BHP

OGDEN-BECHTEL-PMR

433 MW (Net) Quezon Power Project
Mauban, Quezon

Environmental Impact Statement

Volume I

TECH-183, Rev. 1
Issued 30 May 1995

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

GLOSSARY

AC	-	Alternating Current
ARI	-	Acute Respiratory Infections
BEn	-	Bechtel Enterprises, Incorporated
BHPE	-	BHP Engineering Philippines, Incorporated
BM	-	Bench Mark
BOD	-	biochemical oxygen demand
BOD5	-	5-day Biochemical Oxygen Demand
BOO	-	Build-Own-Operate
BOT	-	Build-Operate-Transfer
BSWM	-	Bureau of Soils and Water Management
$c/km^2/yr$	-	Carbon per square kilometer per year
Ca	-	Calcium
CAFGU	-	Civilian Armed Force Geographical Unit
CALABARZON	-	Cavite, Laguna, Batangas, Rizal and Quezon
CATV	-	Cable Television
CBR	-	Crude Birth Rate
Cd	-	Cadmium
CDR	-	Crude Death Rate
Cl	-	Chloride
CLUPS	-	Comprehensive Land Use Plans
CM	-	Cubic Meter
cm/s	-	centimeter per second
CO2	-	Carbon Dioxide
COD	-	Chemical Oxygen Demand
Cr	-	Chromium
Cu	-	Copper
cu.m./day	-	cubic meter per day
DA	-	Department of Agriculture
DAO	-	Department Administrative Order
DAR	-	Department of Agrarian Reform
dB(A)	-	decibel weighted average
DC	-	Direct Current
deg	-	degrees
DENR	-	Department of Environment and Natural Resources
DIA	-	Direct Impact Area
DO	-	dissolved oxygen
DOE	-	Department of Energy

GLOSSARY

lps	-	liter per second
M	-	million
m	-	meter
m/s	-	meter per second
m^3	-	cubic meter
m^3/sec	-	cubic meter per second
mbgs	-	meter below ground surface
MCM	-	Million Cubic Meter
MCR	-	maximum continous rating
Meralco	-	Manila Electric Company
Mg	-	Magnesium
mg/L	-	milligrams per liter
mg/m^3	-	milligram per cubic meter
mg/ncm	-	milligram per normal cubic meter
MHHW	-	Mean Higher High Water
MHO	-	Municipal Health Office
min	-	minimum
mm	-	millimeter
Mn	-	Manganese
MPDC	-	Municipal Planning and Development Coordinator
mps	-	meter per second
MS (1a-7a)	-	Marine Station (1a-7a)
MSI	-	Marine Science Institute
MSL	-	Mean Sea Level
Mt/year	-	million ton per year
MTPH	-	metric tons per hour
MW	-	megawatt
N	-	North
Na	-	Sodium
NAMRIA	-	National Mapping and Resource Information Authority
NE	-	Northeast
NE-SW	-	Northeast-Southwest
NEDA	-	National Economic and Development Authority
NGO	-	non-government organization
NIA	-	National Irrigation Administration
NMYC	-	National Manpower and Youth Council
NNE-SSW	-	North Northeast- South Southwest
NO_2	-	Nitrogen Dioxide

GLOSSARY

DOH	-	Department of Health
DOLE	-	Department of Labor and Employment
DWT	-	dead weight tons
E	-	East
e.g.	-	for example
ECC	-	Environmental Compliance Certificate
EIA	-	Environmental Impact Assessment
EIS	-	Environmental Impact Statement
EMB	-	Environmental Management Bureau
ESP	-	Electrostatic Precipitator
FAO	-	Food and Agriculture Organization
Fe	-	Iron
FGD	-	Flue Gas Desulphurizer
FLECO	-	First Laguna Electric Cooperative
ft	-	feet
$gC/m^2/day$	-	gram Carbon per square meter per day
GLC	-	Ground Level Concentration
GNP	-	gross national product
gpd	-	Gallons per day
gpm	-	Gallons per minute
GPS	-	Global Positioning System
GRDP	-	Gross Regional Domestic Product
GWH	-	Giga Watt Hours
H_2S	-	Hydrogen Sulfide
ha	-	hectare
HHW	-	Higher High Water
HLURB	-	Housing and Land Use Regulatory Board
hrs	-	hours
kg/ha	-	kilogram per hectare
Kgs	-	kilograms
Km	-	kilometers
Km^2	-	square kilometer
kV	-	kilovolts
KWh	-	kilowatt hour
LBC	-	Luzon Brokerage Corporation
LGU	-	Local Government Unit
LLDA	-	Laguna Lake Development Authority
LLW	-	Lower Low Water

GLOSSARY

SE	-	Southeast
sec	-	second
SiO_2	-	Silica
SO_2	-	Sulfur Dioxide
SO_4	-	Sulphate
sp.	-	species
SPSS	-	Statistical Package for the Social Sciences
SW	-	Southwest
t	-	tons
t/year	-	ton per year
tons/Km^2	-	tons per kilometer
TSP	-	Total Suspended Particulates
TSS	-	total suspended solids
25-KRIZ	-	twenty five - kilometer radius impact zone
u	-	microns
ug/ncm	-	microgram per normal cubic meter
UPLB	-	University of the Philippines, Los Banos
UPMSI	-	University of the Philippines Marine Science Institute
US-EPA	-	United States Environmental Protection Agency
V	-	Venadium
W	-	West
WB	-	World Bank

GLOSSARY

NOx	-	nitrogen oxides
NPC	-	National Power Corporation
NPCC	-	National Pollution Control Commission
NSO	-	National Statistics Office
NW	-	Northwest
NW-SE	-	Northwest-Southeast
NWRB	-	National Water Regulatory Board
O2	-	Dioxide
OPI	-	Ogden Projects, Incorporated
OQP	-	Ogden Quezon Power
P/R	-	photosynthesis-respiration ratio
PAGASA	-	Philippine Atmospheric Geophysical and Astronomical Services Administration
PAR	-	Philippine Area of Responsibility
Pb	-	lead
PD	-	Presidential Decree
PFS	-	Philippine Fault System
pH	-	negative logarithm of the Hydrogen ion concentration
PHIVOLCS	-	Philippine Institute of Volcanology
PHP	-	Philippine Peso
PIZ	-	Probable Impact Zone
PLDT	-	Philippine Long Distance Telephone Co.
PO_4	-	Phosphate
PPA	-	Philippine Ports Authority
ppm	-	parts per million
ppt	-	parts per thousand
PQ	-	photosynthetic quotient
psi	-	Pounds per square inch
PT&T	-	Philippine Telegraph and Telephones
QPP	-	Quezon Power Project
RAPSTRE	-	Rapid Appraisal of Plant Structure in Tropical Reefs
RCPI	-	Radio Communication Phils., Inc.
RNI	-	Rate of Natural Increase
RO	-	Reverse Osmosis
S	-	South
S	-	Sulfur
SC	-	Classification of water use
SDA	-	Spray Dryer Absorber

EXECUTIVE SUMMARY

2.2 Construction Phase

The project construction will be for a period of about 40 months and will require about 2,400 personnel over the term of construction.

The design and configuration of the plant will be in accordance with all applicable regulations, codes and standards with all major equipment based on standard proven technologies.

During the construction phase, some structures will be constructed such as a jetty which will be used to deliver equipment and materials for the construction stage.

Temporary housing for sub-contractors and workers will be developed in the area. Also generators will be provided for the power requirements during the construction period.

2.3 Operation and Maintenance

The plant will use sub-bituminous coal as primary fuel and #2 fuel oil (diesel) as secondary fuel. Coal consumption will be approximately 1.9 million metric tons per year. A minimum of 45 days coal supply will be stocked at the inactive coal storage area. Diesel oil will be used for the plant start up.

The plant will be operated 365 days a year with regular preventive maintenance.

The plant's fresh water and potable water requirements will be drawn from groundwater sources at a rate of 2,750 m^3 per day.

Seawater will be used for cooling water needs at a rate of 18.3 m^3/sec. The change in temperature will be 8.3 °C higher than ambient. The design of the thermal plume will be such that a temperature at the edge of the mixing zone will not have a differential temperature greater than 3°C.

The plant will employ approximately 220 personnel during plant operation.

2.4 Emissions, Wastes and Treatment Systems

Plant air emissions will consist of sulfur dioxide (SO_2), oxides of nitrogen (NO_x) and particulate emissions (TSP). The facility is designed with a 150 m. stack. The air pollution control equipment will consist of an electrostatic precipitator (ESP) and an acid gas scrubber to control particulate and SO_2 emissions. Low NO_x burners will also be used to minimize NO_x emission.

Coal will be stored on the site in an inactive storage area and an active storage area. The inactive storage area will be compacted and surface-treated with an encrusting agent to minimize fugitive dust and the potential for spontaneous combustion. Coal stored in the active pile will be fed to the boiler on a continuous basis to the boiler. Belt conveyors will be covered except for sections of the conveyor traversed by trippers. The continuous use of the active coal pile will decrease storage time such that spontaneous combustion will not occur.

Noise attenuation will be undertaken to satisfy the applicable standard for industrial areas at the perimeter of the plant, which is 75 dB(A) during daytime, 70 dB(A) during morning and evening and 65 dB(A) during nighttime.

The air heater washwater, boiler blowdown and RO reject water are all directed to the waste water basin for reuse in the plant. The filter backwash, neutralized demineralized waste, treated sanitary effluent and miscellaneous floor drains, oil/water separator drainage are directed into the plant discharge sump.

I. EXECUTIVE SUMMARY

1.0 INTRODUCTION

The power development program of the Philippine government formulated by the Department of Energy (DOE) and the National Power Corporation (NPC) includes various power projects aimed at supplying projected power demand.

The proposed Quezon Power Project (QPP) would be designed, built, owned and operated by a consortium of companies with a proven track record in the power industry, collectively known as Ogden Quezon Power (OQP).

The QPP will be a 433 (net) megawatts (MW) coal-fired plant to be constructed in Mauban, Quezon. This project will be built under the Build-Own-Operate (BOO) scheme and will be the first such project to be undertaken under this scheme. The OQP has a 25-year power purchase agreement with the biggest electric distributor, Manila Electric Company (MERALCO). QPP is identified to supply the power needs by year 2000.

Consistent with the requirements of the Philippine government, this Environmental Impact Statement (EIS) was prepared to determine the potential impacts of the project on the environment and recommend measures to minimize and mitigate these impacts.

The scope of the EIS was determined through a scoping session conducted with representatives from the Environmental Management Bureau (EMB), the Mauban local government unit (LGU), the proponents and the environmental consultants. This document presents the results of the study. A summary of impacts and mitigating measures are outlined in **Table I-1-1** provided at the end of this executive summary.

2.0 THE PROPOSAL

2.1 Project Description

The proposed 433 MW (net) capacity coal fired plant is comprised of a single boiler and turbine generator utilizing sub-bituminous coals for fuel. This will be a baseload power plant designed to supply the partial needs of the MERALCO service area for at least the next 25 years commencing operation by the year 2000.

The plant will use coal imported from Indonesia and/or Australia which will meet the fuel specifications of the plant equipment.

The proposed plant and appurtenant structures will be built on an approximately 100 hectare site in Sitios Dalig, Sabang and Dinahican in Barangay Cagsiay I, Municipality of Mauban, Quezon. The site will accommodate major components such as a turbine and boiler, an auxiliary boiler, an active coal yard, an inactive coal yard, an acid gas scrubber and electrostatic precipitator (ESP), chimney, switchyard, ash disposal area and a jetty and a pier facility for fuel delivery. Furthermore, a transmission line with substation connecting the plant to MERALCO service areas in Payatas, Quezon City, will also be constructed. An EIS is also provided for the transmission line as a separate volume to this document

Total project cost is estimated at US$825 Million.

3.2 Oceanography, Hydrology and Water Quality

3.2.1 Oceanography

Two types of tides prevail over the area, the diurnal and semi-diurnal type. The maximum tide range occurs during the diurnal period.

The surface currents in the area are mainly wind-driven. However, tidal forcing dominates at times when the prevailing winds are weak. Current observations at the outfall and vicinity using SD-30 recording current meter showed current speeds up to about 7 cm/s and directions of generally southwest since the prevailing wind during the survey was northeast. This wind direction prevails for about eight months.

3.2.2 Hydrology

The project has abundant groundwater resources. It belongs to the "shallow well area" classification of the National Water Resource Board (NWRB) where well depths can be within 20 m and average static water level within 6 m below ground surface.

Storage of the groundwater aquifer is about 13,500 MCM with a safe yield of about 900 MCM/year based on groundwater recharge. The 50-year groundwater mean yield is 1,170 MCM/year.

3.2.3 Water Quality

Water quality was generally found to satisfy ambient standards for groundwater, marine and surface waters. However, some metals like Cd, Cu and Pb showed exceedances for marine waters. This could be attributed to dynamite fishing and fuel spillages by boats plying the area. Another notable exceedance is the bacterial test for all stations sampled. Both fresh and spring water were found positive of coliform.

3.3 Geology, Soils and Terrain

On a regional scale there are three prominent geologic features in south Quezon province that have significant bearing on the project site, viz., a branch of the Philippine Fault Zone, Mt. Banahaw volcano, and the metavolcanics/metasedimentary rocks.

The Philippine Fault Zone is the most active tectonic feature of Philippine geology. Most of the recent major earthquakes in Luzon are directly related to this fault. Its track is invariably traced through Mauban or very close to the offshore of Lopez Bay. Detailed mapping at the Saley Point-Cagsiay project site, however, failed to identify a fault large enough to be considered part of the Philippine Fault Zone.

The dominant Mt. Banahaw volcano with its peak at about +2100m MSL looms over the Luzon Pacific coast 30 km southwest of Mauban. No eruption nor extent of destruction of previous eruptions exist in historical records.

Large patches of metamorphosed rocks outcrop along the east coast of the south Quezon province. These are part of the so-called "basement" rocks denoting the oldest rocks in the country. Schistose rocks have been mapped just outside the northern boundary of the project site (MGB, 1963). On the project site itself, however, detailed mapping did not disclose any "true" basement rock. The main

Stormwater runoff from the ash disposal area and coal storage areas will be collected in a lined pond to allow for settling of suspended solids and then be neutralized prior to discharge to the sea with the cooling water effluent. Uncontaminated stormwater collected from the remainder of the plant site will be collected in a series of storm drains and swales and discharged at the shoreline. The combine plant effluent will meet the DAO No. 35 Philippine standard.

The plant water systems will be designed to reduce the volume of discharge as well as water requirements.

Generated bottom ash and fly ash will be disposed of in a properly lined ash disposal area on site. Further studies on possible beneficial uses of the ash will be made during the life of the plant, e.g., road surfacing.

The facility will comply with all Philippine standards for air, waste water discharge and noise.

3.0 *DESCRIPTION OF THE EXISTING ENVIRONMENT*

3.1 Air Quality and Meteorology

The climate of the proposed project area falls under the Type II of the Modified Coronas Classification having a very pronounced maximum rainfall without a dry season. The rainiest months occur during October to November with a rainfall range of 500-526 mm for the Tayabas station. Based on the data from the Infanta station, maximum rainfall is experienced during October to December ranging from 612-656 mm. Highest temperatures recorded both Infanta and Tayabas stations are 32°C and 31°C while the lowest was 21.8°C for both stations, with a mean annual temperature of 27°C and 30°C, respectively.

The mean annual relative humidity is 85 percent for Tayabas and 82 percent for Infanta. The highest relative humidity is experienced during December with 88 percent and 86 percent for Tayabas and Infanta stations, respectively.

The prevailing surface winds for Tayabas is northeasterly with a 2 mps wind speed. While for Infanta, northerly winds are dominant at a speed of 2 mps. Northeastern winds occur during January to May while northern winds occur from September to June.

Frequency of the passage of tropical cyclones in the area is about three cyclones in two years. Thunderstorms and lightning are frequent during the months of May to July and September with more than 11 thunderstorm days and 17 lightning days in a year.

Air quality at the project site is characteristic of rural areas. The average one-hour sampling results obtained were 93 ug/ncm for TSP, 1.2 ug/ncm for SO_2 and 10 ug/ncm for NO_2. The average 24-hour concentrations measured were 52 ug/ncm, 2 ug/ncm and 7 ug/ncm for TSP, SO_2 and NO_2, respectively.

The concentrations obtained in the area above reflect three months of sampling and are within the Philippines' Good Air Quality Index.

Average noise levels measured in the area ranged from 40.9 to 56.4 dB(A). Current noise levels can be attributed to the proximity of the site to the ocean.

herbivorous and arboreal wildlife species, respectively. These species were observed near the Paete Land Grant of UPLB.

3.5 Aquatic Ecology

Data show that in February-March 1995, the seaweed, seagrass, mangrove, coral, plankton, and reef-associated fish communities at five study sites in the vicinity of the proposed power plant were comparatively depauperate. This condition is largely due to stresses imposed by natural elements (waves and wind), and there were signs that man-mediated disturbances were significant in bringing about the changes. The mangroves in the immediate vicinity of the proposed project site are mostly remnants of primary stands currently without any signs of significant recruitment capacity, and the object of intense unsustainable use by coastal inhabitants.

Overall, the present coastal environmental condition at the proposed project site is significantly affected by the discharge of effluents from saw mills, domestic establishments, motorized boats of varied sizes, and impacts of unsustainable fishing practices (e. g. blast fishing). The situation is expected to deteriorate and unless the proper and timely amelioration techniques are effected, it will deteriorate further to a point where the cost of rehabilitation or restoration of its fundamental ecological features would be excessively prohibitive.

3.6 Socio-economics and Public Health

The population within the 5-km radius (designated as the project's probable impact zone or PIZ) and within the direct impact area (DIA) is mostly composed of household members whose ages range from 20 years old and below (52%). Highest educational attainment is elementary level (66%).

In the PIZ, fishing (25%) and farming (21%) are among the main sources of income of the household heads. Those in the DIA, however, are mostly farmers (46%) and are either laborers or construction employees (25%).

Average monthly income derived by the household heads from their main sources in the DIA and PIZ is estimated at PHP 3,000, and PHP 6,000, respectively.

Among the illnesses or symptoms experienced by household members in the PIZ last year were fever diseases which are basically respiratory in nature (19%), influenza (17%), cold (13%) and diarrhea (11%) while residents within the DIA experienced cold (14%), influenza (13%) and asthma (13%).

Results of a project awareness, opinion and perception survey (May 1995 survey) within the DIA and the PIZ reveal that 84.3 and 57.8 percent percent are in favor of the project, respectively. The general opinion is that the project will bring both positive and negative effects to the community.

Forty-five percent of the household heads within the DIA expressed their willingness to relocate should the project require the land occupied by their houses and/or their farmlands. Forty-one percent responded otherwise.

3.7 Land and Resource Use

The dominant land use within the DIA and the PIZ is agriculture, specifically coconut lands. *Similarly, coconut is the major agricultural crop within the 25 km radius.*

The DIA or areas directly affected by project facilities has small clusters of settlements having a total of 64 households. Located on the northern periphery of the project site is also a cluster of settlements.

rock types identified are mostly volcanic-derived sedimentary rocks with signs of inceptual metamorphism. The three rock units are:

- greenish gray tuffaceous SHALE and SANDSTONE (Unit I);
- fine to medium-grained tuffaceous SANDSTONE (Unit II); and
- sub-angular blocks of basaltic lavas chaotically admixed in a clay matrix (Unit III).

3.3.1 Soils

Soil samples were collected from the approximately 100 hectare project site. The soil types essentially conform to the geology and terrain class in which it is located. Thus, the tuffaceous shale (Unit I) has a mantle of residual clay soil. Sands, gravels and other coarse-grained soils are found in the beach and river terraces of the alluvial terrain. On the ridges of the volcanic terrains are the relatively thin clay-rock mixtures.

3.3.2 Terrain

Terrain Classification was on the basis of geology, i.e., soil/rock type and structures. From a regional scale, ten terrain patterns were identified. On a more local scale within the project site and immediate vicinity, three terrain provinces were delineated, viz., alluvial, volcanic and metamorphics. The alluvium is further subdivided into three patterns, A1, A2, and A3.

3.4 Terrestrial Environment

3.4.1 Vegetation

Barangay Cagsiay I and its vicinities are predominantly covered with coconut (*Cocos nucifera*) plantations with patches of rice fields in low-lying flat areas. A very small mangrove area is also within the proposed project site which is surmised to be destroyed even without the project given the fact that no recruits are evident.

Coconut and rice fields are essentially monoculture agroecosystems. In coconut plantations, only coconuts are present in the upper canopy. A few large trees are scattered randomly or in small patches. The undergrowth are suppressed by regular weeding. A plant diversity index of 0.5 was obtained reflecting the lack of diversity of the area. A few individuals of ipil (*Instia bijuga*) and kamia (*Hedychium philippinensi*), both of which are endangered plant species under CITES, were found outside the directly affected areas.

Rice cultivation is essentially monoculture. The most common varieties were R-5, R-22, C-1 and Maharlika. Around 30-50 cavans kgs. of palay are harvested per hectare per year valued at P10,000-P11,000. Rice lands are all rain fed/

In the mangrove area, only 13 plant species were found. Two of these are major mangrove elements (*Avicennia officinales* and Somneratia *alba*). The rest are beach and secondary forest species.

Cagbalete (Cagbalete to locals) Island is predominantly a coconut plantation area with a few patches of rain-fed rice lands.

3.4.2 Wildlife

No endangered species were identified in the vicinity of the project site. However, two species of wildlife that are considered threatened were recorded in this region. These are Slender-tail Cloud Rat (*Phloeomys cumingi*) and Gray Monitor lizard (*Varanus olivaceus grayi*) which are primarily

4.0 IMPACT ASSESSMENT AND MITIGATING MEASURES

4.1 Air Quality

4.1.1 Impact Assessment

Construction Impacts and Mitigation

Construction activities would include clearing, grubbing and earth moving at the project site. These activities would generate particulate emissions (dust) from earth movement and a certain amount of carbon monoxide from the exhausts of construction equipment. After the initial earth moving activities, dust will primarily be generated from equipment and vehicles moving along unpaved roads. This impact should be negligible due to frequent rainshowers experienced in the area and the wetting of road surfaces during dry periods.

The operation of heavy equipment will temporarily increase the noise level in the area of the site. The plan to use barges and to move a majority of the plant components by sea will eliminate the potential of a large quantity of truck deliveries. The operation of heavy equipment will generate SO_2 and NO_2 emissions. However, this is expected to be temporary and insignificant because of the planned use of a jetty for deliveries.

To minimize the noise and vibration impact, pile driving and blasting activities will be carried out only during the day. Further, vehicular movement along populated areas will be limited during daylight hours to minimize disturbance to the residents, particularly those located along the access road.

Operational Impacts and Mitigation

Based on emission estimates from the 3 proposed coals, coal 2 was determined as the worst case. The maximum SO_2 stack emission obtained for coal 2 at 100% load was 600 ug/ncm which is below the Philippine air standard of 700 ug/ncm. For NO_2, emissions are a stronger function of combustion design, thus the 1000 mg/ncm emission standard is expected to be complied with for all types of coal combusted. For TSP, the maximum stack emission for all 3 coals is expected to comply with the Philippine standard, which is 150 mg/ncm.

To predict ground level concentrations, a worst case scenario was determined by combining the maximum emission rates (gm/s) and the most conservative stack gas characteristics (lowest stack gas temperature, and stack flue gas and stack flow rates) and inputting these parameters into a screening dispersion model. Modelling was conducted for two continuous operational scenarios, at 50% and 100% of design load. Maximum ground level concentrations were determined for a 100% load. Maximum one-hour concentrations are 318 ug/ncm for SO_2, 98 ug/ncm for TSP and 106 ug/ncm for NO_2. Maximum 1-hour concentrations were determined to occur at 1100m. downwind from the stack.

The specified one-hour Philippine ambient air quality standards are 340 ug/ncm, 300 ug/ncm and 260 ug/ncm for SO_2, TSP and NO_2, respectively. Maximum one-hour concentrations and baseline concentrations measured in the area resulted in concentrations of 320 ug/ncm for SO_2, 191 ug/ncm for TSP and 116 ug/ncm for NO_2.

A concentration of built-up areas in the Poblacion and the different barangays within 5-km radius is noted, the dominant land uses of which are residential and agricultural.

Ribbon type development characterizes the 25 km radius, wherein, settlements line the major circulation system of the study area.

3.8 Archaeology

A historical and archaeological study was conducted at the proposed site of the power plant and its immediate peripheries. The foci of the study was the determination of any site(s) of prehistoric and historic significance which may be affected by the plant. In the conduct of the study, the systemic and archaeological contexts of the environment were considerably taken into account. Determination of the depositional factors, natural and man-made were cognizantly considered in the analysis of the archaeologic and historical significance of the areas studied.

In the immediate vicinity which is 1 km to 1.5 km south of the plant, the areas of Bulwagin Beach to the Cagsiay I Elementary School, shards of mining type and a stone tools with coralline accretion were found. The areas were heavily exploited by treasure hunters.

The Municipality of Mauban may have historic sites of import as it attracts treasure hunters with high frequency, its mention by Henry Otley Beyer as well as the existence of a market of antiquarian value. These areas are significant in the contemporary local history of Mauban.

The construction of the power plant does not pose any impact on any archaeological artifacts.

During plant operation, wastewater will be generated from water treatment boiler blowdown, domestic sewage, coal pile runoff and ash disposal runoff. The latter two without treatment have the potential of adversely affecting groundwater quality.

Provision of an impermeable lining in the ash disposal and coal pile sites and proper drainage system to account for rainshowers experienced in the area, a runoff collection and a water treatment system will mitigate and minimize any impacts.

4.3 <u>Geology, Soils and Terrain</u>

<u>Foundations</u>

A detailed geotechnical subsurface investigation has been initiated by BECHTEL which supplemented the soils investigation conduced by BHP.

The plant site is divided into three (3) distinct areas in terms of geologic and geotechnical clarification, viz:

- the Powerblock Area;
- the Ash Disposal Area adjacent to the River; and
- the Uplands Area

The powerblock area is underlain by sandy silts in the west while clay and soils of marine origin are prevalent *along the central and eastern sectors.*

In the ash disposal area adjacent to the river, clay dominates the subsurface to as deep as 25.0 m below ground surface.

The metavolcanic bedrock is only 0.7-7.0 m below ground surface in the uplands area.

<u>Potential Impacts During Construction</u>

The potential impacts during construction are generally short term. These include excavating and backfilling some areas to attain the construction level and siltation due to the removal of the vegetative cover.

<u>Potential Impacts During Operation</u>

Long-term settlement along the surficial clayey soil is an important design consideration. Also, bearing failure may occur at the areas planned for heavy infrastructure and dump areas for fly ash.

<u>Seismicity</u>

The record of high intensity earthquake in North Luzon along the Philippine Fault Zone introduces questions of liquefaction in the chosen ash disposal area. Any embankment, rock cuts, or earthfills not properly constructed are subject to destabilization by earth shaking.

<u>Volcanic Eruptions</u>

The *relatively higher* elevation *of the* Mt. *Banahaw peak vis-a-vis the* project site poses risk from ejecta and laharic flows in the event of a violent explosion. However, in the existing drainage systems of the area, there is no direct link between the slopes of the volcano and Saley Point. Possibilities of laharic flows reaching the plant site are minimal.

Fugitive dust from the two active coal stockpiles will also be generated. Each pile will have a maximum emission concentration of 34 ug/ncm. Combining fugitive emissions generated by the coal stockpile, the exhaust stack and the baseline concentrations will result in a total concentration of 229 ug/ncm. This is still below the prescribed standard of 300 ug/ncm. The maximum concentration was predicted to fall within the plant site, limiting the impact to plant personnel. However, due to frequent rainshowers experienced in the area, coupled with the coalyard management measures, coal dust emissions will be lower than modelled.

Predicted 24-hour ground level concentrations can be estimated based on the one-hour average concentration obtained. Total 24-hour concentrations predicted inclusive of background levels are 129 ug/ncm for SO_2, 48 ug/ncm for NO_2 and 91 ug/ncm for TSP. These levels comply with the Philippine Standards of 180 ug/ncm for SO_2, 150 ug/ncm for NO_2 and 230 ug/ncm for TSP.

The operation of heavy equipment and vehicular passage will increase the noise level in the area. Likewise, vibration levels will also increase due to these activities, however, these impacts should be minor and will only be experienced intermittently.

4.2 Hydrology/Oceanography/Water Quality

Hydrology

The freshwater requirement is about 1.0 MCM/year. Domestic, agricultural and industrial water needs in the basin in the year 2000 is about 668 MCM/year.

With 900 MCM/year available from the goundwater aquifer, this freshwater requirement can be amply supplied without importation from other watersheds and without any adverse impacts on the water resources in the area.

Thermal Plume

The proposed power plant will discharge cooling water at a maximum temperature of 38.3°C reflecting an 8.3°C temperature rise above the maximum ambient seawater temperature of 30°C. Thermal plume modelling indicates that a predicted temperature increase of 3°C occurs from the outfall to a downstream distance of about 30 m for a mixing zone area of 400 m^2. The maximum 3°C temperature mixing zone will mitigate the effects of increased seawater temperature in conformance with Philippine SC criteria.

Water Quality

The construction of the power plant will require the excavation and movement of large volumes of soil which has the potential of increasing the silt load of the river and eventually the bay.

The construction of silt traps along the drainageways to minimize the discharge of silt-laden runoff in water bodies will be implemented to mitigate and minimize impacts;

Possible oil spillages during construction and operation may also result in impacts on water quality.

The provision of containment in the storage areas for oil and the motor pool area will mitigate these impacts.

During the operation of the power plant, there are projected to be minimal impacts, however, the secondary impacts in the region are projected to be as follows:

- possible increased cutting of coconuts for coco-lumber;
- conversion of agricultural farms to residential areas;
- conservation of forest resources; and
- intensified cultivation of cash crops.

The proponents will, in accordance with the DOE requirements, conduct the following mitigating measures:

- implement reforestation;
- provide livelihood training;
- control and monitor emissions; and
- provide aesthetic landscaping.

No direct impacts are foreseen on the vegetation of Cagbalete Island since it is about 2 km from the power plant. However, possible indirect impact is intensification of crop production because of the larger market in the Quezon mainland.

4.4.2 Wildlife

Impacts identified during the construction phase are mainly temporary dust and noise generation due to utilization of heavy equipment and machineries.

Mitigating measures include the daily sprinkling of roads during dry days by water tanker to minimize dust generation. Significant rainfall in the area will normally mitigate dust generation. Noise that may disturb wildlife is expected to be temporary as this will occur mainly during construction.

During the operation phase, no impacts are expected on the surrounding wildlife habitats.

4.5 Aquatic Ecology

The construction and maintenance of the jetty, the pier and intake/discharge structures are expected to have an impact on the aquatic ecology of the area. However, the latter have the most significant and direct impacts on the coastal and marine environments. These impacts include: habitat disturbance or modification; possible siltation or sedimentation; discharge of effluents (thermal, etc.); entrainment and impingement of organisms; physical disturbance; chlorination; and provision of additional substrates for attachment of organisms. Depending upon the degree of disturbance or modification of the habitats, and the intensity and duration the activities appears to be undertaken, these impacts may be positive or negative.

In order to mitigate the impacts on the coastal and marine environments, the following actions will be undertaken:

- minimize silt-laden runoff from the river, using physical barriers such as silt screens and earthen berms;

- thermal effects will be minimized by limiting the temperature increase at the edge of the mixing zone to 3°C in order to ensure that minimal damage is done to the coral communities. Positioning of discharge pipe near steep submarine topography will be studied to mitigate impacts on reefs.

Ash Disposal Runoff

Three geotechnical boreholes at the ash disposal site were tested for permeability. These falling head tests resulted in low magnitudes of permeability coefficient indicating a highly impermeable (1.7 x 10^{-5} cm/sec) clay cover at the inner parts and more permeable (8 x 10^{-5} cm/sec) sandy material along the edge of the river terrace. Although generally covered with clay, this chosen ash disposal site has sand deposited by Cagsiay River along its edge. The ash disposal site will be lined with an impermeable membrane. e.g., clay blanket properly compacted or a synthetic geomembrane. No permeating runoff impacts are expected.

Flooding

Runoff from this area will be collected in a lined perimeter ditch and treated prior to discharge to mitigate any potential impact to groundwater or surface water resources. The Cagsiay River is reported by residents to be prone to flash flooding that would reach and engulf the proposed ash disposal area as often as four times a year. Flash floods are anticipated not only in this river but also in the creeks and streams that traverse the proposed project site, this includes Dalig Creek in the extreme north and Miniana Creeks 1 and 2, all tributaries of Cagsiay River.

The site will be elevated to a height of +8 m above mean sea level. The area adjacent to the river will also have a significant elevation which will prevent ash and flood waters from entering the ash disposal area. River gauges will be installed to verify maximum flood heights for design to ensure that floods should have no impact on ash disposal area.

Backfills

Samples of the soil and rock material from the areas to be excavated need to be properly tested with respect to their optimum moisture content to attain 90 percent compaction. These tests will determine their appropriateness as backfills and as load-bearing materials.

Settlement and Bearing Failure

Proper soil mechanics analysis must be conducted at the ash disposal area to determine the maximum loads that the in-situ materials can bear. Areas shown to be prone to liquefaction will be replaced or strengthened by soil stabilization processes.

4.4 Terrestrial Environment

4.4.1 Vegetation

During the construction phase, coconut and rice farms in the areas covered by the power plant site will be cleared. The small mangrove stand will also be eliminated because of its proximity to the plant site. These are seen as the residual impacts of the project. However, if there are any healthy ipil and kamia trees in the areas to be developed, these species will be baled and transferred to another location.

However, there are also potential benefits of the plant construction which are:

- enhanced conservation of forest resources because of improvement of infrastructure;
- existence of alternative source of livelihood; and
- reduced dependence on farming as a result of other sources of income.

A total of 64 households will be directly affected/displaced by the project including clusters of settlements in Sitios Dinahican and Dalig.

4.8 Archaeology

Records of archaeological sites exist in Mauban and the oral tradition of people gave an account of the *Bulwagin Beach and Cagsiay I Elementary School as sites of significant contemporary local history of* Mauban. Primary investigation suggestively supports findings of these claims. However, these sites are not within the direct impact areas of the proposed plant. Thus, it is not expected to pose any danger or impact to any archaeological or historical sites. Conclusively, the power plant does not have an impact on the historical and archaeological environment. The threat of destruction of any possible significant sites from antiquarian collectors and treasure hunters due to the increase in migration and economic activity of which treasure hunting is done clandestinely by locals. The proponents will promote and engage in cultural sensitivity with the local residents.

- reducing entrainment and impingement losses by providing a low velocity intake pipe design;
- Relocation of the discharge structure to south of the jetty to avoid fair to good quality coal.
- chlorination effects will be minimized by low residual chloride levels of 0.5 mg/l and properly maintaining the underwater structures.
- Complement the above specific measures with activities emphasizing public awareness, impact management, including marine parks and reserves.

4.6 Socio-economics and Public Health

The project will displace around 64 households within the DIA to give way to the construction of the power plant and the ash disposal site.

The project will generate employment to approximately 2,400 workers during the 40 month project construction period and to 220 personnel during project operation. Population trend is expected to rise as a result of the project's employment requirements.

Spin-off economic activities are likely to occur especially during the project's construction phase. These would include setting up canteens and stores, offering board and lodging services for migrant workers and marketing of services as suppliers and contractors for the project.

The project is expected to contribute to the local government revenues since the proponent will pay local taxes and secure local permits.

