 kg Wr= 4,033.64 kg		4,033.64 kg
4.9	Form work		
		A 5.027 m^2 L 36.065 m^2 B 35.081 m^2 M 18.720 m^2 C 3.301 m^2 N 8.840 m^2 D 27.565 m^2 O 2.507 m^2 E 3.301 m^2 P 0.536 m^2 F 23.323 m^2 Q 1.950 m^2 G 4.147 m^2 R 2.730 m^2 H 4.535 m^2 S 0.242 m^2 I 2.586 m^2 T 0.242 m^2 J 28.825 m^2 U 0.600 m^2 K 28.825 m^2	
		Af = 238.95 m^2	238.95 m^2
4.10	Sand Flush Gate	50cm x 50cm	1.00 unit
4.11	Screen		1.00 unit

Contents	Calculation	Quantities
5. Penstock, Spillway		
5.1 Clean and Grubbing	ST+10.0m	



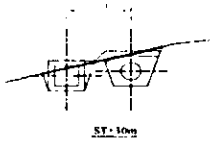
B= 5.992 m

ST+20.0m



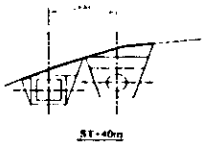
B= 5.688 m

ST+30.0m



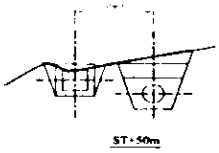
B= 5.216 m

ST+40.0m



B= 5.887 m

ST+50.0m

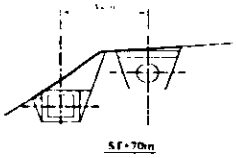


B= 6.036 m

ST+60.0m

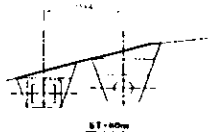
B= 6.489 m

ST+70.0m



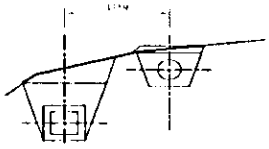
B= 6.611 m

ST+80.0m



B= 6.775 m

ST+80.0m



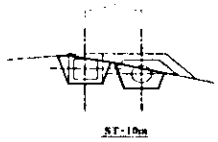
Energy dissipater → Powerhouse

B= 6.796 m

Section	B (m)	Bav (m)	L (m)	dA (m^2)
ST	5.992			
ST+10	5.992	5.992	10.000	59.920
ST+20	5.688	5.840	10.000	58.400
ST+30	5.216	5.452	10.000	54.520
ST+40	5.887	5.552	10.000	55.515
ST+50	6.036	5.962	10.000	59.615
ST+60	6.489	6.263	10.000	62.625
ST+70	6.611	6.550	10.000	65.500
ST+80	6.775	6.693	10.000	66.930
St+90	6.796	6.786	10.000	67.855
	6.796	6.796	15.331	104.189
total			105.331	655.069

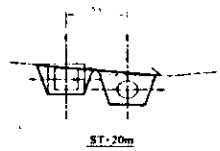
Ac= 655.069 x 1.2 = 786.08 m^2 | 786.08 m^2

5.2 Excavation (Clay-Sand-Cobbles)	ST+10.0m	



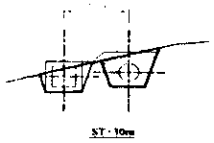
A= 4.289 m^2

ST+20.0m



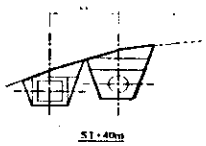
A= 5.440 m^2

ST+30.0m



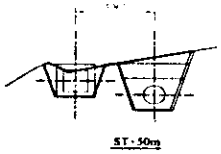
A= 5.220 m^2

ST+40.0m



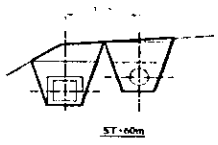
A= 9.050 m^2

ST+50.0m



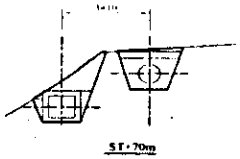
A= 7.905 m^2

ST+60.0m



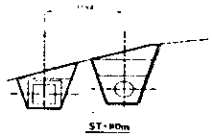
A= 13.023 m^2

ST+70.0m



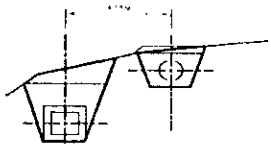
A= 8.235 m^2

ST+80.0m



A= 10.579 m^2

ST+90.0m

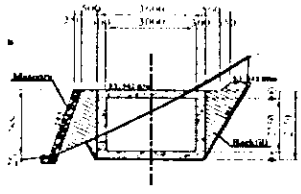


A= 10.781 m^2

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
ST	4.289			
ST+10	4.289	4.289	10.000	42.886
ST+20	5.440	4.864	10.000	48.641
ST+30	5.220	5.330	10.000	53.296
ST+40	9.050	7.135	10.000	71.348
ST+50	7.905	8.477	10.000	84.773
ST+60	13.023	10.464	10.000	104.638
ST+70	8.235	10.629	10.000	106.290
ST+80	10.579	9.407	10.000	94.071
ST+90	10.781	10.680	10.000	106.800
	10.781	10.781	15.331	165.279
total			105.331	878.022

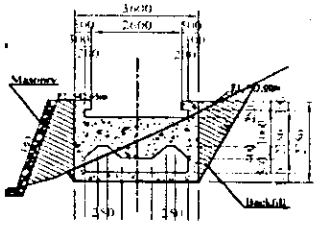
Energy Dissipater

B-B Section



A= 10.264 m^2

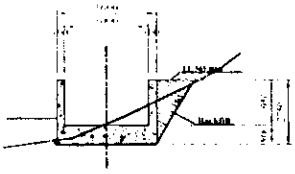
C-C Section



A= 7.084 m^2

D-D Section

A= 4.393 m^2



Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
B-B	10.264			
C-C	7.084	8.674	1.750	15.180
D-D	4.393	5.739	2.550	14.634
	4.393	4.393	0.300	1.318
total			4.600	31.132

V= 878.022 + 31.132 = 909.15 m^2

Excavation Clay-Sand- Cobble

Vc= 909.15 x 50% = 454.58 m^3 | 454.58 m^3

5.3 Excavation (Boulder)

Excavation Boulder

Vb= 909.15 x 40% = 363.66 m^3 | 363.66 m^3

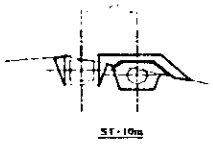
5.4 Excavation (Rock)

Excavation Rock

Vr= 909.15 x 10% = 90.92 m^3 | 90.92 m^3

5.5 Backfill

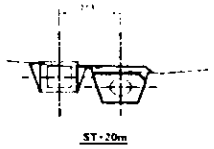
ST+10.0m



A= 1.975 m^2

Asand= 2.117 m^2

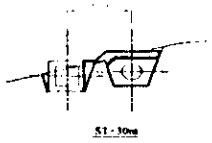
ST+20.0m



A= 1.361 m^2

Asand= 2.093 m^2

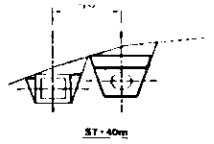
ST+30.0m



A= 1.297 m^2

Asand= 2.093 m^2

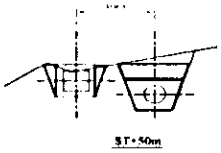
ST+40.0m



A= 1.960 m^2

Asand= 2.166 m^2

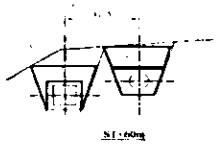
ST+50.0m



A= 2.448 m^2

Asand= 2.166 m^2

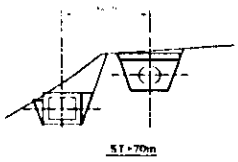
ST+60.0m



A= 5.571 m^2

Asand= 2.166 m^2

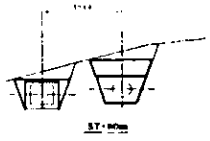
ST+70.0m



A= 1.275 m^2

Asand= 2.166 m^2

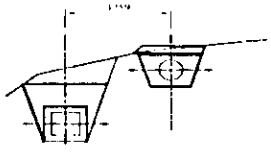
ST+80.0m



A= 3.222 m^2

Asand= 2.166 m^2

ST+90.0m



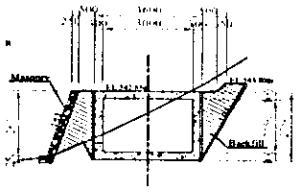
A= 3.970 m^2

Asand= 2.166 m^2

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
ST	1.975			
ST+10	1.975	1.975	10.000	19.753
ST+20	1.361	1.668	10.000	16.684
ST+30	1.297	1.329	10.000	13.292
ST+40	1.960	1.628	10.000	16.284
ST+50	2.448	2.204	10.000	22.041
ST+60	5.571	4.010	10.000	40.097
ST+70	1.275	3.423	10.000	34.231
ST+80	3.222	2.248	10.000	22.484
ST+90	3.970	3.596	10.000	35.960
	3.970	3.970	15.331	60.868
total			105.331	281.693

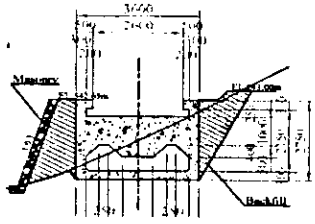
Energy Dissipater

B-B Section



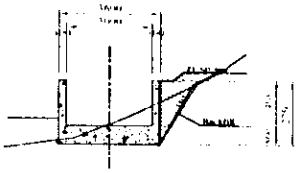
A= 4.165 m^2

C-C Section



A= 4.583 m^2

D-D Section



A= 2.314 m^2

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
B-B	4.165			
C-C	4.583	4.374	1.750	7.655
D-D	2.314	3.449	2.550	8.794
	2.314	2.314	0.300	0.694
total			4.600	17.143

V= 281.693 + 17.143 = 298.84 m^3 298.84 m^3

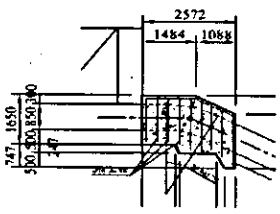
5.6 Sandfill

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
ST	2.117			
ST+10	2.117	2.117	10.000	21.173
ST+20	2.093	2.105	10.000	21.052
ST+30	2.093	2.093	10.000	20.930
ST+40	2.166	2.129	10.000	21.294
ST+50	2.166	2.166	10.000	21.658
ST+60	2.166	2.166	10.000	21.658
ST+70	2.166	2.166	10.000	21.658
ST+80	2.166	2.166	10.000	21.658
ST+90	2.166	2.166	10.000	21.658
	2.166	2.166	15.331	33.204
total			105.331	225.944

225.94 m^3

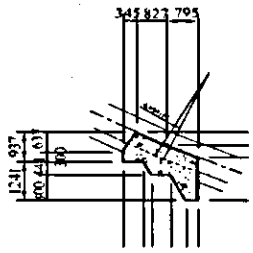
5.7 Concrete

No.1 Anchor Block



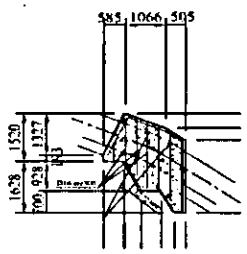
A= 4.534 m^2
B= 1.450 m
Penstock= -1.543 m^2
V= 5.031 m^3

No.2 Anchor Block



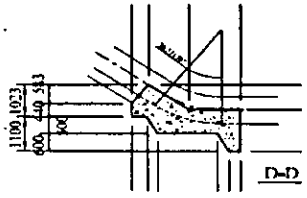
A= 2.033 m^2
B= 1.450 m
Penstock= -0.576 m^2
V= 2.373 m^3

No.3 Anchor Block



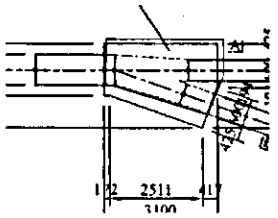
A= 3.922 m^2
B= 1.450 m
Penstock= -1.229 m^2
V= 4.458 m^3

No.4 Anchor Block



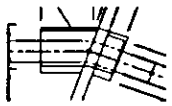
A= 2.722 m^2
B= 1.450 m
Penstock= -0.745 m^2
V= 3.203 m^3

No.5 Anchor Block



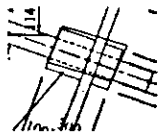
A= 5.785 m^2
H= 1.650 m
Penstock= -1.756 m^2
V= 7.789 m^3

No.6 Anchor Block



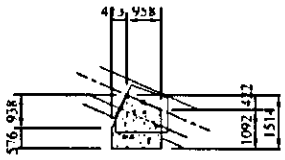
A= 2.195 m^2
H= 1.900 m
Penstock= -0.795 m^2
V= 3.375 m^3

No.7 Anchor Block



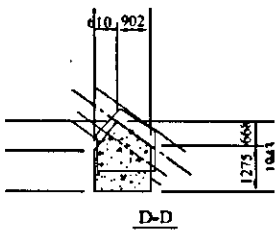
A= 1.800 m^2
H= 1.900 m
Penstock= -0.424 m^2
V= 2.996 m^3

No.1, 2 Thrust Block



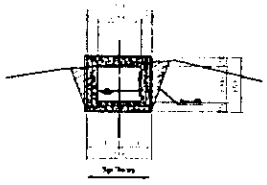
A= 1.680 m^2
B= 1.450 m
Penstock= -0.297 m^2
V= 2.140 m^3

No.3 Thrust Block



A= 2.385 m^2
B= 1.450 m
Penstock= -0.318 m^2
V= 3.140 m^3

Spillway



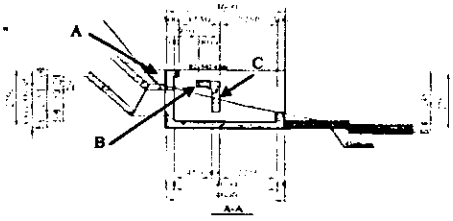
Area = 1.250 m^3/m
Length = 109.189 m
V= 136.486 m^3

Key Block

Type A	Area =	0.196	m^2
	Width =	1.500	m
	Unit =	7.0	units
	V=	2.060	m^3
Type B	Area =	0.920	m^2
	Width =	1.500	m
	Unit =	1.0	units
	V=	1.380	m^3
Type C	Area =	0.121	m^2
	Width =	1.500	m
	Unit =	2.0	units
	V=	0.363	m^3
Type D	Area =	0.822	m^2
	Width =	1.500	m
	Unit =	1.0	units
	V=	1.233	m^3
Type E	Area =	0.242	m^2
	Width =	1.500	m
	Unit =	7.0	units
	V=	2.540	m^3
Type F	Area =	0.794	m^2
	Width =	1.500	m
	Unit =	1.0	units
	V=	1.190	m^3
Type G	Area =	0.515	m^2
	Width =	1.500	m
	Unit =	2.0	units
	V=	1.544	m^3

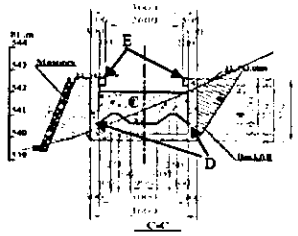
Key Block total = 10.309 m^3

Energy Dissipater



A
A= 2.331 m^2
B= 3.000 m
Inlet= -0.300 m^3
V= 6.694 m^3

B
A= 0.128 m^2
B= 3.000 m
V= 0.383 m^3



C
A= 3.680 m^2
B= 0.300 m
V= 1.104 m^3

D
A= 12.650 m^2
B= 0.300 m
V= 3.795 m^3

D
A= 0.120 m^2
B= 1.750 m
V= 0.210 m^3

Vc= 193.485 m^3 193.48 m^3

5.8 Reinforce bar

Anchor Block

No.1 D16
W= =2x9x1.7x1.0/0.3xπ x0.016^2/4x7850
= 160.990 kg

No.3 D16
W= =2x7x2.0x1.0/0.3xπ x0.016^2/4x7850
= 147.311 kg

No.5 D16
W= =2x11x1.45x1.0/0.3xπ x0.016^2/4x7850

= 167.830 kg

No.6 D16

W= =2x7x1.45x1.0/0.3xπ x0.016²/4x7850

= 106.801 kg

No.7 D16

W= =2x7x1.45x1.0/0.3xπ x0.016²/4x7850

= 106.801 kg

sub-total Wr1= 689.733 kg

Spillway

D16

w =4x1.3x1.0/0.3xπ x0.016²/4x7850

= 27.358 kg/m

L = 109.189 m

W16 = 2987.174 kg

D10

w =16xπ x0.010²/4x7850

= 9.865 kg/m

L = 109.189 m

W10 = 1077.106 kg

sub-total Wr2= 4064.280 kg

Energy Dissipater

Roof

D16

w =0.7x1.0/0.3xπ x0.016²/4x7850

= 3.683 kg/m

L = 5.266 m

W16 = 19.394 kg

D10

w =2xπ x0.010²/4x7850

= 1.233 kg/m

L = 5.266 m

W10 = 6.493 kg

Upstream wall

D16

w =5.2x1.0/0.3xπ x0.016²/4x7850

= 27.358 kg/m

L = 3.400 m

W16 = 93.017 kg

D10

w =22xπ x0.010²/4x7850

= 13.564 kg/m

L = 3.400 m

W10 = 46.117 kg

Side wall

D16

w =5.2x1.0/0.3xπ x0.016²/4x7850

= 27.358 kg/m

L = 4.000 m

W16 = 109.431 kg

D10

w =22xπ x0.010²/4x7850

= 13.564 kg/m

L = 4.000 m

W10 = 54.255 kg

Basement

D16

w =2*3.4x1.0/0.3xπ x0.016²/4x7850

= 27.358 kg/m

L = 4.000 m

W16 = 109.431 kg

D10

w =22xπ x0.010²/4x7850

= 13.564 kg/m

L = 4.000 m

W10 = 54.255 kg

Downstream wall

D16

w =1.3x1.0/0.3xπ x0.016²/4x7850

= 6.839 kg/m

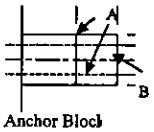
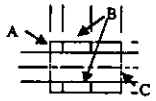
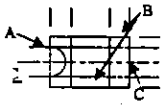
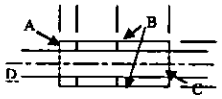
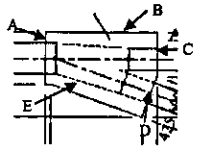
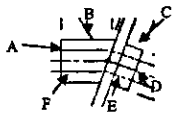
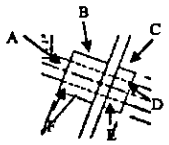
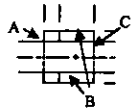
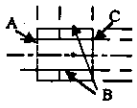
L = 3.400 m