Improvement in infrastructure will be among the benefits which will result from project implementation. This would include the paving of approximately 6 km roadway from Mauban town to the project site.

With regard to health conditions, especially during project construction, proper sanitation at workers' camps will be monitored and sanitation facilities will be provided.

The project proponent will ensure that the project's socio-economic benefits will be returned to the local population:

- implementing an acceptable resettlement and compensation program to ensure that existing living conditions of those who will be affected by the plant will be uplifted.
- conduct of skills and livelihood trainings to prepare the locals for jobs which may or may not be related to the project
- preferential hiring of qualified local population

A project awareness, opinion and perceived effects survey indicate project acceptance of 84.3 percent in the DIA and 57.8% in the PIZ.

4.7 Land and Resource Use

The direct positive impact due to the project is the accelerated urbanization and industrialization of the study area's urban centers and its dominantly rural municipalities.

Conversion of agricultural lands, specifically coconut and ricelands, is the only impact of the proposed power plant project to the DIA and PIZ.

	Silt screens and berms will be constructed. Natural depressions will be used as sedimentation ponds to reduce suspended solids.
Spillage and washings of oil and grease from heavy construction equipment will produce a thin film on the surface water.	Temporary containment will be provided around the perimeter of the motor pool. Run-off laden with oil spills will be directed to an oil-water separator to remove oil from water.
Water Quality - Operation Phase	
Settleable solids such as paper, rags and refuse will increase resulting in the formation of sludge deposits which will increase BOD.	Good housekeeping and proper construction practices will be employed--biodegradable wastes will be collected and disposed of regularly while non-biodegradable materials can be collected and sold.
Periodic boiler blowdown and chemical cleaning of boilers may cause turbidity due to accumulated precipitates and increase the normal temperature of the receiving water body which may then affect the replenishment of DO and change in pH.	Boiler blowdown and chemical cleaning water will be reused for scrubber feed water and the remaining effluents generated during the operation of the plant requiring discharge will undergo treatment in the wastewater treatment facility consisting of neutralization and oil and water separation.
Washing of equipment during maintenance may contain oil and water while spillage and droppings may result to surface runoff laden with grease and oil.	Electro-mechanical discharges will be piped to the treatment plant for oil water separation prior to discharge.
Domestic sewage may be unsightly, odorous and depletes DO causing turbidity and effect recreational use of water.	Domestic waste water will be treated in a sewage treatment facility.
Run-off from the coal storage area and ash pile may contain trace elements and may contaminate groundwater.	Impervious lining materials will be used to line the coal storage area, the ash pile area and the perimeter collection system. Runoff requiring discharge will be neutralized.
Cagsiay River would be prone to ash contamination during flooding, monsoons and typhoons.	Two measures will be undertaken--first, raise the elevation of the site by backfilling and second, build an embankment along the ash pile.
Oceanography - Operation Phase	
Sea water temperature will increase due to water discharges from the cooling system of the power plant.	Maintain the temperature increase at the edge of the mixing to 3°C or less.

TABLE I-1-1
SUMMARY OF IMPACTS AND MITIGATING MEASURES

IMPACTS	MITIGATING MEASURES
A. Air Quality and Noise	
Construction Phase	
Potential increase of dust as a result of construction activities.	Sprinkling of road surfaces on dry days with water to reduce the generation of dust. Frequent rainshowers will also mitigate these impacts.
There will be a slight increase in the ambient levels of SO_2 and NO_x from the exhaust of construction equipment.	Temporary impact, intermittent no long term impacts are expected.
Noise and vibration levels will increase during construction due to increased frequency of vehicular passage.	Pile driving and blasting activities will be carried out during the day. The plan to use barges transport by sea, for the majority of the plant components will eliminate potential of large quantities of truck deliveries.
Operation Phase	
There will be SO_2, NO_2 and TSP emissions from the combustion process.	An acid gas scrubber and electrostatic precipitator (ESP) will be installed to control SO_2 and TSP concentrations, respectively. Low NO_x burner will be used to control NO_x emissions.
There will be fugitive dust emissions from the active coal storage area.	Wind buffers such as trees, etc. will be constructed to minimize wind erosion to lessen fugitive dust from the coal storage area. Frequent rainshowers will also mitigate these impacts. Coal management measures will be formulated and effected.
B. Oceanography, Hydrology and Water Quality	
Construction Phase	
Silt run-off from the excavated areas may result during earthworks and dredging.	Natural drainage course will be maintained and kept free from debris to prevent the discharge of silt into the river.

Operation Phase

Cutting of coconuts for lumber will leave areas bare. Accelerated soil erosion may result in hilly areas if not properly addressed.	Local government unit should monitor these activities and encourage replanting of trees.
Rice fields and coconut lands will be converted to residential areas with the increase in demand for housing facilities.	Land use planning should be initiated by the local government unit in conjunction with the proponents to identify zones suitable for housing.
Potential impacts on vegetation from facility emissions.	Monitoring of crop yields to measure changes and the factors affecting them.
Increased access to the area and increased demand for coco lumber may render forested areas vulnerable to illegal logging.	Improved access to the area and better communication facilities could strengthen forest protection activities and prevent illegal logging.
	Alternative sources of income coming from the project could reduce dependence on farming and illegal logging.

Wildlife

No endangered species were identified in the vicinity of the project site.	No mitigation required.
Temporary dislocation of birds	The planting of vegetation will provide alternative habitat.

E. Aquatic Ecology

Construction Phase

Trench excavation and construction of intake and discharge piping structures will entail the removal of substrate sand and coral.	Physical barriers like silt screens and earthen berms can be effective in reducing the areas that may be affected by dredging and filling operations.
Increase in turbidity may be detrimental to primary producers as a result of the reduction of light penetration and DO content. Sediments generated during the construction of intake and outfall structures can affect coral reefs.	Any waste water discharge will be treated prior to discharge.
The installed structures would change the bottom contour and is expected to change the local bottom topography.	Positioning of discharge pipe near steep submarine topography will be studied to mitigate impacts on reefs.

Hydrology - Operation Phase

Fresh make up water will be required by the project at approximately 1.0 MCM/year.	Design and location of deep wells which will supply the plant's freshwater requirements will be properly studied to prevent saline water intrusion and drying-up of nearby shallow wells.

C. Geology, Soils and Terrain

Design Phase

The proximity of a main segment of the Philippine Fault System to Mauban would be the most critical consideration in the evaluation of the stability of the structures.	Design analysis should focus on seismicity, bedrock acceleration and amplification of soil and infrastructure resonance in conformance with applicable codes.

Construction Phase

Blasting will subject the rocks to excessive shattering because of the closely spaced and steeply dipping joints and bedding planes.	Blasting will be carried out in a controlled manner.

Operation Phase

Settlements of the appurtenant structures are expected to be greatest at the ash pile site due to the thickness of the clay material.	Pre-consolidation, pre-compaction of the ground will be considered where settlements affect critical components of the project.

D. Terrestrial Ecology

Vegetation

Construction Phase

The construction of the power plant will entail the clearing of all the vegetation in the coconut lands.	Healthy Ipil and Kamia which are endangered species, if found in the vicinities of the project site, will be boled and transferred to other sites.
There will be a loss in the production of some 480 to 800 cavans of rice per year. However, there will be no loss of biodiversity since rice cultivation is essentially monocropping.	Fair compensation value for lost crops will be provided.
The small patch of mangrove area close to the proposed plant site will be cleared.	Existing stand has nominal terrestrial value. No mitigation required.

People will be attracted to the project site as a result of increased economic activities, thereby causing an increase in the demands for public services.	The project will contribute to local government revenues through taxes and permit application fees.
	Approximately, 6 km of roads leading to the project site will be enhanced.
Illnesses and accidents may arise from physical hazards in the construction site.	Project management will make provisions for adequate housing space and sanitary facilities for the project employees.
	Strict compliance on occupational health and safety regulations should be underscored by management. Workers on-site should be given thorough briefings and first aid trainings.
Make shift structures/dwelling units and small commercial establishment may proliferate within the immediate vicinity of the project site.	Strict implementation of municipal ordinances and monitoring by LGU.
<u>Operation Phase</u>	
Employment opportunities will be provided to approximately 220 personnel during the 25-year life of the plant.	Project management will adopt a policy giving priority employment to qualified local residents.
Provide impetus for industrial development and investment in the country.	
Increased revenues and taxes from the plant.	
Provide multiplier effect on the local, regional and national economy.	

G. Land and Resource Use

Construction Phase

Conversion of hectares of croplands planted to coconut and rice.	Reforestation Fund as required by DOE will be established.
There will be increased traffic in the roads within the Poblacion due to the transport of equipment, supplies and materials as well as the influx of people.	Specific streets will be designated for the passage of heavy equipment vehicles and appropriate traffic signs should be posted in conspicuous areas. All major facility components will be transported through barges.

Operation Phase

Organisms such as bacteria, phytoplankton, zooplankton, fish eggs and larvae may be entrained as the intake structure continuously takes in water for cooling. This may subject these organisms to mechanical, thermal and chemical stresses which may possibly cause a reduction in their population.	The intake pipe should be cleaned frequently to keep it from obstructions that would effectively reduce the pipe diameter and increase the intake velocity. Reduction in population is insignificant compared to the overall population. Modifications to conventional travelling screens may be the best available intake technology for power plants on coral reefs.
It is estimated that 400 m^2 of the reef area including its bottom cover will be affected by the projected discharge of thermal effluents.	Water from boiler blowdown and chemical cleaning operations will be reused as scrubber water and other process and potable water will be treated at the facility prior to discharge. The temperature at the edge of the mixing zone (area of 400 m^2) will be maintained below 3°C. The discharge structure was relocated south of the jetty to minimize impacts on the coral reef.
Inhibition of the growth of marine organisms with the construction of submerged structures.	These structures are expected in the long term to provide additional substrate for benthic organisms and artificial shelters to other marine forms.

F. Socio-economics and Public Health

Construction Phase

Approximately 64 households in the direct impact area (DIA) will be required to relocate.	The resettlement and just compensation program should be negotiated with all concerned parties.
Economic displacement of household heads 27 of whom are engaged in farming and its related activities while 5 are engaged in fishing activities will be brought about.	Skills training and livelihood programs will be offered to those who will be relocated. This will prepare them for jobs with the project or as an alternative source of income.
Employment will be generated to 2,400 skilled and unskilled workers during the 40-month construction.	Local hiring will be emphasized by project management to its contractors. Economic activities ranging from the supply of construction materials, setting-up of stores, etc. will be encouraged.

Operation Phase

Residential areas will expand in Barangays Cagsiay I and the Poblacion due to the migrants and the natural increase in population and would then encoach into the agricultural sites of the municipality.

Local Government unit should monitor these activities and encourage conservation.

There will be energization of the "power-less" barangays.

Local ambient air quality may improve as kerosene lighting is replaced with electrical lighting.

Based on the National Urban Development and Housing Framework, 1993 to 1998, of the Housing and Land Use Regulatory Board, Mauban (and also Atimonan; both in Quezon) will have small service areas and will render production and marketing related services to the agricultural areas and provide basic social services to outlying municipalities.

Mauban should update its Comprehensive Land Use Plan to consider the overall urbanization/industrialization effects as a result of the project.

H. Archaeology

Construction Phase

Personnel engaged in excavation work will be required to undergo an orientation provided by an archaeologist and coordination with the National Museum and the University of the Philippines' Department of Anthropology.

THE PROPOSAL

1.1 Project Proponent

The project proponents will be collectively known as the Ogden Quezon Power (OQP). The group is composed of three companies namely:

Ogden Power Development Company
Bechtel Enterprises, Inc. (BEn)
PMR Power, Inc.

OGDEN is the largest operator of municipal solid waste-to-energy thermal plants in the world and will be the operator of this proposed plant. BEn, is a developer, owner and operator of infrastructure and power projects worldwide and will be a co-developer in this venture and will be responsible for the engineering design through its affiliate, Overseas Bechtel. Lastly, PMR is a local company with expertise in the local power industry.

Office address of the group is as follows:

Ogden Quezon Power
c/o Bechtel, Inc.
22nd Floor, 6750 Building
Ayala Avenue, Makati
Metro Manila, Philippines

1.2 Name, Location and Type of Project

1.2.1 Project Name

The project will be known as the Quezon Power Project (QPP). The QPP will be a 433 MW (net capacity) coal-fired plant. The project will also include a 90 km, 230 kV transmission line from Mauban to Payatas. (The socio-economic as well as the land and resource use description of areas that will be traversed by the alternative routes of the transmission line for the project is included with this submission).

1.2.2 Project Location and Accessibility

The proposed project site occupies approximately 100 hectares in Sitios Dalig, Sabang and Dinahican, Barangay Cagsiay I, Mauban, Quezon.

Mauban town is located on the eastern coast of Quezon province and bounded in the north by Real, in the south by Pagbilao, in the west by Sampaloc, Lucban and Tayabas and in the east by Lamon Bay.

Mauban is about 150 km road distance southeast of Manila and can be accessed via the South Expressway through Los Banos and Pagsanjan or via Lucena. Travel time to the area is about 4 to 4.5 hrs.

Cagsiay I is 6 km further north of the town of Mauban through unpaved roads.

Figure II-1-1 is the location map of the project site.

1.2.3 Project Type

The QPP will be a coal-fired power plant which will have a gross rated capacity of 490 MW and a net generating capacity of 433 MW.

II. THE PROPOSAL

1.0 INTRODUCTION

The recent upturn in the Philippine economy coupled with a rapidly growing population has resulted in a significant demand for power. Power consumption is projected to increase by an average of 10.8 percent annually till year 2010, equivalent to new generating capacities totalling 14,411 MW for the period 1995 - 2005.[1]

To avoid a situation where inadequate supply may again cause paralyzing power shortages, the government has developed a program which identifies the various power projects that will satisfy the projected requirement for the planning period. In view of the limited resources of the government, a strategy to involve the private sector in developing dependable power supply at more competitive prices continues.

The proposed 433 MW (net) coal-fired plant to be constructed in Mauban, Quezon and a 90 km transmission line is one of the private sector power projects planned for implementation which will supply Luzon's power requirements by the year 2000. The design and construction schedule is provided in Annex 1. This project will be built under a Build-Own and Operate (BOO) scheme. The proponents signed a power purchase agreement with MERALCO on 12 August 1994. This will be the first power project to be built under this scheme. Unlike Build-Operate-Transfer (BOT) projects, BOOs are entirely private enterprise initiatives with no National Power Corporation (NPC) involvement including land acquisition.

In compliance with Philippine regulations, particularly PD (Presidential Decree) 1586, this Environmental Impact Statement (EIS) was prepared to document the present baseline environmental conditions of the site, assess the possible impacts of the project on the environment and propose mitigating measures to minimize these impacts . In this regard, BHP Engineering Philippines, Inc. (BHPE) was contracted by Ogden Quezon Power to undertake the Environmental Impact Assessment (EIA) and prepare the EIS for the proposed power project.

Prior to conducting the EIS, several public meetings were held with local officials and residents of the affected barangays and municipalities. On 19 January 1995, a scoping session was convened and the participants included: the Environmental Management Bureau (EMB), officials of the Mauban Local Government Unit (LGU), representatives of the project proponent and the environmental consultants, in this case, BHPE. The proposed EIS scope of work is shown in Annex 2.

In view of the timing of the project it was mutually agreed upon during the scoping meeting, that some environmental parameters which need a full year of data will continue to be monitored even after the submission of the EIS to establish trends . Results for such parameters, i.e., long term air and water quality monitoring will be submitted quarterly to the Department of Environment and Natural Resources (DENR). This is designed to minimize the conditions that need to be included when an Environmental Compliance Certificate (ECC) is granted.

[1] 1995 Power Development Program, National Power Corporation, December 1994.

The QPP will involve the construction of a plant and appurtenant structures, a pier for unloading fuel, an operations unloading wharf, a transmission line that will connect it to the franchise of MERALCO in Payatas, Quezon City and a sub-station to be constructed also in Payatas.

1.3 Project Goals, Objectives, Purpose and Benefits

1.3.1 Rationale

DOE and NPC have developed a power development program for the country which is aimed at supplying the projected growth in power requirements in the coming years. This is designed not only to prevent the occurrence of the debilitating power outages similar to that in 1993 but likewise aimed at diversifying power sources to reduce dependence on one particular fuel type to supply the country's power needs.

The proposed 433 MW (net) QPP is one of the power projects being developed to satisfy the power requirements by the year 2000. This power project will be developed under the BOO scheme.

This power project will entirely be a private enterprise undertaking. It will be designed to supply a reliable, environmentally sound, and competitively priced source of power during the life of the plant.

1.3.2 The Current Power Distribution System

The NPC supplies power to the entire country through the three major grids corresponding to the three island aggrupations. The NPC sells power to major distributors/retailers like the MERALCO and the various cooperatives which, in turn, are responsible for distribution to their respective customers.

The liberalization of the power development law through Executive Order 215 on 10 July 1987 made it possible for the private sector to be involved in electricity generation. Thus, the serious shortfall in power in the early 1990s, made it imperative for the government to develop several fast-track projects in coordination with the private sector under the BOT scheme. All power generated by such plants, however, were sold to NPC which distributes the power through its various grids.

1.3.3 The Current Power Situation and Demand

In Luzon, energy sales are expected to reach 21,658 GWH in 1994 which is 16.5 percent higher than the 1993 figures. This is projected to further increase to 31,088 GWH in 1998 and 107,631 GWH by 2010 or an equivalent annual growth rate of 10.9 percent during the period 1994-2010.[2]

Table II-1-1 shows the system load forecast until year 2010.

Based on the above forecasts, the power program requires the addition of at least 600 MW annually during the period 1995 to 2005.

The proposed project is planned to supply the projected power requirement by the year 2000 in addition to the other power projects which have been approved and are being implemented. All of these plants are designed to supply the power requirements at various periods as summarized in the succeeding table.

[2]NPC, Power Development Program, 1995-2005.

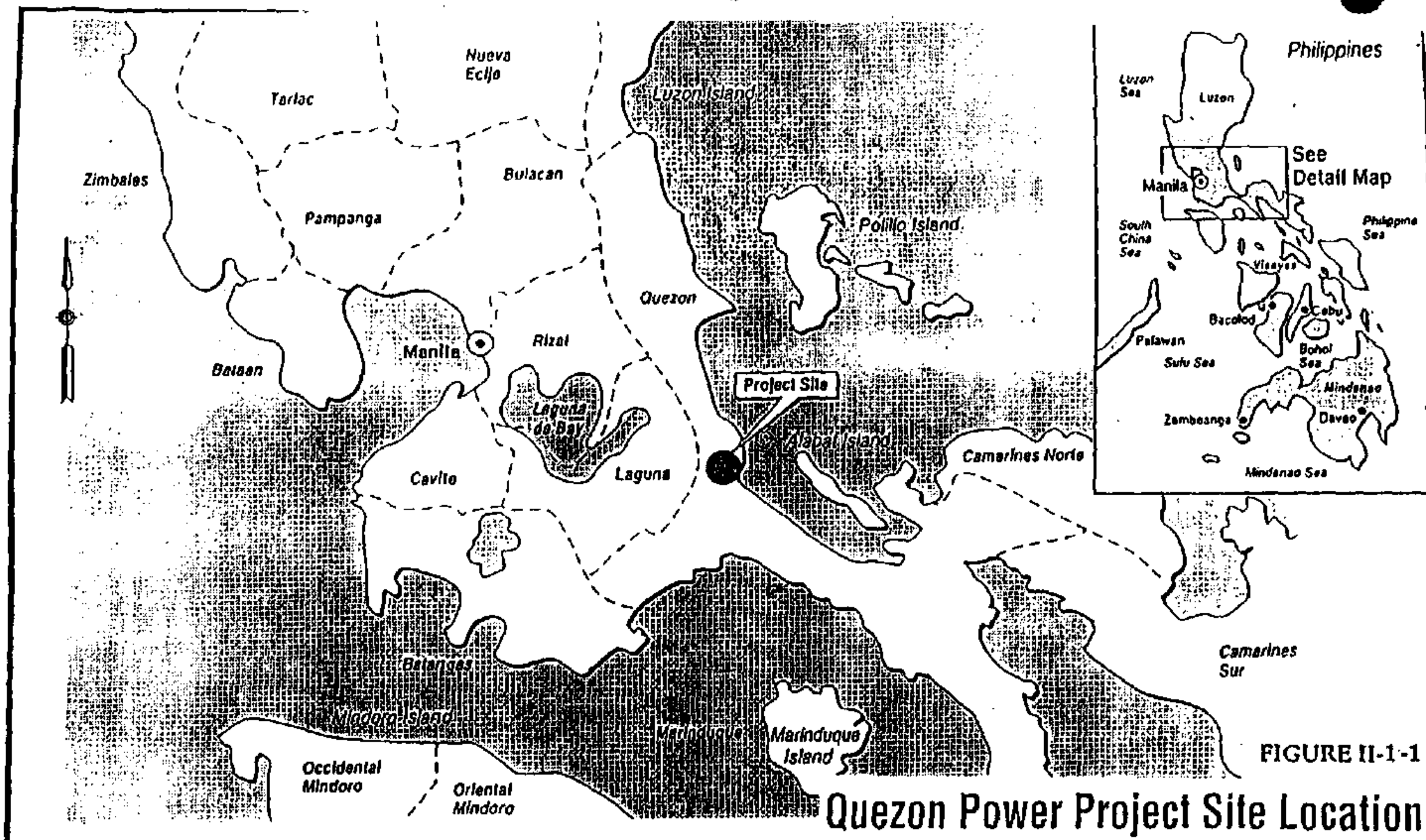

FIGURE II-1-1

Quezon Power Project Site Location

No.	DATE	BY	DESCRIPTION	DFT.	ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK		APPROVAL		REFERENCE DRAWINGS	

BHP — BHP ENGINEERING, BHP Service Companies

	Name	Sign	Date
DRAWN			
DRAFTING			
ENGINEERING			
R. ENGR.			
CLIENT			

BHP Engineering PHILIPPINES Inc.

433 MW (NET) QUEZON POWER PROJECT ENVIRONMENTAL IMPACT STUDY

SCALE	BHPE DRG No.	REV.
A4		A

CAD FILE :

DATE OF LAST EDIT:

1.3.4 Benefits

Aside from supplying the power needed to prime the Philippine economy, this project is also aimed at providing other benefits consistent with the guidelines formulated by DOE and the local government code aimed at providing other benefits to the host community as follows:

- Taxes
- Electrification benefits under prioritization of load dispatch
- Skills development
- Priority in employment
- Procurement of local supplies and services
- Development of livelihood fund
- Reforestation, watershed management, health and/or environmental enhancement fund
- Preconstruction skills training community enhancement program

The above benefits are discussed in more detail in Section IV.

1.4 Regulatory Requirements

The following government permits and clearances will be secured for the project

- Environmental Compliance Certificate (ECC) for the Power Plant and Associated Transmission Line from the Department of Environment and Natural Resources (DENR)
- Locational Clearance for the Power Plant and Substation from the Housing and Land Use Regulatory Board (HLURB)
- Land Use Conversion Permit for the Power Plant and Substation from the Department of Agrarian Reform (DAR)
- Authority to Construct and Permit to Operate Air Quality Pollution Facilities from DENR Region IV office
- Authority to Construct and Permit to Operate Wastewater Treatment Facilities from DENR Region IV office
- Permit for the construction of the Pier and Jetty from the Philippine Ports Authority (PPA)
- Water Use Permit from the National Water Regulatory Board (NWRB)

In addition, building permits and DOLE (Department of Labor and Employment) permits will be required.

2.0 THE PROJECT

2.1 General Information

The QPP is a 433 MW net capacity power plant comprised of a single boiler and turbine generator. The plant is designed to use sub-bituminous coals for fuel which conforms with the specifications outlined in Section 3.2. The plant will supply the partial power requirements of the MERALCO franchise area through a transmission line from Mauban and a sub-station to be built in Payatas, Quezon City. The QPP will sell power to MERALCO through a 25-year power purchase agreement with the utility company. The QPP is planned to be on-line by the year 2000.

2.2 General Layout

Plant facilities of QPP will be located in Sitios Dalig, Sabang and Dinahican in Barangay Cagsiay I, Mauban, Quezon. The total project area is about 100 hectares including the proposed ash disposal area. The plant will consist of a turbine and boiler, an auxiliary boiler, an active and inactive coal storage area, air pollution control equipment, chimney, switchyard, ash disposal area, pier and unloading facility, a construction jetty and a transmission line from the plant to Payatas, Quezon City.

TABLE II-1-1
SYSTEM LOAD FORECAST (PDP 1995)

		Energy Sales in GWH				Peak Demand in MW			
Year		Luzon	Visayas	Mindanao	Phil.	Luzon	Visayas	Mindanao	Phil
Actual	1986	13,535	1,355	2,960	17,850	2,435	309	484	3,228
	1987	14,980	1,305	3,146	19,431	2,592	334	533	3,459
	1988	16,319	1,768	3,486	21,573	2,780	358	571	3,709
	1989	17,142	1,881	3,708	22,731	2,938	378	617	3,933
	1990	17,638	1924	3,761	23,323	2,973	381	621	3,975
	1991	18,123	2,138	3,585	23,846	3,045	427	626	4,098
	1992	18,596	2,232	3,165	23,993	3,250	472	573	4,295
	1993	18,589	2,500	3,667	24,756	3,473	512	691	4,676
% Growth Rate									
(1987 - 1993)		4.6	9.1	3.1	4.8	5.2	7.5	5.2	5.4
Forecast	1994	21,658	2,693	4,109	28,460	3,759	517	709	4,985
	1995	22,205	3,089	4,853	30,147	3,855	585	837	5,277
% Growth Rate									
(1994-1995)		9.3	11.2	15.0	10.4	5.4	6.9	10.1	6.2
	1996	24,415	3,482	5,635	33,532	4,239	657	959	5,855
	1997	27,331	3,918	6,641	37,890	4,744	739	1,130	6.613
	1998	31,088	4,406	7,989	43,483	5,397	832	1,359	7,588
	1999	35,019	5,062	9,330	49,411	6,079	955	1,587	8,621
	2000	39,054	5,794	10,711	55,559	6,779	1,080	1,822	9,681
% Growth Rate									
(1996-2000)		12.0	13.4	17.2	13.0	12.0	13.0	16.8	12.9
	2001	43,111	6,727	12,102	61,940	7,484	1,254	2,059	10,797
	2002	47,616	7,536	13,640	68,792	8,266	1,405	2,321	11,992
	2003	52,623	8,348	15,339	76,310	9,135	1,556	2,610	13,301
	2004	58,191	8,995	17,219	84,405	10,102	1676	2,930	14,708
	2005	64,383	9,636	19,294	93,313	11,177	1,796	3,283	16,256
% Growth Rate									
(2001-2005)		10.5	10.7	12.5	10.9	10.5	10.7	12.5	10.9
	2006	71,275	10,323	21,590	103,188	12,373	1,924	3,673	17,970
	2007	78,947	11,060	24,130	114,137	13.705	2,061	4,105	19,871
	2008	67,493	11,849	26,939	126,281	15,188	2,208	4,583	21,979
	2009	97,016	12,697	30,047	139,760	16,842	2,366	5,112	24,320
	2010	107,631	13,605	33,488	154,724	18.684	2,536	5,698	26,918
% Growth Rate									
(2006-2010)		10.8	7.1	11.7	10.6	10.8	7.1	11.7	10.6
(1994-2010)		10.9	10.5	13.9	11.4	10.4	9.9	13.2	10.8

Source: Power Development Program 1995-2005, NPC, Dec. 1994

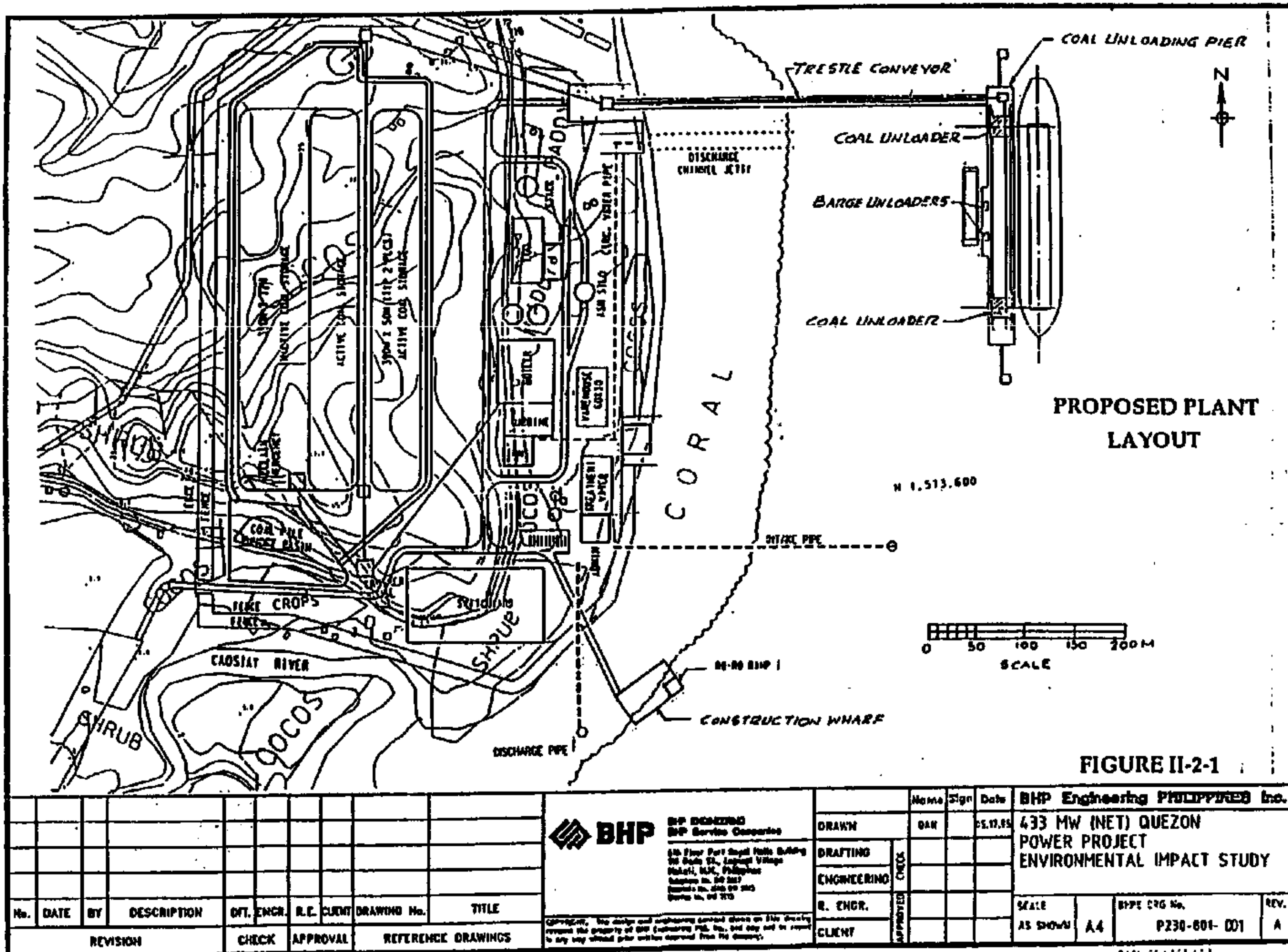
COAL UNLOADING PIER
TRESTLE CONVEYOR
COAL UNLOADER
BARGE UNLOADERS
COAL UNLOADER
N
PROPOSED PLANT LAYOUT
DISCHARGE CHANNEL JETTY
ASH SILO
BOILER
TURBINE
CORAL
N 1,513,600
INTAKE PIPE
0 50 100 150 200 M
SCALE
CONSTRUCTION WHARF
DISCHARGE PIPE
COAL PILE RUNOFF BASIN
FENCE
CROPS
CAOSIAY RIVER
SHRUB
COCOS
ACTIVE COAL STORAGE
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FIGURE II-2-1

The plant will use seawater for one-through cooling and will, therefore, have an intake and outfall structures.

The proposed plant layout is shown in Figure II-2-1.

2.3 Construction Requirements

Project construction will be for about 40 months which will require about 2,400 personnel over the term of construction. It is estimated, of this number, 4 percent are engineers, 78 percent semi-skilled workers and 18 percent unskilled workers. The design and construction schedule is provided in Annex 1.

The major structures of the facility will be constructed at +8 m elevation, coal storage is at +25 m elevation.

2.4 Project Cost

The QPP including the construction of the transmission line from Mauban to Payatas, Quezon City will require the investment of approximately US$825 Million. This will consist of equity from the members of the consortium, and financing from foreign and international banks.

3.0 DESIGN FEATURES

3.1 Facility Description

The Project will be a 433 MW (net) electric generating facility that will utilize pulverized coal for fuel. The project will have a single reheat type boiler which will generate steam to be directed to a single steam turbine generator. An auxiliary boiler is also provided to supply steam during start-up for soot blowing following firing of fuel oil.

The plant will have a pier for coal unloading. A coal yard, ash disposal area, stack, switchyard, administration building and offices, housing for some plant operations personnel and a 230 kV transmission line from Mauban to a substation in Payatas, Quezon City will all form part of the project. It will use seawater for cooling and will construct intake and outfall structures for this purpose. For process and potable water needs, the plant will use new groundwater wells to be developed in the area.

The selection and configuration of all major equipment will be based on standard proven technologies.

To reduce emissions and meet the Philippine standards (DAO No. 14), the plant design includes the installation of pollution control equipment: an Acid Gas Scrubber (scrubber) to reduce SO_2 emissions, low NO_x burners to control NO_x emissions and an electrostatic precipitator (ESP) to control particulate emissions.

3.2 Fuel

The QPP is a baseload plant which will use imported coal during normal operations.

For start up, the plant will use #2 fuel oil (diesel) fuel. The auxiliary boiler will also utilize #2 fuel oil.

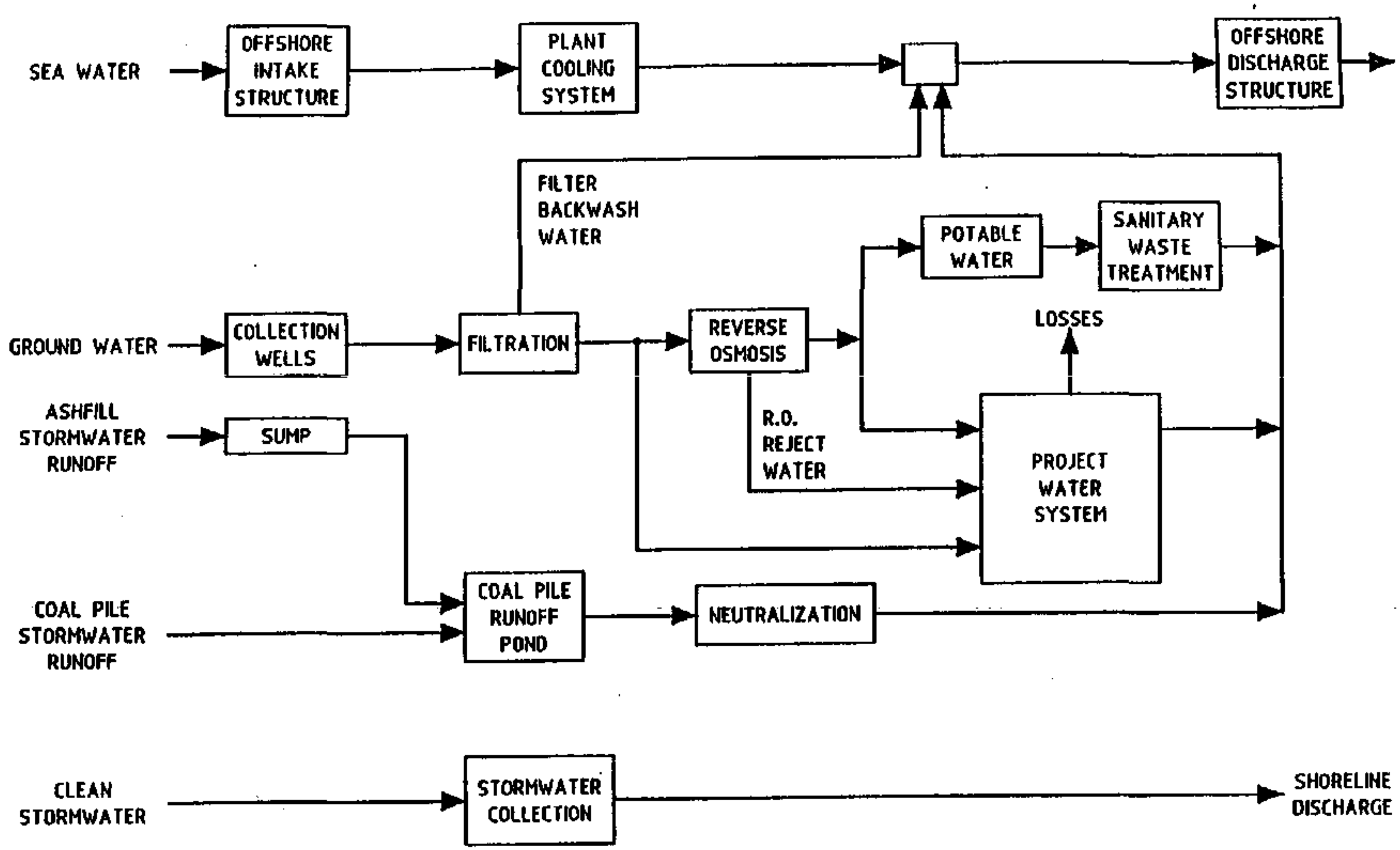

FIGURE II-2-2

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QUEZON POWER PROJECT
ENVIRONMENTAL IMPACT STUDY
BLOCK DIAGRAM OF PLANT
WATER SYSTEM

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R. ENGR.			
CLIENT			

SCALE		BHPE DRG No.	REV.
NTS	A4	P230 101 058	A

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BHP Service Companies

CAD FILE : P230058

DATE OF LAST EDIT: 19.05.95

3.2.1 Coal

Coal consumption will be about 1.9 Mt/year.

For environmental reasons and to meet the specifications of the equipment, the choice of coal will be guided by the following criteria:

- low sulfur content less than 1 percent
- ash characteristics less than 14 percent
- high heating value
- moisture content

Adequate and reliable coal supply will be a major consideration. Therefore, coal suppliers from Australia and/or Indonesia are being considered.

3.3 Utilities

3.3.1 Water Supply

The plant will use sea water for cooling water needs. Fresh, make-up water requirements will be sourced from groundwater wells which are found to be very extensive in the area (see Section III-2). Freshwater will be utilized for domestic use and for the operation of the air pollution control equipment. A block diagram of Plant Water Systems is shown in **Figure II-2-2.**

Cooling Water

Seawater is planned to be used for once-through cooling for the condenser of the power plant.

An intake structure to be located about 275 to 300 m off-shore and at a depth of 10.5 m at MLLW will be constructed. The intake structure which is to be provided with a velocity cap will have a diameter of about 10.5 meters. The inlet opening is about 2.1 m high and will have a velocity of 0.3 m/s and a flow rate of 18.3 m^3/sec.

Cooling water will be discharged back to the sea via a 3 m diameter (inside) pipe that discharges near the water surface some 150 to 175 m offshore. Water depth at this point is about 4 m at MLLW increasing to about 8 m at a relatively short distance. Velocity of discharge water will be 2.6 m/s while the temperature change will be about 8.3°C higher than ambient. The design of the thermal plume will be such that a temperature at the edge of the mixing zone will not be greater than 3°C.

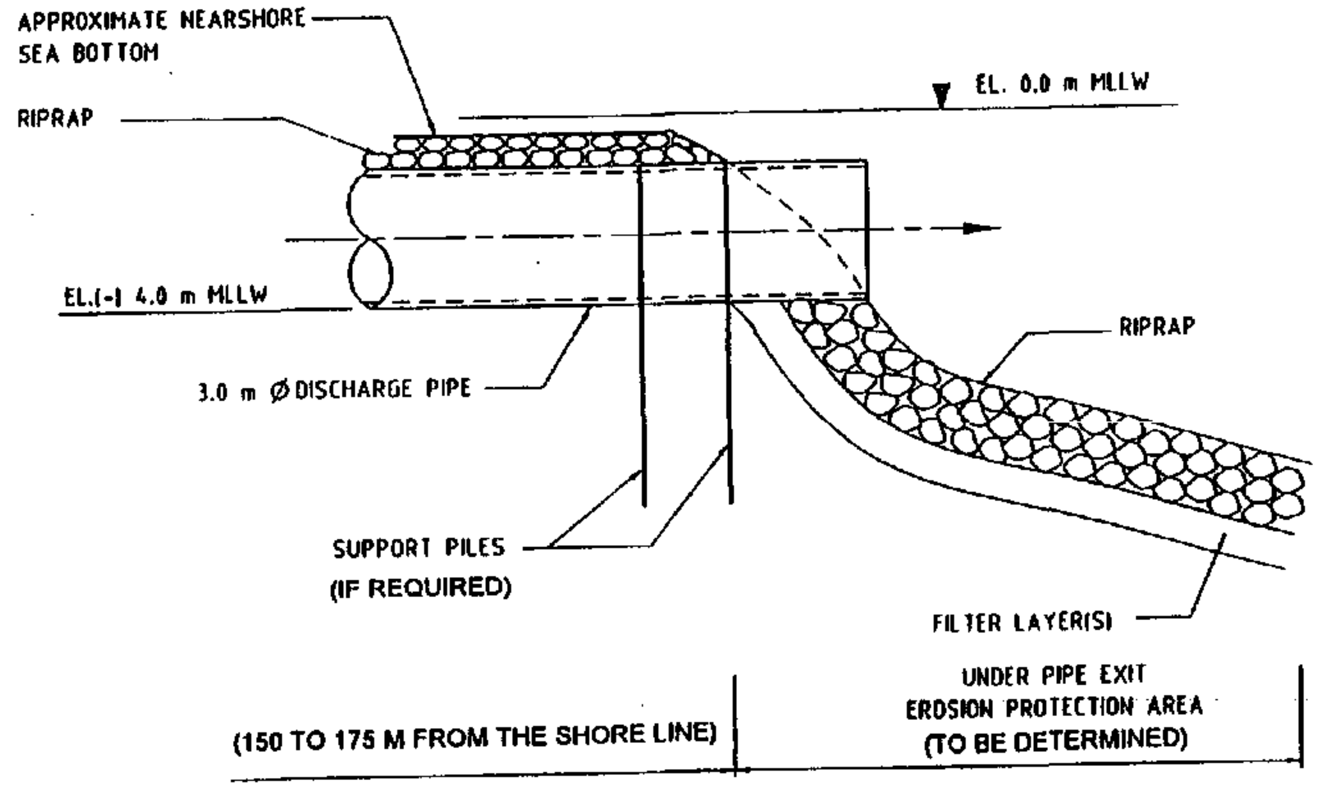
Figures II-2-3 and II-2-4 show the conceptual layout of the off-shore intake and outfall structures.

Freshwater Requirements

The plant fresh water requirements will be drawn from groundwater wells and will be used for process supply water, fire protection, domestic (potable) water supply and for other plant uses such as for lime slurry preparation for the scrubber.

Total freshwater requirements will be about 2,750 cu. m./day consisting of the following:

- demineralizer flow (boiler make up) plus regeneration wastes;
- miscellaneous plant water use;
- Slaking, dilution (in the spray dryer absorber-scrubber), ash and coal handling dust suppression and bottom ash sealing;
- filter backwash cycles each day;
- Domestic water demand for 220 people.



CONCEPTUAL LAYOUT OF OUTFALL STRUCTURE

FIGURE II-2-4

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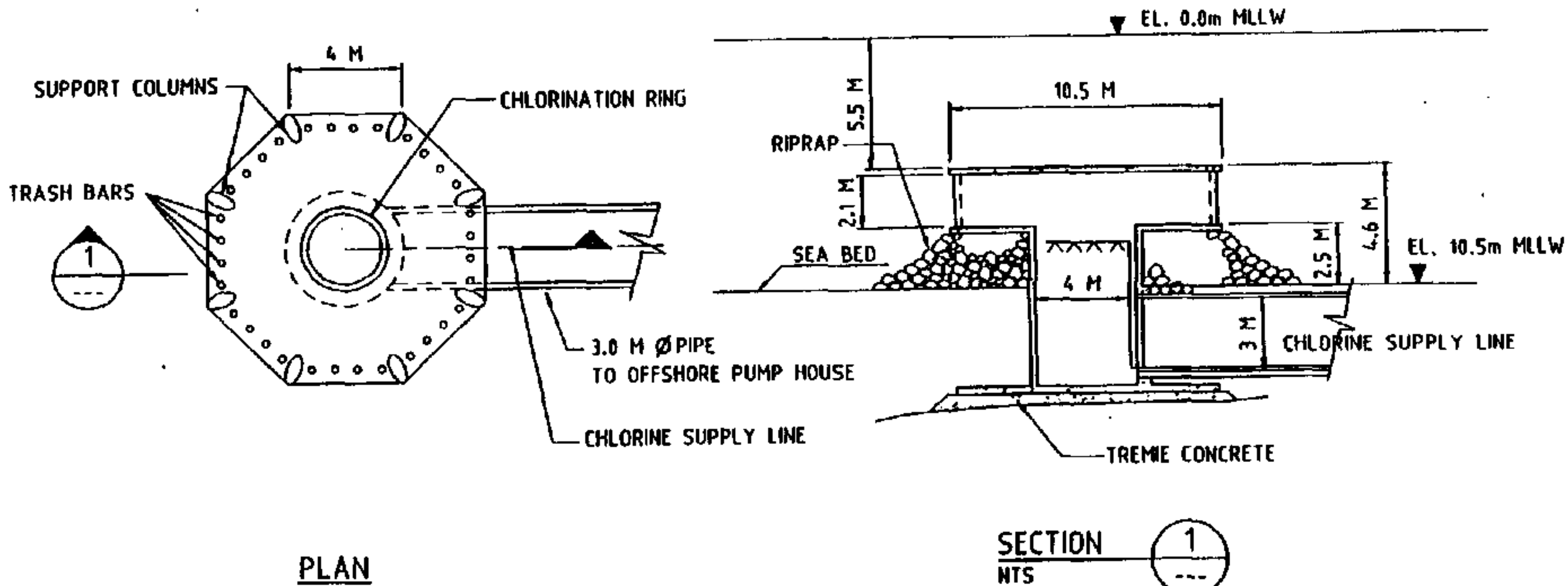

CONCEPTUAL LAYOUT OF OFF-SHORE INTAKE

FIGURE II-2-3

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SCALE		BHPE DRG No.	REV.
NTS	A4	P230 101 055	A

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3.3.3 Electricity

The project site is currently not serviced by MERALCO. Thus, for the construction phase, until a permanent interconnection to the grid is made, electricity will be provided through onsite generators.

3.4 Fuel Handling

3.4.1 Diesel Receiving and Storage

Diesel oil will be delivered to the site by 75,000 gallon barges. A storage tank with a 100,000 gallon capacity will be constructed and will be sufficient to supply the fuel requirements of the diesel generators to be used during the construction and boiler cold starts during normal plant operation.

The unloading system will consist of booster pumps, a storage tank and two 50 percent capacity transfer pumps. The unloading pump will be sized so as to allow unloading of the barge within five hours.

The diesel unloading station at the barge pier will be designed to contain spills. Likewise, the storage tank will be protected from overfilling by a high level sensor that will automatically shut down the unloading pump when a certain level is reached. As an added precaution, a dike will be constructed around the storage tank which can contain 110 percent of the total storage volume.

3.4.2 Coal Handling

Coal will be delivered to the site by 'Panamax' size ships with a capacity of approximately 60,000 - 70,000 tonnes. Ship deliveries will average one every 12 days, docking and unloading operations are expected to take three days. A pile supported pier and moorings will be provided to dock the ship and support unloading equipment. The pier will be located in deep water so that no dredging operations will be required during construction. Ships will be unloaded with a continuous screw unloader. This equipment was selected because it transports the coal in an enclosed tube from the ship's hold to the horizontal conveyor belt on the ship unloading pier. The conveyor belts will be covered except in sections traversed by trippers to transport the coal from the pier to the coal storage area.

The coal storage area is approximately 400 meters by 200 meters and is lined to avoid percolation of water into the ground. This area will contain both the inactive pile and the active pile. The inactive pile provides a long term reserve of coal to be used in the event of a major disruption of coal deliveries. In anticipation of long term storage, the coal stockpiled will be selected for its long term stability. This coal will be compacted, graded and treated with chemical agents to form a 'crust' that will shed rain and minimize fugitive dust. During normal operation, this pile will be dormant. If needed, the coal will be reclaimed by mobile equipment. The inactive coal pile is designed to hold up 240,000 tonnes.

The active coal pile will consist of two windrows approximately 400 meters long and triangular in cross-section. A travelling stacker/reclaimer will be mounted on rails between the windrows. A swivelling and elevating boom will allow stacking out and reclaiming from either windrow. The active pile is designed to hold up to 240,000 tonnes.

Recycled water will be used from the plant discharge sump to minimize freshwater make up and waste water discharges.

Treatment Requirements

- Pretreatment

  Chlorination (or other similar biofouling treatment) and alum feed of raw water will be provided between the raw water well pump discharge and pressure filters. This water can be used directly as plant slaking water (for lime slurry preparation), fire protection, plant wash water without treatment. Other plant requirements will be further treated.

- Reverse Osmosis

  The RO system will treat water after passing through the pressure filters and before it goes to the demineralizer system or the potable water tank. The RO system will use standard cartridge filters.

- Demineralization

  For turbine/boiler steam cycle makeups, the water to be used need to be demineralized. The demineralizer plant consists of anions, cations and mixed bed vessels with a decarbonator.

3.3.2 Wastewater Treatment

Sewage

A sewage treatment facility will be installed for the plant which will consist of extended aeration, clarification and post chlorination with sludge drying in a sludge basin. Manual sludge disposal is planned.

Plant Wastewater

The plant will have a wastewater treatment facility which will be used for pH neutralization. Oily wastes will be processed through an oil/water separator with a coalescing filter. Waste oil will be collected in a tank and removed manually.

Demineralizer regenerated waste will be neutralized in a dedicated tank prior to discharge.

Storm Water

The project site will have two storm water collection systems. One storm water collection system serves the ash and coal pile. Storm water from the ash pile will be collected in a sump and pumped to a lined pond adjacent to the coal pile. Coal pile runoff will be collected in a series of swales and flow by gravity to the pond. The pond will be sized to allow settling of suspended solids. A neutralization system will be provided to adjust the pond water pH and transfer the treated water to the cooling water discharge pipe. The water will mix with the cooling water and be discharged at the outfall structure approximately 150 meters offshore.

Storm water from the remainder of the site will not be contaminated. It will be collected in a system of catch basins and swales and discharged to the receiving body at the shoreline. The design of the collection system and the final site grading will control the level of suspended solids in this water to the regulated levels.

4.4 Effluents

Effluents will be generated from the following:

- Air heater washwater
- Boiler blowdown
- RO reject water
- Filter backwash
- Neutralized demineralized water waste
- Storm water runoff
- Ash pile runoff
- Treated sanitary effluent
- Oil/water separator drainage
- Coal pile runoff

The air heater washwater, boiler blowdown and RO reject water are all directed to the waste water basin for reuse in the plant. The filter backwash, neutralized demineralized waste, treated sanitary effluent and miscellaneous floor drains, oil/water separator drainage are directed into the plant discharge sump. Coal pile runoff is combined with effluents from the plant discharge sump in the coal pile runoff pond which is neutralized prior to discharge into the circulating water discharge.

The combined plant effluent will meet the following Philippine standards:

TABLE II-4-1
PHILIPPINE STANDARDS
(DAO #35, MARINE WATER CLASS SC)

Parameter	Effluent Limit
pH	6 to 9
BOD	100 mg/L
Oil and Grease	10 mg/L
Total Suspended Solids	150 mg/L
Temperature	3°C max. rise at the edge of a designated mixing zone
Color	Discharge shall not cause abnormal discoloration in the receiving water outside of the mixing zone
Surfactants	10.0 mg/L
Phenolic substances as phenol	0.5 mg/L
COD	200 mg/L
Chromium (hexavelent)	0.2 mg/L
Cadmium	0.1 mg/L
Lead	0.5 mg/L
Total Mercury	0.005 mg/L

Coal will be transferred from the active pile to coal silos located in the boiler structure several times each day. The stacker/reclaimer will dig coal from the windrows of the active pile and transfer it to a reclaim conveyor. The reclaim conveyor will transport the coal to the crusher house where it is fed into a surge bin. From the surge bin coal is metered into one of two crushers where the coal is reduced in size to less than two inches. After crushing the coal is transported to conveyor belt to the coal silos. Five silos will be provided (one per coal pulverizer). Silos will be sized to hold 12 hours of coal consumption at full load.

In the event that the stacker/reclaimer is out of service, the coal handling system has provisions for unloading ships to an "emergency" pile. Mobile equipment will be used to move coal from this pile to either the active pile or inactive pile as needed. During an outage of the stacker/reclaimer coal will be transported to the boiler by means of mobile equipment pushing coal into an in-ground hopper with vibrating feeder. An emergency reclaim belt will carry the coal to the top of the crusher house where it will be processed and supplied to the coal silos.

4.0 WASTES, EMISSIONS AND EFFLUENTS

4.1 Ash Production and Disposal

The plant will generate both bottom and fly ash. The design ash content of coal to be used in ash disposal design is 14 percent. Based on the projected coal utilization rate, total ash is estimated to be 252,000 tons/year. The ash will consist of a mixture of bottom ash, fly ash and scrubber residue that will be disposed in the ash pile area. This combined ash stream agglomerates which will minimize dust problems.

4.2 Flue Gas

The combustion of coal will generate particulate, SO_2 and NOx emissions. Based on the projected coal consumption and the equipment specifications, the QPP will exhibit the following emission characteristics which will meet or better the criteria set forth by the Philippine government.

SO_2	=	600 mg/ncm	Opacity	=	< 20% opacity
NO_x	=	1,000 mg/ncm	Total Suspended Particles (TSP)	=	150 mg/ncm @ 12% CO_2

The flue gas will be channeled to a stack which is about 150 m tall after passing through an acid gas scrubber using lime slurry to reduce SO_2 emissions and an electrostatic precipitator to control particulate emissions. Low NO_x burners will be used to minimize NO_x emissions.

4.3 Noise

Although the facility site is currently classified as a residential area, the site will be reclassified to industrial area before the power plant operates. The QPP, as a heavy industry, will comply with noise standards at the plant's perimeter fence at 75 dB(A) during daytime, 70 dB(A) during morning and evening and 65 dB(A) during nighttime.

In the design of the facility, noise levels were taken into consideration such that the above industrial noise standards can be met within the perimeter fence of the plant. Also, buffers will be constructed around the fence line to further decrease the noise impact of the plant.

5.7 Pollution Control Equipment and Features

The QPP will utilize low sulfur and ash coal which will minimize SO_2 and particulate emissions. Additionally, the plant will install an acid gas scrubber using lime to further reduce SO_2 emissions. To reduce particulate emissions, an electrostatic precipitator will be installed. Low NO_x burners will be used to reduce NO_x emissions.

The traveling screw type unloader for coal feeding will utilize a totally enclosed conveying system. Dust suppression and dust collectors are provided at all transfer points for the coal unloading. The conveyor system will be covered, as permitted by travelling equipment, to minimize fugitive emissions.

The inactive coal stockpile will be compacted and sealed to minimize dust and potential spontaneous combustion.

A stack which is 150 m high will be constructed to facilitate the dispersion of emissions.

Stack gas emissions will be monitored by a continuous emission monitoring (CEM) system. The CEM will monitor concentrations of SO_2, O_2, NO_x, and opacity on a continuous basis. A dedicated computer will accumulate and process data from the CEM system and other facility operating data.

The facility will be designed to satisfy promulgated noise standards.

A low velocity intake structure for cooling water will be provided to minimize entrainment and entrapment. The change in temperature between inlet and outlet cooling water streams will be 8.3 °C from ambient. The design of the thermal plume will be such that a temperature at the edge of the mixing zone will not have a differential temperature greater than 3°C in compliance with DENR requirements.

The ash disposal area and coal pile area will be lined and will be designed with a neutralization system for collected stormwaters prior to discharge to the Cagsiay River and eventually to Lamon Bay.

5.0 SAFETY MEASURES AND CONTINGENCY PLANS

5.1 Site Access and Control

The construction and operation of the power plant will require the improvement of site access for vehicles, equipment and for workers. OQP will pave approximately 6 km of roadway from the town to the site.

During construction, only authorized personnel will be allowed access into the construction area. The existing road will be routed around the site. Appropriate warnings and signs will be installed to guide traffic.

5.2 Seismic and Wind Design

Design of all buildings and other facilities will meet the requirements of the National Structural Code of the Philippines, particularly Seismic Zone 4 with importance factor I=1 and Category III. Design for wind loads will be in accordance with the same code, particularly for wind speeds of 200 km/hr. with an importance factor of 1 and Exposure Category D.

5.3 Eye Wash Stations

In areas where potential eye irritation may occur e.g., chemical/laboratory storage, chlorination, ship unloader and turbine room near the chemical feed system, eye wash stations will be provided.

5.4 Security, Safety and Fire Protection

The plant will be fenced both during construction and operation to ensure that only authorized personnel are allowed access. During construction, work on site will be guided by a SAFETY FIRST policy. Only personnel wearing appropriate safety equipment/gear will be allowed inside the construction area. Safety instructions will be given to all construction personnel before being allowed to work on site. Safety will be a regular item in meetings.

During operation, appropriate signs and a logging system will be installed/adopted to provide adequate warning of any hazards.

The fire protection system will include both automatic and manual features to provide alarm, detection and suppression capability consistent with building code requirements, NFPA guidance and industry practices.

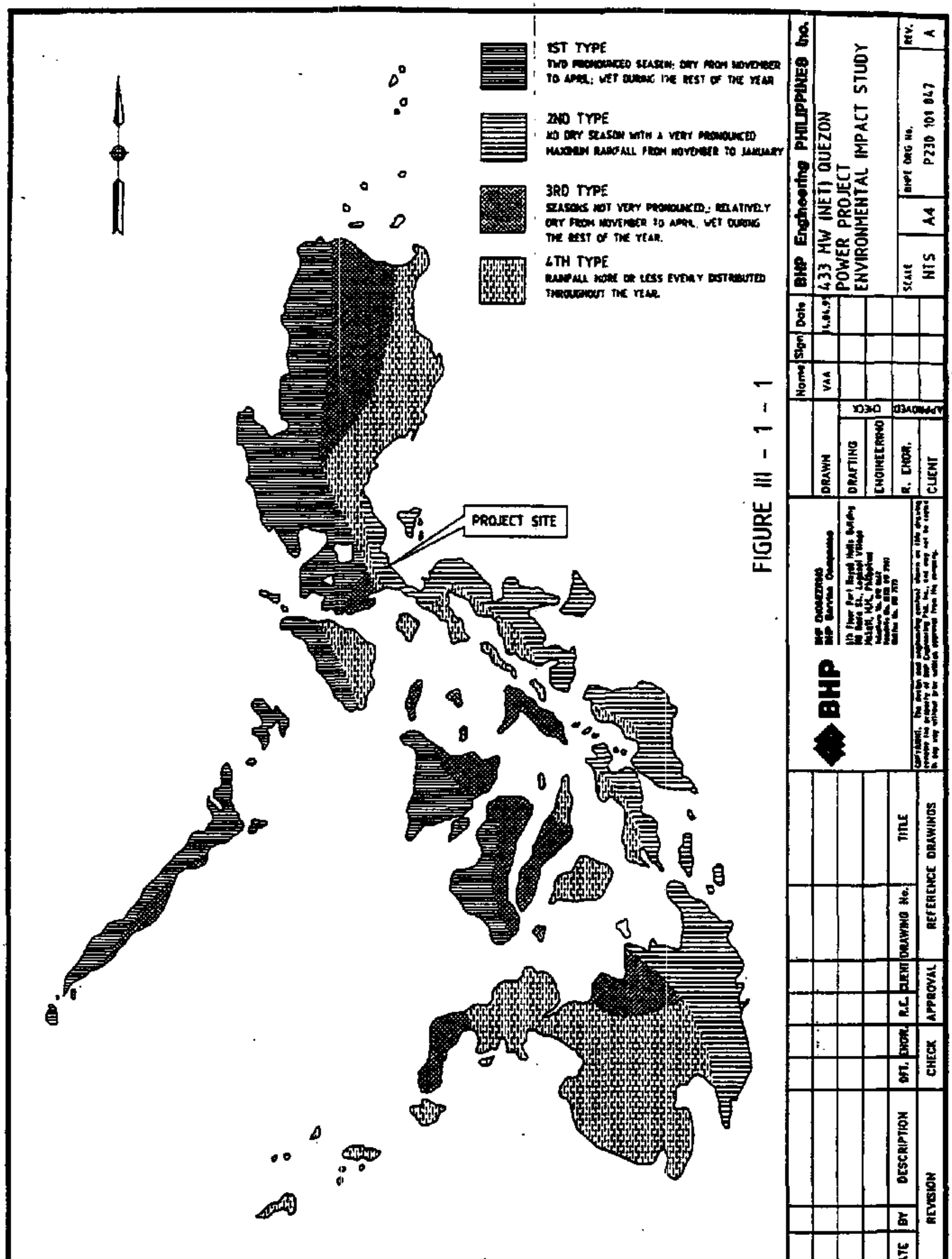
5.5 Insulation

Hot surfaces of equipment, ductwork and piping in the vicinity of personnel will be insulated to limit outside lagging surface temperature to a maximum of 60°C. This insulation will be provided up to 2.1 m directly above any platform or walkway and to a distance of 1.2 m beyond handrails or 0.3 m beyond anywhere personnel can normally reach.

5.6 Ventilation in Occupied Buildings

Any occupied buildings will be air-conditioned to 23.8°C. Areas containing electrical equipment will be ventilated to provide a 40°C maximum inside temperature or 43.3°C for those without electrical equipment.

THE EXISTING ENVIRONMENT



CLIMATOLOGICAL MAP OF THE PHILIPPINES

III. THE EXISTING ENVIRONMENT

1.0 AIR QUALITY, METEOROLOGY AND NOISE

The scope of this study is consistent with that agreed upon during the scoping meeting which was conducted with the attendance of representatives from the Environmental Management Bureau of the DENR, some members of the Mauban community, the proponents, and the environmental consultants.

1.1 Methodology

The air quality and meteorology study made use of both secondary and primary data to characterize the existing environment. To establish site meteorology, data from two of the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) weather stations were considered. First, the weather station in Tayabas, Quezon which is nearest the site and second, the Infanta, Quezon weather station, which is located further from the proposed plant site was consulted. The latter station was considered due to the similarity of the area with the coastal conditions of Lamon Bay (Mauban).

The existing air quality at the site and nearby vicinities was determined by actual measurements and through a survey of existing pollution sources in an area within a 10 km radius of the project site, as agreed upon during the scoping meeting with the DENR on 19 January 1995. Measurements for SO_2 and NO_2 were made using di-gas samplers. Total Suspended Particulates (TSP) were determined using a high-volume sampler.

A total of seven stations were established consistent with the agreement at the scoping meeting. The bases for the locations of these sampling stations were determined from the prevailing wind patterns in the area, the estimated distance of the predicted occurrence of maximum ground level concentrations from stack emissions and the location of critical receptors. To increase reliability of the sampling, two 1-hour samples were carried out for each station. Additionally, 24-hour samplings were also conducted in three of the established stations.

Consistent with the agreements with the DENR during the scoping meeting, the baseline air quality data will be augmented by further monthly sampling for a period of one year at the same stations. The first quarter of results are for the months of February, March and April which are included in this EIS. Data collected subsequently will be submitted to the DENR on a quarterly basis.

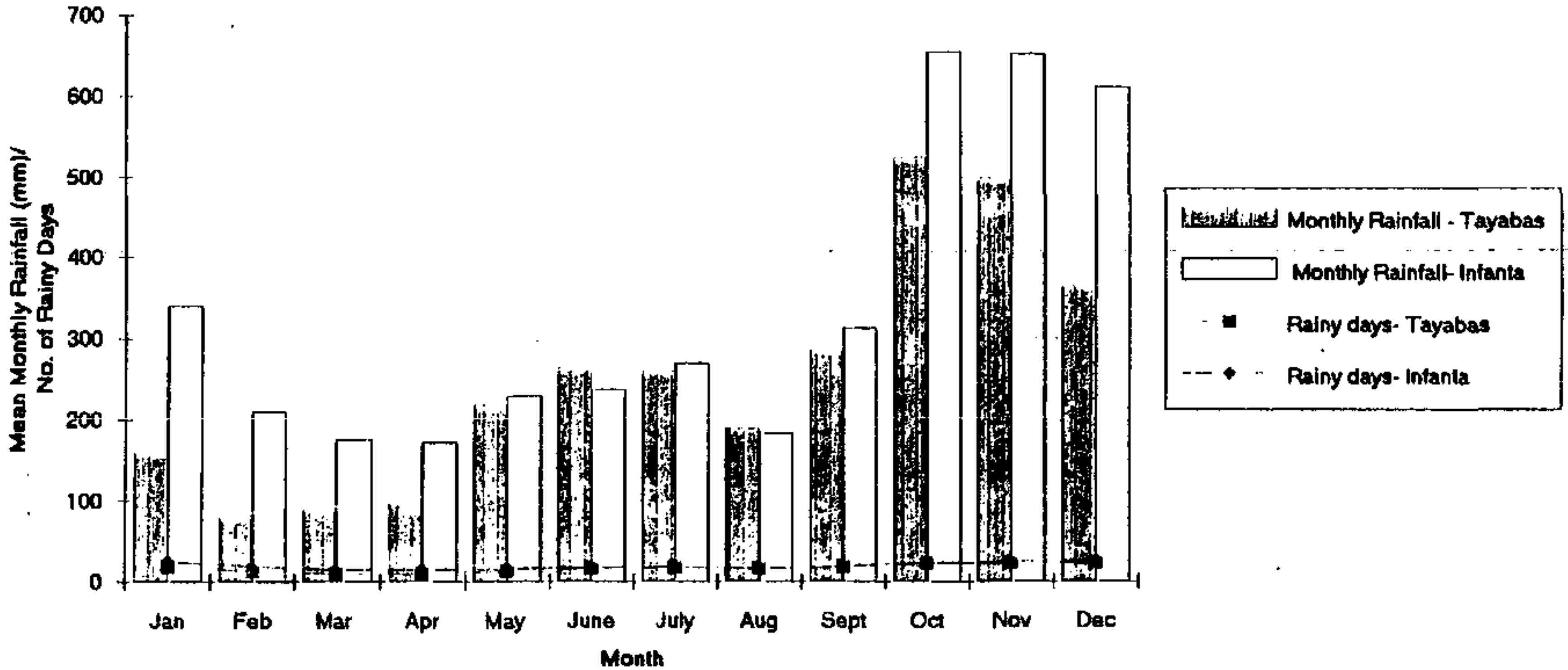
Analyses of the samples were done using DENR prescribed methods. The gravimetric method was used to analyze TSP samples, Griess-Saltzman method for NO_2 and Pararosaniline method for SO_2 estimation.

Noise measurements were also conducted using a digital noise meter. Based on the DENR prescribed methods, seven readings (at least two sample readings at different scales, were carried out per station) within a span of 20 minutes were noted from each sampling station. From these readings, the arithmetic median and average were computed.

1.2 Meteorological Setting

The area's climate can be categorized under the Type II Modified Coronas classification. This type is characterized by no dry season with a very pronounced maximum rainfall. Maximum rainfall normally occurs during the months of October to December. Figure III-1-1 shows the climatological map of the Philippines.

FIGURE III-1-2
MEAN MONTHLY RAINFALL AND NO. OF RAINY DAYS



1.2.2 Temperature

The mean annual temperature in the area is around 26°C in both Infanta and Tayabas stations. The warmest months are from May to August at approximately 32°C. The coolest months are January to February with an approximate minimum temperature of 21 °C. **Table III-1-2** and **Figure III-1-3** show the mean monthly temperatures together with the extreme temperatures of the Infanta and Tayabas stations.

TABLE III-1-2
MEAN MONTHLY TEMPERATURES

	Tayabas Station			Infanta Station		
Month	**Max.**	**Min.**	**Mean**	**Max.**	**Min.**	**Mean**
January	27.4	21.6	24.5	27.0	21.8	24.4
February	28.3	21.7	25.0	27.8	21.8	24.8
March	29.7	22.4	26.1	29.3	22.5	25.9
April	31.4	23.5	27.4	30.9	23.6	27.3
May	32.0	23.9	28.0	32.4	24.4	28.4
June	31.3	23.6	27.4	32.7	24.6	28.6
July	30.9	23.2	27.0	32.2	24.4	28.3
August	31.0	23.2	27.1	32.2	24.7	28.0
September	30.7	23.0	26.9	31.5	24.0	27.8
October	29.8	23.2	26.5	30.1	23.6	26.9
November	29.0	23.1	26.0	29.1	23.5	26.3
December	27.6	22.1	24.8	27.6	22.8	25.2
Annual	29.9	22.9	26.4	30.2	23.5	26.9

Source: PAG-ASA, Period of Record 1971-1990

1.2.3 Relative Humidity

Relative humidity is the measure of the degree of saturation of the ambient air with water vapor. **Table III-1-3** and **Figure III-1-4** show the mean monthly relative humidity for the Tayabas and Infanta stations. The average annual relative humidity is 82 percent for Infanta and 85 percent for Tayabas. The maximum monthly relative humidity for Infanta and Tayabas was recorded in December with 86 percent and 88 percent, respectively. Relative humidities are usually high during the intensification of the northeast monsoon when moist air passes over the area. Higher values are normally observed during the nights and early mornings while it is the opposite during the day and early evenings.