W16 = 23.254 kg

D10

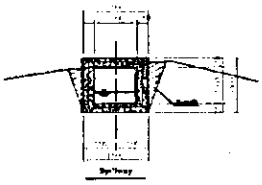
w =6xπ x0.010²/4x7850

= 13.564 kg/m

			L	=	3.400 m		
			W10	=	46.117 kg		
		Baffle wall					
			D16				
			w	=1.0xπ x0.016^2/4x7850			
				=	1.578 kg/m		
			L	=	67.776 m		
			W16	=	106.973 kg		
		Haunch					
			D10				
			w	=1.0π x0.010^2/4x7850			
				=	0.617 kg/m		
			L	=	23.950 m		
			W10	=	14.766 kg		
					sub-total Wr3=	683.504 kg	
					Wr=	5437.517 kg	5,437.52 kg
5.9	Form work	No.1 Anchor Block					
					A	9.068 m^2	
					B	2.054 m^2	
		No.2 Anchor Block					
					A	0.768 m^2	
					B	4.066 m^2	
					C	1.722 m^2	
		No.3 Anchor Block					
					A	1.815 m^2	
					B	7.844 m^2	
					C	2.773 m^2	
		No.4 Anchor Block					
					A	1.406 m^2	
					B	5.445 m^2	
					C	1.638 m^2	
		PL.					
		No.5 Anchor Block					
					A	1.825 m^2	
					B	5.115 m^2	
					C	1.729 m^2	
					D	1.729 m^2	
					E	4.693 m^2	
		No.6 Anchor Block					
					A	1.997 m^2	
					B	2.704 m^2	
					C	0.700 m^2	
					D	1.397 m^2	
					E	0.700 m^2	
					F	2.088 m^2	
		No.7 Anchor Block					
					A	1.997 m^2	
					B	24.700 m^2	
					C	0.700 m^2	
					D	1.397 m^2	
					E	0.700 m^2	
					F	1.900 m^2	
		No.1, 2 Thrust Block					
					A	2.038 m^2	
					B	3.360 m^2	
					C	1.300 m^2	
		No.32 Thrust Block					
					A	2.825 m^2	
					B	4.770 m^2	
					C	1.565 m^2	

Anchor Thrust Block total = 110.526 m^2

Spillway



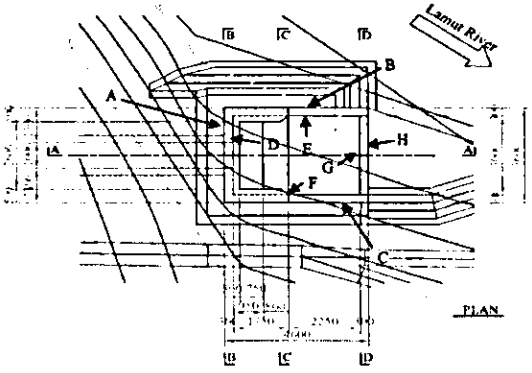
Area = 6.000 m^2/m
Length = 109.189 m
A= 655.134 m^2

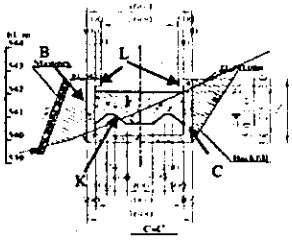
Key Block

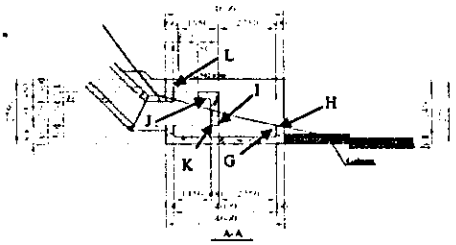
Type A	Area =	0.392	m^2
	Unit =	7.0	units
	A =	2.747	m^3
Type B	Area =	2.839	m^2
	Unit =	1.0	units
	A =	2.839	m^3
Type C	Area =	0.242	m^2
	Unit =	2.0	units
	A =	0.484	m^3
Type D	Area =	2.241	m^2
	Unit =	1.0	units
	A =	2.241	m^3
Type E	Area =	0.484	m^2
	Unit =	7.0	units
	A =	3.386	m^3
Type F	Area =	1.721	m^2
	Unit =	1.0	units
	A =	1.721	m^3
Type G	Area =	1.029	m^2
	Unit =	2.0	units
	A =	2.058	m^3

Key Block total = 15.475 m^3

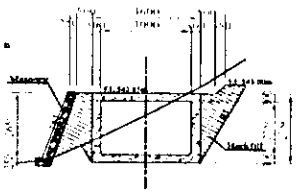
Energy Dissipater

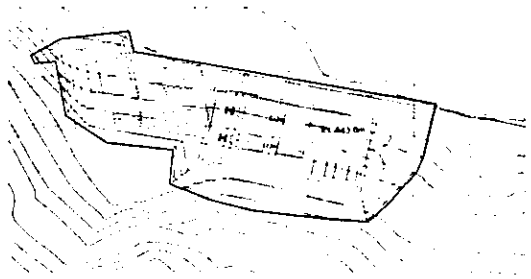
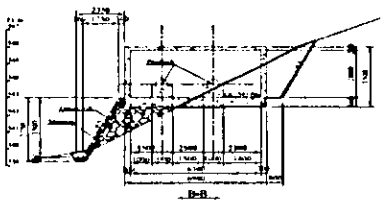
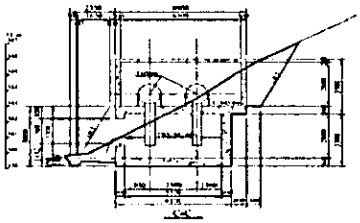
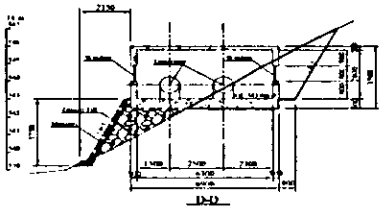






A	7.650	m^2
B	12.650	m^2
C	12.650	m^2
D	5.450	m^2
E	10.680	m^2
F	10.680	m^2
G	1.500	m^2
H	4.050	m^2
I	3.680	m^2
J	5.180	m^2
K	1.099	m^2
L	3.050	m^2
total	78.32	m^2

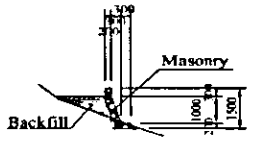
			Af= 859.454 m^2		859.45 m^3
5.10	Stone Masonry		A= 0.778 m^2 B= 6.898 m V= 5.368 m^3		5.37 m^3
5.11	Gabion	A= 8.717 m^2 H= 0.400 m Vg= 3.487 m^3			3.49 m^2
5.12	Steel Pipe	Diameter = 0.850 m Length = 118.532 m Thickness = 0.006 m Weight = π x 0.850 x 0.006 x 118.532 x 7850	14,908.20	kg	14908.20 kg
5.13	Steel Pipe for Air Pipe	L = 2.20 m Diameter = 0.20 m Unit = 3.0 Total length = 6.60 m			6.60 m

Contents	Calculation	Quantities
6. Powerhouse		
6.1 Clean and Grubbing		
	Ac= 299.30 x 1.2 = 359.16	359.16 m^2
6.2 Excavation (Clay-Sand-Cobbles)	Section B-B  A= 9.909 m^2	
	Section C-C  A= 31.143 m^2	
	Section D-D  A= 11.147 m^2	

Section	A (m^2)	Aav (m^2)	L (m)	dV (m^3)
B-B-0.75	9.909			
B-B+0.95	9.909	9.909	1.700	16.845
C-C-2.0	31.143	20.526	0.000	0.000
C-C+2.0	31.143	31.143	4.000	124.572
D-D-1.52	11.147	21.145	0.000	0.000
D-D+5.48	11.147	11.147	7.000	78.029
total				219.446

Opposite Bank Protection

A= 0.130 m^2
L= 150.0 m
V= 19.492 m^3



Opposite Bank Protection
L=150m

V= 219.446 + 19.492 = 238.938 m^3

Excavation Clay-Sand- Cobble

Vc= 238.94 x 30% = 71.68 m^3 | 71.68 m^3

6.3 Excavation (Boulder)

Excavation Boulder

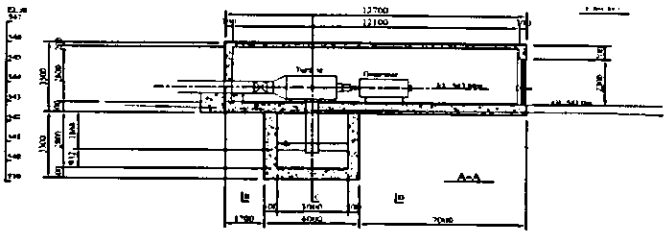
Vb= 238.94 x 50% = 119.47 m^3 | 119.47 m^3

6.4 Excavation (Rock)

Excavation Rock

Vr= 238.94 x 20% = 47.79 m^3 | 47.79 m^3

6.5	Rubble stone	A=	6.9	x	12.7	=	87.63 m^2	
		Thickness				=	0.300 m	
		V=	87.63	x	0.300	=	26.289 m^3	26.29 m^3
6.6	Concrete	Section A-A						

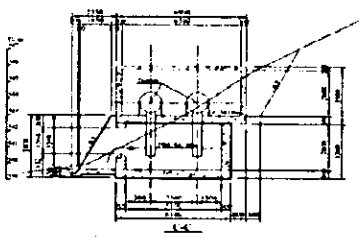


Outside volume = 12.70 x 6.90 x 3.50 =	306.705 m^3
Inside volume = - 12.10 x 6.30 x 2.80 =	-213.444 m^3
Door = - 2.30 x 0.30 x 3.00 =	-2.070 m^3
Window = - 2 x 2.00 x 0.90 x 0.30 =	-1.080 m^3
Penstock = - 2 x π x 0.60^2 /4 =	-0.565 m^3
Drafttube = - 2 x π x 0.50^2 /4 =	-0.393 m^3
Anchor Block = 2 x (0.80 x 1.00 x 1.80 -π x 0.60^2 /4 x 2) =	1.749 m^3

V = Outside - Inside - Door - Window - Penstock -Drafttube + Anchor Blo
= 90.902 m^3

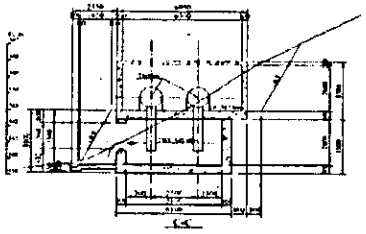
Tailrace

Upstream and Downstream Wal



A= 24.380 m^2
L= 1.000 m
V= 24.380 m^3

Sidewall and others



A= 5.554 m^2
L= 1.000 m
V= 5.554 m^3

Vc = 120.84 m^3 120.84 m^3

6.7 Reinforce bar

Roof

D20

w	=6.7x1/0.3xπ x0.020^2/4x7850	
	=	55.077 kg/m
L=	=	12.500 m
W20	=	688.467 kg

D10

w	=12.5x1/0.3xπ x0.010^2/4x7850	
	=	25.689 kg/m
L=	=	6.700 m
W10	=	172.117 kg

Wall

D20

w	=2x3.3x1/0.3xπ x0.020^2/4x7850	
	=	54.255 kg/m
L=	=	35.400 m
W20	=	1920.638 kg

D10

w	=24x1/0.3xπ x0.010^2/4x7850	
	=	49.323 kg/m
L=	=	35.400 m
W10	=	1746.034 kg

Basement

D20

w =2x6.7x1/0.3xπ x0.020²/4x7850
= 110.155 kg/m
L= = 12.500 m
W20 = 1376.934 kg

D10

w =2x12.5x1/0.3xπ x0.010²/4x7850
= 51.378 kg/m
L= = 6.700 m
W10 = 344.233 kg

Tailrace-Wall and basemen

D20

w =(3.6x4+3.8x2)x1/0.3xπ x0.020²/4x7850
= 180.851 kg/m
L= = 5.300 m
W20 = 958.510 kg

D10

w =66x1/0.3xπ x0.010²/4x7850
= 135.638 kg/m
L= = 5.300 m
W10 = 718.883 kg

Tailrace-Upstream wal

D20

w =(3.6x2)x1/0.3xπ x0.020²/4x7850
= 59.188 kg/m
L= = 3.800 m
W20 = 224.913 kg

D10

w =22x1/0.3xπ x0.010²/4x7850
= 45.213 kg/m
L= = 3.800 m
W10 = 171.808 kg

Tailrace-Outlet

D20

w =3.835x1/0.3xπ x0.020²/4x7850
= 31.526 kg/m
L= = 3.800 m
W20 = 119.797 kg

D10

w =11x1/0.3xπ x0.010²/4x7850
= 22.606 kg/m
L= = 3.800 m
W10 = 85.904 kg

Tailrace-Retainning wal

D20

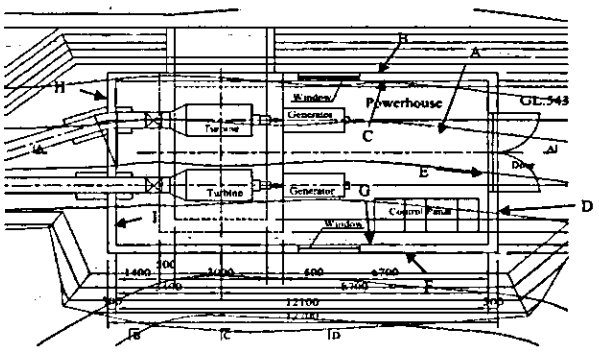
w =7.25x1/0.3xπ x0.020²/4x7850
= 59.599 kg/m
L= = 2.350 m
W20 = 140.057 kg

D10

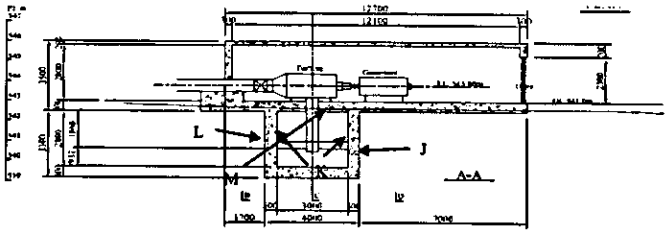
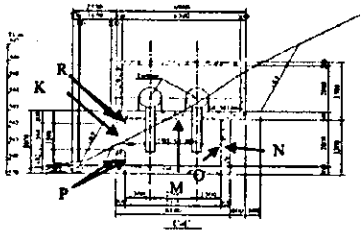
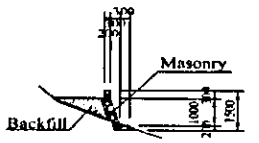
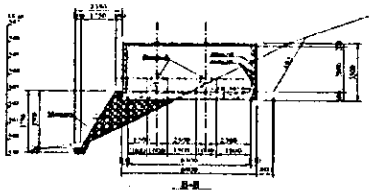
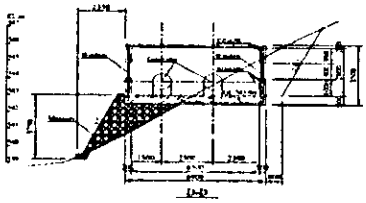
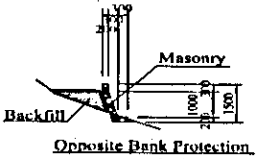
w =27x1/0.3xπ x0.010²/4x7850
= 55.488 kg/m
L= = 2.350 m
W10 = 130.398 kg

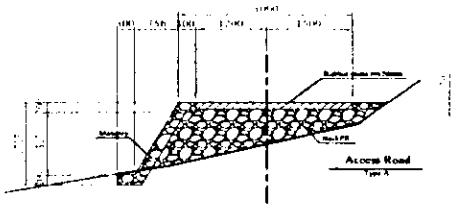
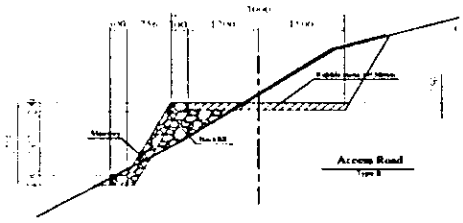
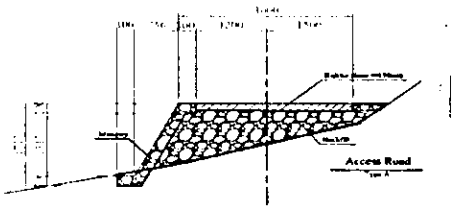
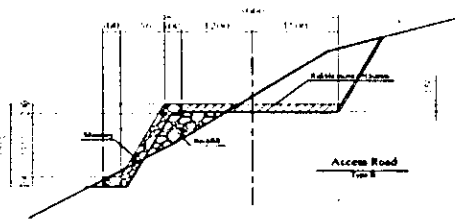
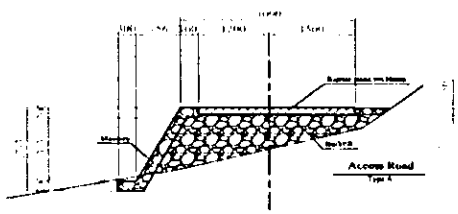
Wr= 8,798.69 kg 8,798.69 kg

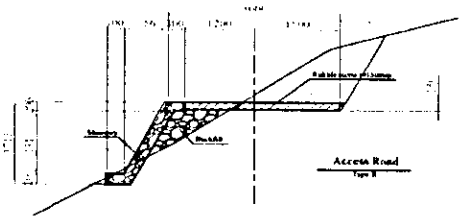
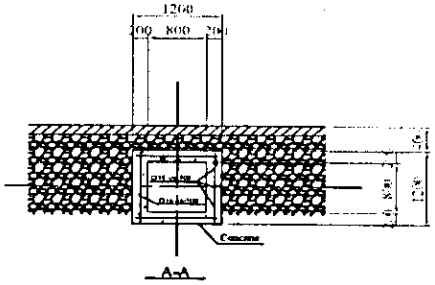
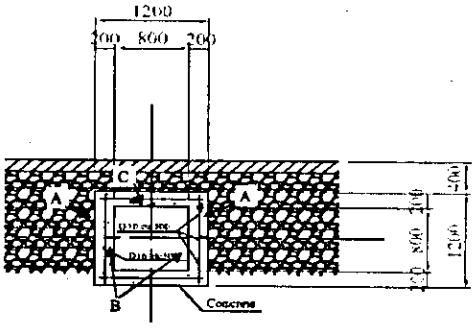
6.8 Form work



A	76.230 m²	F	42.650 m²
B	42.650 m²	G	32.080 m²
C	32.080 m²	H	23.585 m²

	D 17.250 m^2 E 10.740 m^2	I 17.075 m^2	
	 		
	 	J 24.380 m^2 K 37.803 m^2 L 24.380 m^2 M 14.907 m^2 N 13.200 m^2 O 8.400 m^2 P 5.592 m^2 R 3.300 m^2 Door 2.280 m^2 Window 2.280 m^2 Anchor 7.435 m^2	
		Af= 438.30 m^2	438.30 m^2
6.9 Backfill	Opposite Bank Protection		
	 Opposite Bank Protection L=150m	A= 0.692 m^2 L= 150.0 m V= 103.728 m^3	103.73 m^3
6.10 Stone Masonry			
	Section B-B 	A= 4.877 m^2 L= 1.700 m V= 8.291 m^3	
	Section D-D 	A= 5.453 m^2 L= 7.000 m V= 38.173 m^3	
	Opposite Bank Protection  Opposite Bank Protection L=150m	A= 0.364 m^2 L= 150.0 m V= 54.666 m^3	
		V= = 101.13 m^3	101.13 m^3
6.11 Steel Door	2.30m x 3.00m		1.00 unit
6.12 Steel Window	90cm x 200cm		2.00 unit

Contents		Calculation						Quantities
7.	Access Road							
7.1	Clean and Grubbing	Type A L=160m						
					dA=	4.957	m^2/m	
					L=	160.000	m	
					A=	793.120	m^2	
		Type B L=70m						
					dA=	5.969	m^2/m	
					L=	70.000	m	
					A=	417.830	m^2	
		Ac=	1,210.95	x	1.2 =	1453.14		1,453.14 m^2
7.2	Excavation (Clay-Sand-Cobbles)	Type A						
					Excavation			
					A=	0.143	m^2	
					L=	160.000	m	
					V=	22.857	m^3	
					Backfill			
					A=	2.429	m^2	
					L=	160.000	m	
					V=	388.660	m^3	
		Type B						
					Excavation			
					A=	2.021	m^2	
					L=	70.000	m	
					V=	141.500	m^3	
					Backfill			
					A=	0.474	m^2	
					L=	70.000	m	
					V=	33.162	m^3	
		V=	22.857	+	141.500	=	164.36 m^3	
		Excavation Clay-Sand- Cobble						
		Vc=	164.36	x	80% =	131.49	m^3	131.49 m^3
7.3	Excavation (Boulder)	Excavation Boulder						
		Vb=	164.36	x	20% =	32.87	m^3	32.87 m^3
7.4	Excavation (Rock)	Excavation Rock						
		Vr=	164.36	x	0% =	0.00	m^3	0.00 m^3
7.5	Backfill	Vb=	388.660	+	33.162	=	421.82 m^3	421.82 m^3
7.6	Stone Masonry	Type A						
					Stone Masonry			
					A=	0.458	m^2	
					L=	160.000	m	
					V=	73.328	m^3	
					Rubble Stone			
					A=	0.405	m^2	
					L=	160.000	m	
					V=	64.800	m^3	

		Type B		
			Stone Masonry A= 0.458 m² L= 70.000 m V= 32.081 m³ Rubble Stone A= 0.411 m² L= 70.000 m V= 28.744 m³	
		Vs= 73.328 + 32.081 = 105.41 m³		105.41 m³
7.7	Rubble stone	Vr= 64.800 + 28.744 = 93.54 m³		93.54 m³
7.8	Concrete	Culvert		
			A= 0.800 m² L= 4.900 m V= 3.920 m³	
			Vc= 3.92 m³	3.92 m³
7.9	Reinforce bar	D16		
		w = 2x(1.1+1.1)x1.0/0.3xπ x0.016²/4x785(= 23.149 kg/m		
		L = = 4.900 m		
		W16 = 23.149 x 4.900 = 113.430 kg		
		D10		
		w = 16x π x0.010²/4x7850 = 9.865 kg/m		
		L = = 4.900 m		
		W10 = 9.865 x 4.900 = 48.337 kg		
		W = 113.430 + 48.337 = 161.77 kg		161.77 kg
7.10	Form work		A 11.760 m² B 7.840 m² C 3.920 m² Inlet 0.800 m² Outlet 0.800 m²	
			Af = 25.12 m²	25.12 m²

Cost Details for Electro-mechanical Works and Transmission

Contents	Quantity	Unit	Cost (Peso)	Remark
Electro-mechanical Works				
Turbine	1.0	Ls	33,984,000	
Generator	1.0	Ls	16,461,000	
Controller	1.0	Ls	12,744,000	
Control Panel	1.0	Ls	10,620,000	
Circuit Panel	1.0	Ls	2,124,000	
Transformer	1.0	Ls	3,880,000	1. Transformer
Others	1.0	Ls	7,530,000	
Headtank Water Level Gauge	1.0	Ls	637,200	
Overseas Transportation, etc	1.0	Ls	2,017,800	
Supervise	1.0	Ls	2,124,000	
Reverse Power Control	1.0	Ls	531,000	
D.C. Power Supply	1.0	Ls	1,720,000	2. D.C. Power Supply
Inland Transportation, etc	1.0	Ls	250,000	
Cable Installation, etc	1.0	Ls	250,000	
Sub total	1.0	Ls	74,599,000	
Transmission				
Transmission Line	1.0	Ls	5,370,000	3. Transmission Line
Reinforcement of Substation	1.0	Ls	210,000	
Sub total	1.0	Ls	5,580,000	

1. Transformer

Items	Specification	Quantities	Unit Price (Peso)	Cost (Pesos)	Remarks
1.Steel pole				152,529	Estimation-1 A.1
2. Substation					
(1) Main transformer	13.2kV/400V 333kVA	3.0	449,295	1,347,885	Estimation-1 B.2
(2) Other materials	20kV	1.0		760,397	Estimation-1 B.1
Sub-total				2,108,282	
3. Labor cost					
(1) Steel pole		1.0		45,759	Estimation-1 A.2
(2) Substation		1.0		527,071	25% of 2.
Sub-total				572,829	
4. Transportation		1.0		150,000	Estimation-1 C.
5. Contingency		1.0		298,364	10% of above
6. VAT		1.0		393,841	12% of above
7. Foundation and Fence		1.0		200,000	Estimation-1 D.
				3,875,845	
Total				**3,880,000**	

2. D.C. Power Supply

Items	Specification	Quantities	Unit Price (Peso)	Cost (Pesos)	Remarks
1.Battery	200kW	1.0		205,000	Estimation-1 B.3
2. Charger	200kW	1.0		71,300	Estimation-1 B.3
3. Labor cost	200kW	1.0		69,075	25% of above
4. Contingency	200kW	1.0		34,538	10% of above
5. VAT	200kW	1.0		45,590	12% of above
				425,502	
	810kW			1,723,283	Capacity ratio
Total				**1,720,000**	

3. Transmission Line

Items	Specification	Quantities	Unit Price (Peso)	Cost (Pesos)	Remarks
1.Reinfocement of existing line	from No.24 pole, 5.5km				
(1) Materials		1.0		2,012,254	Estimation-3
(2) Labor cost		1.0		323,526	Estimation-3
(3) Contingency		1.0		100,613	Estimation-3
(4) Service Charge		1.0		121,820	Estimation-3
Sub-total				2,558,213	
2. Connection line	from No.24 pole to P/S, 1.0km	1.0			
(1) Materials		1.0		572,546	Estimation-2
(2) Labor cost		1.0		81,202	Estimation-2
(3) Contingency		1.0		28,627	Estimation-2
(4) Service Charge		1.0		34,119	Estimation-2
Sub-total				716,494	
3. Communication line		1.0		2,100,000	
				5,374,707	
Total				**5,370,000**	

IFUGAO ELECTRIC COOPERATIVE, INC.
Lagawe, Ifugao

Project: Likud Mini Hydro Power Substation
Location: Likud, Mappit, Kiangan, Ifugao

A.1 Substation Tower,
Material Cost:

	Particulars	Qntity	Unit	Unit Price	Amount
1	Steel pole, 35 Ft	3	pcs	18,135.04	54,405.12
2	Cross-arm, Steel , 8ft	8	pcs	2,200.00	17,600.00
3	Suspension insulator, 10" diam	18	pcs	325.77	5,863.86
4	Ball Clevis, for 10" sus-insulator	150	pcs	136.00	20,400.00
5	Eye Socket, for 10" sus-insulator	150	pcs	123.00	18,450.00
6	Clamp, strain type, for 2/0 ACSR	13	pcs	701.13	9,114.69
7	Clamp, loop dead end, for 2/0 ACSR	20	pcs	181.43	3,628.60
8	Double Arming Bolt, 5/8 x 22"	15	pcs	59.45	891.75
9	Machine bolt, 5/8' x 10"	1	pc	75.90	75.90
10	Eye nut, 5/8	9	pcs	74.11	666.99
11	Clevis swinging	1	pcs	94.01	94.01
12	Spool Insulator, 3"diam	1	pcs	43.51	43.51
13	Eye bolt, 5/8 x 12	3	pcs	55.79	167.37
14	Nut, 5/8	22	pcs	74.11	1,630.42
15	Washer, 1/4"x2"x2" , 5/8" hole	22	pcs	11.36	249.92
16	Steel Brace,	2	pcs	181.32	362.64
17	Carriage bolt, 4"	2	pcs	20.39	40.78
18	Clamp, Hot line , 2/0	9	pcs	287.84	2,590.56
19	Guy Malleable	1	pc	135.30	135.30
20	Guy wire	50	ft	26.26	1,313.00
21	Anchor Expanding, 8Ways	1	pc	942.93	942.93
22	Anchor rod, Thimble Eye	1	pc	564.33	564.33
23	Conductor, 2/0 ACSR	35	m	58.93	2,062.55
24	Grounding rod, 5/8" x7'	21	pc	500.00	10,500.00
25	Grounding Clamp	21	pc	35.00	735.00
				Material Cost =	152,529.23

Note: Ball Clevis/Eye Socket are included for 3ph Line.

A.2	Labor Cost: 30% of Material Cost, (A)		45,758.77
		Total Cost, (A)=	198,288.00

B.1 Metering, Lightning Arrester, PT, CT

	Particulars	Qntity	Unit	Unit Price	Amount
1	GE KV2C meter, 3Ph, Electronic Programmed, Input-Output(4-NGCP)	1	set	50,000.00	50,000.00
2	GE KV2C meter, 3Ph, Electronic(LMHPP)	1	set	35,000.00	35,000.00
3	L .A. , 20KV, Substation Type w/ clamps	3	set	11,100.00	33,300.00
4	P.T., 70:1, w/ Clamps	3	set	44,992.00	134,976.00
5	C.T., 50:5, w/ clamps	3	set	44,992.00	134,976.00
6	C.T., 100:5, w/ clamps,Indoor type, w/ CT Box for Ground Relay	1	set	20,000.00	20,000.00
7	Load Break Switch(LBS), 3Ph, 24KV	1	set	276,159.00	276,159.00
8	Power Fuse, 200A, Chance	6	pcs	11,200.00	67,200.00
9	Fuse Link,25A	6	pcs	134.40	806.40
10	Machine bolt 1/4" x 5"	36	pcs	50.00	1,800.00
11	PVC Pipe, Orange, 1"	4	pcs	150.00	600.00
12	PVC adoptor, 1"	12	pcs	35.00	420.00
13	PVC Elbow, 1"	4	pcs	35.00	140.00
14	Meter box	1	pc	2,500.00	2,500.00
15	3.5 mmSQ THHN Cu. Wire Colored	56	m	45.00	2,520.00
				Material Cost,(B.1)=	760,397.40

B.2	Substation Transformer				
	Particulars	Qntity	Unit	Unit Price	Amount
	1-MVA, Transfomer, 440V/7620V/ 13.2 KV L-L w/ Terminal Clamps	1	set	921,111.00	921,111.00
	333KVA Transformer,440V/7620V	3	pcs	449,295.00	1,347,885.00
B.3	Battery & Charger				
	Battery, wet cell, 2V w/ Batter Rack (13 pcs)	1	set	205,000.00	205,000.00
	Battery Charger, 240V-Input 24VDC-Output	1	set	71,300.00	71,300.00
				Material Cost, (B)=	2,384,582.40
B.4	Labor Cost: 25 % Material Cost (B)				596,145.60
				Total Cost, (B)=	2,980,728.00
C.	Hauling & Delivery to the site: (A & B)				150,000.00
				Total Cost, (A+B+C)=	3,329,016.00
				Incidental Cost, 10%=	332,901.60
				Sub-Total=	3,661,917.60
				Taxes, 12%=	439,430.11
				Grand Total Cost (A+B+C+ ic+taxes)=	4,101,347.71
D.	Substation Pad & Fence: (Note: referred to Civil Engineer since its Civil Works)				200,000.00
				Project Cost,(GTC + D)=	4,301,347.71

Prepared by:	Checked by:	Noted by:
YPUGGO T. TUGUINAY	CHESTER D. BELERAN	JAIME PE BENITO, JR.
OP/D Div. Chief	TSD Manager	General Manager

IFUGAO ELECTRIC COOPERATIVE,INC.
Lagawe,Ifugao

PROJECT:PROPOSSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
LOCATION:MAPPIT, KIANGAN ,IFUGAO (From Power Station To Pole # 24)
SUBJECT: TOTAL COST ESTIMATES

1. MATERIAL COST:

NEA CODE NO.	DESCRIPTION	UNIT COST (PESOS)	PROJECT REQ'MNTS.	EXTENDED COST
0093 38 10	Anchor, Expanding, 10,000 Pounds, 8 Way, Galvanized Steel	942.93	11	10,372.23
0215 02 00	Attachment, Guy, Malleable Type With 11/16" Hole Diameter	135.30	11	1,488.30
0631 03 04	Bolt, Carriage 3/8" X 4-1/2"	20.39	16	326.17
0633 05 22	Bolt, Double Arming, 5/8" X 22"	59.45	3	178.35
0633 05 24	Bolt, Double Arming, 5/8" X 24"	57.03	15	855.45
0636 15 12	Bolt, Oval Eye, 5/8" X 12"	55.79	21	1,171.59
0636 15 18	Bolt, Oval Eye, 5/8" X 18"	189.90	12	2,278.83
0638 04 06	Bolt, Machine, 1/2" X 6"	38.59	8	308.71
0638 05 08	Bolt, Machine, 5/8" X 8"	41.27	15	619.05
0638 05 12	Bolt, Machine, 5/8" X 12"	81.83	8	654.63
0638 05 14	Bolt, Machine, 5/8" X 14"	90.07	6	540.42
0753 51 28	Brace, Crossarm, 28" Steel or Wood (Each)	181.32	16	2,901.06
0753 51 68	Brace, Crossarm, 60" - 18" Drop (Pair)	1231.60	4	4,926.40
0780 45 00	Bracket, Clevis Deadend Without Spool	289.90	3	869.70
1141 19 10	Clamp, Hot Line, #2 - #4/0 ACSR Main to #2 - #4/0	287.84	6	1,727.04
1171 11 10	Clamp, Anchor Rod Bonding, Single Eye	51.27	11	563.97
1172 10 25	Clamp, Loop Deadend, #6 to #2/0 ACSR	181.43	18	3,265.74
1172 33 35	Clamp, Deadend Strain, #4 - #4/0 ACSR	701.13	27	18,930.51
1173 22 91	Clamp, Guy Straight, 3 Bolt Heavy Duty Steel	273.06	22	6,007.32
1230 12 01	Clevis, Secondary Swinging Without Spool	94.01	9	846.09
1230 28 00	Shackle, Anchor, Forged Steel, Galvanized	93.71	12	1,124.52
1260 10 00	Clip, Groundwire	8.75	15	131.25
1511 20 61	Conductor, Bare, ACSR #2/0, AWG, 6/1 (MTS.)	58.93	3896	229,591.28
1701 16 39	Connector, Compression, #6 - #1/0 ACSR Run To #6 -#2	62.00	37	2,294.12
1731 00 30	Connector, Ground Rod (Clamp) For 5/8" Steel Rod	303.61	3	910.83
1765 16 57	Connector, Split Bolt	353.75	3	1,061.25
3422 31 10	Insulator, Pin Type, Porcelain,ANSI Class 55-5	180.00	20	3,600.00
3426 40 11	Insulator, Spool, 3", ANSI Class 53 - 4	43.51	12	522.12
3428 10 11	Insulator, Suspension, 10"	325.77	54	17,591.58
4290 10 63	Nut, Eye, 5/8" Conventional	74.11	27	2,000.97
4290 30 38	Nut, Lock, Mf Type, 3/8"	3.50	16	56.00
4290 30 50	Nut, Lock, Mf Type, 1/2"	4.50	8	36.00
4290 30 63	Nut, Lock, Mf Type, 5/8"	10.84	105	1,138.20
4541 21 51	Pin, Crossarm, Long Shank, 1" Thread Diameter	138.71	12	1,664.52
4561 21 20	Pin, Pole Top, Channel, 1" Thread, 20" Long	200.80	8	1,606.40
5361 85 07	Rod, Anchor, Threaded, Single Eye, 5/8" X 7'	564.33	11	6,207.63
5371 70 21	Rod, Armor, Preformed For #2 ACSR, Single Set	255.13	5	1,275.65
5371 70 22	Rod, Armor, Preformed For #2 ACSR, Double Set	367.41	9	3,306.71
5371 70 23	Rod, Tapping, Preformed For #2 ACSR	139.63	6	837.78
5386 85 10	Rod, Ground Steel, Galvanized, 5/8" X 10'	376.48	3	1,129.43
5550 44 40	Lag, Screw, 1/2" X 4"	14.05	8	112.39
6000 75 01	Spacer, Pipe, 3/4" X 1-1/2"	15.20	6	91.20
6066 59 19	Splice, Preformed, Full Tension For #2 ACSR	158.84	1	158.84
6180 28 10	Staple, Groundwire, 1/2" X 2" (Pounds)	62.16	5.025	312.34
7102 04 51	Washer, Square, Flat 2-1/4" X 2-1/4" X 3/16", 13/16" Diameter Hole	11.36	109	1,238.24
7103 59 31	Washer, Round, 1-3/8" Diameter With 9/16" Diameter Hole	7.28	8	58.20
7232 04 01	Wire, Tie, Aluminum Alloy, Soft, #4 AWG (Ft.)	13.53	324	4,382.62
7232 00 20	Wire, Tape, Armor, Aluminum Alloy, 0.5 " X 0.3" (Ft.)	12.69	14	177.63
7232 04 03	Wire, Grounding, Aluminum Alloy, 3 Strand, #4 AWG (Ft.)	13.06	90	1,175.80
7383 83 07	Wire, Guy, Steel, 3/8", 7 Strand (Ft.)	26.26	550	14,440.36
		SUB-TOTAL		357,065.42

2. TIMBER MATERIAL

1826 01 11	Crossarm, Steel, 3-1/2" X 4-1/2" X 8'	2200.00	32	70,400.00
	Steel Pole, 35ft., STD	18135.04	8	145,080.32
		SUB-TOTAL		215,480.32
		TOTAL MATERIAL COST		572,545.74

3. Labor Cost Per Assembly Units

ASSEMBLY UNITS	QUANTITY	UNIT PRICE	EXTENDED COST
I. POLE TOP ASSEMBLY UNITS			
C2	3	1904.00	5,712.00
C4-1	2	1683.00	3,366.00
C7	1	1547.00	1,547.00
C8	2	2380.00	4,760.00
		Sub – Total	15,385.00
III. GROUNDING ASSEMBLY UNITS			
M2-1A	3	425.00	1,275.00
M2-9	12	170.00	2,040.00
		Sub – Total	3,315.00
IV. GUY ASSEMBLY UNITS			
E1-2	11	306.00	3,366.00
		Sub – Total	3,366.00
V. ANCHOR ASSEMBLY UNITS			
F1-2	11	442.00	4,862.00
		Sub – Total	4,862.00
VIII. POLE			
35 Ft.	8	3009.00	24,072.00
		Sub – Total	24,072.00
IX. CONDUCTOR ASSEMBLY BARE			
#2/0, AWG, ASCR	3.9	7752.00	30,201.79
		Sub-Total	30,201.79
		TOTAL LABOR COST	81,201.79

Summary of Evaluation :

Total Material Cost	PHP	572,545.74
Total Labor Cost	PHP	81,201.79
Contingency (5% of TMC)	PHP	28,627.29
Service Charge (5% of TMC, Contingency & TLC)	PHP	34,118.74
TOTAL	PHP	716,493.56

4. Total Evaluated Cost : PHP 716,493.56

Prepared by:

YPUGGO T. TUGUINAY
OP/D Division Chief

Checked by:

CHESTER D. BELERAN
TSD Manager

Approved by:

JAIME PE BENITO,JR.
General Manager

SKETCH

N

SEE SHEET NO. 1

SEE ATTACHED SKETCH

IFUGAO ELECTRIC COOPERATIVE, INC.
Lagawe, Ifugao
Address

STAKING SHEET

PRIMARY CONDUCTOR #2 ACSR
NEUTRAL CONDUCTOR #2 ACSR
RULING SPAN ____ METERS

PROJECT PROPOSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
SUBSTATION
LOCATION BARANGAY MAPPIT, KIANGAN, IFUGAO

SHEET NO. 1
OF 1
MAP REF.