FIGURE III-1-3
MEAN MONTHLY TEMPERATURES
(ºC)

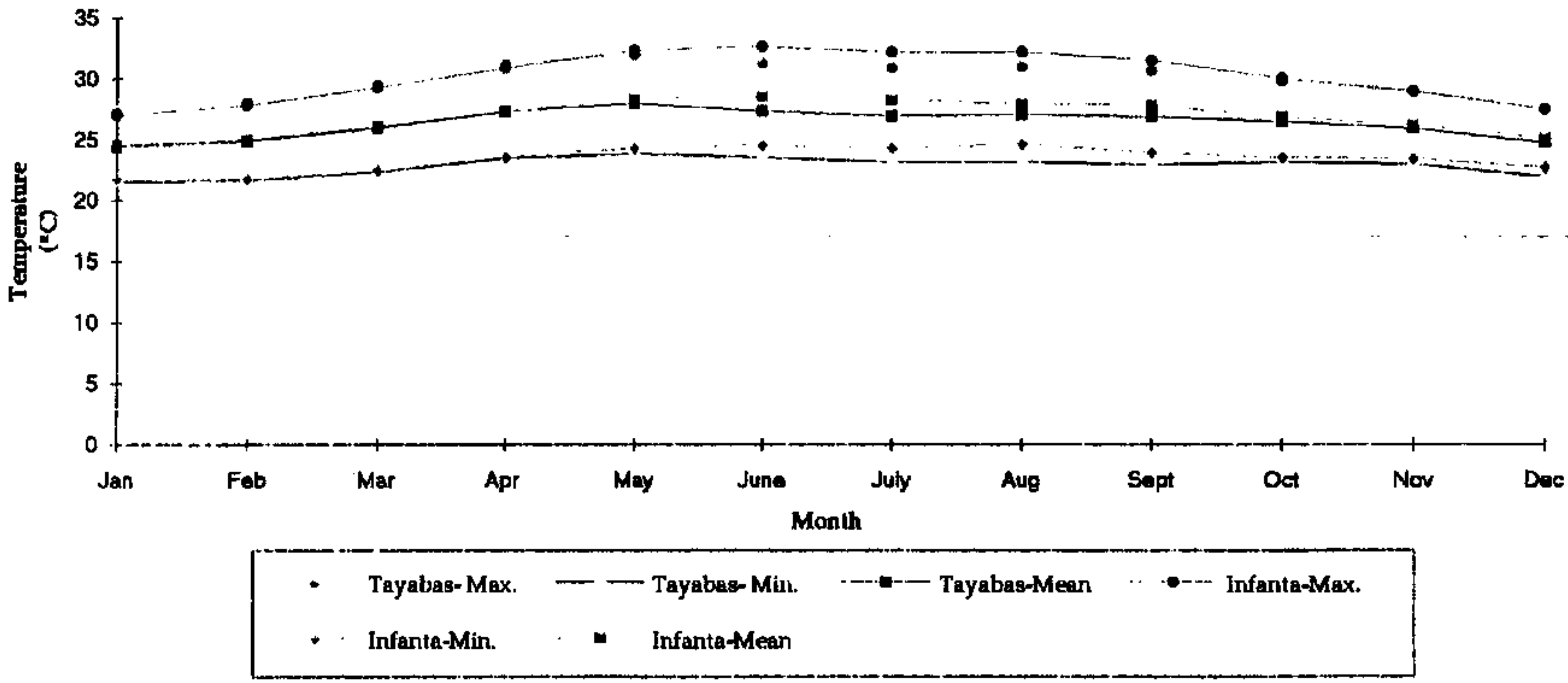


FIGURE III-1-4
RELATIVE HUMIDITIES

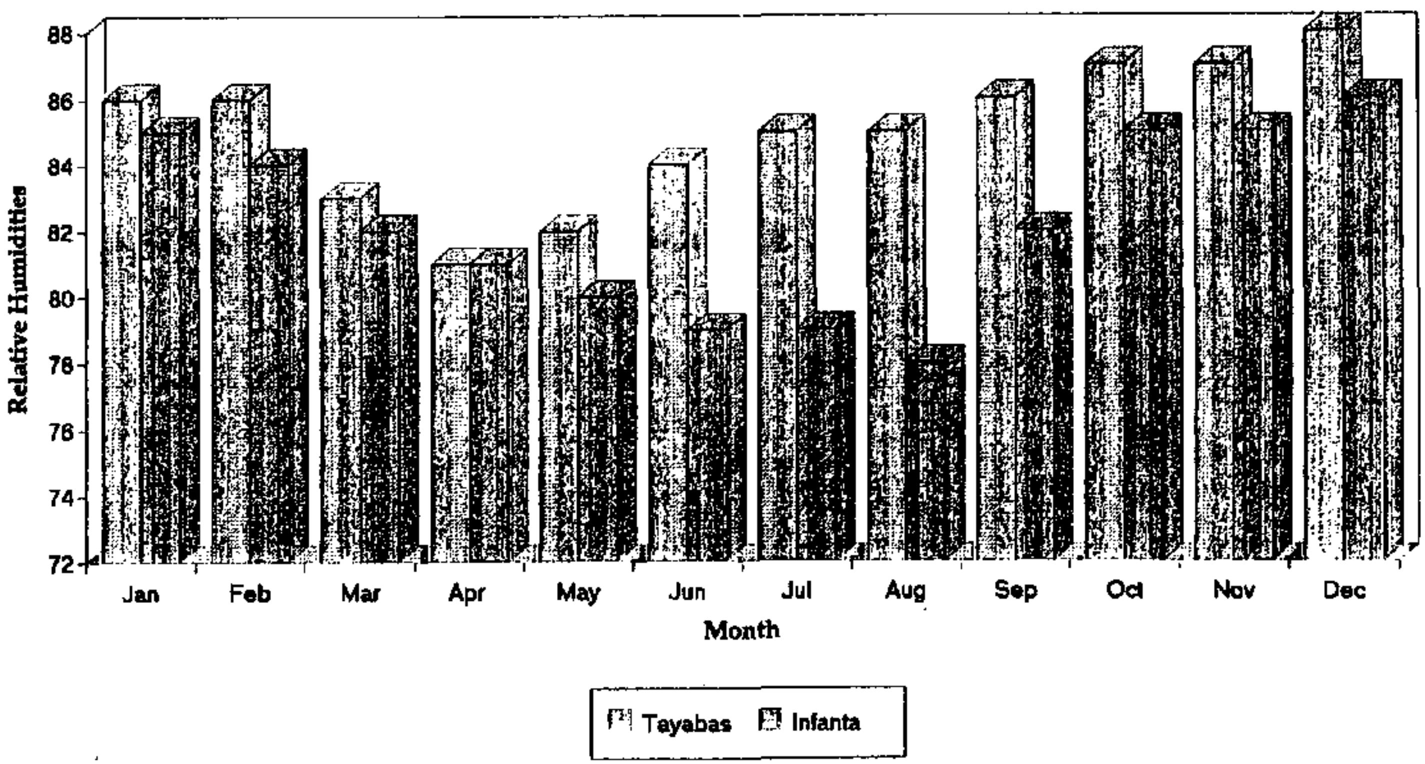


TABLE III-1-3
RELATIVE HUMIDITIES

Month	STATIONS	
	Tayabas	Infanta
January	86	85
February	86	84
March	83	82
April	81	81
May	82	80
June	84	79
July	85	79
August	85	78
September	86	82
October	87	85
November	87	85
December	88	86
Annual	85	82

Source: PAG-ASA, Period of Record 1971-1990

1.2.4 Surface Winds

The prevailing wind direction for the Infanta station is northerly with an average wind speed of 2 mps. This is prevalent during the months of September to June. For the other months, southwesterly winds are dominant.

For the Tayabas station, the prevalent wind direction in the area is northeasterly with an average wind speed of 2 mps. This occurs from January to May with southwesterly winds prevailing during June to August. For the remaining months, north and northeasterly winds are prevalent.

Figures III-1-5 and **III-1-6** show the annual wind rose diagrams for Tayabas and Infanta stations while **Table III-1-4** shows the monthly wind direction and speed for both stations.

TABLE III-1-4
PREVAILING WIND DIRECTION

Month	Infanta		Tayabas	
	Wind Direction	Wind Speed (mps)	Wind Direction	Wind Speed (mps)
January	N	3	NE	3
February	N	2	NE	2
March	N	2	NE	2
April	N	2	NE	2
May	N	1	NE	2
June	N	1	SW	2
July	SW	1	SW	2
August	SW	1	SW	2
September	N	1	NE	2
October	N	2	N	2
November	N	2	NE	3
December	N	3	N	3
Annual	N	2	NE	2

Source: PAG-ASA, Period of Record 1971-1990

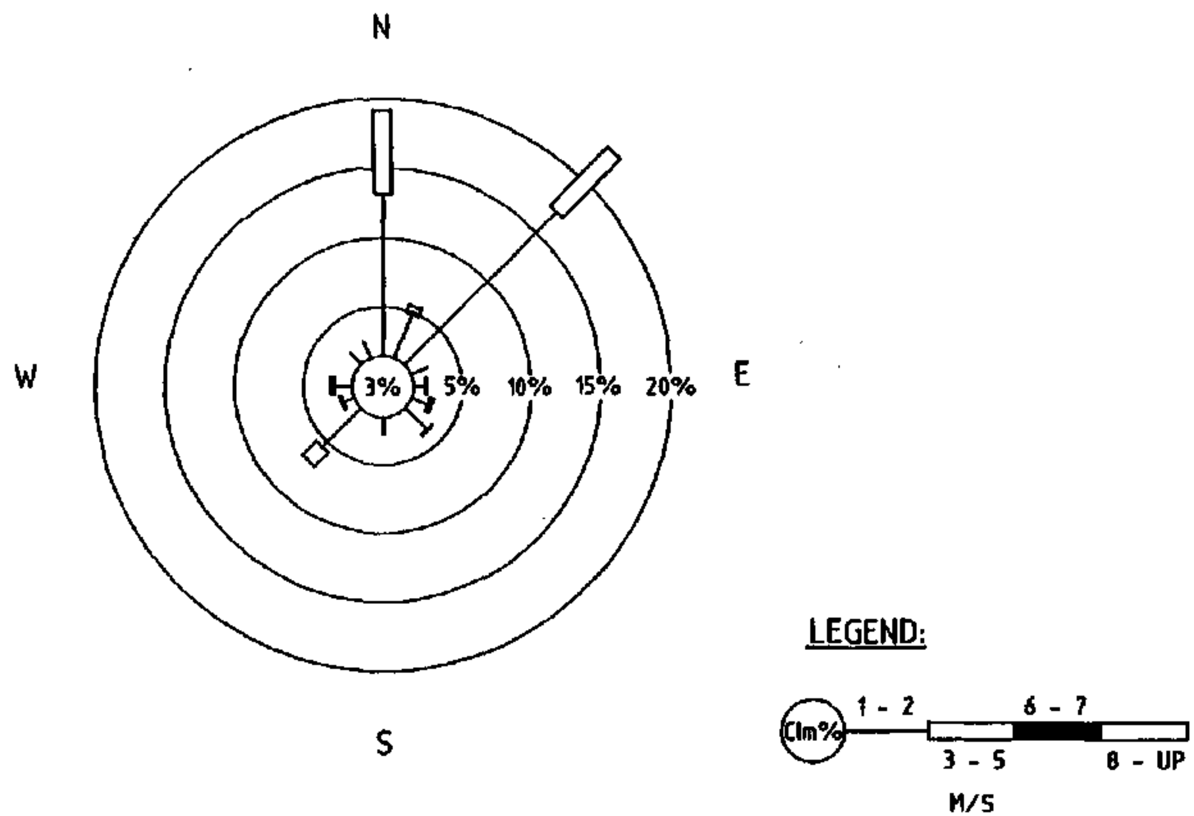


FIGURE III-1-5

BHP Engineering PHILIPPINES Inc.						
DRAWN	GAN		290395	.433 MW (NET) QUEZON POWER PROJ. ENVIRONMENTAL IMPACT STUDY WIND ROSE DIAGRAM - TAYABAS		
DRAFTING				SCALE		BHPE DRG No. / REV.
ENGINEERING				NTS	A4	P230 101 045 / A
R. ENGR.						
CLIENT						

No.	DATE	BY	DESCRIPTION	DFT.	ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK		APPROVAL		REFERENCE DRAWINGS	

BHP ENGINEERING
BHP Service Companies

CAD FILE : P230013

DATE OF LAST EDIT : 29.03.95

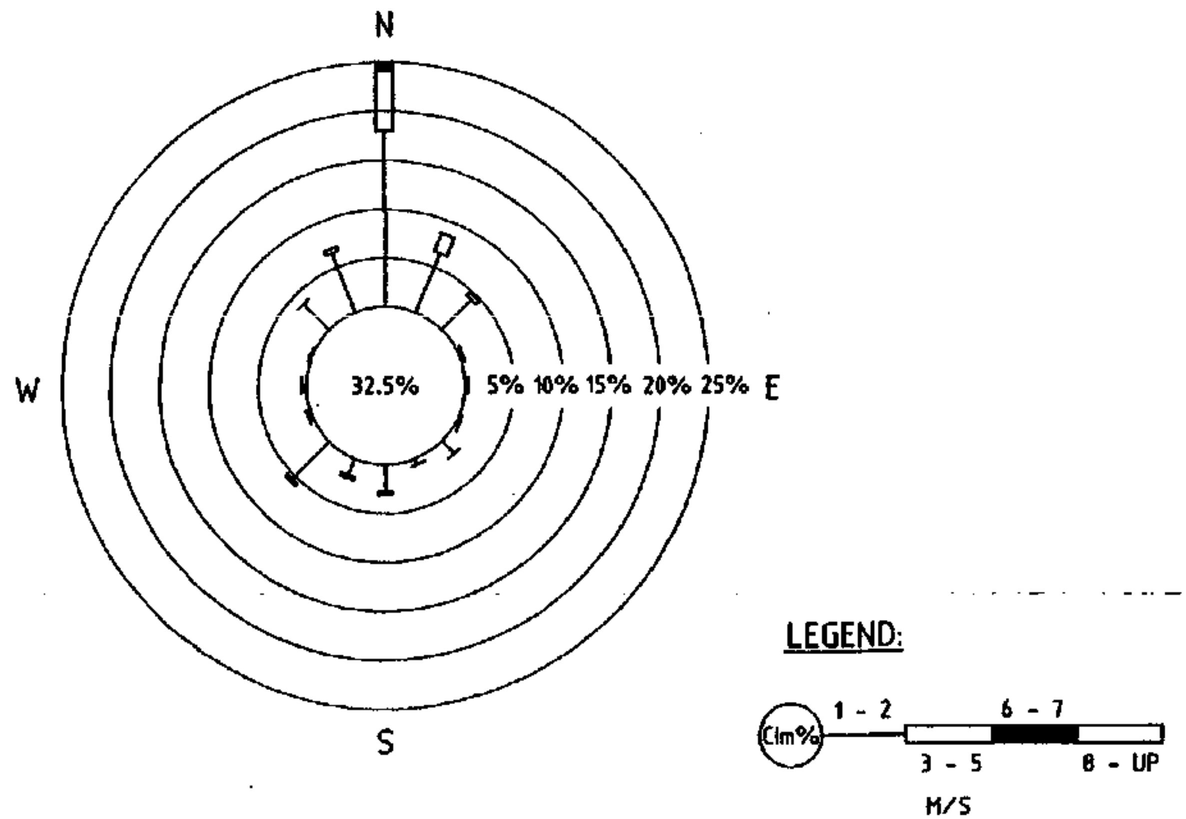


FIGURE III-1-6

No.	DATE	BY	DESCRIPTION	DFT.	ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK		APPROVAL		REFERENCE DRAWINGS	

BHP Engineering PHILIPPINES Inc.

433 MW (NET) QUEZON POWER PROJECT
ENVIRONMENTAL IMPACT STUDY
WIND ROSE DIAGRAM - INFANTA

	Name	Sign	Date
DRAWN	DAU		290395
DRAFTING (CHECK)			
ENGINEERING (CHECK)			
R. ENGR. (APPROVAL)			
CLIENT (APPROVAL)			

SCALE		BHPE DRG No.	REV.
NTS	A4	P230 101 044	A

CAD FILE - P230012B

DATE OF LAST EDIT - 26.05.95

1.2.5 Tropical Cyclones

Tropical cyclones passing over the Philippine Area of Responsibility (PAR) originate from the Pacific Ocean at about 5 ° north of the equator and usually move northwestward. Typhoons frequently pass over the northern part of the country from June to September while in the last quarter of the year, typhoons generally cross over the country through Central Visayas.

The total number of tropical cyclones forming in or entering the PAR from 1948 - 1982 (35 year period) is 693 giving an annual average of 19.7 cyclones. For the proposed site, the tropical cyclone passage is three cyclones in two years. Figure III-1-7 shows the frequency of tropical cyclone passage for the different regions in the Philippines.

1.2.6 *Cloudiness, Thunderstorms and Lightning*

Cloud amount is measured based on the density of its formation in an imaginary hemisphere referred to the horizon of an observer. The unit of measurement is octa which is equal to 1/8 cloud cover. Thus, an eight octa cloud represents an overcast condition. In the proposed project site, the average monthly cloud cover is 6 octa for both stations. This means that the area generally has an overcast condition. Normally, cloud cover is correlated with the number of rainy days observed. The higher the number of rainy days, the more overcast the area becomes.

Thunderstorms and lightning are frequent during the months of May to July and September, with more than 11 thunderstorm days and 17 lightning days in a month. However, none are experienced during the months of January and February. The total annual average occurrence of these conditions are 73 and 96 days for thunderstorms and 110 and 131 days for lightning, for Infanta and Tayabas, respectively.

The regional climatological conditions described above may not accurately describe the microclimatic condition at the project site. Some characteristics of the Infanta station may be similar with the project site while the other settings could be the same as that of the Tayabas station. In any case, deviations from the data presented are expected due to the unique geophysical characteristics of the area. For example, strong gusty winds may be the prevalent characteristic at the project site due to its proximity to the coast and is therefore greatly affected by land and sea breezes. Air temperature may also be higher due to the terrain formation and the expanse of the water body which reflects much of the solar radiation.

1.3 Ambient Air Quality

1.3.1 Sampling Stations

The first air quality sampling was conducted on 7-10 February 1995. A total of seven stations were established as agreed upon during the scoping meeting with DENR-EMB in January. Hourly samples were taken at the seven stations and additional 24-hr. samples were taken on three of these stations. To increase reliability, duplicate sampling was conducted. Using two sets of equipment, SO_2, NO_2 and TSP were simultaneously sampled for each station. Location of these stations are as follows:

Station 1 — Located in Cagsiay I Chapel near the Interwood sawmill. This is about 300 m from the proposed plant site.

Station 2 — Located in one of the residential areas near the proposed ash disposal area. This is approximately 700 m from the proposed stack location.

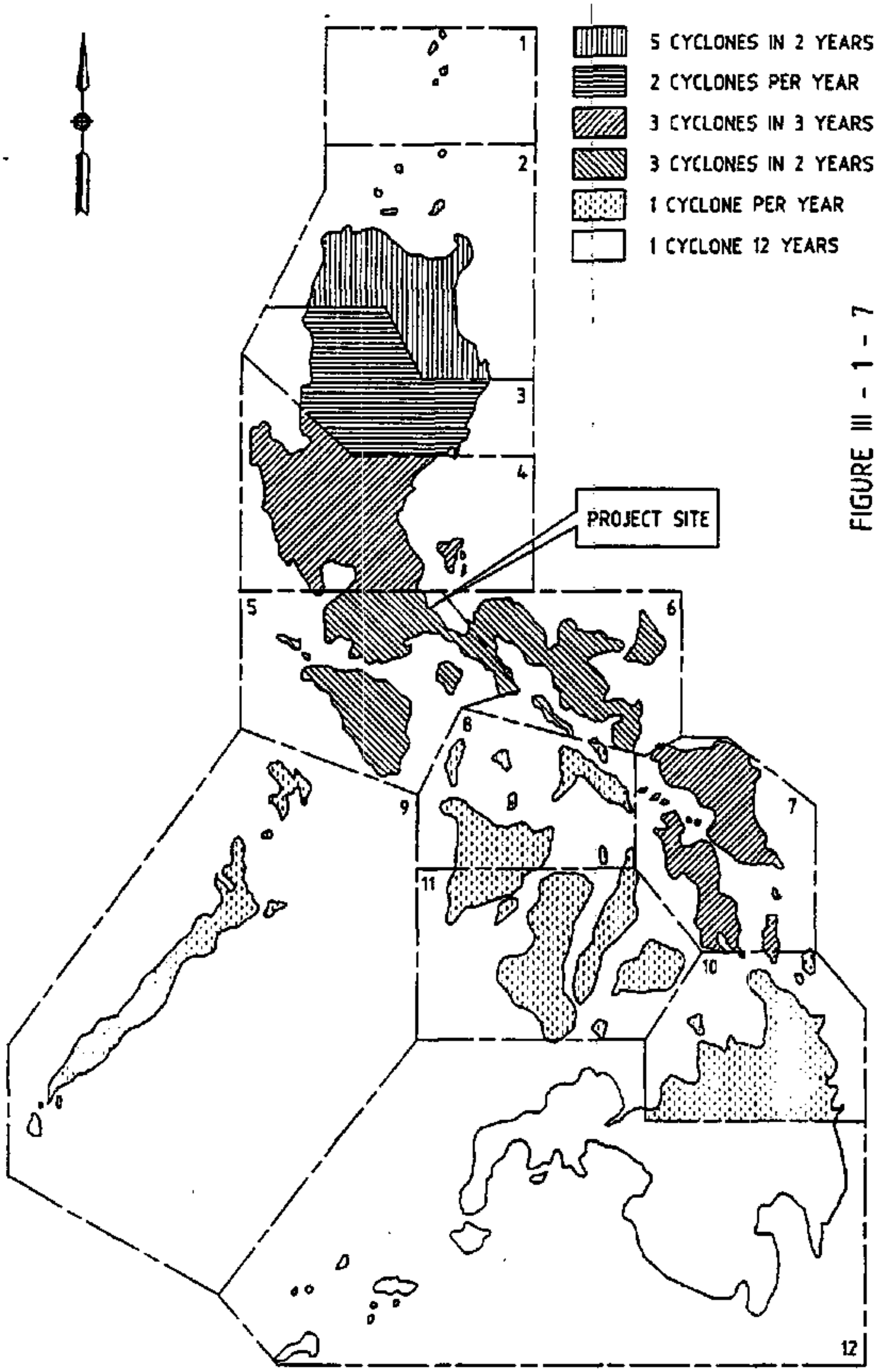


FIGURE III - 1 - 7

MAP SHOWING FREQUENCY OF TROPICAL CYCLONES IN THE PHILIPPINES

BHP Engineering PHILIPPINES Inc.
433 MW (NET) QUEZON POWER PROJECT ENVIRONMENTAL IMPACT STUDY

SCALE	NTS	A4	BHPE DWG No.	P230 101 046	REV.	A

	Name	Sign	Date
DRAWN	VAA		14.04.95
DRAFTING			
ENGINEERING			
R. ENGR.			
CLIENT			

No.	DATE	BY	DESCRIPTION	DFT.	ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
			REVISION	CHECK		APPROVAL		REFERENCE DRAWINGS	

Station 3	Located near the Barangay office of Cagsiay I. This is about 800 m. south-southwest from the proposed stack location. Northeastern wind direction would traverse the station's path. 24-hour sampling was also conducted in this station.
Station 4	Located near the Cagsiay II Elementary School. This is approximately 1 km south-southeast from the plant site. Since this was considered as a critical receptor area, 24-hour sampling was also conducted in the area.
Station 5	Located at an abandoned sawmill in Cagsiay II about 1 km from the plant site. 24-hour sampling was also conducted in this area.
Station 6	Located near the residential area of Cagsiay II about 400 m north of the plant site. Initially, 24 hour sampling was also conducted in this station.
Station 7	Located at the Cagbalete Island. This is approximately 4 kms from the plant site.

The sampling stations were located using a NAV 5000 DX Global Positioning System (GPS) and plotted on a map as shown in Figure III-1-8. Table III-1-5 shows the results of the parameters while Table III-1-6 provides the meteorological conditions at the time of sampling. As can be in Table III-1-6, the most predominant wind direction observed was NE. This corresponds to the prevailing wind stated in the PAG-ASA data. Maximum wind speed observed was 8 mph which was recorded at station 5. The temperature range recorded during sampling was 24-31°C.

As agreed upon during the scoping meeting, monthly air samplings will be conducted for one year in all the stations established. This will augment the data which were gathered. The results will be submitted quarterly to DENR-EMB. The initial results of the monitoring are tabulated in this report. Thus, the March and April monitoring sampling results are also included.

1.3.2 Discussion of Results

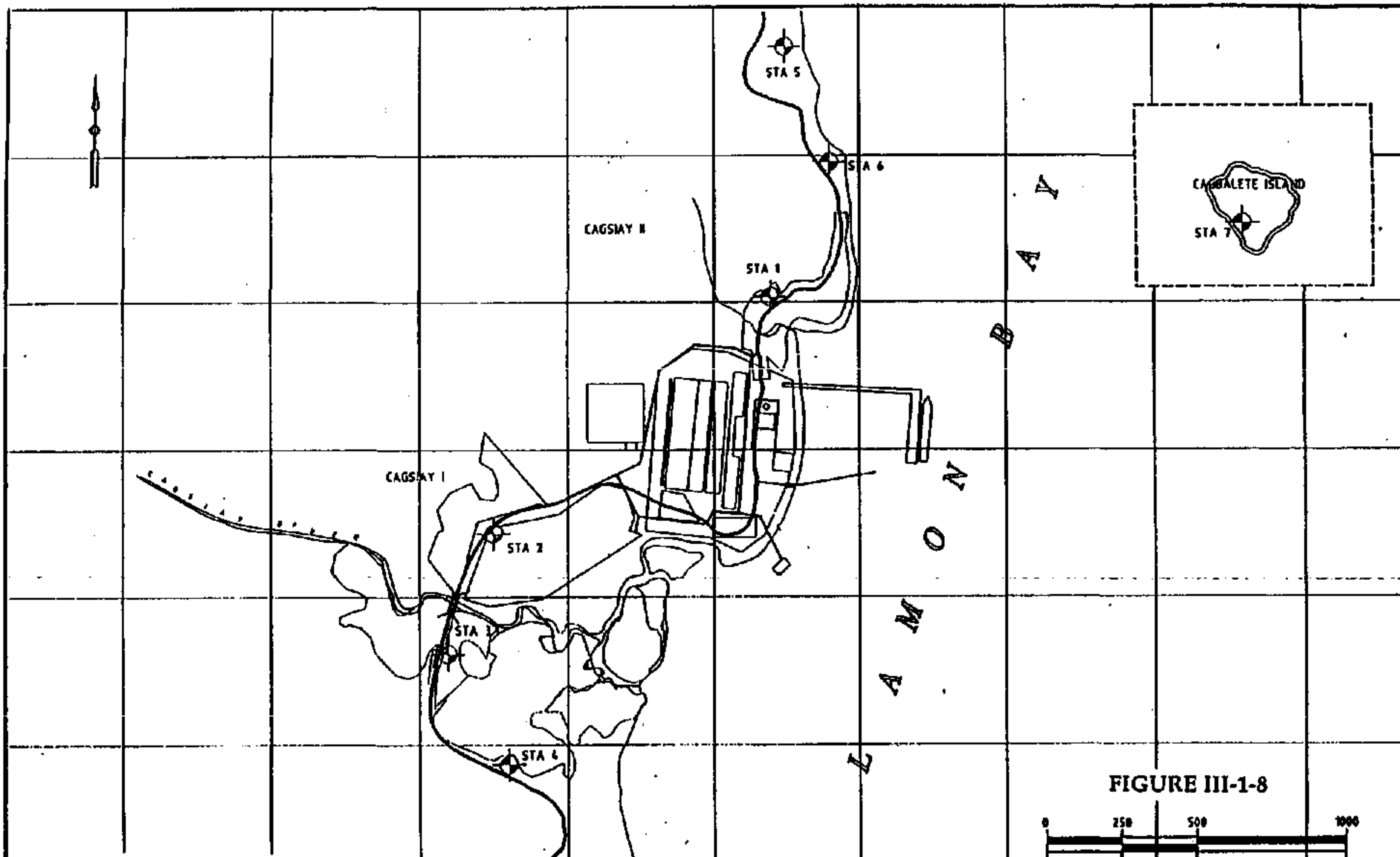
Total Suspended Particulates (TSP)

Results of the one hour sampling conducted for three months were averaged to obtain the general baseline concentration for each station. The overall average concentration was 93 ug/ncm. Averaging the concentrations measured for each station, station 1 obtained the highest average with 275 ug/ncm while the lowest level was obtained in station 6 with less than 14 ug/ncm. Possible cause of the high TSP level at station 1 are the charcoal-making plants nearby, dust generated by the sawmill as well as vehicular passage.

For the 24-hour sampling, average concentration for the three months sampled was 52 ug/ncm. The highest level was observed at station 3 with 122 ug/ncm while station 5 showed the lowest average concentration of 23 ug/ncm. Resulting average concentrations were well below the prescribed 24-hr. Philippine Standard of 230 ug/ncm (DAO 14).

Sulfur Dioxide

One hour sampling results showed concentrations ranging from less than 0.1 ug/ncm to 11 ug/ncm. The overall resulting average level was determined to be 2 ug/ncm. Averaging the concentration for the stations showed station 5 had the highest average concentration at 4 ug/ncm while the lowest had 0.1 ug/ncm at station 7. Concentrations obtained during the month of April are higher than the previous results with an average concentration of 5 ug/ncm as against 0.5 ug/ncm for the previous months. However, these concentrations are still well within the Philippine Standard of 150 ug/ncm (AO14) and can be considered good air quality based on the air quality index.



AIR QUALITY SAMPLING STATIONS

FIGURE III-1-8

BHP Engineering PHILIPPINES Inc.

433 MW (NET) QUEZON POWER PROJECT ENVIRONMENTAL IMPACT STUDY

SCALE		DWG NO.	REV.
AS SHOWN	A3	P230 101 010	A

TABLE III-1-5
AIR SAMPLING RESULTS
(February, March and April 1995)

	Station	NO_2 (ug/ncm)			SO_2 (ug/ncm)			TSP (ug/ncm)		
		February	March	April	February	March	April	February	March	April
	ONE-HOUR									
1.	Cagsiay II	16.2	7.5	13.2	ND	0.7	11.0	183.7	165.9	495.0
	Chapel	10.0	9.4	9.4	ND	0.2	11.0	157.5	258.3	392.0
2.	Near ash	0.6	13.2	7.5	ND	0.2	10.0	ND	35.3	48.0
	disposal area	5.1	22.6	7.5	ND	0.4	ND	ND	19.0	66.7
3.	Barangay	0.6	11.3	5.6	ND	0.4	4.0	ND	29.7	53.0
	Office	2.4	11.3	9.4	ND	0.5	1.0	194.9	143.2	137.8
4.	Cagsiay I	1.9	9.4	7.5	0.2	ND	4.0	26.2	80.8	16.0
	School	3.2	11.3	7.5	0.3	ND	3.0	ND	59.3	8.0
5.	Abandoned Sawmill in	5.1	11.3	7.5	1.5	1.8	10.0	ND	59.5	2.7
	Cagsiay II	7.0	7.5	7.5	2.1	0.3	6.0	ND	56.7	2.7
6.	Cagsiay II	5.1	11.3	9.4	1.3	0.9	2.0	ND	23.9	2.7
		3.8	11.3	9.4	0.3	0.2	ND	ND	53.2	5.3
7.	Cagbalete I	2.5	30.1	16.9	ND	ND	ND	83.4	228.9	264.3
		5.6	37.6	11.3	0.6	ND	ND	164.2	288.2	231.4
	AVERAGE	4.9	14.7	9.3	0.4	0.4	4.4	57.9	98.1	123.5
	QUARTERLY AVE.			9.6			1.8			93.1
	PHIL. STANDARD (1 hr)	260	260	260	340	340	340	300	300	300
	24-HOUR									
3.	Barangay Office	2.8	7.5	5.6	0.3	0.2	6.0	29.0	60.7	122.3
4.	Cagsiay I School	7.7	7.5	7.5	0.7	0.9	5.0	34.8	38.7	115.7
5.	Cagsiay II	4.3	9.4	5.6	0.3	0.5	5.0	21.1	47.2	2.0
	AVERAGE	4.9	8.1	6.3	0.4	0.5	5.3	28.3	48.9	80.0
	QUARTERLY AVE.			6.4			2.1			53.29
	PHIL. STANDARD (24 hr)	150	150	150	180	180	180	230	230	230

NOTE: Minimum detection limits: SO_2 = 0.1 ug/ncm
NO_2 = 2.0 ug/ncm
TSP = 2.5 ug/ncm

TABLE III-1-6
AIR SAMPLING RESULTS
(February, March and April 1995)

	Station	Wind Direction			Wind Speed (mph)			Temperature (°C)		
		February	March	April	February	March	April	February	March	April
	ONE-HOUR									
1.	Cagsiay II Chapel	E	E	E	3-5	3-7	1.4-3.8	26	30	29
2.	Near ash disposal area	E	NE	E	2-4	3-5	3.7-7.4	30	29	31
3.	Barangay Office	NE	E	NE	3-5	1-3	1.8-3-9	27	28	29
4.	Cagsiay I School	ENE	NE	NE	<3	<2	3.2-5.4	26	27	30
5.	Abandoned Sawmill in Cagsiay II	NE	NE	NE	1-4	3-7	5.2-8.3	30	28	31
6.	Cagsiay II	NE	NE	NE	3-6	3-8	4.2-7.1	30	30	30
7.	Cagbalete I	NE	NW	SW	3-5	3-5	2.3-3.8	24	27	28
	24-HOUR									
3.	Barangay Office	NE	E	NE	<3	<2	2.0-4.7	26	28	31
4.	Cagsiay I School	N	NE	SW	<3	1-5	2.3-3.8	30	27	32
5.	Cagsiay II	NE	ENE	NE	3-6	3-9	5.2-8.1	30	28	29

mph = miles per hour

Nitrogen Dioxide

The results of the one hour sampling showed values ranging from 0.6-38 ug/ncm with the highest observed at station 7. The overall average concentration is about 10 ug/ncm with station 7 having an average concentration of 17 ug/ncm.

For the 24-hour sampling, the overall average concentration is 7 ug/ncm with the other three stations ranging from 6-8 ug/ncm. This shows that the concentrations measured in the area are not too variable. The prescribed 24-hour Philippine standard for NO_2 is 180 ug/ncm (DAO 14). Monthly concentrations obtained are all within this limit.

1.3.3 Survey of Existing Air Emission Sources

A survey of the existing industrial plants was conducted within a 10 km radius from the site to determine other possible sources of emissions in the area. This was done through secondary data gathering and survey of the area.

The survey revealed that the industries existing within the area are charcoal-making plants and sawmills. A major charcoal plant is operating in Cagsiay I about 0.5 km from the site. More than 10 backyard charcoal making plants were observed in both Cagsiay I and II. Two sawmills were seen in the area, one located in Cagsiay II about 400 m from the site and the other located in San Lorenzo, approximately 3 kms from the site. These sources normally generate particulate emissions.

1.3.4 Noise Level Monitoring

Noise level monitoring was conducted around the vicinity of the plant. The same sampling stations as those sampled for air quality were used to characterize baseline noise levels in the area. Table III-1-7 shows summary of the results for the months of February, March, April and May and the applicable noise standards.

The average noise levels at the project site ranged from 41 dB(A) to 57 dB(A). At present, land use of the area is agricultural. Thus, the standard to be applied would be for residential areas, i.e. 55 dB(A) during daytime, 50 dB(A) during morning and evening and 45 dB(A) during nighttime. Under this standard, noise readings obtained in stations 1, 6 and 7 exceeded the allowable limit. However, this could be attributed to sounds generated by strong waves, boat engines and heavy rainfall.

Other noise contributors identified around the area were noise from the Interwood sawmill, noise generated by the heavy downpour that occurred during sampling, strong winds and noise coming from school children.

1.3.5 Assessment of Existing Air Quality

The existing air quality in the area typifies a rural area. Although some emission sources were observed, the resulting levels, SO_2 and NO_2 levels are within the good level standard based on the Air Quality Index of DAO No. 14. For TSP, although high levels were experienced in station 1, the quarterly TSP level is still within the good air quality index level. The probable cause of the high concentration could be the presence of the nearby sawmill.