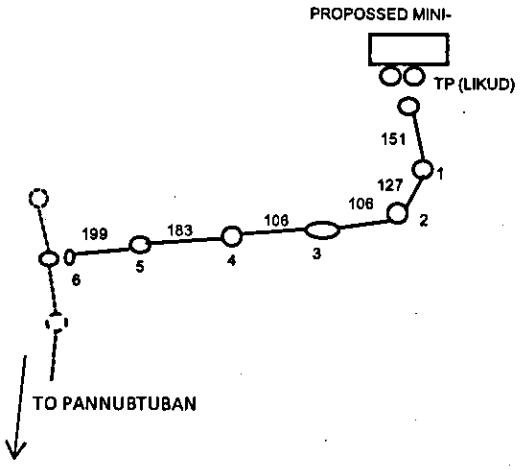
Project No. ____ (c)
Checked by
Date
Released by
Date

Page No. ____ (c)
Staked by
Date ____ (5)
Final Inv. by
Date ____ (8)

POLE NO.	PRI. BACK SPAN MTRS.	POLE			PRI. P. TOP UNIT (A.B.C.)		ANGLE	TRANS FORMER "G"		GRND "M"		GUY "E"		LEAD	ANC. "F"		SECONDARY					SERVICE					MISC. UNITS "M"		RIGHT OF WAY "RI"		CONS		REMARKS
																	SPAN MTRS	2W or UB	WIRE SIZE	NO	"J"	DROP MTRS	NO	SIZE	NO	"K"						
	Q	C	Q	H	C	Q	CODE	E	Q	CODE	Q	CODE	Q	CODE	M	Q	CODE	Q	C		Q	CODE	Q	Q		Q	CODE	Q	CODE	Q	CODE	Computer Coding
TP	0		1	35		1	C8				2	M2-9	2	E1-2		2	F1-2											1	M5-10				Taping pole w/ LBS
											1	M2-1A																				
1	122		1	35		1	C4				2	M2-9	2	E1-2		2	F1-2																
2	127		1	35		1	C4				2	M2-9	2	E1-2		2	F1-2																
3	106		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2																
											1	M2-1A																						
4	106		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2																
5	183		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2																
6	199		1	35		1	C8				2	M2-9	2	E1-2		2	F1-2																
7	4		1	35		1	C2/C7				1	M2-9	1	E1-2		1	F1-2																Connection point
											1	M2-1A																				

	QUAN	PH	Q	HT	CL	Q	CODE		Q	CODE	Q	CODE	Q	CODE		Q	CODE	QTY	CD	SIZE	Q	CODE				Q	CODE	Q	CODE	Q	CODE	QUANTITY	CODE	
	847						C1			G-		M2-		E			F			D						K		M		Ri		R		D	ACSR
		3φ				3	C2				12	9	11	1-2		11	1-2		OS								5-10				C		D	ACSR
			8	35	std		C3				3	1A																			PB			
						2	C4												1UB												LP			
						1	C7																								IR		N	INS
						2	C8																								SL		D	DUP

SUBJECT: PROPOSSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
SKETCH PLAN
LOCATION: BARANGAY MAPPIT, KIANGAN, IFUGAO



LEGEND:

Three Phase Line	———
Pole	O
Back Span (meters)	###

IFUGAO ELECTRIC COOPERATIVE,INC.
Lagawe,Ifugao

PROJECT:PROPOSSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
LOCATION:MAPPIT, KIANGAN ,IFUGAO (From Pole # 24 To Existing Three Phase Line)
SUBJECT: TOTAL COST ESTIMATES

1. MATERIAL COST:

NEA CODE NO.	DESCRIPTION	UNIT COST (PESOS)	PROJECT REQ'MNTS	EXTENDED COST
0093 38 10	Anchor, Expanding, 10,000 Pounds, 8 Way, Galvanized Steel	942.93	55	51,861.15
0215 02 00	Attachment, Guy, Malleable Type With 11/16" Hole Diameter	135.30	55	7,441.50
0631 03 04	Bolt, Carriage 3/8" X 4-1/2"	20.39	138	2,813.20
0633 05 22	Bolt, Double Arming, 5/8" X 22"	59.45	12	713.40
0633 05 24	Bolt, Double Arming, 5/8" X 24"	57.03	93	5,303.79
0636 15 12	Bolt, Oval Eye, 5/8" X 12"	55.79	88	4,909.52
0636 15 18	Bolt, Oval Eye, 5/8" X 18"	189.90	28	5,317.28
0638 04 06	Bolt, Machine, 1/2" X 6"	38.59	32	1,234.85
0638 05 08	Bolt, Machine, 5/8" X 8"	41.27	71	2,930.17
0638 05 10	Bolt, Machine, 5/8" X 10"	75.90	30	2,277.00
0638 05 12	Bolt, Machine, 5/8" X 12"	81.83	54	4,418.78
0638 05 14	Bolt, Machine, 5/8" X 14"	90.07	61	5,494.24
0639 05 10	Bolt, Single Upset, 5/8" X 10"	82.73	15	1,240.98
0753 51 28	Brace, Crossarm, 28" Steel or Wood (Each)	181.32	138	25,021.65
0753 51 68	Brace, Crossarm, 60" - 18" Drop (Pair)	1,231.60	16	19,705.62
0780 45 00	Bracket, Clevis Deadend Without Spool	289.90	23	6,667.70
1141 19 10	Clamp, Hot Line, #2 - #4/0 ACSR Main to #2 - #4/0	287.84	9	2,590.56
1171 11 10	Clamp, Anchor Rod Bonding, Single Eye	51.27	55	2,819.85
1172 10 25	Clamp, Loop Deadend, #6 to #2/0 ACSR	181.43	52	9,434.36
1172 33 35	Clamp, Deadend Strain, #4 - #4/0 ACSR	701.13	78	54,688.14
1173 22 91	Clamp, Guy Straight, 3 Bolt Heavy Duty Steel	273.06	110	30,036.60
1174 22 19	Clamp, Suspension, Alumunum Alloy Clevis, 2 Bolts #2 ACSR Max.	599.82	33	19,794.06
1230 12 01	Clevis, Secondary Swinging Without Spool	94.01	37	3,478.37
1230 28 00	Shackle, Anchor, Forged Steel, Galvanized	93.71	61	5,716.31
1260 10 00	Clip, Groundwire	8.75	71	621.25
1511 10 61	Conductor, Bare, ACSR #1/0, AWG. 6/1 (MTS.)	58.93	8752	515,755.36
1701 16 39	Connector, Compression, #6 - #1/0 ACSR Run To #6 -#2	62.00	181	11,222.58
1731 00 30	Connector, Ground Rod (Clamp) For 5/8" Steel Rod	303.61	5	1,518.05
1765 16 57	Connector, Split Bolt	353.75	5	1,768.75
3422 31 10	Insulator, Pin Type, Porcelain,ANSI Class 55-5	180.00	191	34,380.00
3426 20 11	Insulator, Spool, 1-3/4", ANSI Class 53 - 2	43.09	15	646.35
3426 40 11	Insulator, Spool, 3", ANSI Class 53 - 4	43.51	60	2,610.60
3428 10 11	Insulator, Suspension, 10"	325.77	222	72,320.94
4290 10 63	Nut, Eye, 5/8" Conventional	74.11	88	6,521.68
4290 30 38	Nut, Lock, Mf Type, 3/8"	3.50	138	483.00
4290 30 50	Nut, Lock, Mf Type, 1/2"	4.50	32	144.00
4290 30 63	Nut, Lock, Mf Type, 5/8"	10.84	623	6,753.32
4541 21 51	Pin, Crossarm, Long Shank, 1" Thread Diameter	138.71	122	16,922.62
4561 21 20	Pin, Pole Top, Channel, 1" Thread, 20" Long	200.80	69	13,855.20
5361 85 07	Rod, Anchor, Threaded, Single Eye, 5/8" X 7'	564.33	55	31,038.15
5371 70 21	Rod, Armor, Preformed For #2 ACSR, Single Set	255.13	135	34,442.55
5371 70 22	Rod, Armor, Preformed For #2 ACSR, Double Set	367.41	69	25,351.43
5371 70 23	Rod, Tapping, Preformed For #2 ACSR	139.63	9	1,256.67
5386 85 10	Rod, Ground Steel, Galvanized, 5/8" X 10'	376.48	5	1,882.38
5550 44 40	Lag, Screw, 1/2" X 4"	14.05	69	969.39
6000 75 01	Spacer, Pipe, 3/4" X 1-1/2"	15.20	46	699.20
6066 59 19	Splice, Preformed, Full Tension For #2 ACSR	158.84	6	953.06
6180 28 10	Staple, Groundwire, 1/2" X 2" (Pounds)	62.16	17.575	1,092.42
7102 04 51	Washer, Square, Flat 2-1/4" X 2-1/4" X 3/16", 13/16" Diameter Hole	11.36	669	7,599.84
7103 59 31	Washer, Round, 1-3/8" Diameter With 9/16" Diameter Hole	7.28	32	232.80
7232 04 01	Wire, Tie, Aluminum Alloy, Soft, #4 AWG (Ft.)	13.53	2604	35,223.28
7232 00 20	Wire, Tape, Armor, Aluminum Alloy, 0.5 " X 0.3" (Ft.)	12.69	36	456.77
7232 04 03	Wire, Grounding, Aluminum Alloy, 3 Strand, #4 AWG (Ft.)	13.06	150	1,959.66
7383 83 07	Wire, Guy, Steel, 3/8", 7 Strand (Ft.)	26.26	2750	72,201.80
		SUB-TOTAL		1,176,792.18

2. TIMBER MATERIAL

1826 01 11	Crossarm, Steel, 3-1/2" X 4-1/2" X 8'	2,200.00	83	182,600.00
	Steel Pole, 35ft.., STD	18,135.04	36	652,861.44
		SUB-TOTAL		835,461.44
		TOTAL MATERIAL COST		2,012,253.62

3. Labor Cost Per Assembly Units

ASSEMBLY UNITS	QUANTITY	UNIT PRICE	EXTENDED COST
I. POLE TOP ASSEMBLY UNITS			
C1	15	867.00	13,005.00
C2	23	1,904.00	43,792.00
C3	11	527.00	5,797.00
C4-1	3	1,683.00	5,049.00
C7	4	1,547.00	6,188.00
C8	8	2,380.00	19,040.00
		Sub - Total	92,871.00
III. GROUNDING ASSEMBLY U	71		
M2-1A	5	425.00	2,125.00
M2-9	66	170.00	11,220.00
		Sub - Total	13,345.00
IV. GUY ASSEMBLY UNITS			
E1-2	55	306.00	16,830.00
	55	Sub - Total	16,830.00
	55		
V. ANCHOR ASSEMBLY UNITS			
F1-2	55	442.00	24,310.00
	55		
	55	Sub - Total	24,310.00
VIII. POLE			
35 Ft.	36	3,009.00	108,324.00
		Sub - Total	108,324.00
IX. CONDUCTOR ASSEMBLY			
BARE			
#2/0, AWG, ASCR	8.752	7,752.00	67,845.50
	71	TOTAL LABOR COST	323,525.50

Summary of Evaluation :

Total Material Cost	PHP	2,012,253.62
Total Labor Cost	PHP	323,525.50
Contingency (5% of TMC)	PHP	100,612.68
Service Charge (5% of TMC, Contingency & TLC)	PHP	121,819.59
TOTAL	PHP	2,558,211.40

4. Total Evaluated Cost : PHP 2,558,211.4

Prepared by:	Checked by:	Approved by:
YPUGGO T. TUGUINAY	CHESTER D. BELERAN	JAIME PE BENITO,JR.
OP/D Division Chief	TSD Manager	General Manager

SKETCH

N

SEE SHEET NO.

SEE ATTACHED SKETCH

IFUGAO ELECTRIC COOPERATIVE, INC.
Lagawe, Ifugao
Address

STAKING SHEET

SHEET NO. 1
OF 4
MAP REF.

Project No. _____ (c) Page No. (c)
Checked by _____ Staked by _____
Date _____ Date (5)
Released by _____ Final Inv. by _____
Date _____ Date (8)

PRIMARY CONDUCTOR #2 ACSR PROJECT PROPOSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
NEUTRAL CONDUCTOR #2 ACSR SUBSTATION
RULING SPAN _____ METERS LOCATION BARANGAY MAPPIT, KIANGAN, IFUGAO

POLE NO.	PRI. BACK SPAN MTRS.	POLE			PRI. P. TOP UNIT (A.B.C.)		ANGL	TRANS FORMER "G"	GRND "M"		GUY "E"		LEAD	ANC. "F"		SECONDARY					SERVICE					MISC. UNITS "M"		RIGHT OF WAY "RI"		CONS		REMARKS
																SPAN MTRS.	2W or UB	WIRE SIZE	NO	"J"	DROP MTRS.	NO	SIZE	NO	"K"							
	Q	C	Q	H	C	Q	CODE	E	Q	CODE	Q	CODE	Q	CODE	M	Q	CODE	Q	C		Q	CODE	Q	Q		Q	CODE	Q	CODE	Q	CODE	Q	CODE	Computer Coding
TP	0		1	35		1	C8				2	M2-9	2	E1-2		2	F1-2															
											1	M2-1A																				
1	4		1	35		1	C3				1	M2-9	1	E1-2		1	F1-2															
2	137		1	35		1	C7/C8				2	M2-9	2	E1-2		2	F1-2															
3	83		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2															
4	60		1	35		1	C1				1	M2-9																				
5	50		1	35		1	C3				1	M2-9	1	E1-2		1	F1-2															
6	158		1	35		1	C3				1	M2-9	1	E1-2		1	F1-2															
											1	M2-1A																				
7	86		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2															
8	300		1	35		1	C8				2	M2-9	2	E1-2		2	F1-2															
9	160		1	35		1	C3				1	M2-9	1	E1-2		1	F1-2															
10	71		1	35		1	C1				1	M2-9																				
11	140		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2															
12	160		1	35		1	C1				1	M2-9																				
13	77		1	35		1	C1				1	M2-9																				
14	109		1	35		1	C1				1	M2-9																				
QUAN	QUAN	PH	Q	HT	CL	Q	CODE		Q	CODE	Q	CODE	Q	CODE		Q	CODE	QTY	CD	SIZE	Q	CODE				Q	CODE	Q	CODE	Q	CODE	QUANTITY	CODE	
						2	C1			G-		M2-		E			F			D						K		M		RI		R		D	ACSR
	1779	3ø				8	C2				18	9	15	1-2		15	1-2		OS								5-10				C		D	ACSR
			15	35	std	3	C3				2	1A																			PB			
							C4												1UB												LP			
						1	C7																								IR		N	INS
						2	C8																								SL		D	DUP

SKETCH

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IFUGAO ELECTRIC COOPERATIVE, INC.
Lagawe, Ifugao
Address

STAKING SHEET

PRIMARY CONDUCTOR #2 ACSR
NEUTRAL CONDUCTOR #2 ACSR
RULING SPAN ____ METERS

PROJECT PROPOSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
SUBSTATION
LOCATION BARANGAY MAPPIT, KIANGAN, IFUGAO

SHEET NO. 2
OF 4
MAP REF.

Project No. ____ (c) Page No. ____ (c)
Checked by ____ Staked by ____
Date ____ Date ____ (5)
Released by ____ Final Inv. by ____
Date ____ Date ____ (8)

POLE NO.	PRI. BACK SPAN MTRS.	POLE				PRI. P. TOP UNIT (A.B.C.)		ANGL	TRANS FORMER "G"		GRND "M"		GUY "E"		LEAD	ANC. "F"		SECONDARY					SERVICE					MISC. UNITS "M"		RIGHT OF WAY "RI"		CONS		REMARKS
																		SPAN MTRS.	2W or UB	WIRE SIZE	NO	"J"	DROP MTRS.	NO	SIZE	NO	"K"						
	Q	C	Q	H	C	Q	CODE	E	Q	CODE	Q	CODE	Q	CODE	M	Q	CODE	Q	C		Q	CODE	Q	Q		Q	CODE	Q	CODE	Q	CODE	Q	CODE	Computer Coding
15	106		1	35		1	C3				1	M2-9	1	E1-2		1	F1-2															
16	56		1	35		1	C3				1	M2-9	1	E1-2		1	F1-2															
17	112		1	35		1	C1				1	M2-9																				
18	72		1	35		1	C3				1	M2-9	1	E1-2		1	F1-2															
19	86		1	35		1	C1				1	M2-9																				
20	33		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2															
21	35		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2															
											1	M2-1A																					
22	112		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2															
23	90		1	35		1	C3				1	M2-9	1	E1-2		1	F1-2															
24	56		1	35		1	C1				1	M2-9																				
25	198		1	35		1	C2				1	M2-9	1	E1-2		1	F1-2															
26	95					1	C2				1	M2-9	1	E1-2		1	F1-2															
27	94					1	C1				1	M2-9																				
28	76					1	C3				1	M2-9	1	E1-2		1	F1-2															
29	90					1	C8				2	M2-9	2	E1-2		2	F1-2															

QUAN	PH	Q	HT	CL	Q	CODE		Q	CODE	Q	CODE	Q	CODE		Q	CODE	QTY	CD	SIZE	Q	CODE				Q	CODE	Q	CODE	Q	CODE	Q	CODE	UANTITY	CODE	
					4	C1			G-		M2-		E			F			D							K		M		RI		R		D	
1311	3ø				5	C2				16	9	12	1-2		12	1-2		OS									5-10				C		D	ACSR
		15	35	std	5	C3				1	1A																			PB			
						C4												1UB													LP			
						C7																									IR		N	INS
					1	C8																									SL		D	DUP

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IFUGAO ELECTRIC COOPERATIVE, INC.
Lagawe, Ifugao
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STAKING SHEET

SHEET NO. 3
OF 4
MAP REF.

PRIMARY CONDUCTOR #2 ACSR
NEUTRAL CONDUCTOR #2 ACSR
RULING SPAN ___ METERS

PROJECT PROPOSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
SUBSTATION
LOCATION BARANGAY MAPPIT, KIANGAN, IFUGAO

Project No. ___ (c) Page No. ___ (c)
Checked by ___ Staked by ___
Date ___ Date ___ (5)
Released by ___ Final Inv. by ___
Date ___ Date ___ (8)

POLE NO.	PRI. BACK SPAN MTRS.	POLE				PRI. P. TOP UNIT (A,B,C.)		ANGL E	TRANS FORMER "G"		GRND "M"		GUY "E"		LEAD M	ANC. "F"		SECONDARY SPAN MTRS.	2W or UB	WIRE SIZE	NO	"J"	SERVICE DROP MTRS.	NO	SIZE	NO	"K"	MISC. UNITS "M"		RIGHT OF WAY "RI"		CONS		REMARKS
	Q	C	Q	H	C	Q	CODE	E	Q	CODE	Q	CODE	Q	CODE	M	Q	CODE	Q	C		Q	CODE	Q	Q		Q	CODE	Q	CODE	Q	CODE	Q	CODE	Computer Coding
30	177					1	C1				1	M2-9																					
31	52					1	C7/C8				1	M2-9	2	E1-2		2	F1-2																
32	86					1	C2				1	M2-9	1	E1-2		1	F1-2																
33	70					1	C1				1	M2-9																					
34	151					1	C2				1	M2-9	1	E1-2		1	F1-2																
35	164					1	C1				1	M2-9																					
36	155					1	C3				1	M2-9	1	E1-2		1	F1-2																
											1	M2-1A																					
37	156					1	C1				1	M2-9																					
38	211					1	C1				1	M2-9																					
39	73					1	C2				1	M2-9	1	E1-2		1	F1-2																
40	113					1	C8				2	M2-9	2	E1-2		2	F1-2																
41	166					1	C1				1	M2-9																					
42	58					1	C1				1	M2-9																					
43	55					1	C1				1	M2-9																					
44	60					1	C3				1	M2-9	1	E1-2		1	F1-2																

QUAN	PH	Q	HT	CL	Q	CODE		Q	CODE	Q	CODE	Q	CODE		Q	CODE	QTY	CD	SIZE	Q	CODE				Q	CODE	Q	CODE	Q	CODE	QUANTITY	CODE	
					8	C1			G-		M2-		E			F			D		K					M		RI		R		D	ACSR
1747	3ø				3	C2				16	9	9	1-2		9	1-2		OS							5-10				C		D	ACSR
		5	35	std	2	C3				1	1A																		PB			
						C4												1UB												LP			
					1	C7																								IR		N	INS
					1	C8																								SL		D	DUP

SKETCH — N — SEE SHEET NO.

SEE ATTACHED SKETCH

IFUGAO ELECTRIC COOPERATIVE, INC.
Lagawe, Ifugao
Address

STAKING SHEET

SHEET NO. 4
OF 4
MAP REF.

Project No. (c) Page No. (c)
Checked by Staked by
Date Date (5)
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Date Date (8)

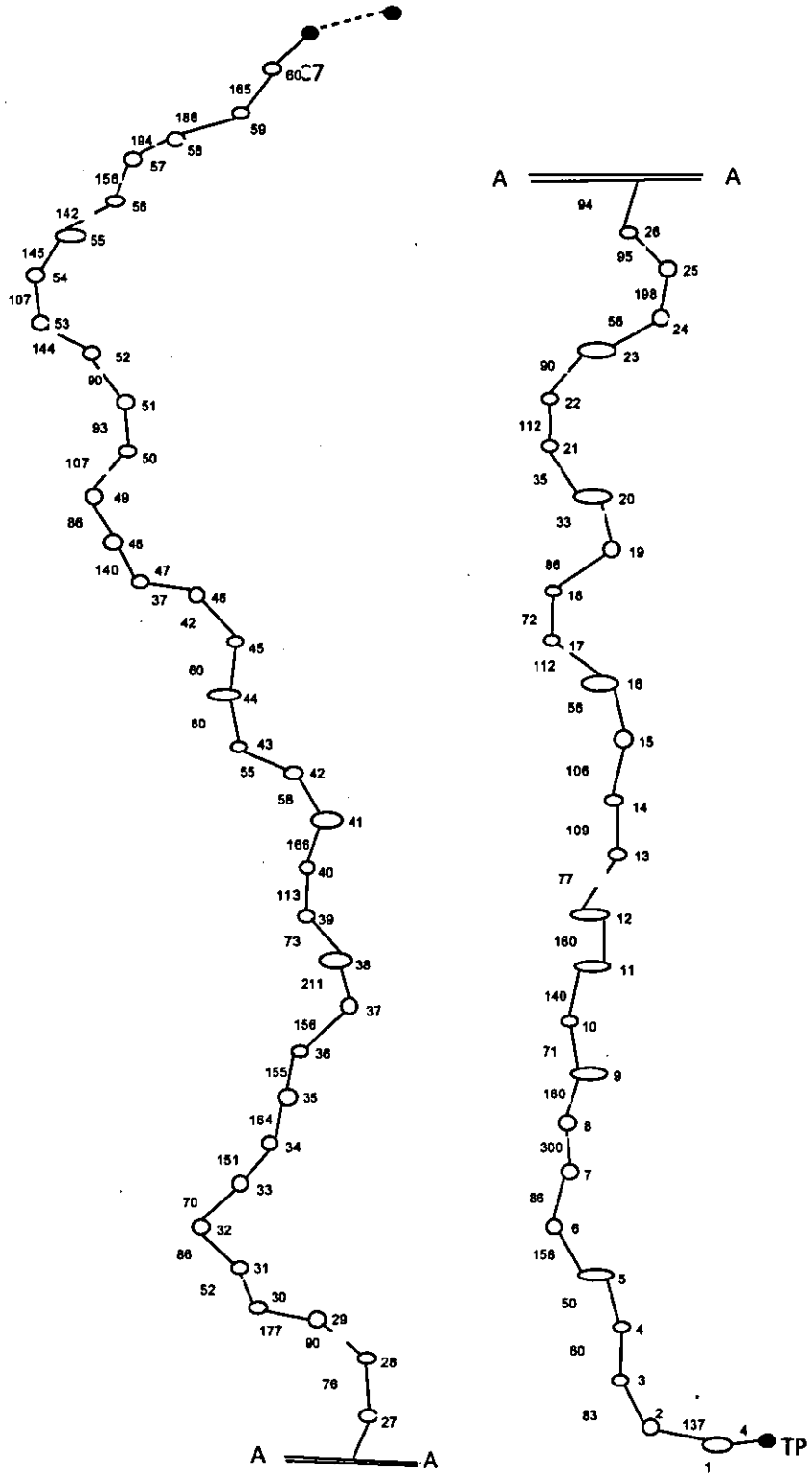
PRIMARY CONDUCTOR #2 ACSR
NEUTRAL CONDUCTOR #2 ACSR
RULING SPAN METERS

PROJECT PROPOSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
SUBSTATION
LOCATION BARANGAY MAPPIT, KIANGAN, IFUGAO

POLE NO.	PRI. BACK SPAN MTRS.	POLE				PRI. P. TOP UNIT (A.B.C.)		ANGL	TRANS FORMER "G"		GRND "M"		GUY "E"		LEAD	ANC. "F"		SECONDARY					SERVICE					MISC. UNITS "M"		RIGHT OF WAY "RI"		CONS		REMARKS
																		SPAN MTRS.	2W or UB	WIRE SIZE	NO	"J"	DROP MTRS.	NO	SIZE	NO	"K"						
	Q	C	Q	H	C	Q	CODE	E	Q	CODE	Q	CODE	Q	CODE	M	Q	CODE	Q	C		Q	CODE	Q	Q		Q	CODE	Q	CODE	Q	CODE	Q	CODE	Computer Coding
45	60					1	C8				2	M2-9	2	E1-2		2	F1-2																
46	42					1	C1				1	M2-9																					
47	37					1	C8				2	M2-9	1	E1-2		1	F1-2																
48	110					1	C7/C8				2	M2-9	2	E1-2		2	F1-2																
49	86					1	C4				2	M2-9	2	E1-2		2	F1-2																
50	107					1	C2				1	M2-9	1	E1-2		1	F1-2																
51	93					1	C2				1	M2-9	1	E1-2		1	F1-2																
52	90					1	C8				2	M2-9	2	E1-2		2	F1-2																
											1	M2-1A																						
53	144					1	C3				1	M2-9	1	E1-2		1	F1-2																
54	107					1	C2				1	M2-9	1	E1-2		1	F1-2																
55	145					1	C4				2	M2-9	2	E1-2		2	F1-2																
56	142					1	C2				1	M2-9	1	E1-2		1	F1-2																
57	156					1	C2				1	M2-9	1	E1-2		1	F1-2																
58	194					1	C2				1	M2-9	1	E1-2		1	F1-2																
59	186					1	C2				1	M2-9	1	E1-2		1	F1-2																
60	165					1	C7/C8				2	M2-9	2	E1-2		2	F1-2																
	QUAN	PH	Q	HT	CL	Q	CODE		Q	CODE	Q	CODE	Q	CODE		Q	CODE	QTY	CD	SIZE	Q	CODE				Q	CODE	Q	CODE	Q	CODE	QUANTITY	CODE	
						1	C1			G-		M2-		E			F			D							K		M		RI		R		D	ACSR
	1864	3ø				7	C2				23	9	23	1-2		14	1-2		OS									5-10				C		D	ACSR
				35	std	1	C3				1	1A																				PB			
						2	C4												1UB													LP			
						2	C7																									IR		N	INS
						5	C8																									SL		D	DUP

TAPPING POINT TO EXISTING THREE PHASE LINE

SUBJECT: PROPOSSED LIKUD MINI-HYDROPOWER THREE PHASE LINE
SKETCH PLAN
LOCATION: BARANGAY MAPPIT, KIANGAN, IFUGAO



LEGEND:

Single Phase Line	——
Pole	O
Back Span (meters)	###

Appendix-IV

設計計算書(土木)

Headloss Calculation

Items	Unit	No.1 turbine					No.2 turbine				Formula
Plant Discharge	m^3/s	2.00					2.00				
Intake water level	EL.m	600.000					600.000				
Tailrace water level	EL.m	541.000					541.000				
Gross Head	m	59.000					59.000				
Head Loss	m	6.424					6.374				
Effective Head	m	52.576					52.626				
Capacity	kW	406.835					407.224				
Head loss											
Intake											
Inlet loss											
Loss coefficient: fi	-	0.500					0.500				
Discharge: Q	m^3/s	2.000					2.000				
Width of Inlet: B	m	1.600					1.600				
Depth of Inlet: h	m	1.300					1.300				
Inflow velocity: vi	m/s	0.962					0.962				
Inflow loss: hfi	m	0.024					0.024				$= fi\ vi^2/2/g$
Loss at Intake	m	**0.024**					**0.024**				
Headrace											
Inflow loss in the end of Settling Basin											
Loss coefficient: fi	-	0.500					0.500				
Discharge Q	m^3/s	2.000					2.000				
Width of Inlet: B	m	1.400					1.400				
Depth of Inlet: h	m	0.894					0.894				
Inflow velocity: vi	m/s	1.598					1.598				
Inflow loss: hfi	m	0.065					0.065				$= fi\ vi^2/2/g$
Loss by incline											
Incline of Headrace: Ih	1/	500					500.000				
Length of Headrace: Lh	m	1875.304					1875.304				
Loss by incline: hfe	m	3.751					3.751				$= Lh/Ih$
Loss at Headrace	m	**3.816**					**3.816**				
Penstock											
Inlet loss											
Loss coefficient: fpi	-	0.500					0.500				
Discharge Q	m^3/s	2.000					2.000				
Diameter: Dp	m	0.850					0.850				
Velocity: vp	m/s	3.525					3.525				
Inlet loss: hfpi	m	0.317					0.317				$= fpi\ vp^2/2/g$
Friction loss											
Penstock length: Lp	m	109.429	9.103	118.532			109.429	8.669	118.098		
Diameter: Dp	m	0.850	0.600				0.850	0.600			
Discharge: Q	m^3/s	2.000	1.000				2.000	1.000			
Velocity: vp	m/s	3.525	3.537				3.525	3.537			
Coefficient of roughness: n	-	0.012	0.012				0.012	0.012			
Coefficient of friction loss: ffp	-	0.019	0.021				0.019	0.021			$= 124.5\ n^2/Dp^{1/3}$
Friction loss: hfpf	m	1.544	0.206				1.544	0.196			$= ffp\ Lp/Dp\ vp^2/2/g$
Total of friction loss	m	1.750					1.740				
Bend loss											
Bend number	-	IP-1	IP-2	IP-3	IP-4	IP-5	IP-1	IP-2	IP-3	IP-4	
Discharge: Q	m^3/s	2.000	2.000	2.000	2.000	1.000	2.000	2.000	2.000	2.000	
Diameter: Dp	m	0.850	0.850	0.850	0.850	0.600	0.850	0.850	0.850	0.850	
Velocity: vp	m/s	3.525	3.525	3.525	3.525	3.537	3.525	3.525	3.525	3.525	
Radius of bend: r	m	2.550	2.550	2.550	2.550	1.800	2.550	2.550	2.550	2.550	
Angle of bend: A	degree	28.446	4.658	12.724	36.512	20.000	28.446	4.658	12.724	36.512	
Coefficient 1: fb1	-	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	0.134	$= 0.131 + 0.1632\ (Dp/r)^{3/2}$
Coefficient 2: fb2	-	0.562	0.228	0.376	0.637	0.471	0.562	0.228	0.376	0.637	$= (A/90)^{1/2}$
Bend loss: hfpb	m	0.048	0.019	0.032	0.054	0.040	0.048	0.019	0.032	0.054	
Total of bend loss	m	0.194					0.154				
Loss by reducer											
Discharge after reducer: Q	m^3/s	1.000					1.000				
Diameter after reducer: Dp2	m	0.600					0.600				
Velocity after reducer: vp	m/s	3.537					3.537				
Diameter before reducer: Dp1	m	0.850					0.850				
Length of reducer: Lr	m	2.000					2.000				
A2/A1		0.498					0.498				
Angle	degree	3.576					3.576				
Coefficient of reducer:	-	0.001					0.001				
Loss by reducer: hfpr	m	0.001					0.001				$= fpr\ vp^2/2/g$
Loss by bifurcation											
Coefficient of bifurcation:	-	0.500					0.500				
Diameter before bifurcation: Dp1	m	0.850					0.850				
Velocity before bifurcation: vp1	m/s	3.525					3.525				
Loss by bifurcation: hfpb	m	0.317					0.317				$= fpb\ vp^2/2/g$
Loss by Inlet valve											
Loss coefficient: fpv	-	0.010					0.010				
Velocity : vp	m/s	3.537					3.537				
Loss by bifurcation: hfpv	m	0.006					0.006				$= fpv\ vp^2/2/g$
Loss at Penstock	m	**2.585**					**2.535**				
Total Head loss											
Total above	m	6.424					6.374				

Settling Basin

Steel Pipe for Irrigation

Area of Rice Filed

A		0.28	ha	
B		2.09	ha	
C		0.12	ha	
D		0.15	ha	
E		1.00	ha	
F		3.81	ha	
Total		7.45	ha	
		10.00	ha	+20%
Regulated Volume		2.00	Litter/ha/s	
	=	0.002	m3/ha/s	
Necessary volume		0.020	m3/s	A

10%Discharge of 85% Dependable flow

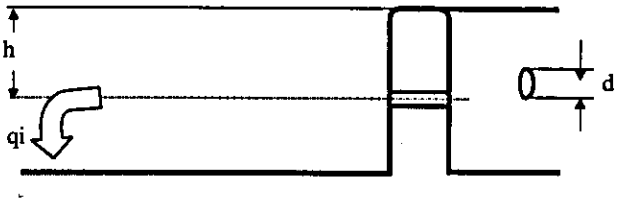
85 % dependable flow	1.360	m3/s	
10% of above discharge	0.136	m3/s	B

Discharge

A<B	0.136	m3/s	

Design of Valve for Irrigation

$qi=0.7*A*(2*g*h)^{0.5}$ =	0.152	m3/s	>B
h=	1.000	m	



d (m)	A (m^2)	qi (m^3/s)
0.200	0.031	0.070
0.250	0.049	0.109
0.300	0.071	0.156

Inlet

Plant discharge:	Q =	2.000	m^3/s
Width:	B =	1.600	m
Water depth:	h =	1.300	m
Velocity:	v =	0.962	m/s (v<1.0m/s)

v > 1.0m/s
0.5 < v < 1.0m/s

v: Inflow velocity (m/s)

B \ h	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
1.00											1.000
1.10										0.957	0.909
1.20								0.980	0.926	0.877	0.833
1.30							**0.962**	0.905	0.855	0.810	0.769
1.40						0.952	0.893	0.840	0.794	0.752	0.714
1.50					0.952	0.889	0.833	0.784	0.741	0.702	0.667
1.60				0.962	0.893	0.833	0.781	0.735	0.694	0.658	0.625
1.70			0.980	0.905	0.840	0.784	0.735	0.692	0.654	0.619	0.588
1.80			0.926	0.855	0.794	0.741	0.694	0.654	0.617	0.585	0.556
1.90		0.957	0.877	0.810	0.752	0.702	0.658	0.619	0.585	0.554	0.526
2.00	1.000	0.909	0.833	0.769	0.714	0.667	0.625	0.588	0.556	0.526	0.500
2.10	0.952	0.866	0.794	0.733	0.680	0.635	0.595	0.560	0.529	0.501	0.476
2.20	0.909	0.826	0.758	0.699	0.649	0.606	0.568	0.535	0.505	0.478	0.455
2.30	0.870	0.791	0.725	0.669	0.621	0.580	0.543	0.512	0.483	0.458	0.435
2.40	0.833	0.758	0.694	0.641	0.595	0.556	0.521	0.490	0.463	0.439	0.417
2.50	0.800	0.727	0.667	0.615	0.571	0.533	0.500	0.471	0.444	0.421	0.400

A: Necessity open area (m^2) minimum= 2.00 m^2

B \ h	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
1.00											2.00
1.10										2.09	2.20
1.20								2.04	2.16	2.28	2.40
1.30							2.08	2.21	2.34	2.47	2.60
1.40						2.10	2.24	2.38	2.52	2.66	2.80
1.50					2.10	2.25	2.40	2.55	2.70	2.85	3.00
1.60				2.08	2.24	2.40	2.56	2.72	2.88	3.04	3.20
1.70			2.04	2.21	2.38	2.55	2.72	2.89	3.06	3.23	3.40
1.80			2.16	2.34	2.52	2.70	2.88	3.06	3.24	3.42	3.60
1.90		2.09	2.28	2.47	2.66	2.85	3.04	3.23	3.42	3.61	3.80
2.00	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00
2.10	2.10	2.31	2.52	2.73	2.94	3.15	3.36	3.57	3.78	3.99	4.20
2.20	2.20	2.42	2.64	2.86	3.08	3.30	3.52	3.74	3.96	4.18	4.40
2.30	2.30	2.53	2.76	2.99	3.22	3.45	3.68	3.91	4.14	4.37	4.60
2.40	2.40	2.64	2.88	3.12	3.36	3.60	3.84	4.08	4.32	4.56	4.80
2.50	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.25	4.50	4.75	5.00

1. Design Flood

(1) Section and Water Level: 174m Downstream of powerhouse with flood mark, FWL.541.0m

(2) Estimation of Design Flood

Section Area=	A=	116.285	m^2	FWL.541.0m
Water Perimeter=	S=	47.574	m	
	R=A/S=	2.444	m	
Incline=1/x	I=1/	50		
Coefficient of Roughness=	n	0.040		
Flow Velocity=	v=	6.415	m/s	
Flood Discharge=	Qfps=	746.016	m^3/s	
	=	750.0	m^3/s	

2. Design Flood Water Level at Intake Weir

(1) Design Flood :

Flood Discharge in Powerhouse	Qfps=	750.0	m^3/s	Critical depth
Powerhouse Catchment Area=		48.6	km^2	5.063 m
Intake Catchment Area=		44.0	km^2	
Flood Discharge in Intake Weir	Qfin=	679.0	m^3/s	
	=	680.0	m^3/s	