TABLE III-1-7
NOISE MONITORING RESULTS
(February, March, April and May 1995)

Station	Low Scale dB(A) *				High Scale dB(A)*				Average dB(A)	Sampling Time	Philippine Standard dB(A)		Remarks
	Feb.	March	April	May	Feb.	March	April	May			Industrial	Residential	
1	54.2	53.2	55.2	53.7	57.4	55.5	56.4	63.5	56.3	Daytime	75	55	Noise coming from the Interwood sawmill can be heard
				48.7				54.7	51.7	Morning	70	50	
				47.1				52.9	50.0	Evening	70	50	
				49.4				54.0	51.7	Nighttime	65	45	
2	45.7	48.9	56.7	39.0	53.5	54.1	61.0	52.1	51.4	Daytime	75	55	Strong winds experienced at the time of April sampling
				43.0				53.0	48.0	Morning	70	50	
				38.2				53.1	45.7	Evening	70	50	
				41.4				51.9	46.7	Nighttime	65	45	
3	53.3	42.8	49.1	47.0	58.4	53.3	55.0	53.6	51.4	Daytime	75	55	Noise due to heavy downpour experienced during February
				46.6				53.0	49.8	Morning	70	50	
	47.0	41.5		45.6	54.8	52.8		53.4	40.9	Evening	70	50	
				49.0				55.2	52.1	Nighttime	65	45	
4	48.4	43.5	49.9	40.9	55.0	52.9	56.2	52.3	49.9	Daytime	75	55	Background noise from school children can be heard
	48.9			44.5	54.6			52.6	50.2	Evening	70	50	
5	41.3	52.8	53.7	48.5	52.9	56.6	57.7	53.8	52.1	Daytime	75	55	High winds experienced at during the April sampling
				44.8		56.8		53.0	48.9	Morning	70	50	
				48.6				53.2	50.9	Nighttime	65	45	
				53.1				56.4	55.0	Morning	70	50	
				37.7				52.4	45.0	Evening	70	50	
				42.0				51.7	46.7	Nighttime	65	45	
6	58.3	60.5	55.9	48.8	61.3	60.5	59.4	54.2	57.4	Daytime	75	55	High winds and strong waves were experienced
					44.9			52.6	48.8	Morning	70	50	
					44.2			53.5	48.9	Evening	70	50	
					41.4			52.4	46.9	Nighttime	65	45	
7	57.9	52.2	54.4	52.6	59.1	59.4	59.3	55.9	56.4	Daytime	75	55	Noise from radio and boat engine can be heard

* Readings were obtained based on the arithmetic median of seven readings.

2.0 OCEANOGRAPHY, HYDROLOGY AND WATER QUALITY

The scope of the study is consistent with that agreed upon during the scoping meeting which was conducted with the attendance of representatives from the Environmental Management Bureau of the DENR, some members of the Mauban community, the proponents, and the environmental consultants.

2.1 Methodology

2.1.1 Oceanography and Hydrology

Data were obtained through primary (i.e., information collected through actual field surveys) and secondary (i.e., information collected through library research or survey of available literature on the subject matter) data gathering.

Ocean Circulation Model

The model used to simulate current patterns in the study area is a two-dimensional vertically integrated hydrodynamic model which runs on an IBM PC/AT 80486 microcomputer and provides graphics output of current vectors. The governing equations used in the model are:

$$\frac{\partial U}{\partial t} = fV - gh\frac{\partial \zeta}{\partial x} + \frac{1}{\rho_w}(\tau_{sx} - \tau_{bx})$$

and

$$\frac{\partial U}{\partial t} = -fU - gh\frac{\partial \zeta}{\partial y} + \frac{1}{\rho_w}(\tau_{sy} - \tau_{by})$$

where	U	=	zonal transport velocity
	V	=	meridional transport velocity
	f	=	Coriolis parameter
	g	=	gravitational acceleration
	ρ_w	=	seawater density
	τ_{sx}	=	zonal component of surface wind stress
	τ_{bx}	=	zonal component of sea bottom stress
	τ_{sy}	=	meridional component of surface wind stress
	τ_{by}	=	meridional component of sea bottom stress
	ζ	=	perturbation from areal mean sea surface elevation

The surface wind stresses are parameterized using the bulk aerodynamic method and are defined by

$$\tau_{sx} = \rho_a C_d |W| W_x$$

and

$$\tau_{sy} = \rho_a C_d |W| W_y$$

where C_d = drag coefficient
W_x, W_y = x- and y-components of the wind

The bottom stresses are parameterized using a linear relationship between the transport velocities and are expressed as

$$\tau_{bx} = k \rho_w \frac{U}{h}$$

and

$$\tau_{by} = k \rho_w \frac{V}{h}$$

where k = bottom drag coefficient
U = zonal component of transport velocity
V = *meridional component of transport velocity*
h = still water depth
ρ_w = sea water density

The effect of tidal oscillation on the bay circulation is represented by specifying a sinusoidal function fitted to the observed of rise and fall of sea surface at the open boundaries of the model domain. This function is defined by

$$\zeta_o = A \sin \left(\frac{2 \pi t}{P}\right) + \zeta_{mean}$$

where A = mean tidal range (m)
P = tidal period (hrs)
t = local time (hrs)

2.1.2 Thermal Plume Model

The model used in the simulation of the thermal plume is described in Annex 3A.

2.1.3 Water Quality

For water quality, the following methodology was used.

The method employed for obtaining samples conform to approved standard methods of sampling.

The following procedures were followed:

- Washing the bottles prior to obtaining the samples.
- Bottles were lowered to a minimum depth of 30 cm below water surface.

In addition, the water samples obtained were as follows:

- Approximately 1 gallon per sample was obtained to cover the physical and chemical water analysis.
- These water samples obtained were sent to a laboratory in Manila for analysis.

Water Quality Parameters

The following parameters were tested from surface, ground and marine water samples:

- Temperature
- pH
- Copper
- Total Suspended Solids
- Cadmium
- Chromium
- Oil and Grease
- Fecal Coliform
- Manganese
- BOD
- COD
- Phosphate
- Vanadium
- Total Coliform
- Lead

2.2 Oceanographic Setting

2.2.1 Tidal Characteristics

The tidal patterns at the project area follow closely the tidal characteristics in Legaspi Port, Legaspi City which is the reference station for Mauban, Quezon. The geographical location of the reference station is at 13° 9' N latitude and 123° 45' E longitude.

Two types of tides prevail over the area, the diurnal and semi-diurnal type. The diurnal type of tide is characterized by one high water and one low water in a lunar day. This type prevails when the moon approaches its maximum declination. The maximum tide range occurs during this period. The semi-diurnal type exhibits two high water and two low water in a lunar day. This type begins to occur when the moon's declination approaches zero.

The various tidal levels at the reference station are:

Mean Sea Level (MSL)	=	0.741 m
Mean Higher High Water(MHHW)	=	1.392 m
Bench Mark Elevation	=	2.866 m

The bench mark (BM 2) is set on a concrete base of the headless monument located at the northern side of the wharf.

A tidal station in Atimonan which is nearer to Mauban (14°00'N, 121°55'E) has a mean tidal level of 0.82 m and a mean diurnal tidal range of 1.55 m. The tidal differences and constants between this station and the reference station in Atimonan are as follows:

High Water (time)	=	+ 0 h 10 min
Low Water (time)	=	+ 0 h 10 min
High Water (height)	=	+ 0.14 m
Low Water (height)	=	0.00 m

On 12-13 February 1995, the tidal pattern was determined through primary data gathering as can be seen from (**Figure III-2-1**), the project was observed to be of diurnal type. The tidal range was about 1.5 m. The Lower Low Water (LLW) occurred at about 11:00 PM local time while the Higher High Water (HHW) was observed at about 2:00 PM.

2.2.2 Waves

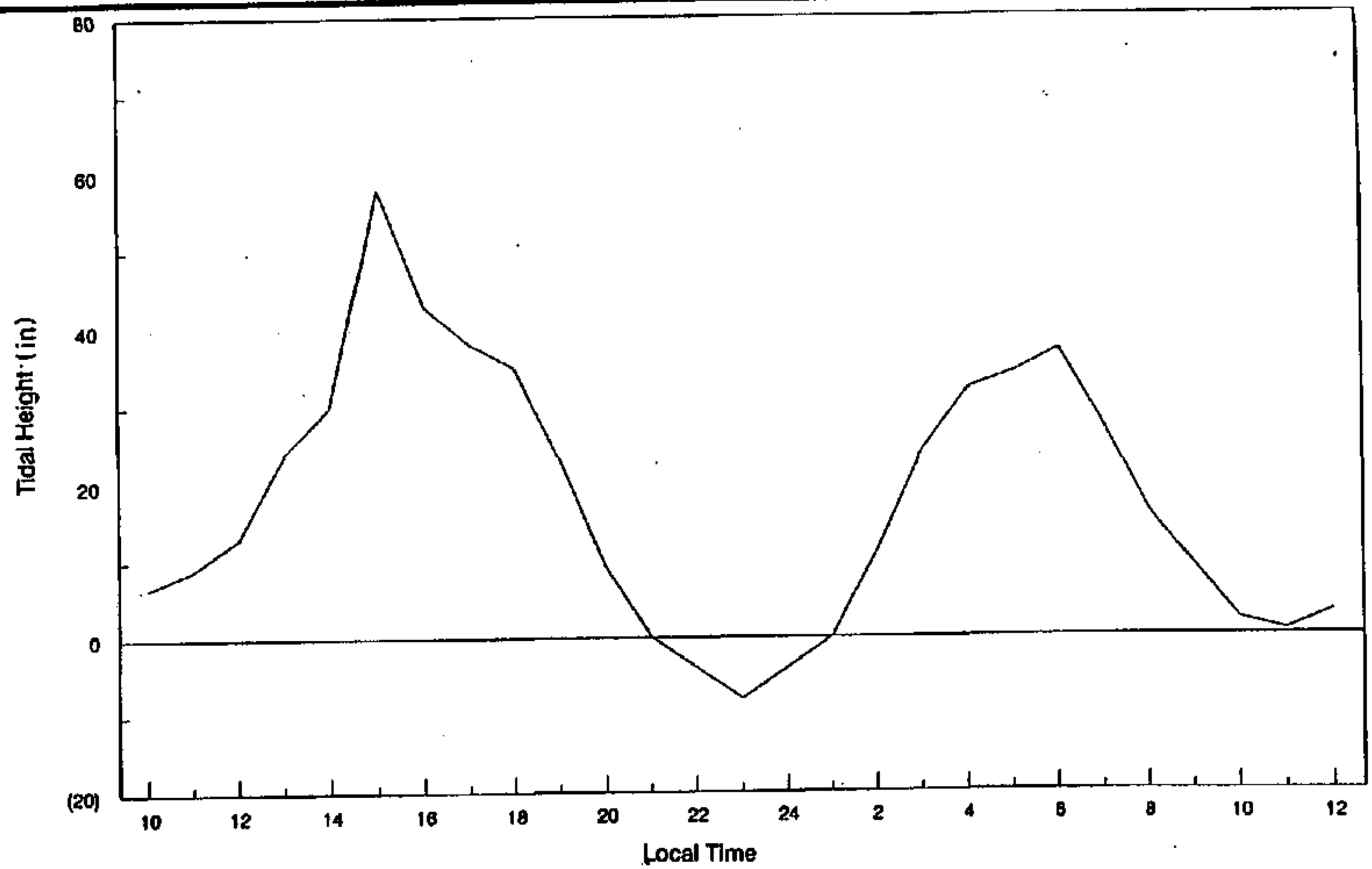
The significant wave heights in the area are relatively small, about 0.1 to 2.0 m. This is attributed to the position of the site which is inside Lamon Bay and partially protected by the Cagbalete Island. During continuous monsoon winds, however, offshore significant wave heights may reach 1.0 to 3.0 m.

2.2.3 Ocean Currents

The existing current patterns in the study area is a result of the combined wind and tidal forcing. Current meter and drogue measurements (**Tables III-2-1 to 3**) conducted last 12, 13 and 25 February 1995 showed that the current speeds in the estuary range from 1 to 4 cm/s at station A thru E near the site and 5-10 cm/s at Cagbalete Island with directions varying with the tidal regimes. During ebb tide (**Figure III-2-2**), the currents are generally directed towards the northeast. During flood tide (**Figure III-2-3**), the currents were observed to be generally directed to the southwest. However, at points very close to the shoreline, currents tend to follow the bathymetry of the area. **Figure III-2-4** also shows the observed currents and direction west of Cagbalete Island.

In order to describe the general features of the ocean circulation pattern in the area as driven by wind and tide forcing, a depth-integrated barotropic ocean circulation model described in Section 2.1.1 was used. The computational domain and the input bathymetry is shown in **Figure III-2-5**. A fishnet 3-D representation of the bathymetry is also shown in **Figure III-2-6**.

The predicted circulation patterns for different seasons are shown in **Figures III-2-7 to 9** for the current vectors and **Figures III-2-10 to 12** for the current directions. From these figures, it can be seen that the currents near the project site are directed to the north during the southwest monsoon season and to the south during the northeast monsoon and transition seasons. The simulated current speeds in the study area ranges from 0.5 cm/s to 12 cm/s with the strongest currents occurring during the northeast and southwest wind regimes.



OBSERVED TIDAL HEIGHTS AT CAGSIAY I, MAUBAN, QUEZON
ON FEBRUARY 12-13, 1995

FIGURE III-2-1

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TABLE III-2-1
OBSERVED OCEAN CURRENTS SPEED, DIRECTION AND TEMPERATURE
Date: 12 February 1995

Station	Depth (m)	Time (hrs)	Speed (cm/s)	Dir (deg)	Temp (°C)
A	8.5	1040	1.4	201.6	25.90
		1050	3.4	186.5	25.85
		1100	3.4	194.4	25.80
B	9.2	1120	3.4	219.8	25.75
		1130	3.6	210.2	25.75
		1140	2.8	219.8	25.75
D	41.9	1330	1.8	124.7	25.95
		1335	3.8	157.5	26.10
		1340	1.2	126.7	26.00
E	20.1	1400	1.0	218.4	25.75
		1410	2.2	163.0	25.75

TABLE III-2-2
OBSERVED OCEAN CURRENTS SPEED, DIRECTION AND TEMPERATURE
Date: 13 February 1995

Station	Depth (m)	Time (hrs)	Speed (cm/s)	Dir (deg)	Temp (°C)
B	9.2	0840	6.8	219.6	25.85
		0850	6.0	247.2	25.85
		0900	6.0	249.0	25.85
		0910	5.8	217.6	25.85
		0920	5.2	186.9	25.75
		0930	5.2	150.1	25.85
		0940	5.0	151.5	25.85
		0950	4.8	151.9	25.85
		1000	4.4	156.2	25.85
		1010	5.0	143.6	25.85
		1020	6.0	142.6	25.85
		1030	4.6	130.0	25.85
		1040	5.0	139.3	25.85
		1050	5.4	132.9	25.85
		1100	5.8	182.5	25.85
		1110	5.8	232.5	25.85
		1120	6.0	232.2	25.85
		1130	5.8	232.2	25.85
		1140	5.6	227.5	25.85
		1150	5.2	228.2	25.95
		1200	6.0	236.5	26.00

TABLE III-2-3
OBSERVED CURRENT SPEED AND DIRECTION AROUND CAGBALETE ISLAND
February 25, 1995

Station	Local Time (hrs)	Current Speed (cm/s)	Current Direction (degree)
1	1430	9.36	80
2	1500	12.26	15
3	1530	8.62	15
4	1555	5.74	10
5	1630	19.60	60

2.3 Hydrologic Setting

2.3.1 Hydrography

The study area for oceanography is a portion of Lamon Bay specifically the near-shore sea off Barangay Cagsiay. The area is quite shallow between Cagbalete Island and the project site with depths of up to about 100 m. The part of the study area closest to the project site is generally sandy and very shallow with depths of less than 10 m.

The average sea temperature is 28°C. It is warmest from April to July averaging 30°C and coldest in January and February averaging approximately 26°C. As expected for shallow coastal seas, the seawater temperature is almost constant for varying depths which indicates that the water column is well mixed.

The surface salinities near the river mouths vary with the tidal regime and range from 25.0 ppt to 30.0 ppt. In the open ocean, the salinity ranges from 32.0 ppt to 34.2 ppt.

2.3.2 Surface Waters

The site belongs to the Maapon River basin with a drainage area of about 88 square kilometers (**Figure III-2-13**). It has a mean annual rainfall ranging from 2300 to 2350 mm (**Figure III-2-14**) and a mean annual runoff of about 1500 to 1600 mm (**Figure III-2-15**). This gives a dependable streamflow of about 3894 million cubic meters per year (MCM/yr).

An ungauged creek (Cagsiay Creek) is located at the southern boundary of the project area with a discharge of about 20 liters per second (lps).

2.3.3 Groundwater

The project site has abundant groundwater resources. It belongs to a "shallow well area" classification of NWRB where well depths can be within 20 m and average static water level is within 6 m below ground surface (mbgs).

The average well depth in the area is 39.08 m with average normal static water level of 4.01 mbgs. The average specific capacity is 0.98 lps/m of drawdown.

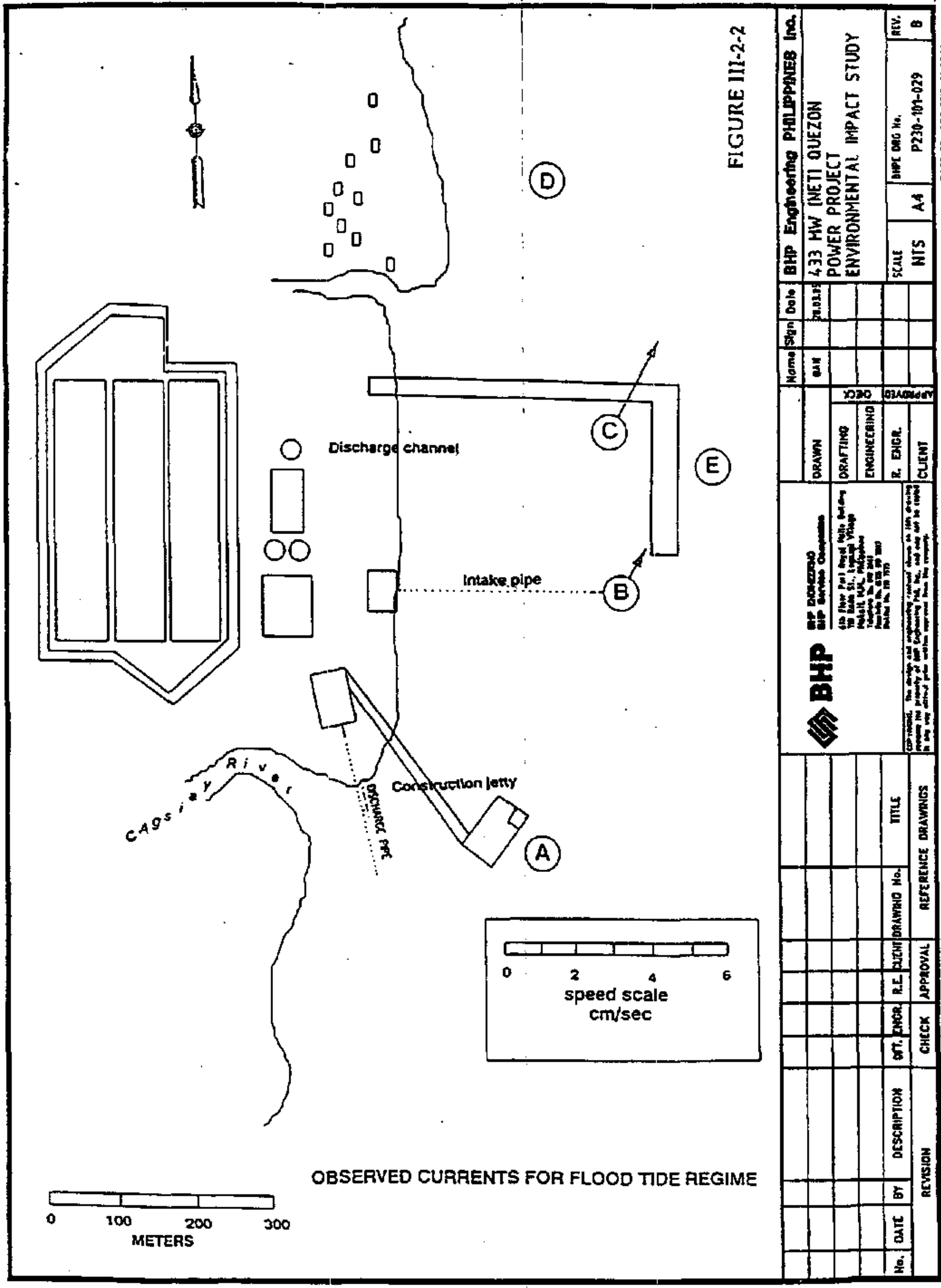

FIGURE III-2-2
OBSERVED CURRENTS FOR FLOOD TIDE REGIME
Discharge channel
Intake pipe
Construction jetty
Cagsiay River
DISCHARGE PIPE
A
B
C
D
E
0
2
4
6
speed scale
cm/sec
0
100
200
300
METERS
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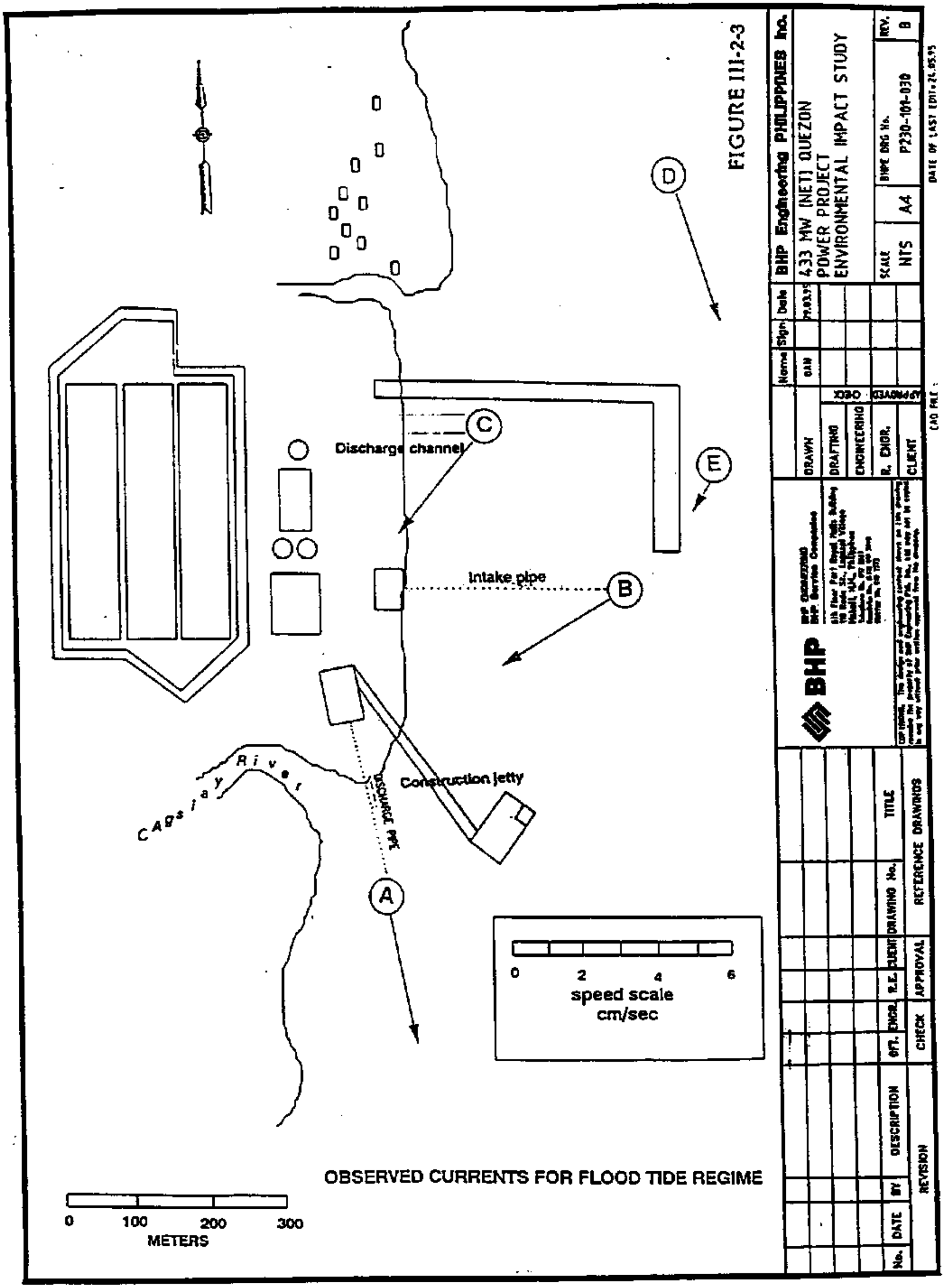

FIGURE III-2-3
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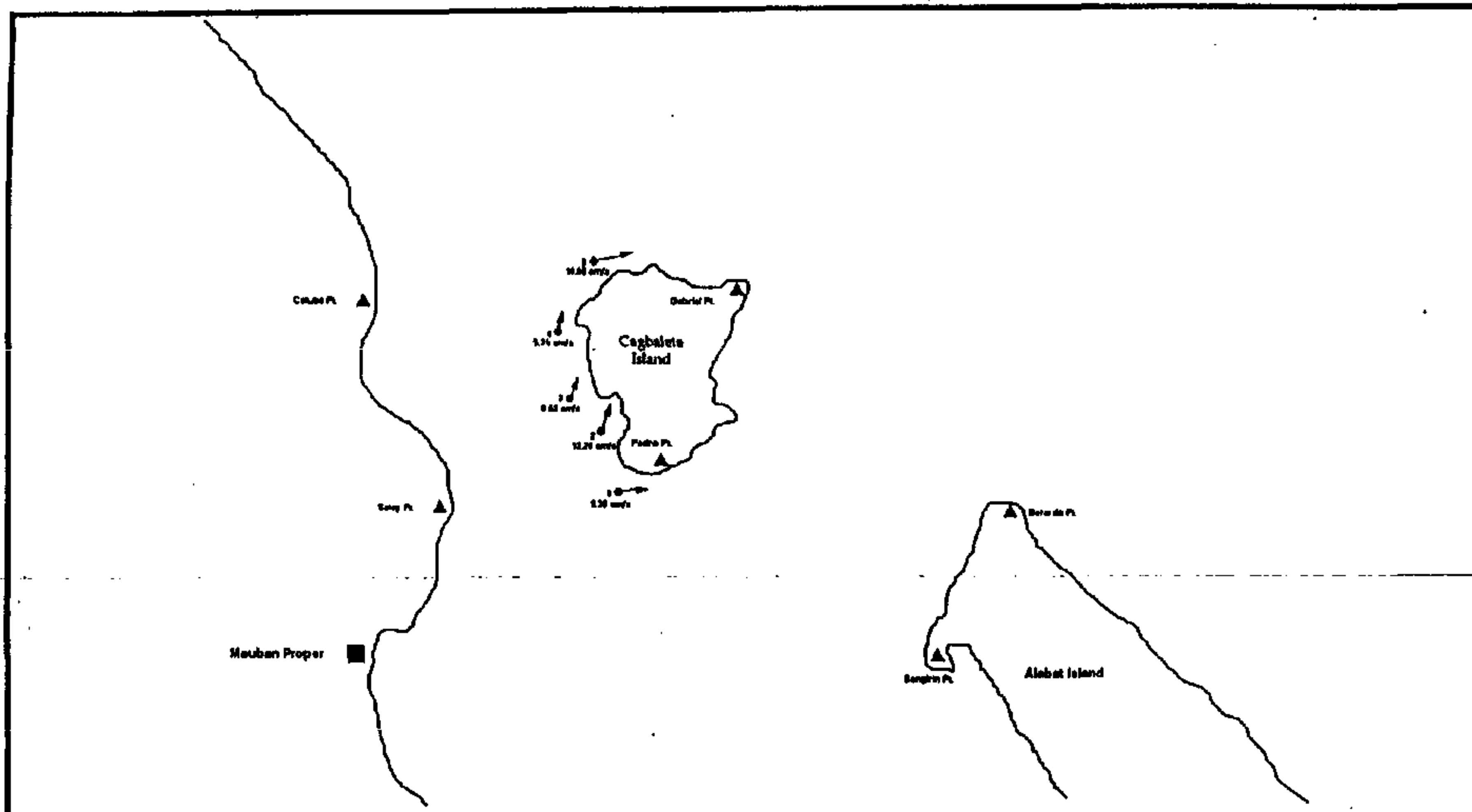
SCALE NTS
A4
BHPE DRG No. P230-101-030
REV. B
Discharge channel
Intake pipe
Construction jetty
DISCHARGE PIPE
Cagsiay River
speed scale cm/sec
0 2 4 6
OBSERVED CURRENTS FOR FLOOD TIDE REGIME
0 100 200 300
METERS
A
B
C
D
E



LOCATION OF OCEANOGRAPHIC STATIONS AROUND CAGBALETE ISLAND

FIGURE III-2-4

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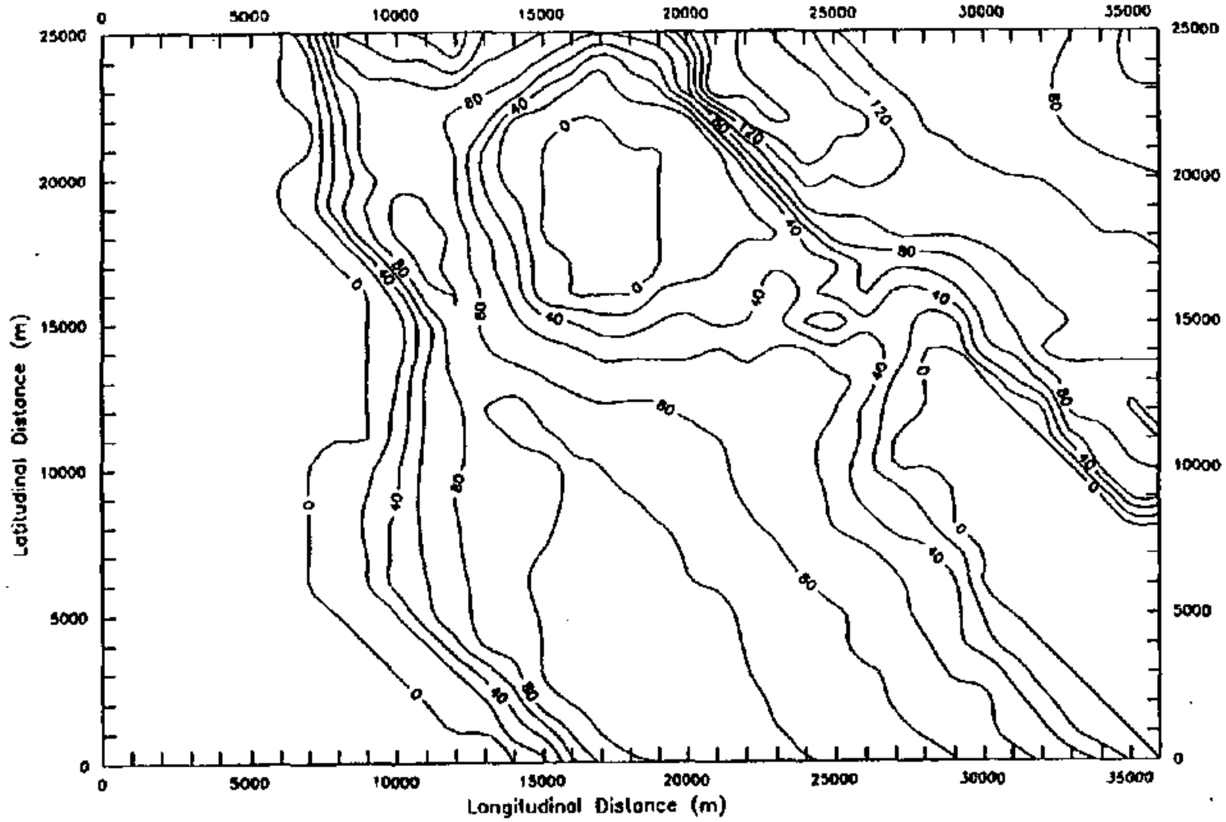

Bathymetry of the Project Area

FIGURE III-2-5

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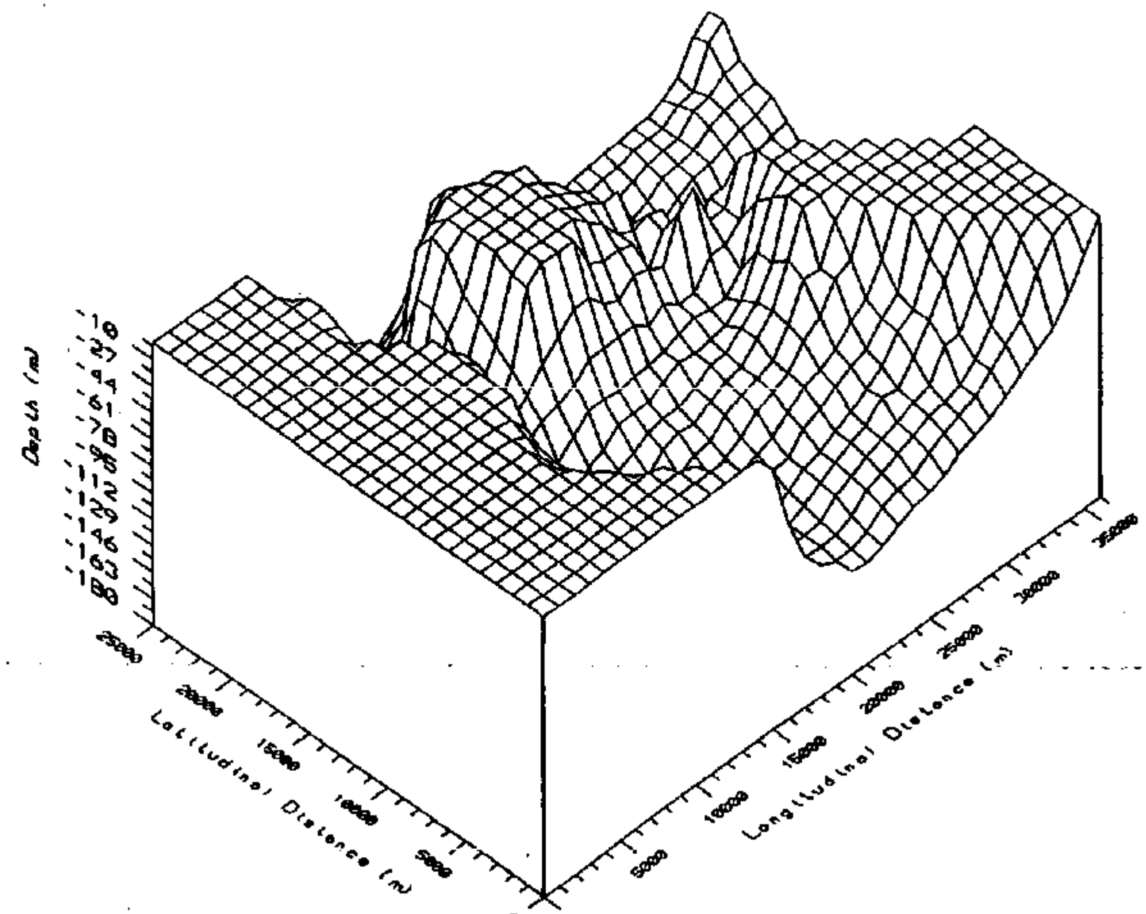