(2) Width of Crest of the Weir : B= 20.0 m

(3) Calculation of Flood Water Leve

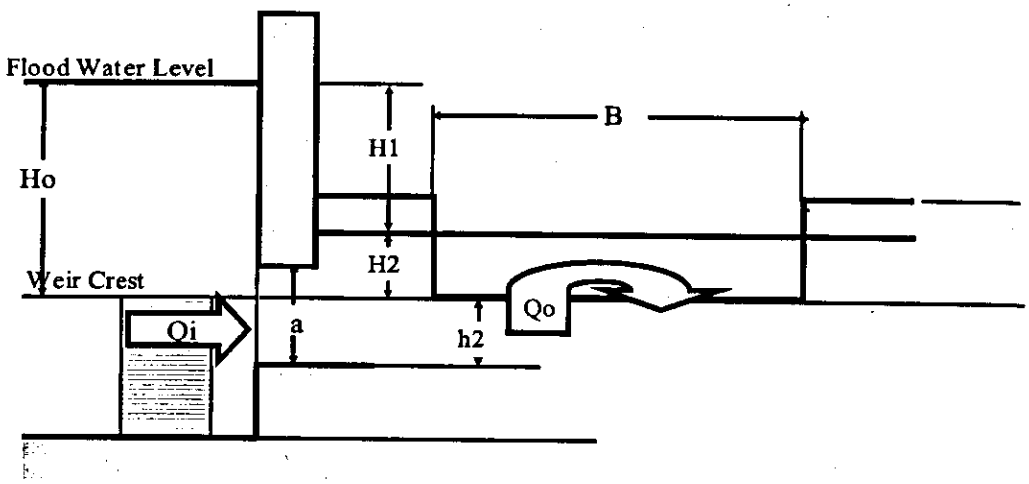
W/L (m)	A (m^2)	P (m)	R (m)	I 1/6	Q (m^3/s)	Remark	
0.000	0.000	20.000	0.000	1/6	0		
0.500	10.000	21.000	0.476	1/6	83		
1.000	20.000	22.000	0.909	1/6	255		
1.500	30.000	23.000	1.304	1/6	487		
1.600	32.000	23.200	1.379	1/6	540		
1.700	34.000	23.400	1.453	1/6	594		
1.800	36.000	23.600	1.525	1/6	649		
1.810	36.200	23.620	1.533	1/6	655		
1.820	36.400	23.640	1.540	1/6	661		
1.830	36.600	23.660	1.547	1/6	666		
1.840	36.800	23.680	1.554	1/6	672		
1.850	37.000	23.700	1.561	1/6	678		
1.860	37.200	23.720	1.568	1/6	683	Design Flood Water Leve	>Qf
1.870	37.400	23.740	1.575	1/6	689		>Qf
1.880	37.600	23.760	1.582	1/6	695		>Qf
1.890	37.800	23.780	1.590	1/6	701	Qf25	>Qf
1.900	38.000	23.800	1.597	1/6	706		>Qf
1.910	38.200	23.820	1.604	1/6	712		>Qf
1.920	38.400	23.840	1.611	1/6	718		>Qf
1.930	38.600	23.860	1.618	1/6	724		>Qf
1.940	38.800	23.880	1.625	1/6	730		>Qf
1.950	39.000	23.900	1.632	1/6	736	Qf30	>Qf
1.960	39.200	23.920	1.639	1/6	741		>Qf
1.970	39.400	23.940	1.646	1/6	747		>Qf
1.980	39.600	23.960	1.653	1/6	753		>Qf
1.990	39.800	23.980	1.660	1/6	759		>Qf
2.000	40.000	24.000	1.667	1/6	765		>Qf
2.010	40.200	24.020	1.674	1/6	771		>Qf
2.020	40.400	24.040	1.681	1/6	777		>Qf
2.030	40.600	24.060	1.687	1/6	783		>Qf
2.040	40.800	24.080	1.694	1/6	789	Qf50	>Qf
2.050	41.000	24.100	1.701	1/6	795		>Qf
2.300	46.000	24.600	1.870	1/6	950		>Qf

Settling Basin

Cross section		Unit						Applied								Remarks
Plant discharge	Q=	m^3/s	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	
Width	B =	m	3.400	3.600	3.800	4.000	4.200	4.400	4.600	4.800	5.000	5.200	5.400	5.600	5.800	
Water depth	h =	m	2.000	1.900	1.800	1.700	1.600	1.700	1.500	1.400	1.400	1.300	1.300	1.200	1.200	> Waterway level
Area	A=Bh=	m^2	6.800	6.840	6.840	6.800	6.720	7.480	6.900	6.720	7.000	6.760	7.020	6.720	6.960	
Velocity	u =	m/s	0.294	0.292	0.292	0.294	0.298	0.267	0.290	0.298	0.286	0.296	0.285	0.298	0.287	< 0.3 m/s
Length																
Necessary length	L = 2 h u/ vg	m	11.765	11.111	10.526	10.000	9.524	9.091	8.696	8.333	8.000	7.692	7.407	7.143	6.897	
	=	m	11.800	11.200	10.600	10.000	9.600	9.100	8.700	8.400	8.000	7.700	7.500	7.200	6.900	
Water depth	h =	m	2.000	1.900	1.800	1.700	1.600	1.700	1.500	1.400	1.400	1.300	1.300	1.200	1.200	
Velocity	u =	m/s	0.294	0.292	0.292	0.294	0.298	0.267	0.290	0.298	0.286	0.296	0.285	0.298	0.287	
Sediment velocity of particle	vg=	m/s	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100	
Overflow spillway																
Plant discharge	Q =	m^3/s	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	
Length of overflow	l =	m	9.500	9.000	8.500	8.000	7.500	7.000	7.000	7.000	7.000	7.000	7.000	7.000	7.000	
Coefficient of overflow	C =		1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	
Depth of overflow	H =	m	0.239	0.248	0.258	0.268	0.280	0.293	0.293	0.293	0.293	0.293	0.293	0.293	0.293	< 0.30 m

Length of Overflow Section in Settling Basin

Item		Unit									
Water level	Ho=	m	1.860	0.400	0.600	0.800	1.000	1.200	1.400	1.600	1.860
Coefficient of overflow	C=		1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800	1.800
Width of overflow	B=	m	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000	13.000
Inlet height	a=	m	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500	1.500
Inlet width	b=	m	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600	1.600
Area	A=	m^2	2.400	2.400	2.400	2.400	2.400	2.400	2.400	2.400	2.400
	h2=	m	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300	1.300
Depth of overflow	H2=	m	0.633	0.287	0.365	0.426	0.477	0.520	0.558	0.593	0.633
	H1=	m	1.227	0.113	0.235	0.374	0.523	0.680	0.842	1.007	1.227
Inflow of Inlet	Qi=A(2gH1)^0.5=	m^3/s	11.770	3.572	5.151	6.498	7.684	8.762	9.750	10.662	11.770
Overflow volume	Qo=C'BH2^1.5=	m^3/s	11.785	3.598	5.160	6.506	7.709	8.774	9.754	10.686	11.785
	Qi-Qo=	m^3/s	-0.015	-0.026	-0.009	-0.008	-0.025	-0.013	-0.004	-0.023	-0.015



Uniform Flow (Rectanglar open channel) Rectangle
矩形

Condition

Roughness	n	0.015		**Water depth**	**0.894** **m**
Incline	I=1/?	500.00			
Width	B	1.400	m		
Discharge	Q	2.000	m^3/s	Input	1 0
Delta H		0.001	m	First, input 0 as initial value	

Depth H (m)	Area A (m^2)	W. Perimeter S (m)	R=A/S m	Velocity v (m/s)	Discharge Q (m^3/s)	Depth H (m)
0.894	1.252	3.188	0.393	1.599	2.001	0.894

0.026 m (Delta H)

	H m	A m^2	S m	R=A/S m	v m/s	Q m^3/s	Difference Q m^3/s
1	0.000	0.000	1.400	0.000	0.000	0.000	2.000
2	0.026	0.036	1.451	0.025	0.253	0.009	1.991
3	0.051	0.072	1.503	0.048	0.393	0.028	1.972
4	0.077	0.108	1.554	0.069	0.503	0.054	1.946
5	0.103	0.144	1.605	0.089	0.596	0.086	1.914
6	0.128	0.179	1.656	0.108	0.678	0.122	1.878
7	0.154	0.215	1.708	0.126	0.750	0.162	1.838
8	0.179	0.251	1.759	0.143	0.815	0.205	1.795
9	0.205	0.287	1.810	0.159	0.874	0.251	1.749
10	0.231	0.323	1.862	0.174	0.928	0.300	1.700
11	0.256	0.359	1.913	0.188	0.977	0.351	1.649
12	0.282	0.395	1.964	0.201	1.023	0.404	1.596
13	0.308	0.431	2.015	0.214	1.066	0.459	1.541
14	0.333	0.467	2.067	0.226	1.106	0.516	1.484
15	0.359	0.503	2.118	0.237	1.143	0.574	1.426
16	0.385	0.538	2.169	0.248	1.178	0.634	1.366
17	0.410	0.574	2.221	0.259	1.210	0.695	1.305
18	0.436	0.610	2.272	0.269	1.241	0.757	1.243
19	0.462	0.646	2.323	0.278	1.270	0.821	1.179
20	0.487	0.682	2.374	0.287	1.298	0.885	1.115
21	0.513	0.718	2.426	0.296	1.324	0.951	1.049
22	0.538	0.754	2.477	0.304	1.349	1.017	0.983
23	0.564	0.790	2.528	0.312	1.373	1.084	0.916
24	0.590	0.826	2.579	0.320	1.395	1.152	0.848
25	0.615	0.862	2.631	0.327	1.417	1.220	0.780
26	0.641	0.897	2.682	0.335	1.437	1.290	0.710
27	0.667	0.933	2.733	0.341	1.457	1.359	0.641
28	0.692	0.969	2.785	0.348	1.475	1.430	0.570
29	0.718	1.005	2.836	0.354	1.493	1.501	0.499
30	0.744	1.041	2.887	0.361	1.510	1.572	0.428
31	0.769	1.077	2.938	0.366	1.527	1.644	0.356
32	0.795	1.113	2.990	0.372	1.543	1.717	0.283
33	0.821	1.149	3.041	0.378	1.558	1.790	0.210
34	0.846	1.185	3.092	0.383	1.573	1.863	0.137
35	0.872	1.221	3.144	0.388	1.587	1.937	0.063
36	0.897	1.256	3.195	0.393	1.600	2.011	-0.011
37	0.923	1.292	3.246	0.398	1.613	2.085	-0.085
38	0.949	1.328	3.297	0.403	1.626	2.160	-0.160
39	0.974	1.364	3.349	0.407	1.638	2.235	-0.235
40	1.000	1.400	3.400	0.412	1.650	2.310	-0.310

Headrace Alignment

Accumulate dis. 1875.304 m Incline=1/ 500

Location	Distance m	Accumulate m	Wide Angle Degree	IA Degree	Coordination X	Coordination Y	Water level m	W/L decrease m	Type
IP-0					296,665.4837	1,851,807.4932	599.911	0.000	A
IP-1	3.3947	3.395	138.48503	41.51497	296,668.8253	1,851,808.0909	599.905	0.007	A
IP-2	27.4910	30.886	167.51515	12.48485	296,692.2964	1,851,793.7778	599.850	0.062	A
IP-3	16.500	47.386	157.00000	23.00000	296,704.1934	1,851,782.3449	599.817	0.095	A
IP-4	8.000	55.386	160.00000	20.00000	296,707.3371	1,851,774.9885	599.801	0.111	A
IP-5	12.000	67.386	170.00000	10.00000	296,715.5424	1,851,766.2321	599.777	0.135	A
IP-6	12.000	79.386	138.26556	41.73444	296,722.1025	1,851,756.1840	599.753	0.159	A
IP-7	18.000	97.386	144.31445	35.68555	296,739.4789	1,851,751.4870	599.717	0.195	B
IP-8	20.000	117.386	159.07584	20.92416	296,752.1163	1,851,735.9855	599.677	0.235	A
IP-9	5.000	122.386	159.72366	20.27634	296,753.6833	1,851,731.2374	599.667	0.245	A
IP-10	9.000	131.386	157.63810	22.36190	296,759.2909	1,851,724.1978	599.649	0.263	B
IP-11	9.500	140.886	151.34927	28.65073	296,767.5919	1,851,719.5780	599.630	0.282	B
IP-12	4.500	145.386	159.69941	20.30059	296,769.9933	1,851,715.7723	599.621	0.291	B
IP-13	10.000	155.386	157.33732	22.66268	296,777.9323	1,851,709.6919	599.601	0.311	B
IP-14	10.000	165.386	175.96828	4.03172	296,782.9156	1,851,701.0220	599.581	0.331	B
IP-15	7.4840	172.870	159.73690	20.26310	296,787.0921	1,851,694.8117	599.566	0.346	B
IP-16	5.6587	178.528	159.73690	20.26310	296,791.6807	1,851,691.5004	599.554	0.357	B
IP-17	23.9831	202.512	168.10571	11.89429	296,814.7856	1,851,685.0699	599.506	0.405	B
IP-18	7.500	210.012	151.41925	28.58075	296,822.2703	1,851,684.5914	599.491	0.420	B
IP-19	5.000	215.012	173.46799	6.53201	296,826.4995	1,851,681.9241	599.481	0.430	B
IP-20	7.000	222.012	171.36579	8.63421	296,832.8066	1,851,678.8877	599.467	0.444	B
IP-21	5.9146	227.926	177.31855	2.68145	296,837.6903	1,851,675.5512	599.455	0.456	B
IP-22	6.000	233.926	125.69879	54.30121	296,842.4806	1,851,671.9384	599.443	0.468	B
IP-23	15.000	248.926	176.08979	3.91021	296,856.8037	1,851,676.3936	599.413	0.498	B
IP-24	13.000	261.926	120.21812	59.78188	296,868.9249	1,851,681.0924	599.387	0.524	B
IP-25	3.700	265.626	132.05816	47.94184	296,869.5055	1,851,684.7465	599.380	0.531	B
IP-26	7.000	272.626	146.55121	33.44879	296,875.3743	1,851,688.5619	599.366	0.545	B
IP-27	4.500	277.126	116.02709	63.97291	296,879.8742	1,851,688.5289	599.357	0.554	B
IP-28	8.500	285.626	168.55873	11.44127	296,883.6599	1,851,696.1394	599.340	0.571	B
IP-29	10.000	295.626	173.81241	6.18759	296,889.8011	1,851,704.0315	599.320	0.591	B
IP-30	6.000	301.626	153.86384	26.13616	296,892.9540	1,851,709.1363	599.308	0.603	B
IP-31	7.000	308.626	145.41231	34.58769	296,893.6328	1,851,716.1033	599.294	0.617	B
IP-32	18.000	326.626	110.87729	69.12271	296,905.2396	1,851,729.8613	599.258	0.653	A
IP-33	34.000	360.626	148.82599	31.17401	296,937.3337	1,851,718.6377	599.190	0.721	A

IP-34	35.000	395.626	162.24392	17.75608	296,959.6205	1,851,691.6507	599.120	0.791	A
IP-35	15.000	410.626	156.26125	23.73875	296,965.1897	1,851,677.7229	599.090	0.821	A
IP-36	25.5065	436.133	146.51049	33.48951	296,964.3245	1,851,652.2311	599.039	0.872	A
IP-37	9.8188	445.951	145.62905	34.37095	296,969.4615	1,851,643.8632	599.019	0.892	A
IP-38	30.000	475.951	146.32338	33.67662	296,967.9827	1,851,613.8997	598.959	0.952	A
IP-39	15.000	490.951	146.09240	33.90760	296,959.0600	1,851,601.8422	598.929	0.982	A
IP-40	15.000	505.951	171.02343	8.97657	296,958.3810	1,851,586.8575	598.899	1.012	A
IP-41	22.000	527.951	169.85756	10.14244	296,960.8265	1,851,564.9939	598.855	1.056	A
IP-42	13.500	541.451	143.88645	36.11355	296,964.6663	1,851,552.0515	598.828	1.083	A
IP-43	8.000	549.451	148.44860	31.55140	296,971.0249	1,851,547.1967	598.812	1.099	A
IP-44	45.981	595.433	147.67079	32.32921	296,987.5681	1,851,504.2945	598.720	1.191	A
IP-45	11.000	606.433	126.60146	53.39854	296,985.4235	1,851,493.5056	598.698	1.213	A
IP-46	20.000	626.433	154.82545	25.17455	296,998.8466	1,851,478.6792	598.658	1.253	A
IP-47	13.000	639.433	149.85219	30.14781	297,010.8423	1,851,473.6689	598.632	1.279	A
IP-48	24.000	663.433	153.17732	26.82268	297,025.3469	1,851,454.5478	598.584	1.327	A
IP-49	8.000	671.433	128.21737	51.78263	297,032.5376	1,851,451.0415	598.568	1.343	A
IP-50	10.000	681.433	156.38190	23.61810	297,041.5417	1,851,455.3920	598.548	1.363	A
IP-51	5.000	686.433	157.75291	22.24709	297,046.5381	1,851,455.5813	598.538	1.373	A
IP-52	18.6217	705.054	156.49943	23.50057	297,064.0282	1,851,449.1888	598.501	1.410	A
IP-53	16.000	721.054	159.49035	20.50965	297,075.6193	1,851,438.1594	598.469	1.442	A
IP-54	6.000	727.054	112.83076	67.16924	297,078.2413	1,851,432.7627	598.457	1.454	A
IP-55	15.000	742.054	132.11234	47.88766	297,093.2196	1,851,433.5691	598.427	1.484	A
IP-56	6.000	748.054	159.79744	20.20256	297,097.4766	1,851,429.3409	598.415	1.496	A
IP-57	5.500	753.554	138.39319	41.60681	297,102.4773	1,851,427.0511	598.404	1.507	A
IP-58	23.500	777.054	166.36311	13.63689	297,111.9569	1,851,405.5479	598.357	1.554	A
IP-59	6.000	783.054	156.34410	23.65590	297,113.0146	1,851,399.6419	598.345	1.566	A
IP-60	8.000	791.054	151.23675	28.76325	297,117.4660	1,851,392.9947	598.329	1.582	A
IP-61	16.500	807.554	141.26290	38.73710	297,132.1113	1,851,385.3943	598.296	1.615	A
IP-62	11.000	818.554	163.46213	16.53787	297,136.5565	1,851,375.3325	598.274	1.637	A
IP-63	5.500	824.054	140.97513	39.02487	297,140.1192	1,851,371.1424	598.263	1.648	A
IP-64	10.000	834.054	159.17563	20.82437	297,149.9485	1,851,369.3025	598.243	1.668	A
IP-65	16.000	850.054	153.90948	26.09052	297,163.6014	1,851,360.9601	598.211	1.700	A
IP-66	7.000	857.054	155.16377	24.83623	297,170.5711	1,851,360.3091	598.197	1.714	A
IP-67	15.000	872.054	170.48947	9.51053	297,183.5389	1,851,352.7702	598.167	1.744	A
IP-68	6.500	878.554	129.62388	50.37612	297,188.5413	1,851,348.6197	598.154	1.757	A
IP-69	14.490	893.044	124.78174	55.21826	297,202.7791	1,851,351.3083	598.125	1.786	A
IP-70	7.500	900.544	111.22462	68.77538	297,208.1262	1,851,346.0491	598.110	1.801	A
IP-71	17.000	917.544	128.50764	51.49236	297,223.6261	1,851,353.0315	598.076	1.835	A
IP-72	6.000	923.544	156.05200	23.94800	297,225.1038	1,851,358.8467	598.064	1.847	A
IP-73	9.500	933.044	167.57680	12.42320	297,223.5046	1,851,368.2112	598.045	1.866	A

IP-74	8.000	941.044	126.19722	53.80278	297,223.8859	1,851,376.2021	598.029	1.882	A
IP-75	21.500	962.544	121.27991	58.72009	297,241.8217	1,851,388.0578	597.986	1.925	A
IP-76	9.500	972.044	137.51174	42.48826	297,250.4137	1,851,384.0046	597.967	1.944	A
IP-77	5.000	977.044	133.68074	46.31926	297,252.3075	1,851,379.3771	597.957	1.954	A
IP-78	12.500	989.544	165.09597	14.90403	297,263.9437	1,851,374.8113	597.932	1.979	A
IP-79	27.000	1016.544	152.24886	27.75114	297,290.7691	1,851,371.7454	597.878	2.033	B
IP-80	5.500	1022.044	159.47351	20.52649	297,295.8958	1,851,373.7371	597.867	2.044	B
IP-81	10.500	1032.544	166.52656	13.47344	297,306.3950	1,851,373.8662	597.846	2.065	B
IP-82	6.000	1038.544	170.13883	9.86117	297,312.2466	1,851,372.5401	597.834	2.077	B
IP-83	9.000	1047.544	172.21248	7.78752	297,320.5537	1,851,369.0771	597.816	2.095	B
IP-84	5.500	1053.044	155.61674	24.38326	297,325.2967	1,851,366.2925	597.805	2.106	B
IP-85	5.000	1058.044	170.79167	9.20833	297,328.1788	1,851,362.2067	597.795	2.116	B
IP-86	10.000	1068.044	151.02302	28.97698	297,332.5611	1,851,353.2180	597.775	2.136	B
IP-87	5.000	1073.044	159.99330	20.00670	297,332.3006	1,851,348.2248	597.765	2.146	B
IP-88	5.000	1078.044	169.79407	10.20593	297,330.3475	1,851,343.6221	597.755	2.156	B
IP-89	7.000	1085.044	174.59743	5.40257	297,328.7982	1,851,336.7957	597.741	2.170	B
IP-90	16.000	1101.044	144.38286	35.61714	297,323.8037	1,851,321.5952	597.709	2.202	B
IP-91	10.000	1111.044	175.25240	4.74760	297,326.7987	1,851,312.0542	597.689	2.222	B
IP-92	6.500	1117.544	139.18547	40.81453	297,329.2521	1,851,306.0350	597.676	2.235	B
IP-93	8.800	1126.344	152.28913	27.71087	297,337.0922	1,851,302.0385	597.659	2.253	B
IP-94	5.500	1131.844	139.06089	40.93911	297,340.2688	1,851,297.5486	597.648	2.264	B
IP-95	10.700	1142.544	135.35163	44.64837	297,339.2134	1,851,286.9007	597.626	2.285	B
IP-96	12.000	1154.544	171.45480	8.54520	297,329.9795	1,851,279.2369	597.602	2.309	B
IP-97	5.500	1160.044	119.64645	60.35355	297,326.3162	1,851,275.1345	597.591	2.320	B
IP-98	5.000	1165.044	167.68243	12.31757	297,327.9102	1,851,270.3953	597.581	2.330	B
IP-99	7.000	1172.044	110.01534	69.98466	297,331.5058	1,851,264.3894	597.567	2.344	B
IP-100	5.000	1177.044	120.71521	59.28479	297,328.3540	1,851,260.5079	597.557	2.354	B
IP-101	15.000	1192.044	141.06869	38.93131	297,313.5134	1,851,262.6892	597.527	2.384	A
IP-102	5.800	1197.844	121.41129	58.58871	297,308.5196	1,851,259.7394	597.516	2.396	A
IP-103	16.000	1213.844	130.96005	49.03995	297,308.2845	1,851,243.7411	597.484	2.428	A
IP-104	28.000	1241.844	165.24165	14.75835	297,286.8725	1,851,225.6988	597.428	2.484	A
IP-105	21.000	1262.844	176.42308	3.57692	297,274.7904	1,851,208.5225	597.386	2.526	A
IP-106	27.000	1289.844	132.54287	47.45713	297,260.6644	1,851,185.5127	597.332	2.580	A
IP-107	15.000	1304.844	171.73598	8.26402	297,264.7765	1,851,171.0873	597.302	2.610	A
IP-108	20.000	1324.844	168.38858	11.61142	297,272.9669	1,851,152.8413	597.262	2.650	A
IP-109	13.500	1338.344	119.80696	60.19304	297,275.9034	1,851,139.6646	597.235	2.677	A
IP-110	28.000	1366.344	131.32368	48.67632	297,302.6449	1,851,131.3644	597.179	2.733	A
IP-111	31.000	1397.344	152.50668	27.49332	297,315.2933	1,851,103.0622	597.117	2.795	A
IP-112	7.500	1404.844	117.50403	62.49597	297,314.8468	1,851,095.5755	597.102	2.810	B
IP-113	6.500	1411.344	154.91756	25.08244	297,308.9130	1,851,092.9223	597.089	2.823	B

IP-114	7.500	1418.844	124.48922	55.51078	297,301.4141	1,851,093.0521	597.074	2.838	B
IP-115	8.000	1426.844	111.26494	68.73506	297,296.7706	1,851,086.5376	597.058	2.854	B
IP-116	9.500	1436.344	114.33831	65.66169	297,301.9800	1,851,078.5932	597.039	2.873	B
IP-117	9.000	1445.344	149.92225	30.07775	297,310.8713	1,851,079.9881	597.021	2.891	C
IP-118	6.000	1451.344	156.31481	23.68519	297,316.4667	1,851,077.8221	597.009	2.903	C
IP-119	5.000	1456.344	166.87598	13.12402	297,320.0116	1,851,074.2960	596.999	2.913	C
IP-120	6.400	1462.744	149.87017	30.12983	297,323.4058	1,851,068.8702	596.986	2.925	C
IP-121	9.000	1471.744	164.06747	15.93253	297,331.3640	1,851,064.6670	596.968	2.943	C
IP-122	5.000	1476.744	160.40283	19.59717	297,334.9744	1,851,061.2079	596.958	2.953	C
IP-123	11.000	1487.744	139.79212	40.20788	297,339.9048	1,851,051.3748	596.936	2.975	C
IP-124	40.500	1528.244	151.29236	28.70764	297,330.3961	1,851,012.0068	596.855	3.056	C
IP-125	25.700	1553.944	163.12184	16.87816	297,337.1036	1,850,987.1975	596.803	3.108	C
IP-126	14.000	1567.944	138.44025	41.55975	297,344.5239	1,850,975.3258	596.775	3.136	C
IP-127	10.000	1577.944	159.86834	20.13166	297,354.1154	1,850,972.4968	596.755	3.156	C
IP-128	44.000	1621.944	124.15249	55.84751	297,389.4554	1,850,946.2845	596.667	3.244	C
IP-129	24.500	1646.444	159.38297	20.61703	297,388.4242	1,850,921.8063	596.618	3.293	C
IP-130	12.000	1658.444	118.35926	61.64074	297,383.7297	1,850,910.7626	596.594	3.317	C
IP-131	7.0474	1665.491	141.80204	38.19796	297,388.1275	1,850,905.2558	596.580	3.331	C
IP-132	14.4127	1679.904	164.43965	15.56035	297,402.1599	1,850,901.9669	596.551	3.360	C
IP-133	5.800	1685.704	148.99882	31.00118	297,407.2449	1,850,899.1771	596.540	3.371	C
IP-134	13.500	1699.204	113.27133	66.72867	297,420.7345	1,850,899.7071	596.513	3.398	C
IP-135	19.000	1718.204	134.64503	45.35497	297,428.9206	1,850,882.5610	596.475	3.436	C
IP-136	16.000	1734.204	147.37950	32.62050	297,444.0376	1,850,877.3193	596.443	3.468	C
IP-137	8.000	1742.204	170.66105	9.33895	297,451.8167	1,850,879.1864	596.427	3.484	C
IP-138	29.000	1771.204	166.30257	13.69743	297,478.5437	1,850,890.4411	596.369	3.542	C
IP-139	12.000	1783.204	160.95449	19.04551	297,488.1858	1,850,897.5846	596.345	3.566	C
IP-140	13.500	1796.704	165.33446	14.66554	297,501.0619	1,850,901.6414	596.318	3.593	C
IP-141	17.000	1813.704	155.56280	24.43720	297,518.0413	1,850,902.4784	596.284	3.627	C
IP-142	13.900	1827.604	132.46420	47.53580	297,530.9638	1,850,897.3581	596.256	3.655	C
IP-143	9.000	1836.604	149.37369	30.62631	297,534.1670	1,850,888.9475	596.238	3.673	C
IP-144	7.000	1843.604	151.51159	28.48841	297,539.6434	1,850,884.5875	596.224	3.687	C
IP-145	14.000	1857.604	172.46344	7.53656	297,553.4292	1,850,882.1478	596.196	3.715	C
IP-146	12.700	1870.304	169.13693	10.86307	297,566.1171	1,850,881.5940	596.171	3.741	C
IP-147	5.000	1875.304	0.00000	180.00000	297,571.0640	1,850,882.3213	596.161	3.751	C

Headtank

Headtank volume

Plant discharge	Q =	2.000	m^3/s	
Necessity area	A =	20.000	m^2	A >5-10Q
Necessity volume	V =	22.000	m^3	V >11 or 7Q

B	L	L'	A	h	L'-l	Remark
Width	Length	round	Area	Depth		
2.000	10.000	10.000	20.000	1.100	3.000	
2.100	9.524	9.600	20.160	1.091	2.600	
2.200	9.091	9.100	20.020	1.099	2.100	
2.300	8.696	8.700	20.010	1.099	1.700	
2.400	8.333	8.400	20.160	1.091	1.400	
2.500	8.000	8.000	20.000	1.100	1.000	
2.600	7.692	**7.800**	20.280	1.085	0.800	Applied
2.700	7.407	7.500	20.250	1.086	0.500	
2.800	7.143	7.200	20.160	1.091	0.200	
2.900	6.897	6.900	20.010	1.099	-0.100	
3.000	6.667	6.700	20.100	1.095	-0.300	
3.100	6.452	6.500	20.150	1.092	-0.500	
3.200	6.250	6.300	20.160	1.091	-0.700	
3.300	6.061	6.100	20.130	1.093	-0.900	
3.400	5.882	5.900	20.060	1.097	-1.100	
3.500	5.714	5.800	20.300	1.084	-1.200	
3.600	5.556	5.600	20.160	1.091	-1.400	
3.700	5.405	5.500	20.350	1.081	-1.500	
3.800	5.263	5.300	20.140	1.092	-1.700	
3.900	5.128	5.200	20.280	1.085	-1.800	
4.000	5.000	5.000	20.000	1.100	-2.000	

Overflow section

Plant discharge	Q =	2.000	m^3/s
Section of overflow	l =	7.000	m
Coefficient of overflow	C =	1.800	
Water depth	H =	0.293	m

Steel Pipe Thickness

Item		unit	Content	Remarks
Headtank water level	WLh =	EL.m	596.161	
Center of Turbine	WLt =	EL.m	543.000	
Design head		m	63.793	
	H =	kg/cm^2	6.379	
Statistical head	Hs = WLh-WLt =	m	53.161	
Water hammer	Hw = r Hs =	m	10.632	
Ratio of water hammer	r =		0.200	
Diameter of pipe	D =	cm	85.0	
Allowable stress of steel	s =	kg/cm^2	1,150.0	
Welding efficiency	e =	-	0.750	site welding
Extra thickness	dt =	cm	0.200	
Total thickness	t = H D / 2 s e + dt =	cm	0.514	
Applied thickness	T =	cm	**0.600**	T min = 6 mm
Circumference	l =	m	2.670	
Unit weight	w =	t/m	0.126	

Water Depth of Spillway

Item		Unit	Section 1	Section 2	Section 3	Section 4
Horizontal length of section	L=	m	34.555	14.826	31.757	9.380
Vertical height of section	H=	m	17.894	5.032	19.567	10.174
Incline	I=1/x	-	1.931	2.946	1.623	0.922
Discharge	Q=	m^3/s	2.000	2.000	2.000	2.000
Width	B=	m	1.000	1.000	1.000	1.000
Water depth	h=	m	0.152	0.175	0.144	0.119
Area	A=	m	0.152	0.175	0.144	0.119
Velocity	v=	m/s	13.158	11.429	13.889	16.807
Froude number	$Fr=v/(gh)^{0.5}=$	-	10.781	8.727	11.692	15.563
Critical depth	$hc=(1.1\ Q^2/g\ B^2)^{1/3}=$	m	0.766	0.766	0.766	0.766
Ratio of entraped air	$m=v^2/200gh=$	-	0.581	0.381	0.683	1.211
Seeming water depth	h'=(1+m)h=	m	0.240	0.242	0.242	0.263
	h-h'	m	0.088	0.067	0.098	0.144

Tailrace Submerged Weir

Item		Unit	Case			
Plant discharge	Q=	m^3/s	2.000	2.000	2.000	2.000
Tailrace width	B=	m	3.000	2.000	1.000	0.500
Critical depth	$hc=(1.1\ Q^2/g\ B^2)^{1/3}=$	m	0.368	0.482	0.766	1.216
Area	A=B hc =	m^2	1.104	0.965	0.766	0.608
Velocity	v=	m/s	1.811	2.073	2.612	3.291
Froude number	$Fr=v/(gh)^{0.5}=$	-	0.953	0.953	0.953	0.953
			Applied			

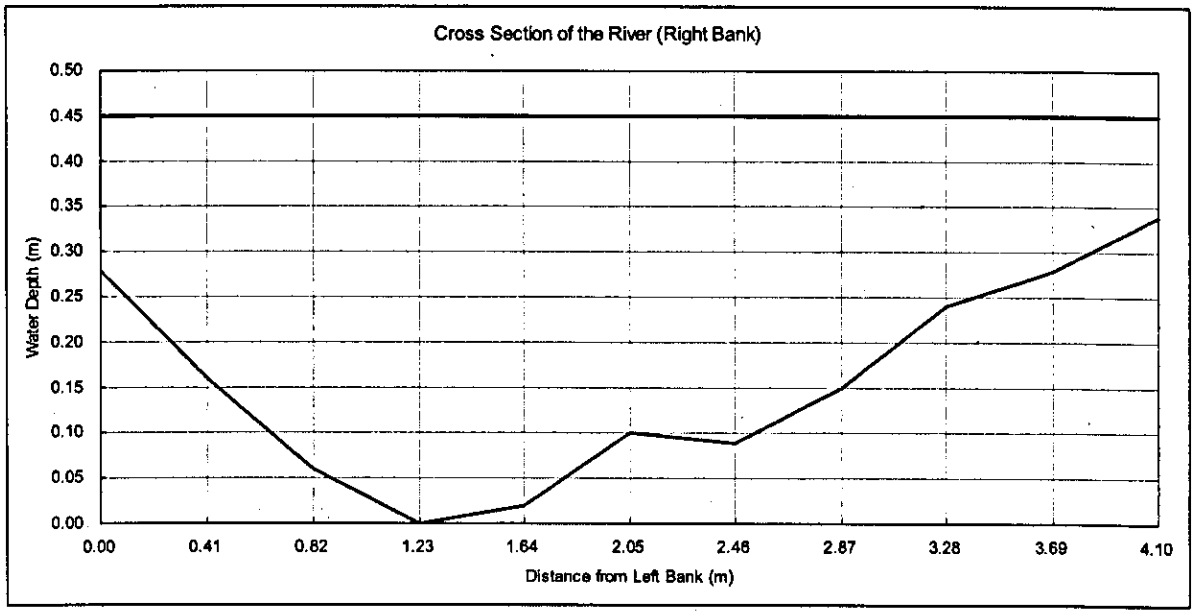
Appendix-V

流量観測記録

Measurement River Flow Record

Flow Measurement Field Sheet Name of Location: Likud Right Bank Date: April 30, 2011 Time: AM 10:40 Staff gauge: 38cm

Number of Segmentation: (i)	1	2		3	4		5	6		7	8		9	10		11	Remark
Distance from left bank: L (cm)	0	41		82	123		164	205		246	287		328	369		410	
Water Depth: D (cm)	17.0	29.0		39.0	45.0		43.0	35.0		36.0	30.0		21.0	17.0		11.0	
Area of Segmentation: A (cm^2)	2,337			3,526			3,055			2,399			1,353				
		H	V		H	V		H	V		H	V		H	V		
Depth from Surface: H (cm)	0.2	6.0	98.0		9.0	93.0		7.0	102.0		6.0	87.0		3.0	8.0		
Velocity : V (cm/s)	0.6	17.0	75.0		29.0	82.0		21.0	81.0		18.0	80.0		10.0	23.0		
	0.8	23.0	42.0		39.0	52.0		31.0	54.0		24.0	45.0		14.0	3.0		
Average Velocity: Va (cm/s)	72.50			77.25			79.50			73.00			14.25				Total
Discharge of Segmentation: q (m^3/s)	0.1694			0.2724			0.2428			0.1751			0.0193				0.8790



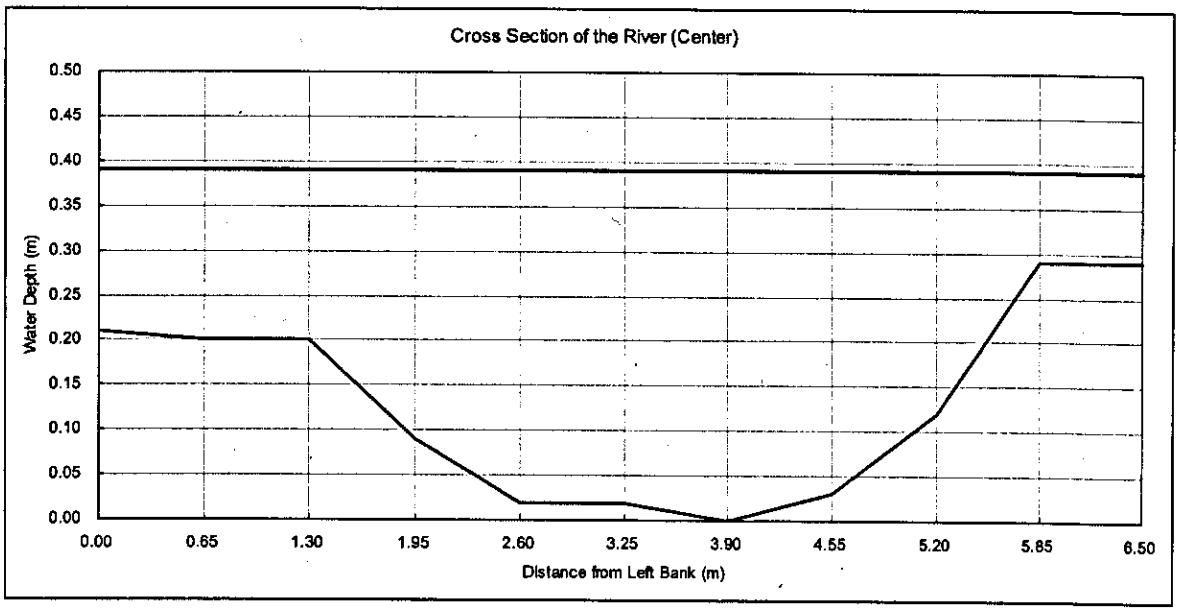
Measurement River Flow Record

Flow Measurement Field Sheet Name of Location: Likud Center Date: April 30, 2011 Time: AM 10:00 Staff gauge: 38.0cm

Number of Segmntation: (i)	1	2	3	4	5	6	7	8	9	10	11	Remark
Distance from left bank: L (cm)	0	65	130	195	260	325	390	455	520	585	650	
Water Depth:D (cm)	18.0	19.0	19.0	30.0	37.0	37.0	39.0	36.0	27.0	10.0	10.0	
Area of Segmantation: A (cm^2)		2,438		3,770		4,875		4,485		1,853		
		H	V	H	V	H	V	H	V	H	V	
Depth from Surface: H (cm)	0.2	4.0	61.0	6.0	43.0	7.0	74.0	7.0	64.0	2.0	33.0	
Velocity : V (cm/s)	0.6	11.0	41.0	18.0	28.0	22.0	58.0	22.0	44.0	6.0	8.0	
	0.8	15.0	33.0	24.0	17.0	30.0	25.0	29.0	30.0	8.0	0.0	
Average Velocity: Va (cm/s)		44.00		29.00		53.75		45.50		12.25		Total
Discharge of Segmantation:q (m^3/s)		0.1073		0.1093		0.2620		0.2041		0.0227		0.7054