Three Dimensional Plot of Bathymetry

FIGURE III-2-6

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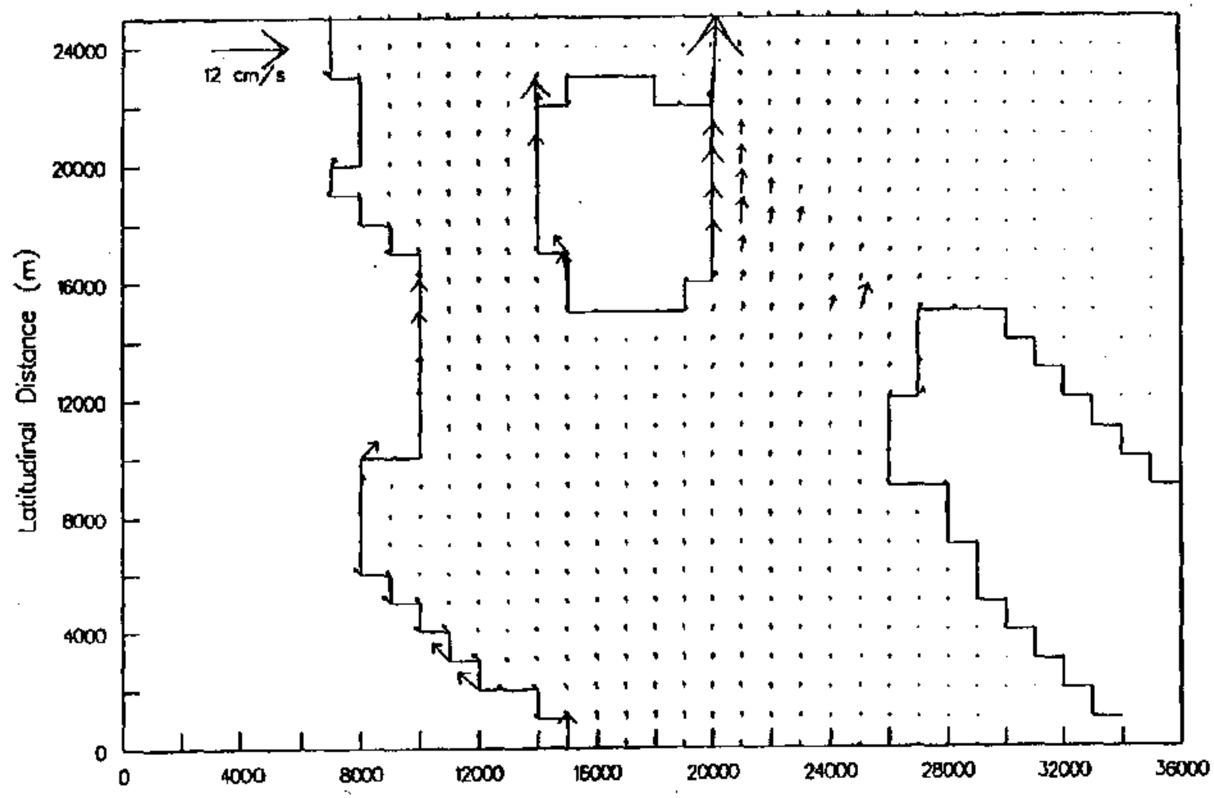

SW Wind Driven Current Dir

FIGURE III-2-7

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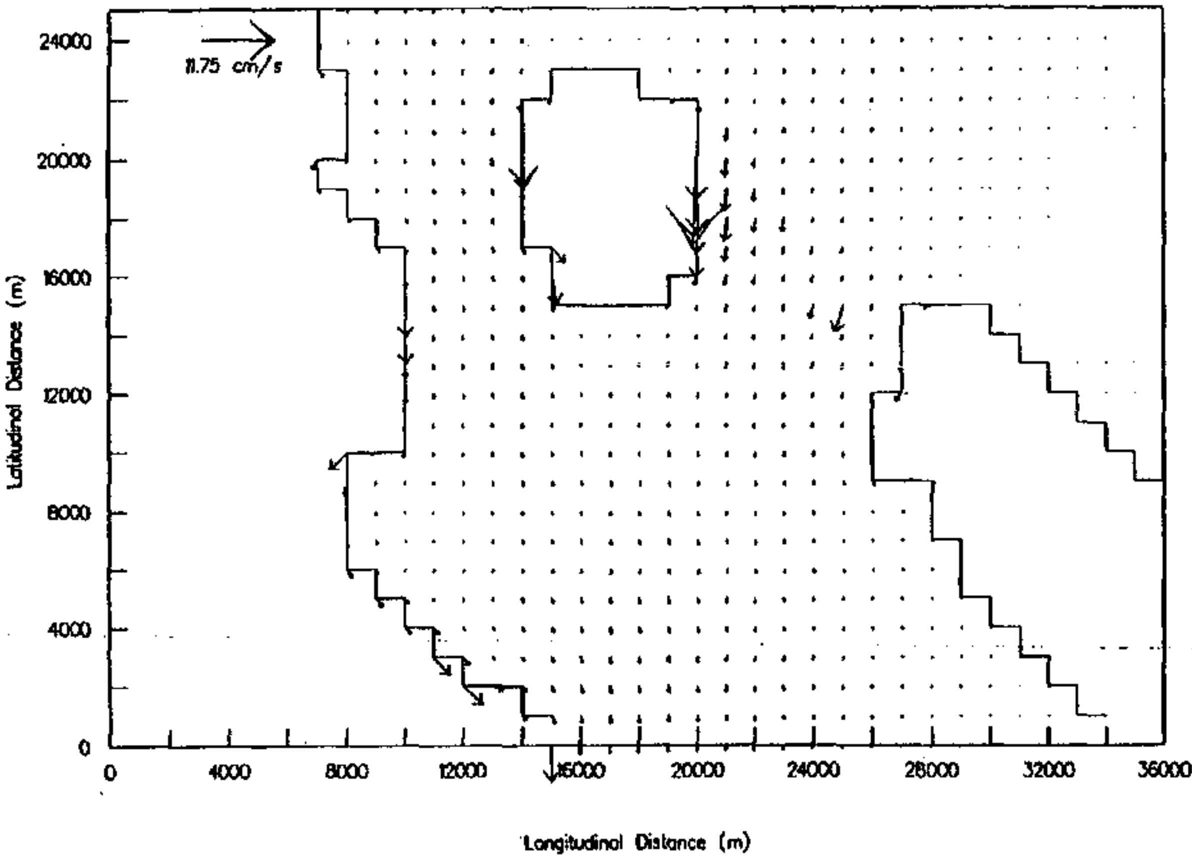

NE Wind Driven Current Dir

FIGURE III-2-8

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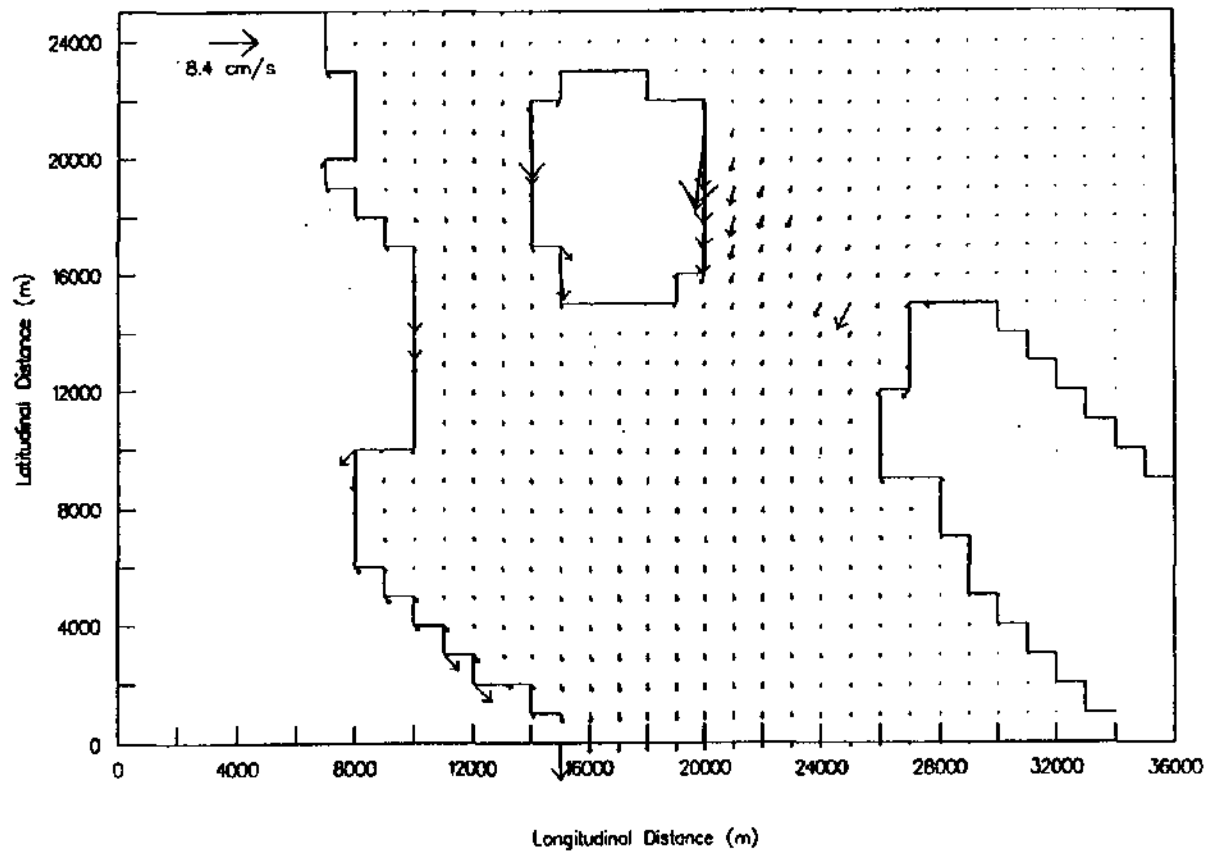

E Wind Driven Current Dir

FIGURE III-2-9

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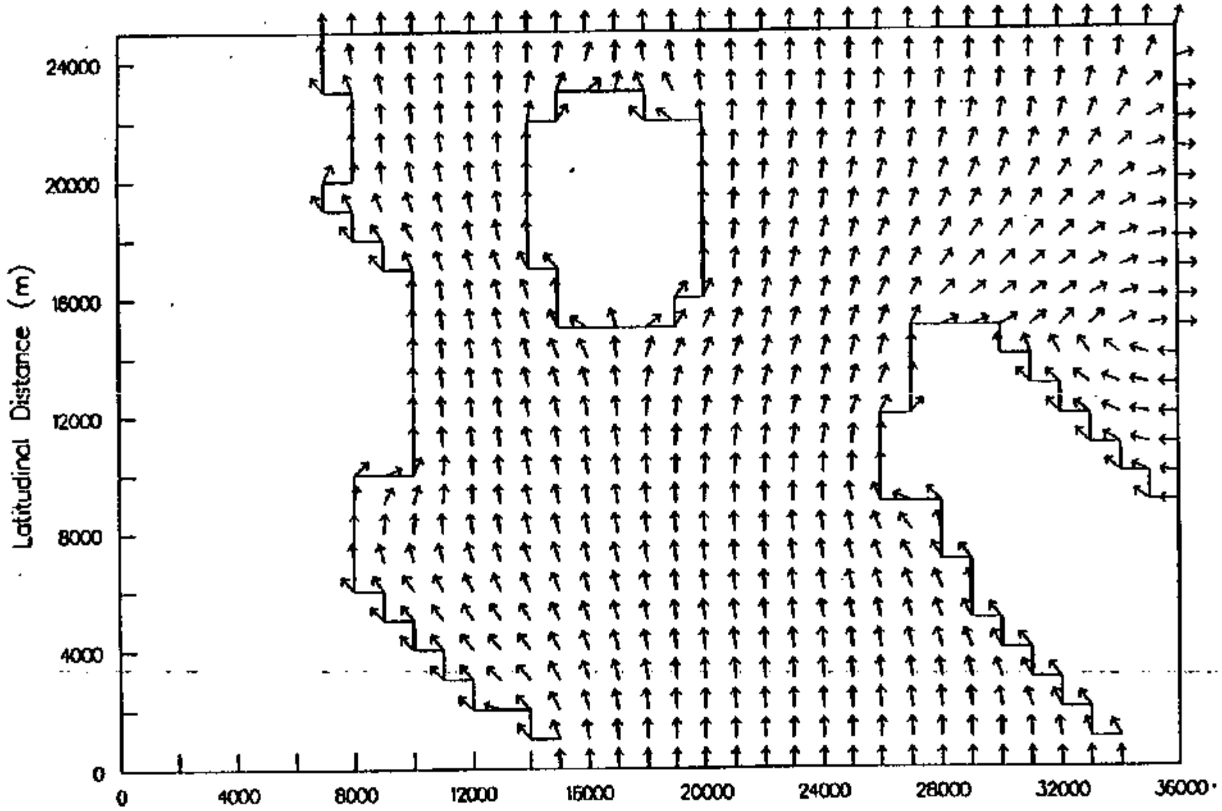

SW Wind Driven Current Dir

FIGURE III-2-10

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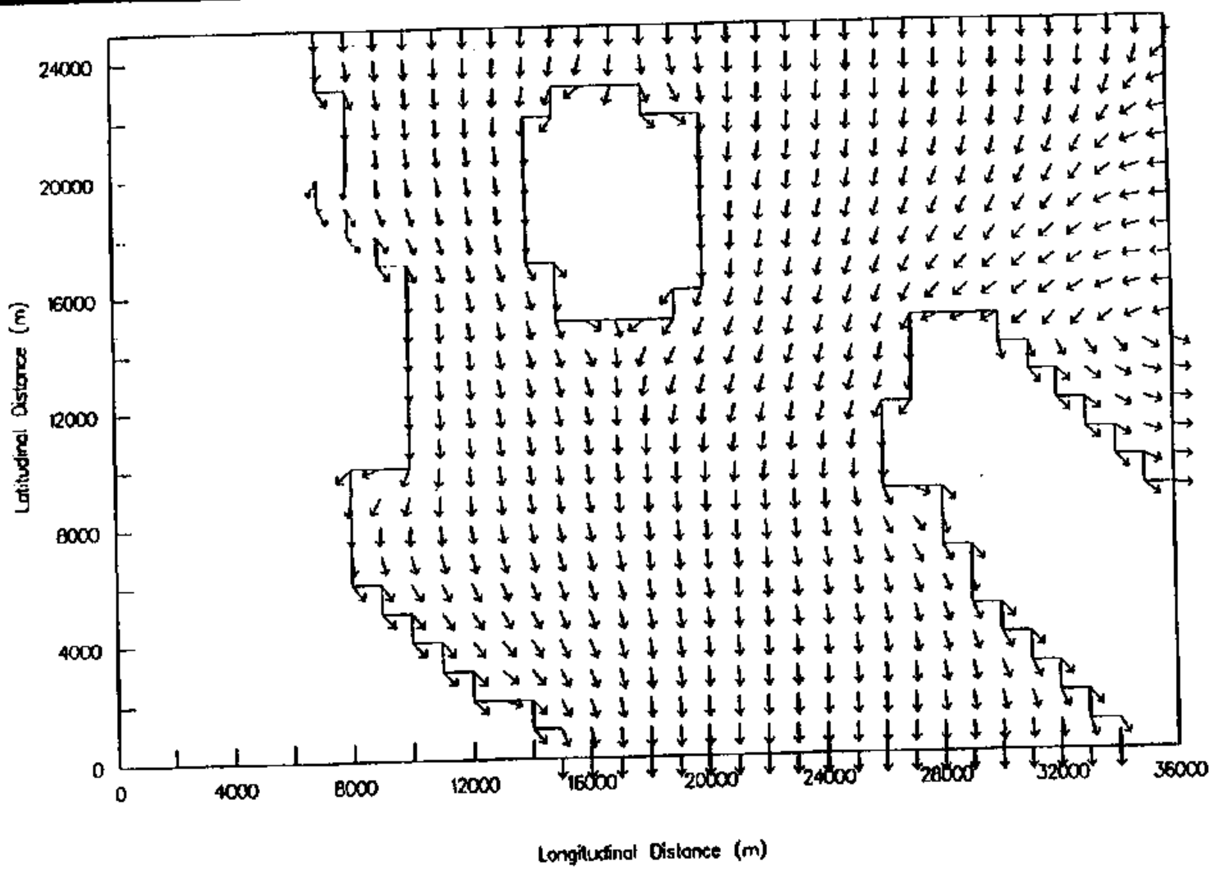

NE Wind Driven Current Dir

FIGURE III-2-11

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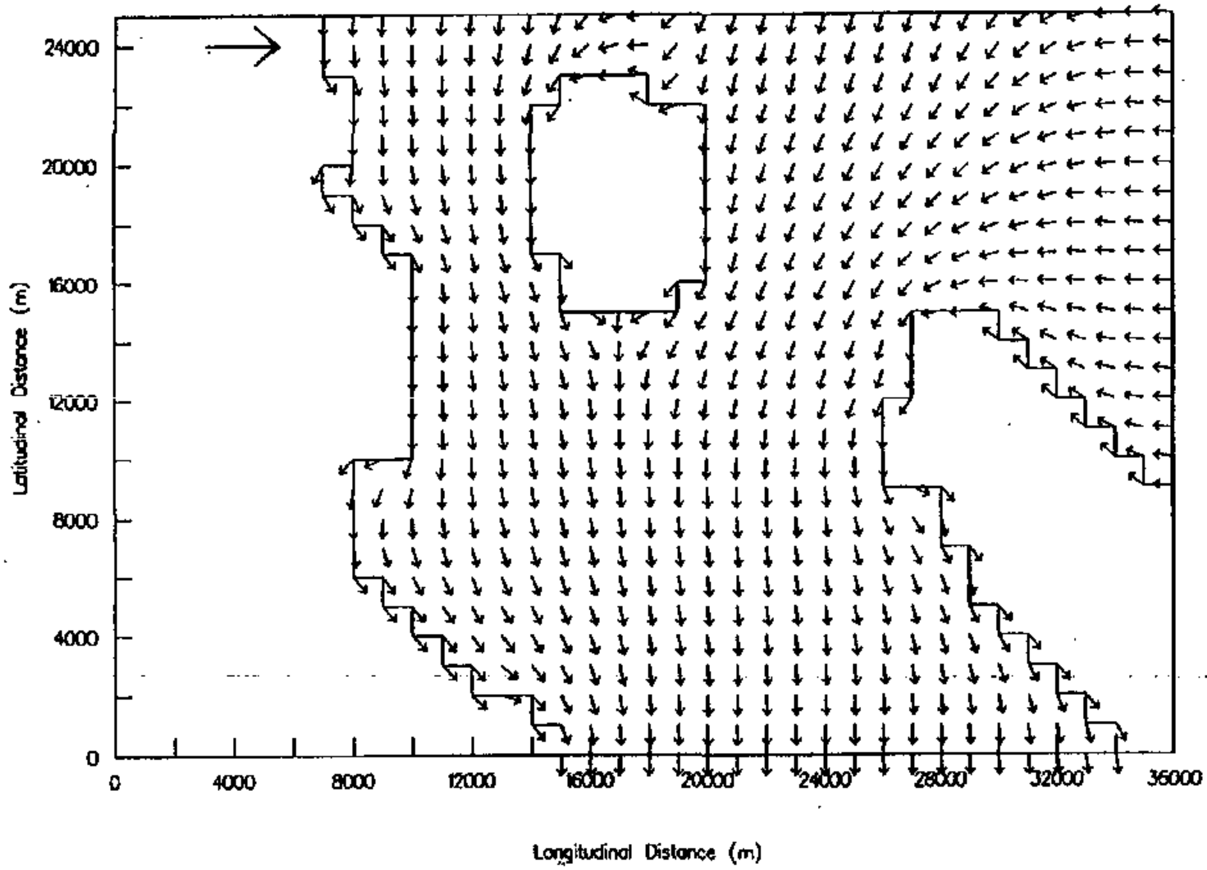

E Wind Driven Current Dir

FIGURE III-2-12

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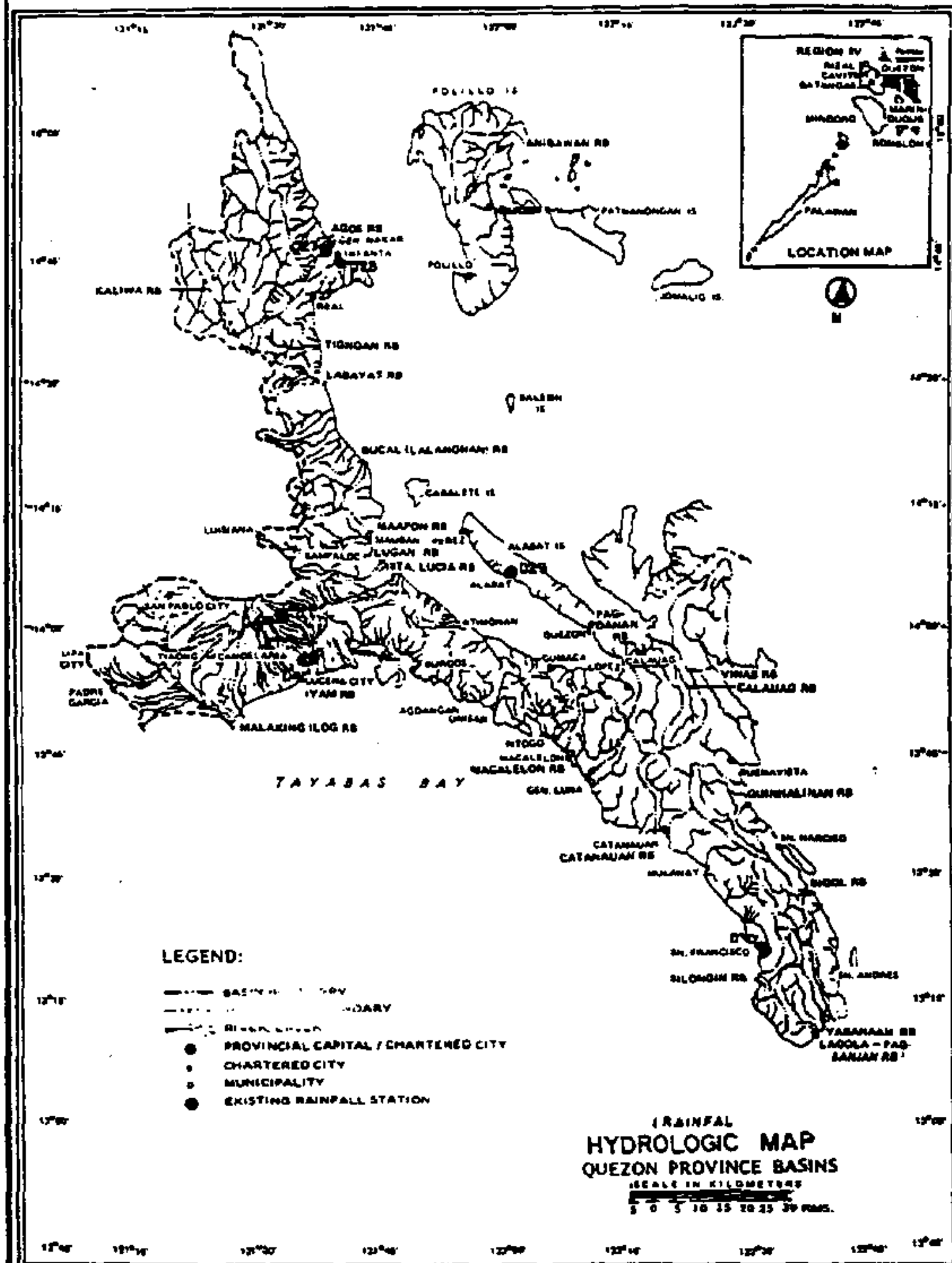

FIGURE III-2-13

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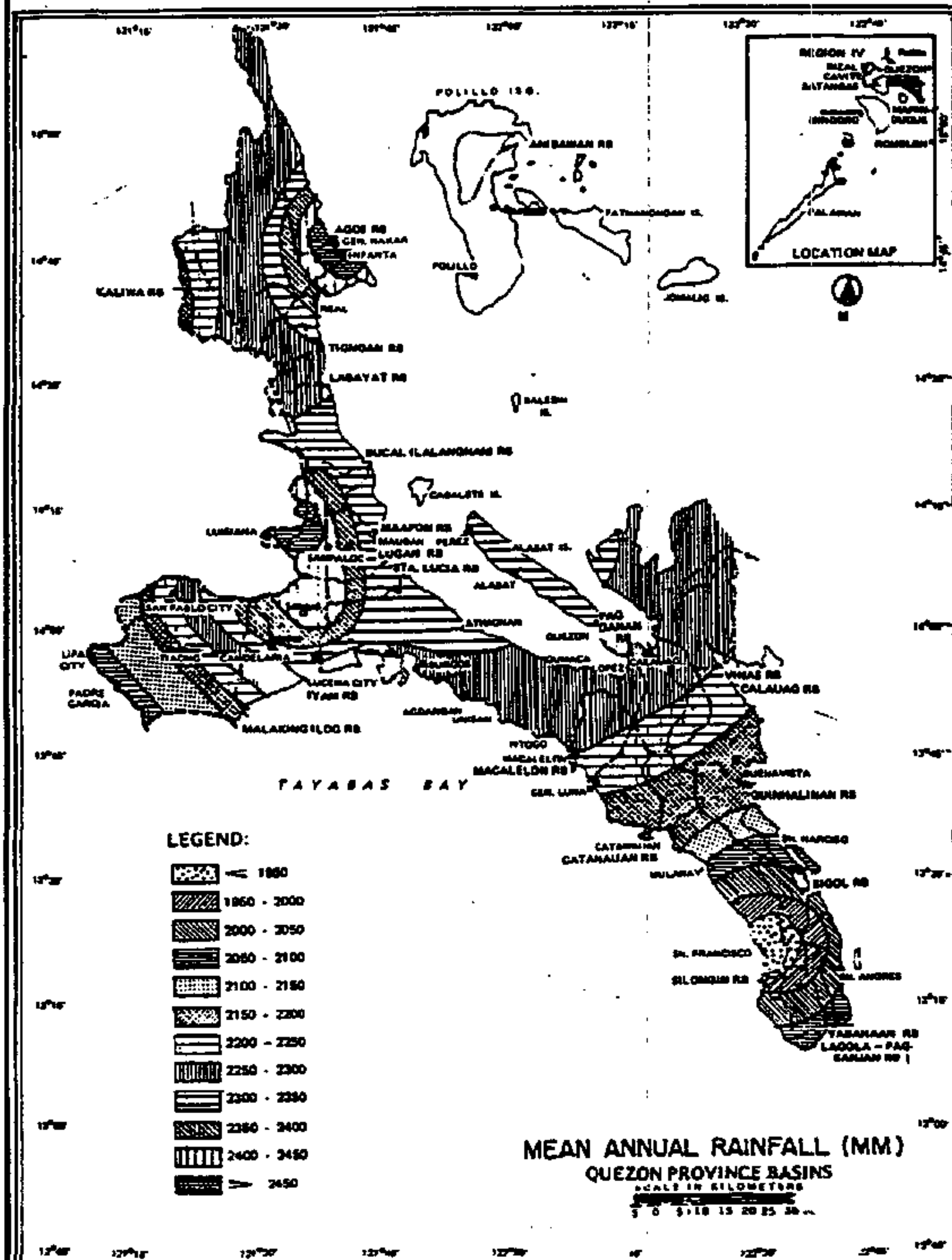

FIGURE III-2-14

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ENVIRONMENTAL IMPACT STUDY

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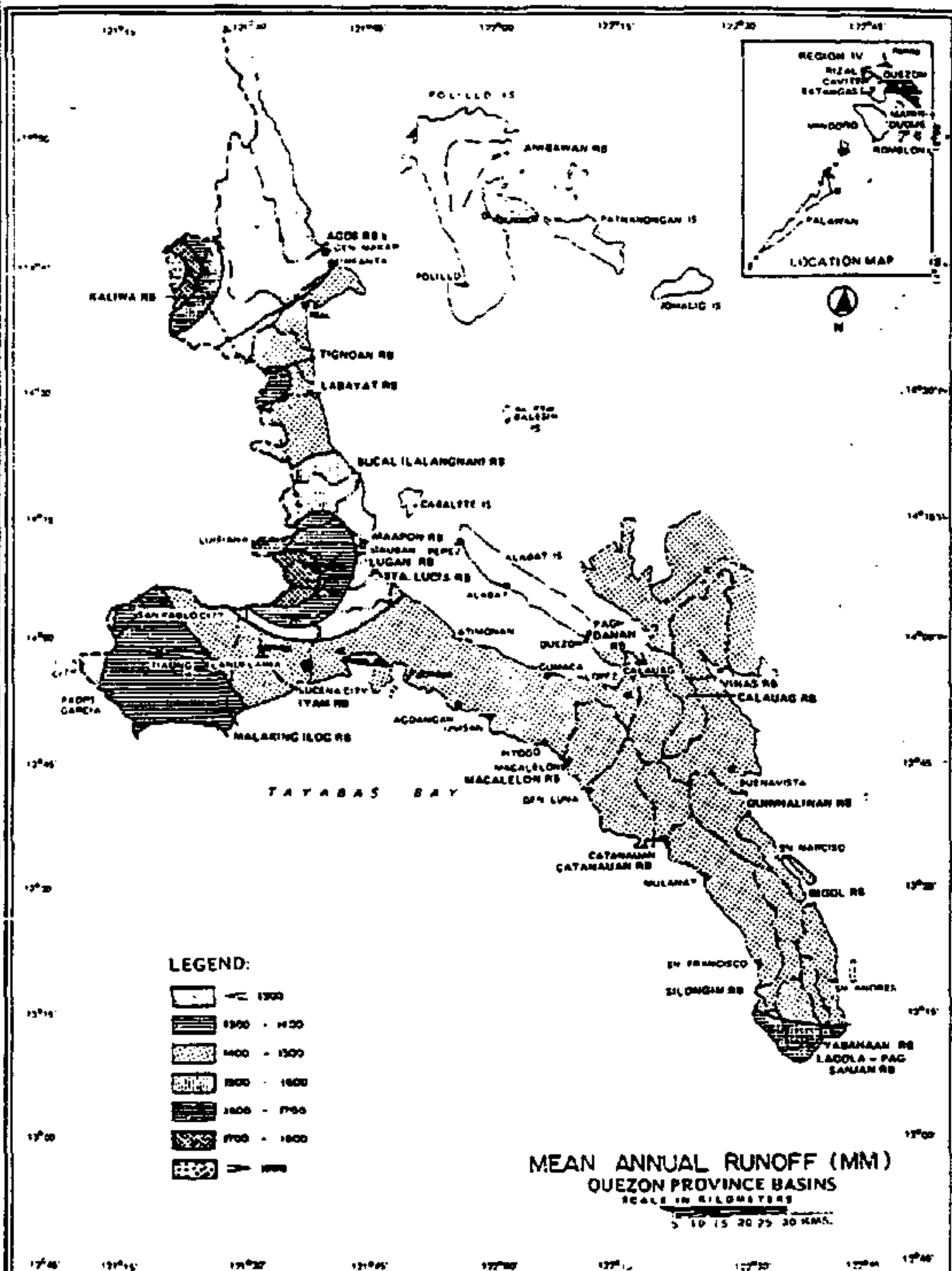

FIGURE III-2-15

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ENVIRONMENTAL IMPACT STUDY

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No.	DATE	BY	DESCRIPTION	INT. ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
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The groundwater storage in the basin is about 13,500 MCM with a safe yield of about 900 MCM/yr based on groundwater recharge. The *50-yr groundwater mining* (GWM) yield is 1,170 MCM/yr which is equivalent to 0.15 MCM/yr/km^2 well density.

2.4 Existing Water Quality

2.4.1 Sampling Stations

The water sampling stations were selected and located in relation to the proposed plant layout. The stations were sited in areas where any direct or indirect impacts of the project may result in changes in water quality.

In addition, control stations were also established to determine changes not attributable to the project. This approach will enable characterization of existing water quality of surface/fresh water, ground water and marine water prior to project implementation and thereby provide reference data once project activities commence.

A total of 12 water sampling stations were established and located as shown in Figure III-2-16. Sampling was conducted on 9-10 February 1995, March 11-12, 1995 and April 18-21, 1995. As agreed during the scoping meeting with DENR-EMB, monthly water quality monitoring will be conducted for a period of one year in the area to come up with a more representative baseline water quality.

Surface Water Stations

The nearest major river observed in the Cagsiay I area is the Cagsiay River. This river flows from southwest of the proposed site to the south and discharges into Lamon Bay. Several tributaries of Cagsiay River were observed to flow along or close to the plant site.

Another river that discharges into Lamon Bay is located in the Cagsiay II residential area. However, this is not as big as the Cagsiay River. Sampling stations were established in these two rivers. For each river, two sampling stations were established, one upstream and the other downstream near the mouth of the bay.

Marine Water Stations

The cooling water requirement of the proposed power plant will be sourced from the sea. Cooling water and other plant water effluents from operations after treatment will be discharged to the sea. To better define the baseline water quality, three impact sampling stations were established. These stations are located at the proposed locations of the jetty, intake and discharge structures. Two control stations were also established. These are located at the Mauban port and in Cagbalete island.

Ground Water

It was observed that the residential communities in the area make use of spring water for domestic needs. They use this for drinking and washing clothes. Three sampling stations were established at these spring sites. These are all located in Cagsiay I.

2.4.2 Surface Water Quality

Results of the analysis are shown in Tables III-2-4, III-2-5 and III-2-6 together with the corresponding DENR standards. For purposes of this study, Cagsiay River is classified as Class C due to current uses, i.e. washing clothes and transport. Although people also use it to dispose of their waste.