Note: $A=0.5\times(D_i+D_{i+2})\times(L_{i+2}-L_i)$ $q=Va\times A$

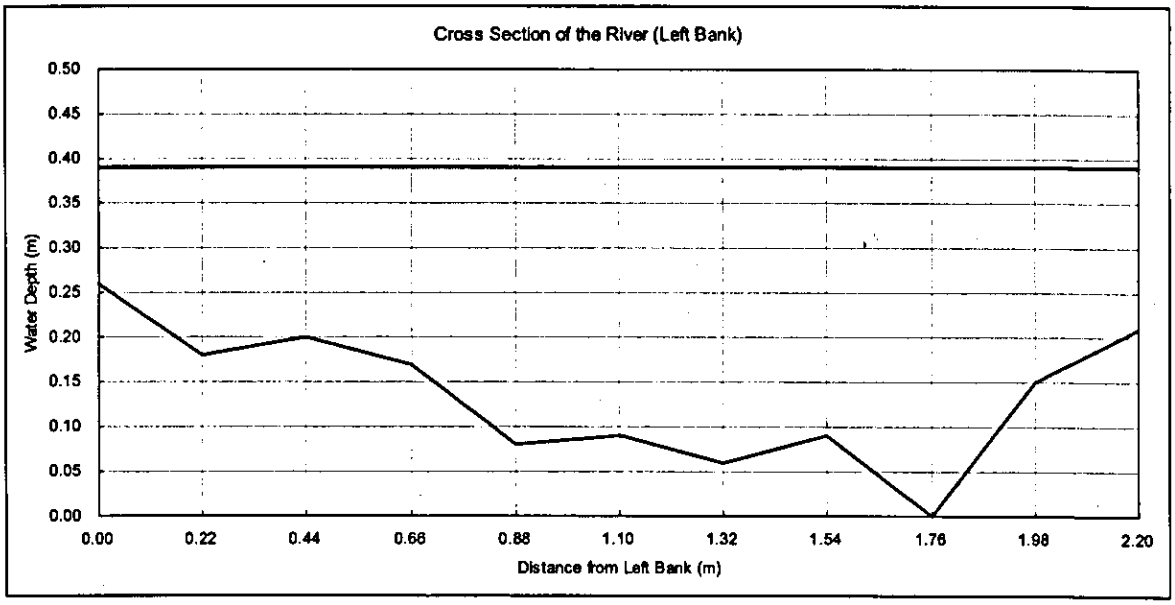
Right Bank	0.8790
Center	0.7054
Left Bank	0.1534
Total	1.7378



Measurement River Flow Record

Flow Measurement Field Sheet Name of Location: Likud Left Bank Date: April 30, 2011 Time: AM 11:20 Staff gauge: 38cm

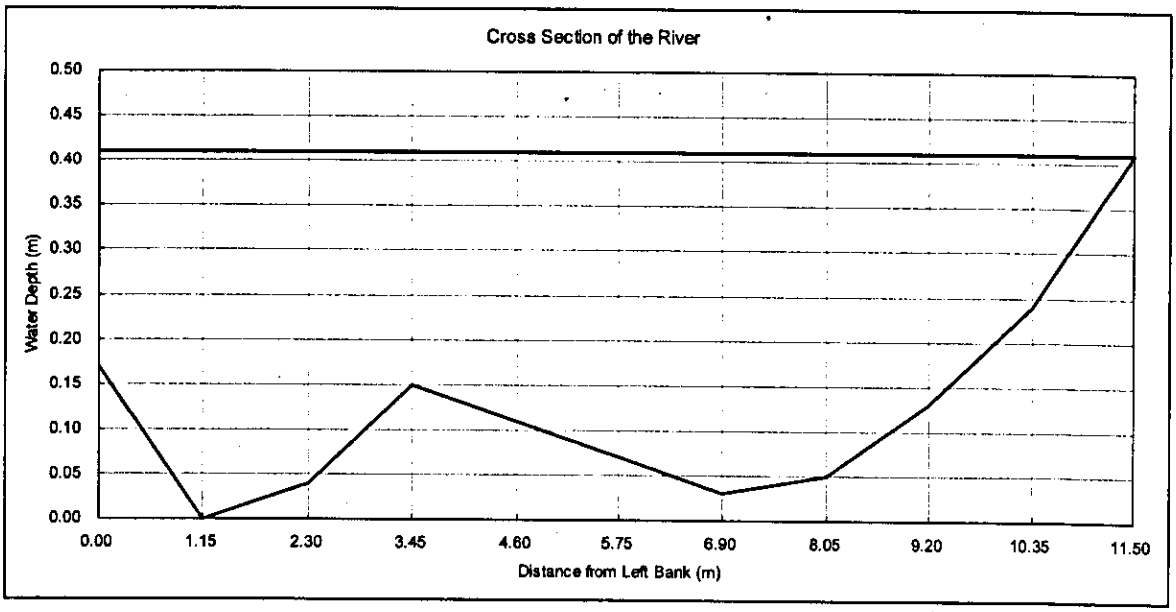
Number of Segmntation: (i)	1	2		3	4		5	6		7	8		9	10		11	Remark
Distance from left bank: L (cm)	0	22		44	66		88	110		132	154		176	198		220	
Water Depth:D (cm)	13.0	21.0		19.0	22.0		31.0	30.0		33.0	30.0		39.0	24.0		18.0	
Area of Segmantation A (cm^2)	814			1,034			1,364			1,452			1,155				
		H	V		H	V		H	V		H	V		H	V		
Depth from Surface: H (cm)	0.2	4.0	30.0		4.0	42.0		6.0	28.0		6.0	37.0		5.0	5.0		
Velocity : V (cm/s)	0.6	13.0	29.0		13.0	23.0		18.0	30.0		18.0	41.0		14.0	15.0		
	0.8	17.0	15.0		16.0	12.0		24.0	24.0		24.0	32.0		19.0	12.0		
Average Velocity: Va (cm/s)	25.75			25.00			28.00			37.75			11.75				Total
Discharge of Segmantation:q (m^3/s)	0.0210			0.0259			0.0382			0.0548			0.0136				0.1534



Measurement River Flow Record

Flow Measurement Field Sheet **Name of Location: Likud Right Bank** **Date: June 30, 2011** **Time: 15:10** **Staff gauge: 42cm**

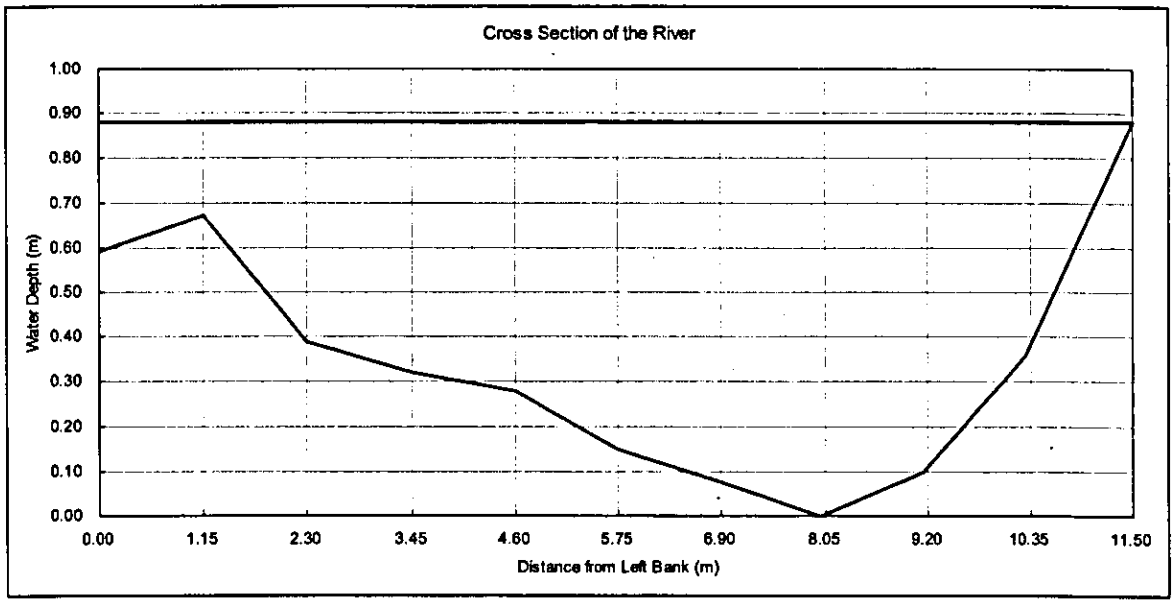
Number of Segmentation: (i)	1	2	3	4	5	6	7	8	9	10	11	Remark
Distance from left bank: L (cm)	0	115	230	345	460	575	690	805	920	1035	1150	
Water Depth:D (cm)	24.0	41.0	37.0	26.0	30.0	34.0	38.0	36.0	28.0	17.0	0.0	
Area of Segmentation: A (cm^2)	8,223		6,843		7,820		7,935		3,565			
	H	V	H	V	H	V	H	V	H	V		
Depth from Surface: H (cm)	0.2	8.2	97.0	5.2	112.0	6.8	68.0	7.2	55.0	3.4	24.0	
Velocity : V (cm/s)	0.6	24.6	86.0	15.6	98.0	20.4	65.0	21.6	45.0	10.2	15.0	
	0.8	32.8	53.0	20.8	42.0	27.2	52.0	28.8	32.0	13.6	4.0	
Average Velocity: Va (cm/s)	80.50		87.50		62.50		44.25		14.50			Total
Discharge of Segmentation:q (m^3/s)	0.6619		0.5987		0.4888		0.3511		0.0517			2.1522



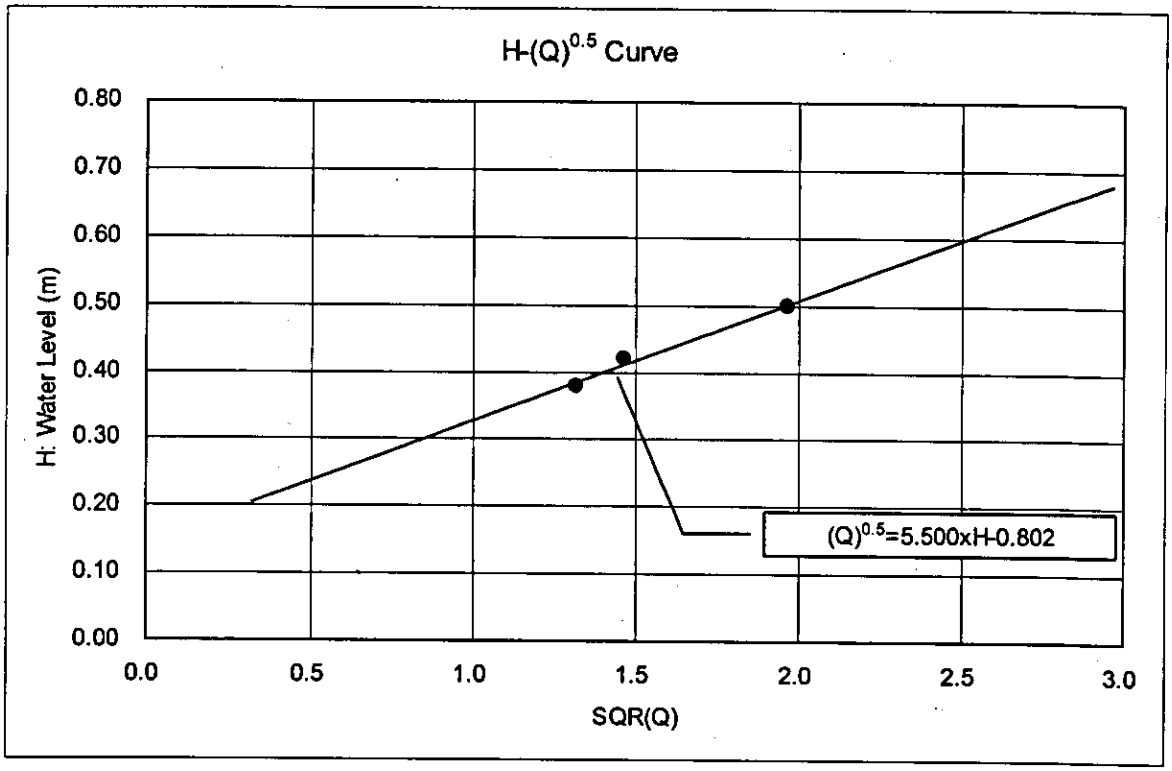
Measurement River Flow Record

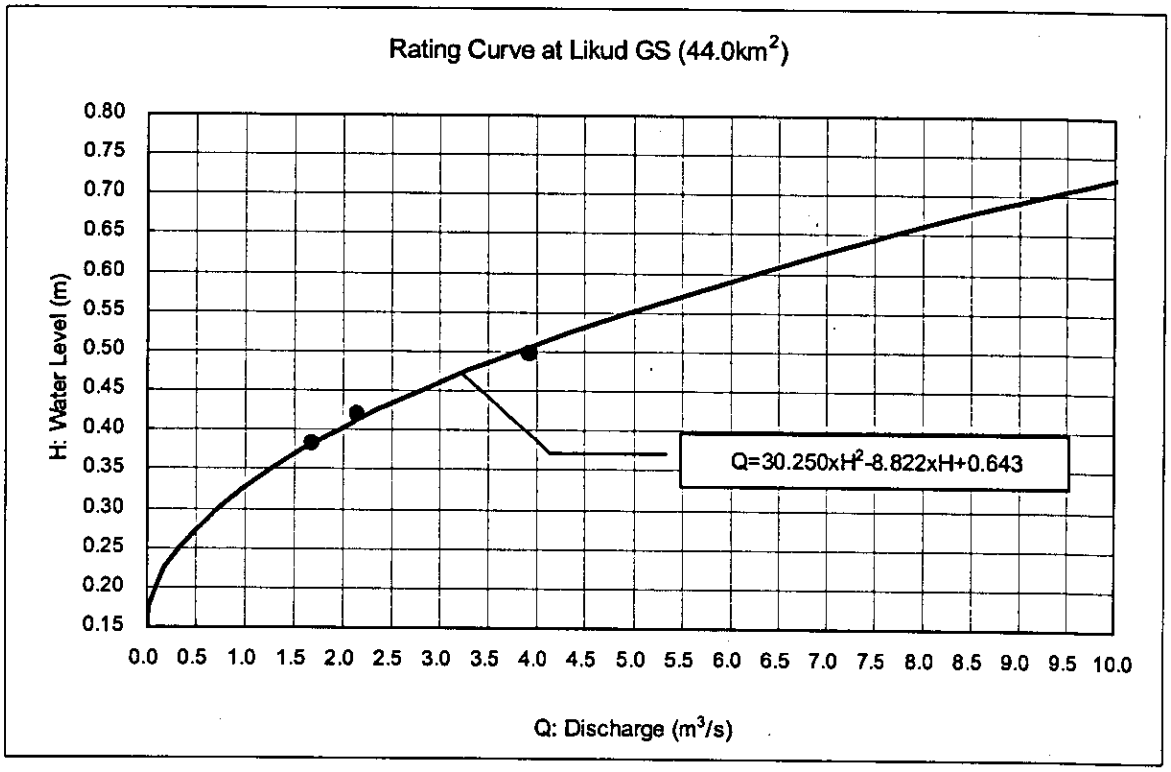
Flow Measurement Field Sheet Name of Location: Likud Flushed Out Bridge Date: July 1, 2011 Time: 13:00 Staff gauge: 50cm

Number of Segmmtation: (i)	1	2		3	4		5	6		7	8		9	10		11	Remark
Distance from left bank: L (cm)	0	115		230	345		460	575		685	800		915	1030		1150	
Water Depth:D (cm)	29.0	21.0		49.0	56.0		60.0	73.0		80.0	88.0		78.0	52.0		0.0	
Area of Segmantation: A(cm^2)	6,900			12,708			16,063			19,205			10,595				
		H	V		H	V		H	V		H	V		H	V		
Depth from Surface: H (cm)	0.2	4.2	5.0		11.2	32.0		14.6	90.0		17.6	146.0		10.4	33.0		
Velocity : V (cm/s)	0.6	12.6	5.0		33.6	32.0		43.8	87.0		52.8	108.0		31.2	47.0		
	0.8	16.8	0.0		44.8	26.0		58.4	72.0		70.4	76.0		41.6	36.0		
Average Velocity: Va (cm/s)	3.75			30.50			84.00			109.50			40.75				Total
Discharge of Segmantation:q (m^3/s)	0.0259			0.3876			1.3493			2.1029			0.4317				4.2974



Flow Ratting Curve





Record of Water Level and River Flow Rate calculated

Date	Water Level (m)					River Flow Rate (m^3/s)				
	March,2011	April	May	June	July	March	April	May	June	July
1	0.35	0.65	0.45	0.47	0.69	1.261	7.689	2.799	3.179	8.958
2	0.55	0.65	0.37	0.45	0.59	4.942	7.689	1.520	2.799	5.968
3	0.55	0.50	0.36	0.42	0.42	4.942	3.795	1.387	2.274	2.274
4	0.57	0.45	0.35	0.39	0.42	5.443	2.799	1.261	1.803	2.274
5	0.57	0.45	0.34	0.37	0.40	5.443	2.799	1.140	1.520	1.954
6	0.56	0.44	0.34	0.35	0.44	5.189	2.618	1.140	1.261	2.618
7	0.58	0.44	0.33	0.34	0.43	5.702	2.618	1.026	1.140	2.443
8	0.70	0.42	0.33	0.34	0.43	9.290	2.274	1.026	1.140	2.443
9	0.67	0.43	0.37	0.37	0.59	8.311	2.443	1.520	1.520	5.968
10	0.65	0.42	0.38	0.37	0.53	7.689	2.274	1.659	1.520	4.465
11	0.57	0.46	0.34	0.36	0.55	5.443	2.986	1.140	1.387	4.942
12	0.50	0.47	0.36	0.36	0.50	3.795	3.179	1.387	1.387	3.795
13	0.45	0.45	0.35	0.34	0.44	2.799	2.799	1.261	1.140	2.618
14	0.43	0.48	0.34	0.35	0.44	2.443	3.378	1.140	1.261	2.618
15	0.45	0.43	0.34	0.35	0.48	2.799	2.443	1.140	1.261	3.378
16	0.46	0.43	0.35	0.34	0.45	2.986	2.443	1.261	1.140	2.799
17	0.52	0.43	0.37	0.33	0.43	4.235	2.443	1.520	1.026	2.443
18	0.48	0.45	0.38	0.33	0.42	3.378	2.799	1.659	1.026	2.274
19	0.48	0.45	0.38	0.33	0.37	3.378	2.799	1.659	1.026	1.520
20	0.45	0.67	0.45	0.33	0.38	2.799	8.311	2.799	1.026	1.659
21	0.45	0.55	0.45	0.32	0.35	2.799	4.942	2.799	0.918	1.261
22	0.44	0.55	0.45	0.32	0.45	2.618	4.942	2.799	0.918	2.799
23	0.44	0.53	0.45	0.42	0.40	2.618	4.465	2.799	2.274	1.954
24	0.43	0.50	0.46	0.38	0.40	2.443	3.795	2.986	1.659	1.954
25	0.45	0.50	0.48	0.38	0.42	2.799	3.795	3.378	1.659	2.274
26	0.52	0.54	0.48	0.48	0.36	4.235	4.700	3.378	3.378	1.387
27	0.47	0.45	0.56	0.42	2.07	3.179	2.799	5.189	2.274	112.000
28	0.60	0.45	0.49	0.41	1.88	6.240	2.799	3.583	2.111	90.973
29	0.57	0.52	0.49	0.40	0.59	5.443	4.235	3.583	1.954	5.968
30	0.66	0.48	0.48	0.36	0.53	7.997	3.378	3.378	1.387	4.465
31	0.68		0.48		0.49	8.632		3.378		3.583
Average						4.557	3.681	2.151	1.612	9.549