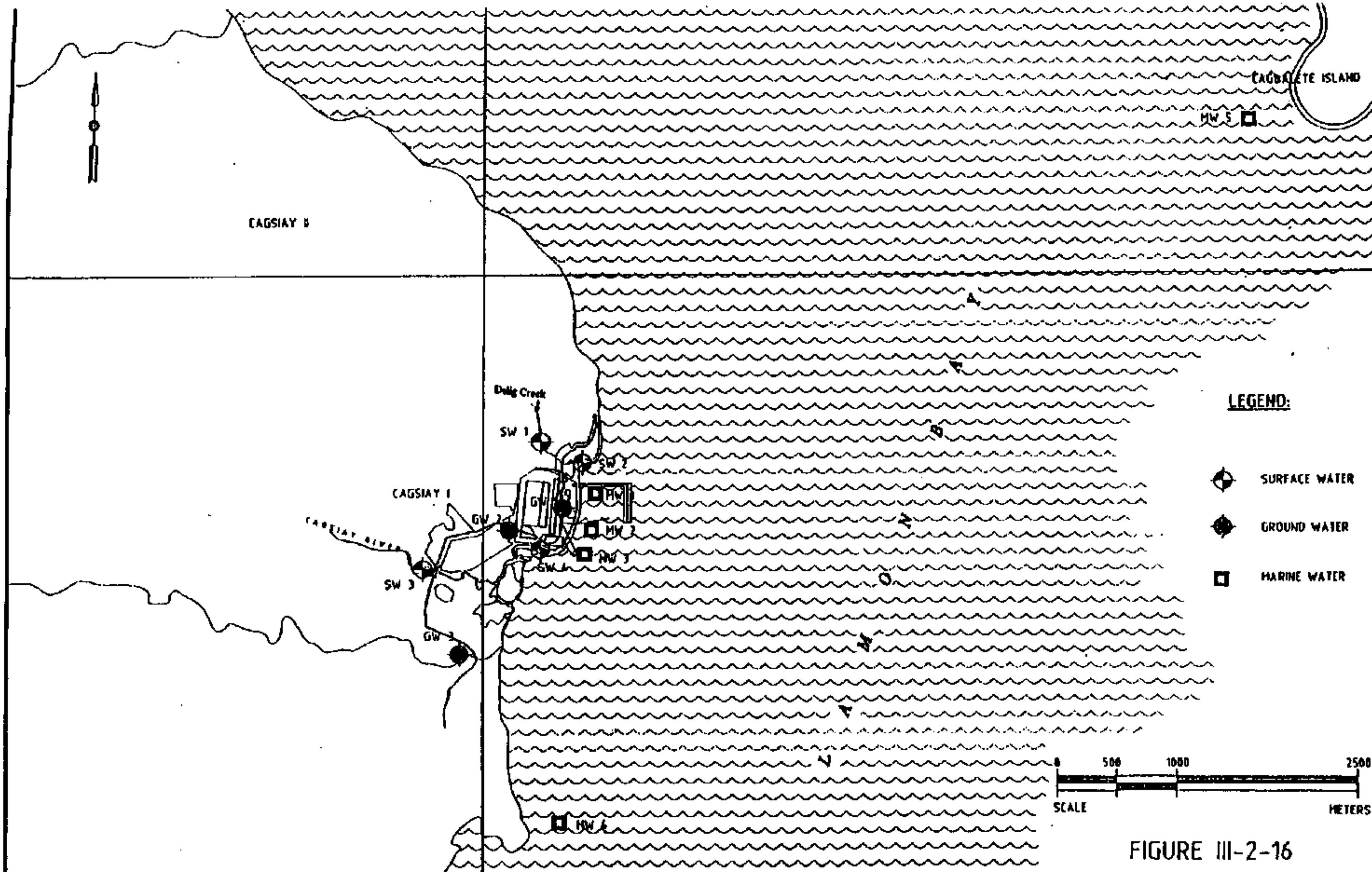

FIGURE III-2-16

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ENVIRONMENTAL IMPACT STUDY
WATER QUALITY SAMPLING STATIONS

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TABLE III-2-4
SURFACE WATER QUALITY RESULTS
(February)

Parameters	Surface Water Sampling Stations				DENR Standard (DAO#34)
	Dalig Creek		Cagsiay River		
	SW1	SW2	SW3	SW4	Class C
Temperature, °C	28.4	28.1	27.8	28.4	+3 max. rise
pH	6.6	6.5	7.5	7.1	6.0-8.5
TSS, mg/L	14	6	14	12	+60 max. rise
Cd, mg/L	<0.003	0.003	0.003	0.003	0.01
Cr, mg/L	<0.02	0.02	0.02	0.02	0.05
Cu, mg/L	<0.003	<0.003	<0.003	<0.003	0.05
Pb, mg/L	<0.02	<0.02	<0.02	<0.02	0.05
Mn, mg/L	<0.007	<0.007	<0.007	<0.007	0.2
BOD, mg/L	1	1	1	1	7
COD, mg/L	10	4	2	102	-
PO_4, mg/L	4.52	7.69	7.77	7.52	0.4
Oil & Grease, mg/L	1.4	1.0	1.2	1.1	2
V,ppm	<0.5	<0.5	<0.5	<0.5	-
Total Coliform, mpn/100 mL	≥1600	≥1600	≥1600	≥1600	5,000
Fecal Coliform, mpn/100 mL	≥1600	≥1600	≥1600	≥1600	-

TABLE III-2-5
SURFACE WATER QUALITY RESULTS
(March)

Parameters	Surface Water Sampling Station				DENR Standard (DAO #34)
	Dalig Creek		Cagsiay River		
	SW1	SW2	SW3	SW4	Class C
Temperature, °C	29	29	29	29	+3 max. rise
pH	7.4	7.6	8.0	7.8	6.0-8.5
TSS, mg/L	18	2	13	4	+60 max. rise
Cd, mg/L	<.003	<.003	<.003	<.003	0.01
Cr, mg/L	<.02	<.02	<.02	<.02	0.05
Cu, mg/L	<.003	<.003	<.003	<.003	0.05
Pb, mg/L	<0.02	<0.02	<0.02	<0.02	0.05
Mn, mg/L	0.091	0.084	0.049	0.049	0.2[1]
BOD, mg/L	2	2	1	1	7
COD, mg/L	14	10	17	189	-
PO4, mg/L	1.88	6.82	4.56	2.45	0.4
Oil & Grease, mg/L	1.8	<0.1	<0.1	<0.1	2
V,ppm	<0.5	<0..5	<0..5	<0..5	-
Total Coliform, mpn/100 mL	≥1600	≥1600	≥1600	≥1600	5,000
Fecal Coliform,mpn/100 mL	1600	1600	1600	1600	-

Notes: [1] = Based on 1978 NPCC Rules and Rules and Regulations, Section 69.

TABLE III-2-6
SURFACE WATER QUALITY RESULTS
(April)

Parameters	Surface Water Sampling Station				DENR Standard (DAO #34)
	Dalig Creek		Cagsiay River		
	SW1	SW2	SW3	SW4	Class C
Temperature, °C	28.1	29.2	29.8	29	+3 max. rise
pH	7.66	7.64	7.81	7.5	6.0-8.5
TSS, mg/L	159	42	151	28	+60 max. rise
Cd, mg/L	<0.003	<0.003	<0.003	<0.023	0.01
Cr, mg/L	<0.02	<0.02	<0.02	<0.02	0.05
Cu, mg/L	<0.005	<0.005	<0.005	<0.274	0.05
Pb, mg/L	<0.02	<0.02	<0.02	<0.104	0.05
Mn, mg/L	0.130	0.326	0.130	0.171	0.2[1]
BOD, mg/L	1	4	5	3	7
COD, mg/L	1	41	8	204	-
PO4, mg/L	12.92	11.67	9.19	5.71	0.4
Oil & Grease, mg/L	1.0	0.7	0.7	0.4	2
V,ppm	<.0.5	<0.5	<0.5	<0.5	-
Total Coliform, mpn/100 mL	>1600	>1600	>1600	>1600	5,000
Fecal Coliform,mpn/100 mL	1600	1600	1600	1600	-

Based on the water sampling results, the quality of the water generally complies with the prescribed standard. Exceedances for phosphates was noted in all stations sampled.

The phosphate standard requires a maximum concentration of 0.4 mg/L. Samples obtained had levels higher than 1 mg/L with the maximum recorded in station 3 at 7.8 mg/L. Exceedance could be attributed to the use of fertilizers for crops being planted in the area and laundry soap which residents use in washing clothes.

Presence of coliform was also observed. The four stations showed total coliform count of more than 1,600 mph/100 mL. Since these rivers are often used as garbage disposal sites, this could account for the presence of bacteria.

It was also noted that COD levels, particularly in station 4, were high with 102 mg/L for the February sampling, 189 mg/L for the March sampling and 204 mg/L for the April sampling. . This means that certain chemicals present in the water depletes the oxygen content of the water. It could also be attributed to the high chloride content.

2.4.3 Marine Water Quality

Marine water samples were taken in Lamon Bay. The bay is a major fishing ground of the residents in the area. Considering its present uses, the water quality of the area may be compared with class SC, fishery waters.

Results of laboratory analysis for marine samples taken for the study are shown in **Tables III-2-7, 8** and 9. Majority of the stations exceeded the prescribed Cu, Cd and Pb standards. Only station 5 consistently complies with the Cu standard. Exceedances of these metals, could be

TABLE III-2-7
MARINE WATER QUALITY RESULTS
(February 1995)

Parameters	Marine Water Sampling Station					DENR Standard (DAO #34)
	MW1	MW2	MW3	MW4	MW5	SC
Temperature, °C	28	28	28	28	28	+3° max. rise
pH	8.0	7.1	7.92	8.3	8.7	6.5-8.5
TSS, mg/L	3	5	16	<1	8	max 30 mg/L rise
Cd, mg/L	0.053	0.064	0.059	0.045	0.053	0.01
Cr, mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	0.1
Cu, mg/L	0.061	0.048	0.051	0.071	0.044	0.05
Pb, mg/L	0.256	0.236	0.217	0.276	0.276	0.05
Mn, mg/L	<0.007	<0.007	<0.007	<0.007	<0.007	-
BOD, mg/L	1	2	1	1	1	7
COD, mg/L	278	376	485	352	406	-
PO4, mg/L	0.67	2.34	1.67	0.67	1.00	-
Oil & Grease, mg/L	1.4	1.3	2.1	1.0	1.8	3
V,ppm	<0.5	<0.5	<0.5	<0.5	<0.5	-
Total Coliform Count, mpn/100 ml	2	26	8	11	70	5,000
Fecal Coliform, npm/100 ml	2	26	8	11	70	-

TABLE III-2-8
MARINE WATER QUALITY RESULTS
(March 1995)

Parameters	Marine Water Sampling Stations					DENR Standard (DAO#34)
	MW1	MW2	MW3	MW4	MW5	SC
Temperature, °C	29	29	29	29	29	+3° max. rise
pH	8.0	8.0	8.1	8.1	8.1	6.5-8.5
TSS, mg/L	<1	2	2	<1	1	max 30 mg/L rise
Cd, mg/L	0.027	0.031	0.027	0.027	0.031	0.01
Cr, mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	0.1
Cu, mg/L	0.064	0.064	0.064	0.056	0.064	0.05
Pb, mg/L	0.271	0.271	0.252	0.290	0.290	0.05
Mn, mg/L	<0.007	<0.007	0.028	<0.007	<0.007	-
BOD, mg/L	1	1	1	1	1	7
COD, mg/L	311	410	518	586	383	-
PO4, mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	-
Oil & Grease, mg/L	<0.1	<0.1	<0.1	0.9	1.1	3
V,ppm	<0.5	<0.5	<0.5	<0.5	<0.5	-
Total Coliform Count, mpn/100 mL	4	22	<2	<2	<2	5,000
Fecal Coliform, npm/100 mL	2	14	<2	<2	<2	-

TABLE III-2-9
MARINE WATER QUALITY RESULTS
(APRIL)

Parameters	Marine Water Sampling Station					DENR Standard (DAO #34) SC
	MW1	MW2	MW3	MW4	MW5	
Temperature °C	30.8	30.2	30.2	30.3	30.8	+3° max. rise
pH	8.76	8.77	8.84	8.70	8.69	6.5-8.5
TSS, mg/L	8	6	3	4	9	max 30 mg/L rise
Cd, mg/L	0.042	0.042	0.046	0.042	0.039	0.01
Cr, mg/L	0.055	0.037	0.111	0.093	0.074	0.1
Cu, mg/L	0.049	0.079	0.064	0.083	0.038	0.05
Pb, mg/L	0.187	0.208	0.229	0.208	0.187	0.05
Mn, mg/L	0.033	0.016	0.024	0.041	0.033	-
BOD, mg/L	1	1	1	1	1	7
COD, mg/L	372	348	356	305	483	-
P04, mg/L	3.97	2.73	4.72	3.97	2.98	-
Oil & Grease, mg/L	0.03	1.0	1.8	0.6	1.6	3
V, ppm	<0.5	<0.5	<0.5	<0.5	<0.5	-
Total Coliform, mpn/100 ml	80	4	23	<2		5000
Fecal Coliform, mpn/100ml	<2	<2	<2	<2		-

attributed to dynamite fishing which is prevalent in the area. Fuel contamination normally used by small motorized boats plying the area could also account for the high metal concentration measured.

Presence of coliform was also observed for all the station samples.

2.4.4 Ground Water Quality (Spring)

Results of the ground water analysis are shown in **Tables III-2-10 and 12.** All parameters tested conform with the standards, however, high coliform count was observed. Total coliform counts showed concentrations greater than 1,600 mpn/100 mL. Although these waters were positive for bacterial test, it is still being used by the residents as drinking water.

2.4.5 Assessment of Water Quality

The results of the sampling of the ground water, surface water and marine water indicate general conformity with the standards.

However, some of the trace metals like Cd, Cu and Pb showed exceedances for marine waters. This could be attributed to dynamite fishing and fuel spillages by boats plying the area. Another notable exceedance is the bacterial test for all stations sampled. Marine, surface and ground water were found positive of coliform.

TABLE III-2-10
RESULTS OF GROUND WATER QUALITY SAMPLING
(February)

Parameters	Ground Water Sampling Stations			DENR Standard[1] Class GA
	GW1	GW2	GW3	
Temperature, °C	27.4	28.1	27.8	-
pH	6.8	6.8	7.5	6.0-8.5
TSS, mg/L	<1	1	5	-
Cd, mg/L	<0.003	<0.003	<0.003	-
Cr, mg/L	<0.02	<0.02	<0.02	-
Cu, mg/L	0.054	<0.003	<0.003	-
Pb, mg/L	<0.02	<0.02	<0.02	0.05
Mn, mg/L	<0.007	<0.007	<0.007	-
BOD, mg/L	1	2	1	-
COD, mg/L	24	15	15	-
PO4, mg/L	1.17	0.25	0.50	-
Oil & Grease, mg/L	1.2	1.2	1.4	-
V,ppm	<0.5	<0.5	<0.5	-
Total Coliform, mpn/100 mL	>1600	≥1600	≥1600	50
Fecal Coliform,mpn/100 mL	19	15	≥1600	-

TABLE III-2-11
RESULTS OF GROUND WATER QUALITY SAMPLING
(March 1995)

Parameters	Ground Water Sampling Station			DENR Standard[1] Class GA
	GW1	GW2	GW3	
Temperature, °C	29	29	29	-
pH	6.6	7.6	7.6	6.0-8.5
TSS, mg/L	<1	<1	1	-
Cd, ppm	<0.003	<0.003	<0.003	-
Cr, ppm	<0.002	<0.002	<0.002	-
Cu, ppm	<0.003	<0.003	<0.003	-
Pb, ppm	<0.02	<0.02	<0.02	0.05
Mn, ppm	<0.007	<0.007	<0.007	-
BOD, mg/L	2	1	1	-
COD, mg/L	2	1	4	-
PO4, mg/L	<0.5	<0.5	<0.5	-
Oil & Grease, mg/L	1.2	1.0	1.5	-
V,ppm	<0.5	<0.5	<0.5	-
Total Coliform, mpn/100 mL	≥1600	>1600	≥1600	50
Fecal Coliform,mpn/100 mL	1600	1600	1600	-

Note:

1. DENR Standard refers to Administrative Order No. 34, 1990

TABLE III-2-12
RESULTS OF GROUND WATER QUALITY SAMPLING
(April 1995)

Parameters	Ground Water Sampling Station			DENR Standard[1]
	GW1	GW2	GW3	SC
Temperature °C	27	27	27	-
pH	7.39	7.61	7.86	6.0-8.5
TSS, mg/L	53	6	53	-
Cd, ppm	<0.003	<0.003	<0.003	-
Cr, ppm	<0.002	<0.002	<0.002	-
Cu, ppm	<0.007	<0.007	<0.007	-
Pb, ppm	<0.002	<0.002	<0.002	0.05
Mn, ppm	<0.007	<0.007	<0.007	-
BOD, mg/L	1	2	1	-
COD, mg/L	1	6	8	-
P04, mg/L	3.97	3.23	0.6	-
Oil & Grease, mg/L	<0.1	<0.1	0.6	-
V, ppm	0.005	<0.005	<0.005	-
Total Coliform, mpn/100 ml	<1600	80	>1600	50
Fecal Coliform, npm/100ml	>1600	110	<1600	-

Note: 1) DENR Standard refers to Administrative Order No. 31, 1990

3.0 GEOLOGY, SOILS AND TERRAIN

This section examines the geological, soils and overall terrain characteristics of the proposed Mauban project site as these may affect the planning, design, construction, and operation of the proposed coal-fired power plant. As a background, the regional interrelationship among topography, geology and drainage in this eastern part of Luzon island is established before considering the project site in detail.

3.1 Methodology

3.1.1 Secondary Data Gathering

Initial site data were obtained from maps and reports of various government agencies which included information on topography, geology, soils, seismicity, tsunamis and volcanoes. From these basic data, a provisional description of the geological-physiographic features and patterns was developed. This was subsequently validated by a reconnaissance mapping of the Southern Quezon region and a detailed geological investigation of the Saley Point project site.

3.1.2 Review of Plant Design and Equipment

Before making the first project site visit, the proposed layout of the appurtenant plant facilities was reviewed. These locations of the plant components were inspected in the field to evaluate possible implications with respect to site preparation, earthworks, excavation and foundation plans. In particular, the proposed coal ash disposal and the coal handling and storage sites were carefully checked.

3.1.3 Geological and Soil Investigation

The physio-geological conditions of the region as well as that of the specific plant site selected were apprised initially by a reconnaissance geological survey. Detailed mapping was subsequently conducted within a 4 km^2 area west and south of Saley Point. Ground studies served to identify rock types, geologic structures and geological processes that are crucial to the environmental assessment of the site. A quick mapping of the near-surface soil overburden that covers the bedrock was effected by soil auger sampling. Thirty six sampling points spread over the whole site were augered down to a depth of 3 m as site conditions allowed. Collected soil samples were tested for the physical index properties as well as for chemical composition (see **Table III-3-1 and Figure III-3-4**). Additionally, twenty soil sample and rock core borings were performed in three areas in regard to developing foundation designs:

- Powerblock area;
- Ash disposal area adjacent to the river; and
- Uplands area.

Soil samples were taken down to 10 meters and rock core borings ranged in depth from 15 to 35 m. This study was conducted to initiate the design and foundations for the QPP.

3.1.4 Terrain Evaluation

On the hypothesis that the geology (rock types and structures) controls the manner in which the land is shaped by weathering and erosion, a Terrain Classification was conducted on a regional and project site scale. As geology to a large extent also controls the engineering characteristics of the ground, the landform as a characteristic of the terrain is a very useful tool for this study. Thus, a terrain map (Figure III-3-4) was developed as a guide particularly to seismic attenuation and erosion susceptibility.

The method adopted for this analysis is the CSIRO's PUCE Programme on Terrain Evaluation for Engineering Purposes.

TABLE III-3-1
SOIL CHEMICAL ANALYSIS

Auger Hole No.		SiO_2%	Fe_2O_3%	MgO%	CaO%	Cl%
AH-1	0.00 - 0.5	46.59	11.29	2.50	1.95	ND
	2.0 - 3.0	48.44	7.78	2.20	1.67	ND
AH-2	0.5 - 1.0	45.45	11.37	3.21	2.93	ND
	2.0 - 3.0	51.93	10.80	2.77	2.75	ND
AH-3	0.0 - 0.5	42.59	14.88	3.36	1.65	ND
	1.0 - 2.0	47.02	13.14	5.14	2.48	ND
AH-4	2.0 - 3.5	43.94	14.85	3.41	0.98	ND
	2.0 - 3.0	47.73	11.10	2.54	2.41	ND
AH-5	0.5 - 1.5	48.74	10.80	2.70	1.95	ND
AH-6	2.5 - 3.0	46.59	10.93	3.06	1.67	ND
	2.0 - 3.0	45.24	9.52	2.25	1.39	ND
AH-7	2.0 - 3.0	42.28	17.78	2.59	2.41	ND
AH-8	2.0 - 3.0	42.93	16.23	3.35	3.31	ND
AH-9	1.0 - 1.5	49.49	10.45	1.80	0.98	ND
	1.0 - 2.0	47.02	13.14	5.14	2.48	ND
AH-10	0.5 - 1.0	46.08	11.11	2.50	1.67	ND
AH-11	0.5 - 1.0	46.28	9.87	1.60	1.95	ND
AH-12	0.5 - 1.0	40.13	17.78	3.24	2.41	ND
AH-13	1.0 - 2.0	43.01	15.59	3.35	3.31	ND
AH-15	2.0 - 3.0	45.05	10.23	3.21	2.93	ND
AH-17	2.0 - 2.5	42.10	15.97	3.24	4.06	ND
AH-18	2.0 - 3.0	43.19	15.56	3.35	3.76	ND
AH-20	0.5 - 1.0	46.19	14.72	3.29	5.28	ND
AH-21	0.5 - 1.0	43.91	15.08	3.27	5.05	0.0065
AH-22	0.0 - 0.5	42.50	16.49	2.78	2.93	ND
AH-24	0.5 - 1.0	36.90	19.48	2.25	0.77	0.0065
AH-25	0.0 - 10.5	41.93	14.99	3.16	4.17	0.0065
AH-27	1.5 - 2.0	44.60	14.99	3.00	5.08	0.0065
AH-28	0.5 - 1.0	40.94	16.49	3.21	2.23	ND
AH-30	2.0 - 3.0	43.20	14.46	2.40	2.79	ND
AH-35	0.5 - 1.0	42.52	10.93	3.01	6.13	ND

3.1.5 Water Quality Analysis by Electrical Resistivity Technique

A quick method of determining the quality of chemical composition of groundwater is by in-situ indirect measurements using the electrical resistivity method. This particular locale was chosen for a quick determination of subsurface of the water quality since this area is designated as ash storage in the facility design.

In principle, dry soil and rocks would register high resistance (low conductance) to passing electrical current. However, water present in the crevices and pores of these earth materials would drastically reduce such electrical resistance. Ground resistance values between the range of 20 ohm-meters to 100 ohm-meters usually reflect fresh water-laden ground. In most areas of the Philippines, measurements using the OYO-McOhm resistivity meter have calibrated salt and brackish waters to be in the range of 0 to 20 ohm-meters.

This geophysical technique was applied at the proposed ash disposal site. Specifically, the Wenner array was used because it is the more accurate technique among the many available. The results of this technique are included in Section 3.7.

3.1.6 Seismicity

A review of significant earthquake occurrences within a 100 km radius of Mauban vis-a-vis known geologic structures was conducted. Various studies showing the path of the Miocene to Recent active Philippine Fault System are presented in this report. The proponent will perform more detailed seismicity analysis as appropriate for design purposes.

A detailed geologic map of the area (Figure III-3-3) is presented and can be used as the framework for acceleration attenuation evaluation.

3.2 Geology

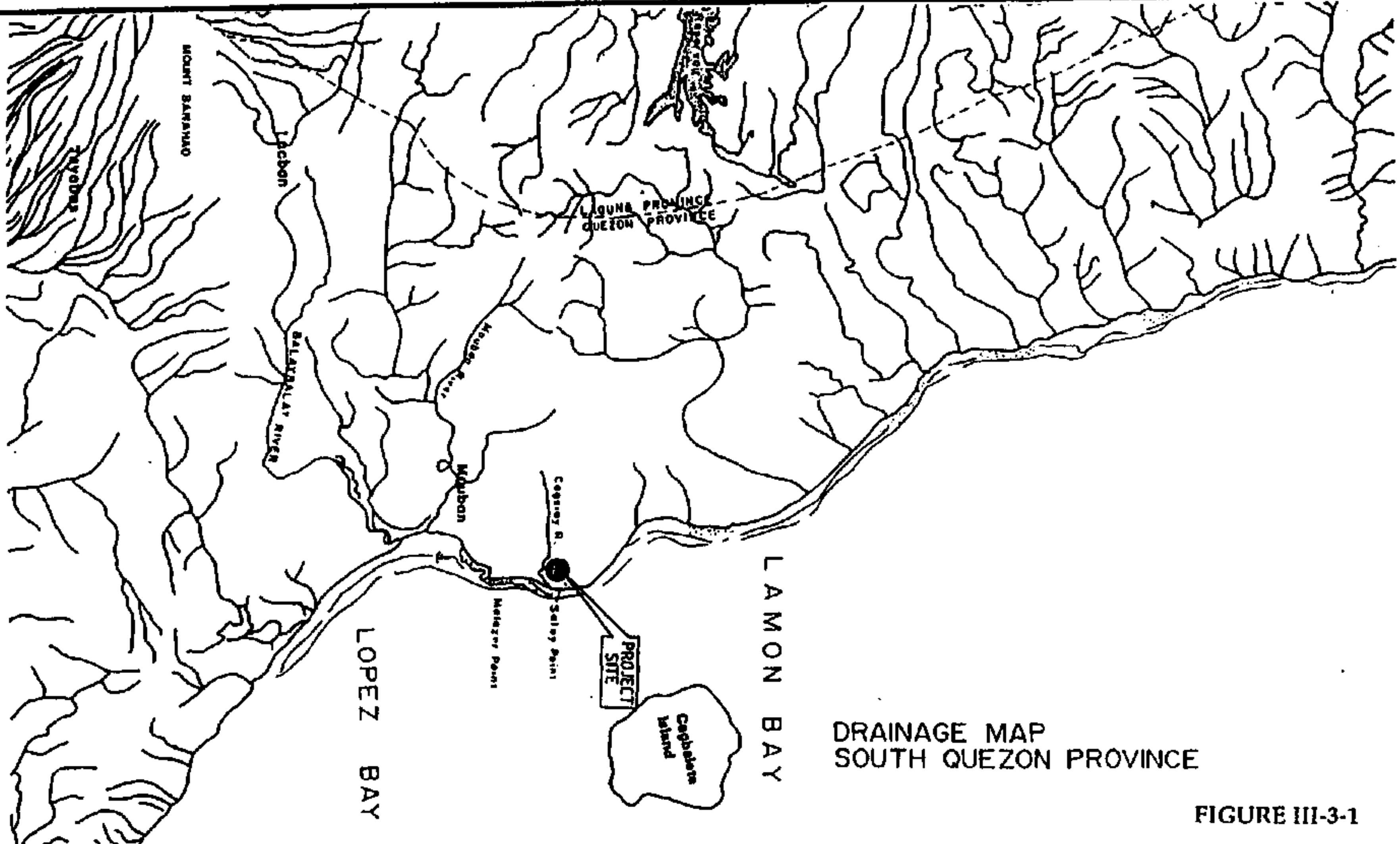
The region of South Luzon that has immediate influence on the Mauban project site is the southern half of Quezon Province (Figure III-3-1). For this study, this is taken to start at 15°N Latitude (the Sierra Madre Range along the eastern coast of Central Luzon) all the way down to 13°N Latitude (the Bondoc Peninsula). Within this general setting, three prominent regional geologic features characterize the project site, viz.,

- the Philippine Fault System,
- Mt. Banahaw volcano and
- the metasedimentary/metavolcanic rocks.

3.2.1 Regional Geologic Structures

The Philippine Fault System (PFS), an active Miocene-Recent sinistral shear zone, traverses virtually the whole length of the Philippine archipelago (Figure III-3-2). There is a concensus among most published literature that the track of this fault system passes immediately east of the Mauban-Atimonan coastline. From its Visayan leg, this fault system reenters land at the Quezon isthmus west of the Bondoc Peninsula. It continues into Lopez and Lamon Bays where its track is interpreted by several studies differently.

Figure III-3-2A is the interpretation of the Philippine Institute of Volcanology (PHIVOLCS, 1992) where two legs of the PFS reenter the vicinity of Mauban. On the other hand, the Bureau of Energy Development (1993) using offshore seismic and airborne gravimetric surveys, traces the PFS offshore after exiting the Quezon isthmus (Figure III-3-2B). This offshore trace passes between the shoreline of Mauban- Atimonan and the Cagbalete-Alabat Islands. A third, interpretation is that of the Bureau of Mines and Geosciences (1963) which has the PFS passing mainly along the eastern and western shores of Alabat Island (Figure III-3-2C).



DRAINAGE MAP
SOUTH QUEZON PROVINCE

FIGURE III-3-1

No.	DATE	BY	DESCRIPTION	DFT.	ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK		APPROVAL		REFERENCE DRAWINGS	

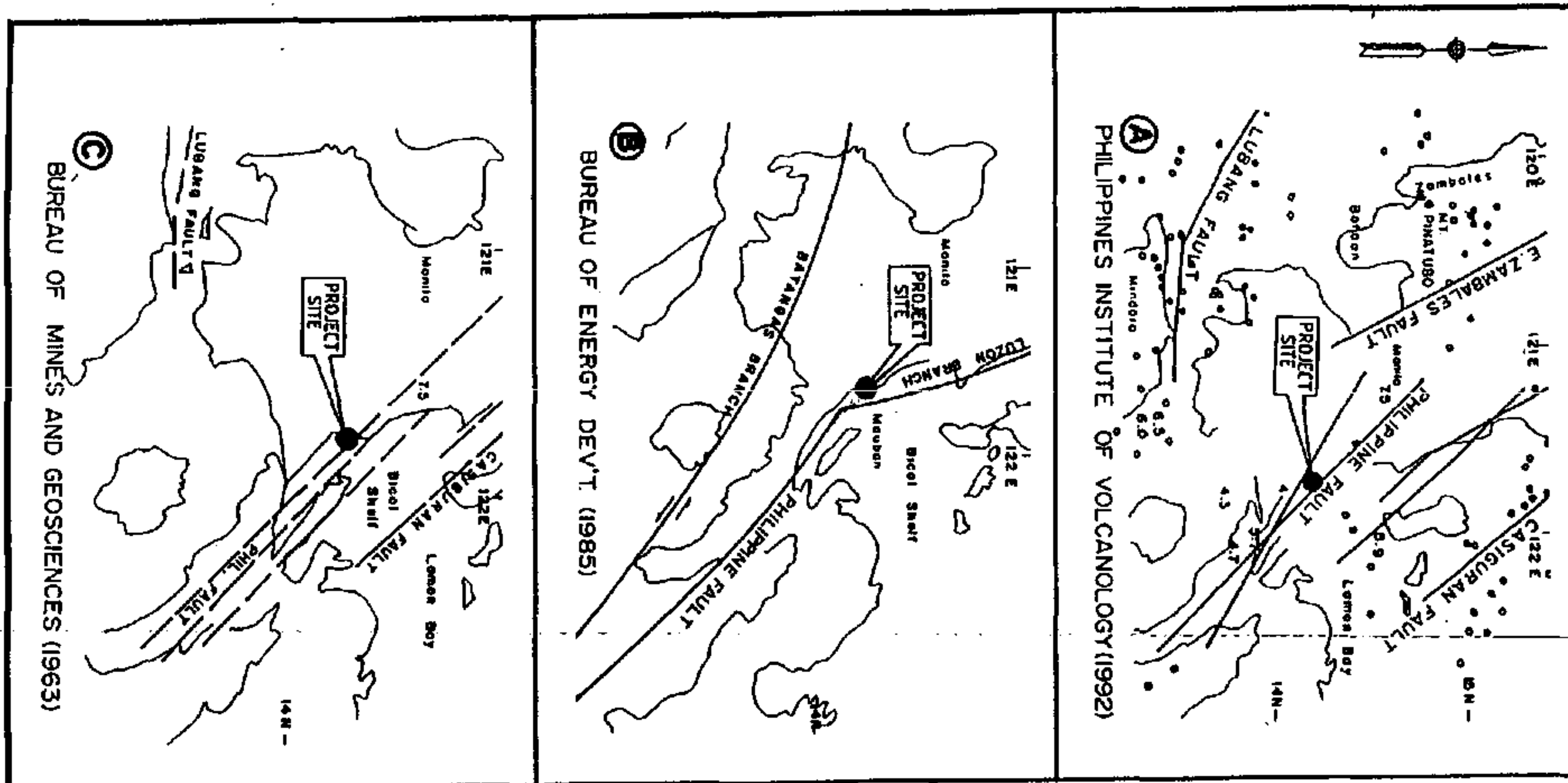
BHP
BHP ENGINEERING
BHP Service Companies

	Name	Sign	Date
DRAWN	VAA		28 3 95
DRAFTING (CHECK)			
ENGINEERING (CHECK)			
R. ENGR. (APPROVED)			
CLIENT (APPROVED)			

BHP Engineering PHILIPPINES Inc.
433 MW (NET) QUEZON
POWER PROJECT
ENVIRONMENTAL IMPACT STUDY

SCALE		BHPE DRG No.	REV.
NTS	A4	P230 101 014	A

CAD FILE
DATE OF LAST EDIT: 27.03.95



THE PHILIPPINE FAULT SYSTEM AND ITS TRACKS IN SOUTH QUEZON AND BICOL SHELF AS MAPPED BY VARIOUS PHILIPPINE GOVERNMENT AGENCIES.

Legend:

o - Earthquake epicenter M 5> Depth <30 km.

7.5 - Magnitude

FIGURE III-3-2

	Name	Sign	Date
DRAWN	VAA		20395
DRAFTING			
ENGINEERING			
R. ENGR.			
CLIENT			

BHP Engineering PHILIPPINES Inc.

433 MW (NET) QUEZON POWER PROJECT ENVIRONMENTAL IMPACT STUDY

SCALE		BHPE DRG No.	REV.
NTS	A4	P238 101 015	A

BHP ENGINEERING
BHP Service Companies

No.	DATE	BY	DESCRIPTION	BT. ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK	APPROVAL		REFERENCE DRAWINGS	

CAD FILE

DATE OF LAST EDIT: 27.03.95

However, it must be pointed out that in the recent movements along the PFS in this region no major ground displacements have actually been observed in the Mauban onshore. In 1973, a 7.1 intensity earthquake caused a 3.0 m left lateral ground displacement in Lopez, Quezon 60 km south southeast of Mauban. Recently, the 6.8 intensity earthquake of July 1990 also caused some 2 to 3 m displacements in the vicinity of the Cordillera Range of northern Luzon some 250 km north of Mauban.

Mt. Banahaw volcano is the other prominent geologic feature in the region under study. Its peak of 2,160 m lies 30 km directly southwest of Mauban but its northeast slopes do not reach Mauban. A broad alluvial plain breaks the volcanic slope about 10 km from the town proper. However, isolated remnants of volcanic flows around Mauban indicate that the lower reaches of the volcano once covered the Mauban area. These volcanics have since been eroded exposing the underlying Cenozoic sedimentary rocks.

3.2.2 Lithology

Within the region of interest, the Quaternary volcanics are the predominant rock types in the areas west and north of Mauban. These are mainly related to the volcanic centers, e.g., Mt. Banahaw, Mt. San Cristobal. To the south southeast, clastic sedimentary rocks characterize the terrain. Significantly large areas are underlain by metasediment and metavolcanics particularly north of the project site and also southeast of Mauban. Biomicritic bedded and massive limestones form prominent topographic features of the landscape within this sedimentary regime.

3.3 Site Geologic Setting

Detailed geologic structural mapping was undertaken within a 4 km^2 area embracing the proposed power plant complex. The main objective is to produce a structural- geologic map to be used as one of the tools in evaluating the engineering geological and geotechnical characteristics of the project area with emphasis on foundation and seismo-tectonic aspects. Data gathering was done in the field with compass-tape traverse along the road and creeks to achieve an accurate plotting of the structures.

Field recording was done on a 1:6,500 scale topographic field sheet, enlarged from the original 1:50,000 National Mapping and Resource Information Authority (NAMRIA) topographic map, Sheet No. 3362-IV and reduced to 1:13,000 in this report (Figure III-3-3).

The mapped area is centrally located in Dalig, Barangay Cagsiay II bordered on the east by Lamon Bay between Saley Point in the north and Malazor Point in the south. Mapping was carried out to about 2 km landward from the coastline. More specifically, the project area is subtended by the geographic coordinates 121°45'20" to 121°45'30" east longitudes and 14°13'20" to 14°14'30" north latitudes.

3.3.1 Topography and Drainage

The topography at the plant site area and vicinity is relatively flat near the coastline and on floodplains but elevations rise gradually landward forming a hilly to moderately mountainous terrain. Crests of ridges are commonly broad with peak elevations ranging from 59 to 280 m above sea level.

Cagsiay River, with its tributaries, is the largest drainage system within the area under consideration. The southern boundary of the plant site drains into this river. Dalig Creek which drains the northeastern portion of the project site is a much smaller runoff channel. These natural drainage systems flow eastward and empty into the Lamon Bay. The valleys of these streams are generally V-shaped, except at the coastal plains, and exhibit a dendritic drainage pattern.

Stratigraphy

- U-IV Unit IV = Unconsolidated/Recent beach sand, floodplain and alluvial deposits.
- U-III Unit III = Subangular blocks of basalt lavas chaotically admixed with clayey soil.
- U-II Unit II = Fine to medium-grained tuffaceous sandstones with shale partings.
- U-I Unit I = Moderately to intensely fractured greenish gray, indurated tuffaceous shale and sandstone with intercalated lime.

Legend

- Strike and dip of fault. D- indicates downthrown side
- Strike of vertical fault.
- Strike and dip of shear.
- Strike and dip of joint.
- Strike and dip of bed.
- Horizontal bed.
- Syncline
- Anticline
- Unit boundary

STRUCTURAL GEOLOGIC MAP

0 0.5 1.0km
KILOMETER

FIGURE III-3-3

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3.3.2 Stratigraphy

Four lithostratigraphic units were mapped within the project site (Figure III-3-3). These are designated as Unit-I, Unit-II, Unit-III and Unit-IV chronologically arranged from youngest to oldest.

Rock Unit-I

This designation applies to the group of stratified and pseudo-stratified rocks occurring north of Cagsiay River. Good exposures of this unit could be observed along the road cut in Sitio Dalig, Cagsiay II opposite the sawmill complex of Interwood Lumber Co.

This unit is composed of light gray to dark greenish gray, tuffaceous shales, siltstones and shaly sandstones with minor intercalations of limestone lenses and tuff breccias. These are moderately to intensely jointed. Near fault zones, the rocks appear brecciated.

The shales, siltstones and sandstones are thin to thick-bedded, well compacted to highly indurated. Faint laminations parallel to the bedding planes are noticeable in hand specimens denoting the onset of metamorphism.

Limestones occur as small lenses within the sandstone- shale sequence. Individual lenses are about 10 cm thick and 20 to 30 cm long light, gray to purplish gray, dense and tough. These occur along Dalig Creek and along a tributary of Miniana I Creek.

The tuff breccias or lapilli are greenish gray, massive with layers as much as 5 meters thick. Lithoclasts are heterolithologic but mostly subrounded to subangular fragments of glassy, vesicular to finely porphyritic basalt, strongly bonded together in an ash to sandy tuff matrix. Good outcrops of this rock type could be observed along Miniana Creeks I and II. Generally, this unit is shale-dominated.

Rock Unit-II

This unit occurs south of Cagsiay River. It is made up of a thick sequence of fine to medium-grained sandstones with thin shale partings. As such, it is sandstone-dominated. The sandstones and shales are light gray to buff and are generally tuffaceous in composition. Individual beds range in thickness from 1 to 50 cm, tough, and are generally less indurated than those of Unit-1. Apparently, this unit lies stratigraphically above Unit-1.

Rock Unit III

This layer is composed of large sub-angular blocks of basalt lavas chaotically admixed with reddish brown or yellowish brown clayey soil. It has a wide lateral distribution and caps both Unit-I and Unit-II. Along the traverse routes, this unit ranges in thickness from 1 to 5 m. This may be a piedmont or talus deposit with its component materials most probably originated from Mt. Banahaw.

Rock Unit IV

This is Recent alluvial deposit along coastal areas (beach sand), river floodplains and estuaries. It is composed of unconsolidated detrital materials or rock debris ranging in size from clay to boulder with varying amounts of organic admixtures.

As of the writing of this report, over twenty boreholes have been drilled at the site. For a systematic assessment of the project site, the boreholes are grouped into three infrastructure sectors, viz., the powerblock area, the ash disposal area, and the uplands area. The borings conducted penetrated the subsurface in these three sectors and the following stratigraphic units were encountered. The individual logs of the drilled boreholes are found in Annex 4, Table 1.

Powerblock Area

The boreholes drilled along the shoreline encountered 5.0 to 9.0m of calcareous sand and gravels of coralline limestone. Beneath this stratum of weathered corals is the metavolcanic bedrock. Further inland, about 200 meters from the shoreline, erosional remnants of the metavolcanic rocks of the uplands pervade the initial 2.0 to 15.0m of the subsurface. These loose, unconsolidated sediments are greenish-gray clays, silts, sands and gravels of tuffaceous origin.

The phreatic surface in this area is very near ground level. In some sectors, the boreholes are freely-flowing.

Ash Disposal Area

The ash disposal area is underlain by sequences of clay, silt and sand all the way to 25.0m below ground level and possibly deeper. The dominance of clay in the upper few meters makes the surface quite impermeable. However, beneath this clay stratum is sand. It is important to take into account the high artesian pressure beneath this area, particularly at the center of the ash disposal site where the borehole drilled is freely flowing. Such high artesian pressures subjected to surface loads may pose engineering problems in the future.

Uplands Area

The uplands area is generally underlain by the metavolcanics. These slightly metamorphosed tuffaceous rocks appear as outcrops in some sectors of the uplands while sometimes overlain by 3.0 to 7.0m of gray, clayey and sandy silt. These are evidently detrital remnants of the metavolcanic bedrock.

3.3.3 Local Geologic Structures

Bedding planes in the clastic sediments and the layers in the pyroclastics mostly trend from NW-SE. Some trend to the NE - SW. Angles of dips are low to moderate and some are horizontal. Although the crests of folds were not seen in the field, the fold axes were drawn inferentially from the measured attitudes of the various strata (Figure III-3-3). Thus, axes of folds appear to be trending along a NW-SE or NE-SW directions. Some reversals in dip directions, however, may have been caused by differential tilting of strata due to faulting.

Faults and shear zones were observed only in Rock Unit- I. These zones range in width from a few centimeters to 3 m with strikes mostly to the NE. Apparent sense of relative movements is sinistral-oblique but the magnitude of displacements are difficult to discern because of the lack of reference planes.

Joints or tension fracture sets in Rock Unit-I can be grouped into NNE-SSW set NE-SW set and NW-SE set, with moderate to steep angles of dip. Commonly, the NE-SW set cut through the NW-SE set, but in some outcrops the reverse is true.

In Rock Unit-II, the joints are either NE-SW or NW-SE trending, but the dip angles in both sets are mostly vertical or nearly so. Moreover, the master joints are parallel to each other and are spaced regularly between 10 and 25 cm. This characteristic induced the formation or numerous waterfalls averaging 5 m high. This stratigraphic unit is apparently less tectonically disturbed compared to Unit-I.

In summary, there are four lithostratigraphic units mapped within the project site and are designated herein as Rock Units-I to IV.

Unit - I appears to have been more severely affected by crustal disturbances than Unit-II as indicated by fracture densities in the outcrops. Faults and shear zones measuring from 2 cm to 3 m wide were encountered only in Unit-I. The amount of displacements in the faults cannot be ascertained, but their sense of motions are mostly oblique- sinistral.

3.3.4 Pedology

Based on the 36 auger holes sampled within the proposed plant site, weathering of the volcanics and metasediment has produced an essentially clay overburden to depth of at least 3 m below ground level (mbgl). **Figure III-3-4** is a map of the soil cover showing very few coarse grained soils near the surface. Sands are found mainly at the edge of the proposed ash disposal site.

The detailed composition of these soils are shown in **Annex 4, Table 2.**

3.3.5 Drainage

The only drainage system of note in the plant site is the Cagsiay River which drains mainly the southern portion of the selected area.

Within the area where the appurtenant facilities are planned to be constructed, no other perennial, integrated drainage system exists. Minimal erosion is therefore expected but flash floods may be common during the monsoon season along the short, steep-sided creeks, e.g. Dalig Creek and Miniana Creek I and II. A very permeable ground is indicated by the scarce runoff. Subsurface water occurs at shallow depth as observed during the ongoing geotechnical drilling. Boreholes drilled for geotechnical purposes at the coast south of Saley Point have been reported to exhibit artesian ground water flow.

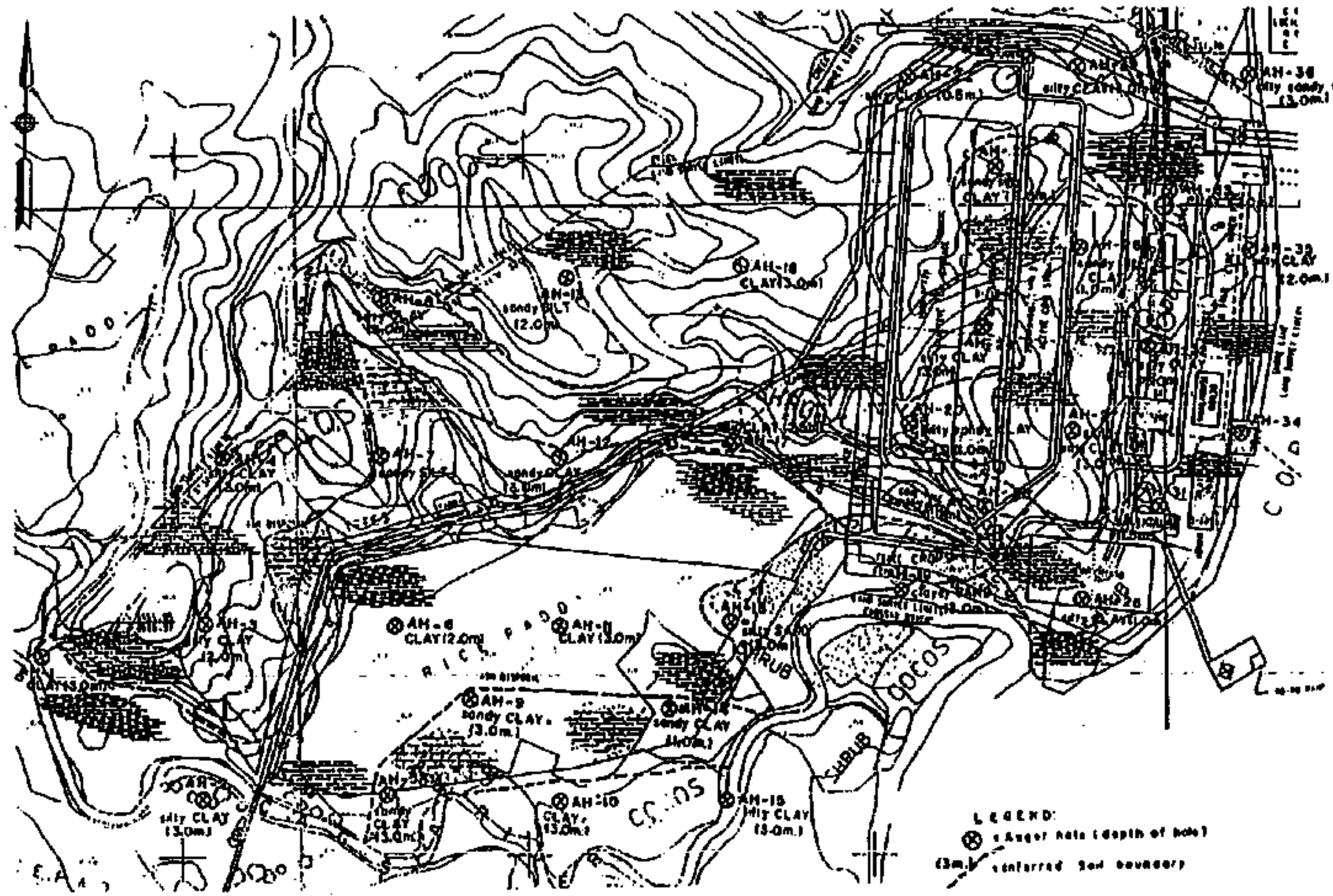
3.4 Terrain Analysis

3.4.1 Regional

A terrain classification map (**Figure III-3-5**) of the region was developed as a tool in further understanding the various geological parameters that may be relevant to the environmental concerns of this power plant site. Each Terrain Class is theoretically a distinct landscape with essentially homogeneous characteristics. Classification was based on the geology, drainage pattern, topography and soils.

Physiological landscape patterns are delineated in the area of study, these are shown in **Table III-3-2.**

The Alluvial Terrains are mainly located along the coast. Three patterns of landforms compose this terrain which are differentiated mainly by their soil composition due to a basic difference in mode of deposition. Terrain Pattern A-1 is river borne but influenced by the sea currents and are clayey in nature. Terrain Class A-2 is wave deposited, hence sandy and coralline. Class A-3 is situated inland along river channels and terraces and do not interact with the sea.



SOIL COVER MAP

FIGURE III-3-4

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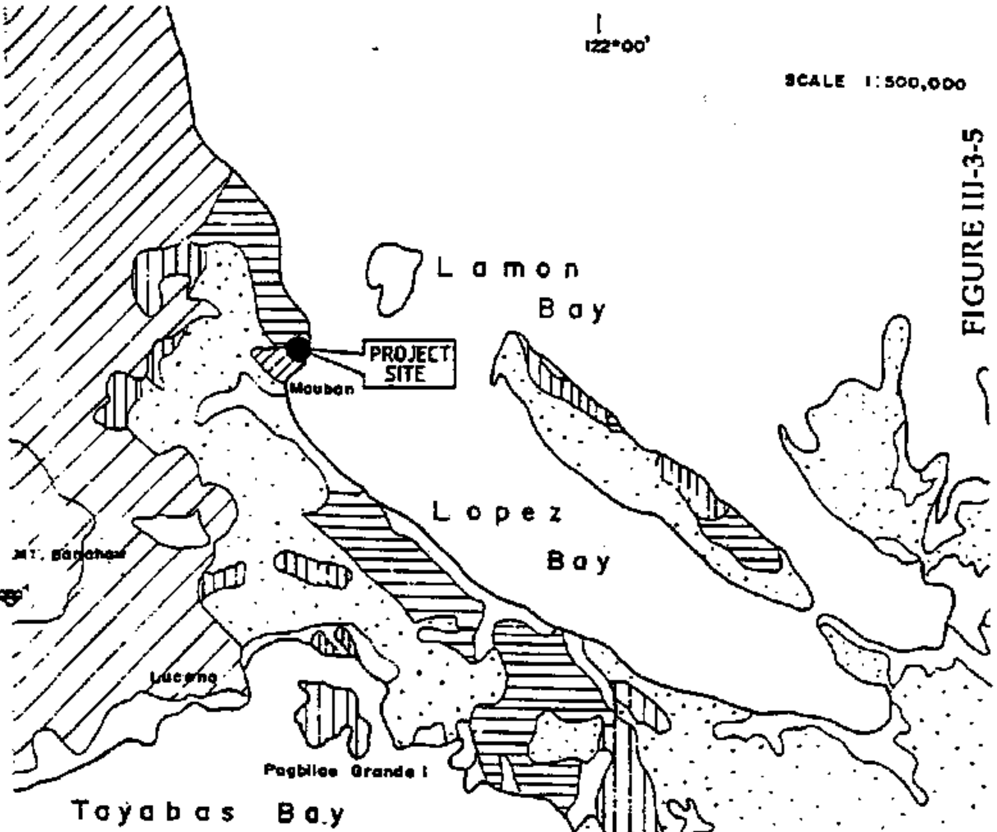

FIGURE III-3-5

Legend:

TERRAIN PROVINCE	LANDFORM	TERRAIN PATTERN
Alluvim	Delta / Tidal flats (clay)	A - 1
	Beach (Sandy)	A - 2
	River Estuaries (Clay)	A - 3
Volcanics	Mountain (high relief)	V - 1
	Piedmont Slopes	V - 2
	Hills, (low relief)	V - 3
Metamorphics	Hills, (moderate to high relief)	M - 1
Sedimentory	Plains (flat)	S - 1
	Hills, (low relief)	S - 2
	Limestone mountains (high elevation & relief)	L - 1

TERRAIN PATTERN MAP OF SOUTHERN QUEZON PROVINCE.

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TABLE III-3-2
TERRAIN CLASSIFICATION OF THE SOUTH QUEZON REGION

Terrain Province	Landform	Terrain Pattern
Alluvium	Delta/Tidal flats (clay) Beach (Sandy) River Estuaries (clay)	A-1 A-2 A-3
Volcanics	Mountain (high relief) Piedmont Slopes Hills, (low relief)	V-1 V-2 V-3
Metamorphics	Hills, (moderate to high relief)	M-1
Sedimentary	Plains (flat) Hills, (low relief) Limestone mountains (high elevation and relief)	S-1 S-2 L-1

The Volcanic Terrain is subdivided into the mountainous high relief areas i.e., the peak of Mt. Banahaw (Terrain Pattern V-1) and the lower volcanic slopes (Terrain Pattern V-2) which gradually decrease in gradient towards the foot of the volcano. These slopes have been deeply incised by a radial drainage pattern (**Figure III-3-1**). Before the volcanic slopes reach the floodplains of the main river system of the coastal region, these break into hills of low relief as a consequence of a more advanced stage of erosion (Terrain Pattern V-3).

Metasediments in the Mauban area exhibit a single type of Terrain Class, M-1, characterized by high relief and rugged morphology. These reflect an area of rather high resistance to erosion but has been subjected longest to such a process, hence, the high peaks and high relief.

The Clastic Sediments (shale/sandstone) terrain S-1 is subdued and low in relief. These occupy the low flat plains behind the metasediments at Mauban. Where sandstone is a dominant clastic component, the sedimentary terrain develops into a relatively higher relief (S-2).

A special sedimentary terrain (L-1) has been set aside to classify wide exposures of Cenozoic limestones which are bedded to massive and exhibit high elevations and high relief throughout the lower half of the Southern Quezon region.

3.4.2 Project Site

As was done for the region, a detailed classification of the terrain within a 2-km radius of the proposed plant site was also developed for the specific engineering requirements of the project (see **Table III-3-3**).

The field delineated lithological boundaries coincide with these terrain classes in the project site.

In general, the site has a relatively more subdued terrain than that of the region. The flat, low relief areas (A1, A2, A3,) are confined to the coast and along river channels. The beach, has a relatively thin gravelly cover and underlain by coralline limestone. The other two alluvial terrains are characterized by a thicker soil cover. Soil is thickest within the valley of Cagsiay River which is now planted to agricultural crops.

TABLE III-3-3
TERRAIN PROVINCES IN THE PROJECT SITE PROPER

Terrain Province	Landform	Terrain Pattern
Alluvium	River estuary, delta (thick clay) Beach (gravelly, underlain by coraline limestone) Flood plains (thick clay and river terrace soil)	A-1 A-2 A-3
Volcanics	Hills, subdued relief, covered with thin residual clayey soil	V-1
Metamorphics	Mountain, high relief, rugged morphology, thin soil.	M-1

With respect to the immediate concern of foundation stability, terrain pattern A-3 poses the highest risk. Its deep, saturated, soft, loose soils would exacerbate any bedrock acceleration generated by seismic shaking.

3.5 Erosion Status and Potential

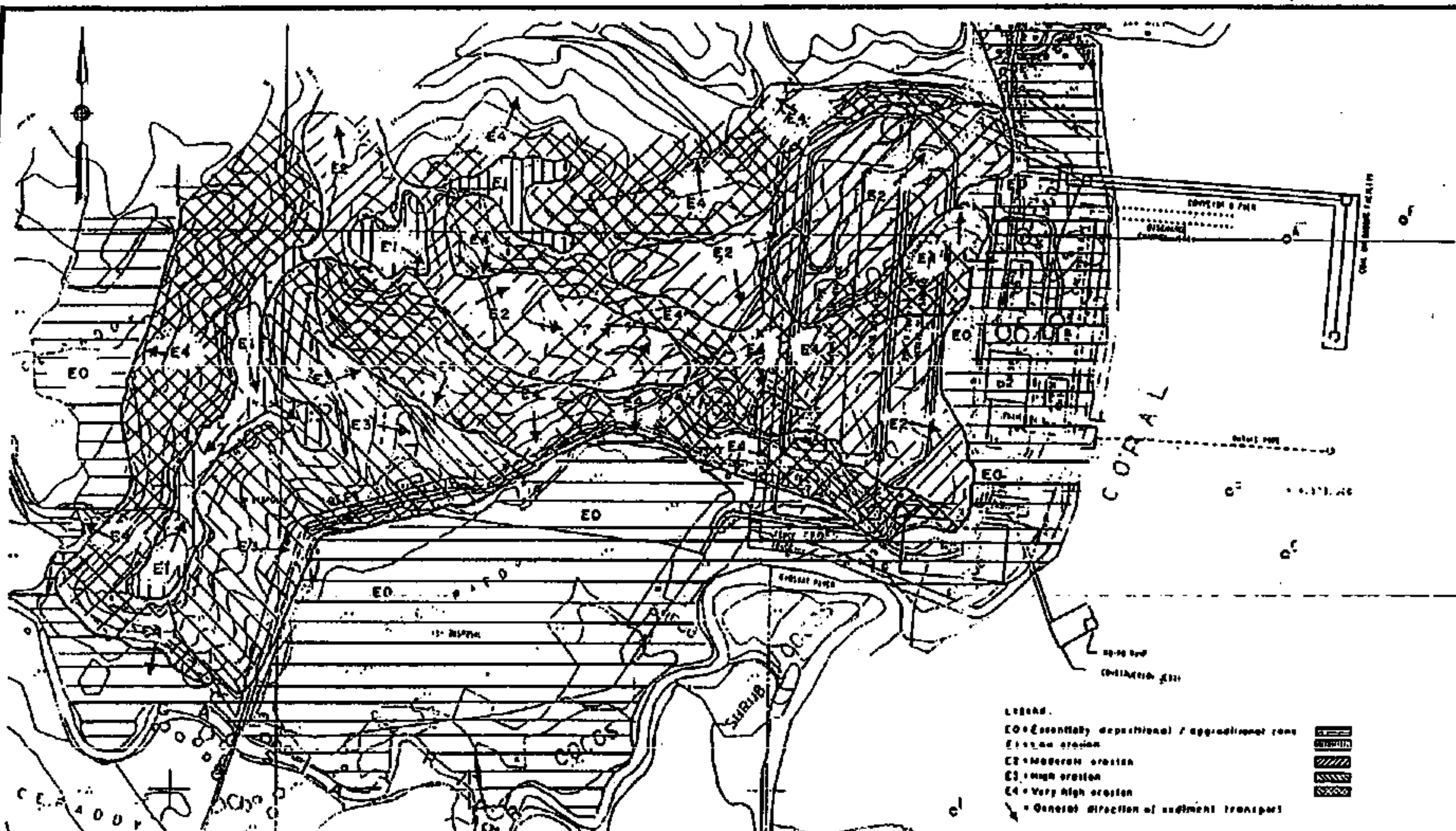
Slope gradient distribution of surface runoff channels, soil overburden, rock type and vegetative cover control the intensity of erosion in an area. Using these criteria, the proposed project area was subdivided into zones of varying erosion susceptibility. The flat terrains along river floodplains and the coast are essentially regimes where sediments were brought down from the high area west of the plant site by gravity or borne by surface runoff.

A detailed erosion susceptibility map (Figure III-3-6) of the site subdivides the area into five degrees of relative erosion intensity, viz.,

E_0 = essentially depositional/aggradational zone.
E_1 = low erosion
E_2 = moderate erosion
E_3 = high erosion
E_4 = very high erosion

While the Cagsiay River may account for the biggest volume of eroded material, Dalig Creek in the north and the other short streams that drain eastward into Lamon Bay (between Saley Point and Cagsiay River), could be significant erosive agents. But these are more on flash-flood type of frequency rather than perennial in nature. Fortunately, the latter two intermittent creeks that drain eastward are located at the extreme north and extreme south of the area and drain away from where the power plant facilities and coal storage areas are to be situated.

For each area in the erosion potential map, the rate of erosion is designated together with the general direction of sediment flow. The bulk of sediment transported from the high, (E_3), and very highly erosive, (E_4), areas are toward the south into the Cagsiay River basin, toward the north into the Dalig Creek channel, and westward away from the project site. Thus the centers of erosion are far from the site of the proposed plant infrastructures. Instead of erosion, the main concern would be the high deposition rates of sediments into the proposed ash disposal areas (E_0).



EROSION SUSCEPTIBILITY MAP

FIGURE III-3-6

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3.6 Seismicity and Tsunami

3.6.1 Earthquakes

Mauban lies directly along or very near the path of one the most active earthquake generators in the country, the Philippine Fault System, whatever tectonic interpretation is adopted (Figure III-3-2). Detailed structural mapping for this study, however, did not show any major fault at the Saley Point-Cagsiay Area (Figure III-3-3).

The seismicity map of North Luzon (Figure III-3-2A) showing regional structures vis-a-vis recorded earthquake epicenters (Intensity >5) illustrates their relationships. Several shallow earthquakes (depth <30 km) of magnitudes greater than 6.0 have occurred within the region under study. The latest of these is the 6.8 magnitude July 1990 earthquake in Digdig, North Luzon. Other large magnitude earthquakes recorded within the Southern Quezon region are shown in Figure III-3-2A.

3.6.2 Tsunami

Directly correlated with the offshore extensions of the Philippine Fault Zone in Lopez Bay and Lamon Bay is the risk of tsunami or giant sea waves generated by undersea earthquakes. Figure III-3-7 showing tsunami records in the country identifies such an occurrence in 1968 in Casiguran immediately north of Lamon Bay. Two elements reduce the risk of tsunami at Mauban, namely:

- the presence of Cagbalete and Alabat Islands east of Mauban virtually protecting the Mauban-Atimonan shoreline from any tsunami generated from Lamon Bay, and

- Lopez Bay is relatively shallow, reducing its potential of generating giant sea waves. No tsunamis are recorded in the area of study.

3.7 Groundwater Quality

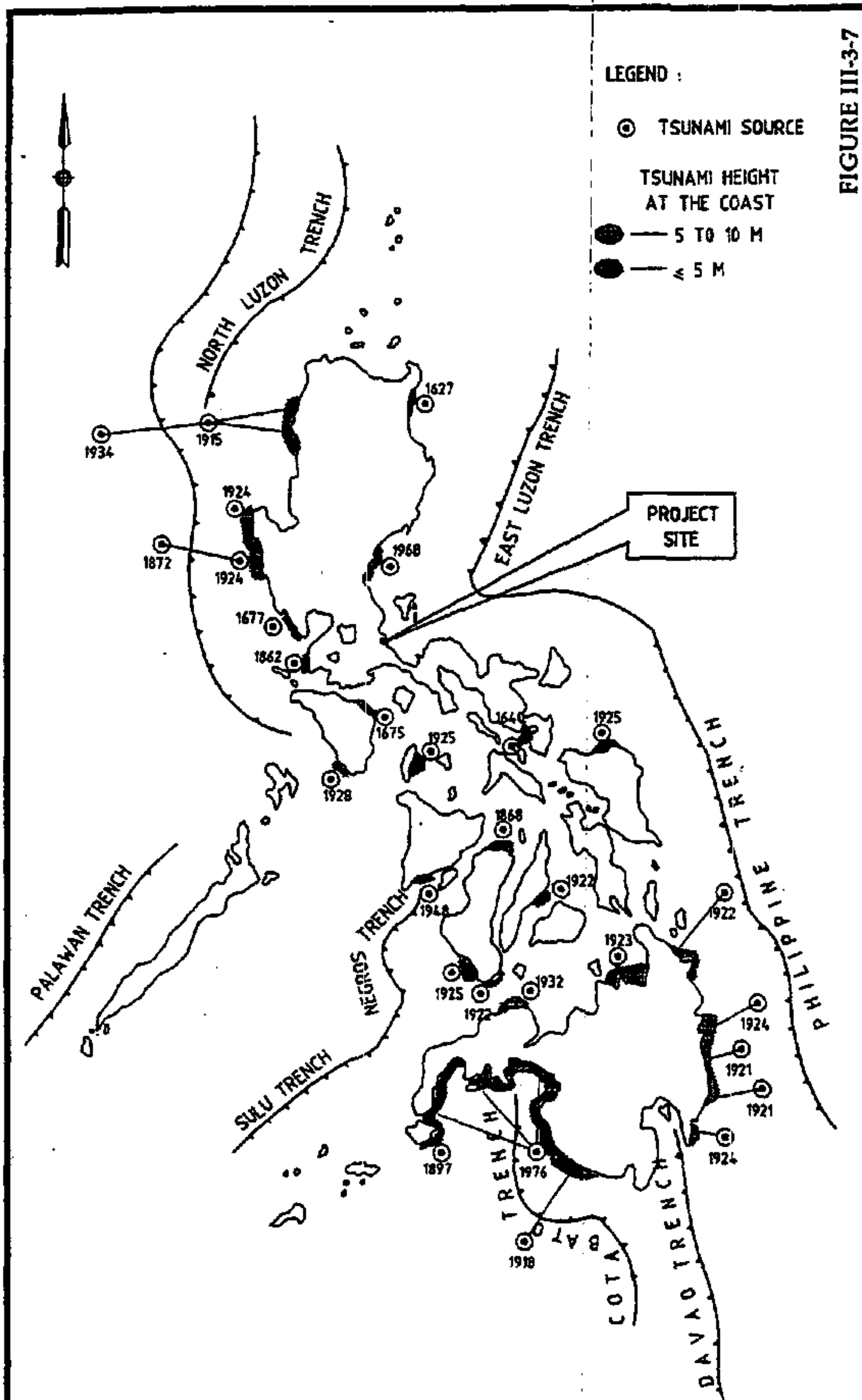
3.7.1 Electrical Resistivity Theory and Field Techniques

In this geophysical method, the resistance to passage of the electric current is determined by measuring the specific resistance (resistivity) of the material between opposite faces of a unit cube of the rock mass. The more permeable or the more broken, jointed or fissured the rock is, the lower is the resistivity.

In general, saturated igneous rocks have a much higher resistivity than saturated sedimentary rocks which, in turn, has higher resistivity than saturated alluvial materials.

For surface resistivity surveys, several techniques involving different electrode arrangements have been developed. Among these are the Wenner and Schlumberger arrays. The former is used mostly for groundwater exploration.

The specific objective of the surface electrical resistivity study for the Mauban site required the use of the electrical profiling survey technique instead of electrical sounding. Electrical profiling provides information on the lateral variations in the resistivity of subsurface materials. This is accomplished by maintaining a constant electrode spacing as the electrodes are moved across an area and a resistivity measurement is made for each new location of the electrode spread.



TSUNAMI RECORD OF THE PHILIPPINES

FIGURE III-3-7

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The Wenner array used in this study (Figure III-3-8) consists of four equally spaced electrodes driven into the ground. In this method, a direct current (DC) or very low frequency alternating current (AC) of known magnitude is passed between the two outer (current) electrodes. This produces an electric field at subsurface, whose pattern is determined by the resistivities of the soils and rocks present within the field and the boundary conditions. The potential drop for the surface current flow line is calculated as shown in Figure III-3-8. Quantitative calculation assumes that the material within the limits of the electric field is homogeneous. The value obtained represents an average resistivity (apparent) for the material within the shaded zone of Figure III-3-8 and measures mainly the resistivities of the subsurface materials to a depth equal to the electrode spacing, A. As this distance A, between electrodes is expanded, the current penetrates deeper into the subsurface. Consequently, the depth of investigation also deepens.

3.7.2 Survey Results and Interpretations

Interpretation Procedures

A thorough analysis of the electrical resistivity data was undertaken for the purpose of evaluating the subsurface hydrology of the Mauban project site (Figure III-3-9). This involved the assessment of vertical electrostratigraphic sections showing fresh water saturated zones and those possibly intruded by saline water. Synthesizing these information onto a map, the vertical and lateral extent and thickness of the saline water intrusion aquifers were readily delineated.

The above tools of interpretation depend almost entirely on the threshold values of resistivity chosen to define zones of fresh-water saturated and, salt-water saturated ground. As discussed earlier, these threshold values are dependent on several variables such as rock type, soil composition, but most especially upon the degree of saturation, chemistry of the groundwater and porosity or intensity of the brokenness of the underlying rock. It is not possible therefore to use standard or universal resistivity values to identify a saturated rock or soil horizon. Each geologic setting virtually has its own "signature" resistivity values for varying degrees of saturation of each type of material.

Surface Data Calibration

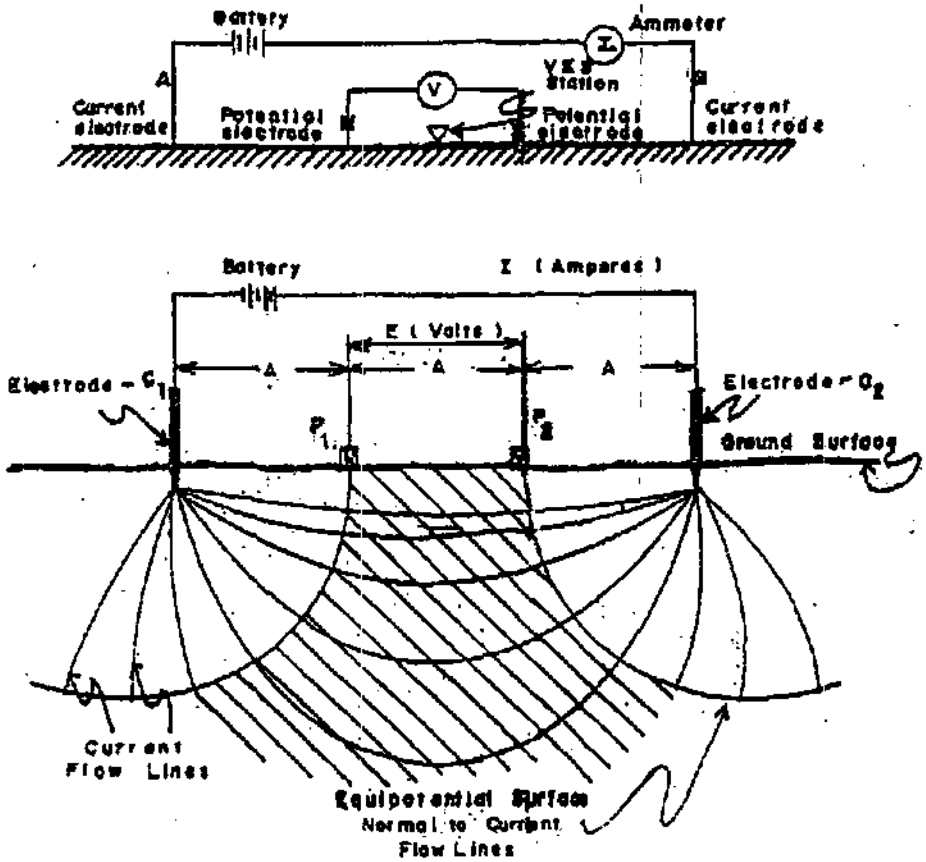
At Mauban, surface geophysical measurements were used to calibrate the resistivity values for fresh water and salt water, saturated soils.

The interpreted resistivity values/electrostratigraphic units and their corresponding lithologic equivalent are shown in Table III-3-4.

TABLE III-3-4
APPARENT RESISTIVITIES OF ELECTRO-STRATIGRAPHIC UNITS

Apparent Resistivity Range (ohm-m)		Lithologic Unit
1.	0-20	salt-water saturated soil
2.	20-100	fresh-water saturated and/or weathered METAVOLCANIC rock

No dry ground nor massive dry rocks were detected in the upper 50 m zone of the Mauban dry ash pile site. All subsurface materials are unconsolidated soil.



APPARENT RESISTIVITY, $\rho_a = \frac{2\pi AV}{I}$

WENNER ARRAY FOR GROUNDWATER RESISTIVITY SURVEYS

FIGURE III-3-8

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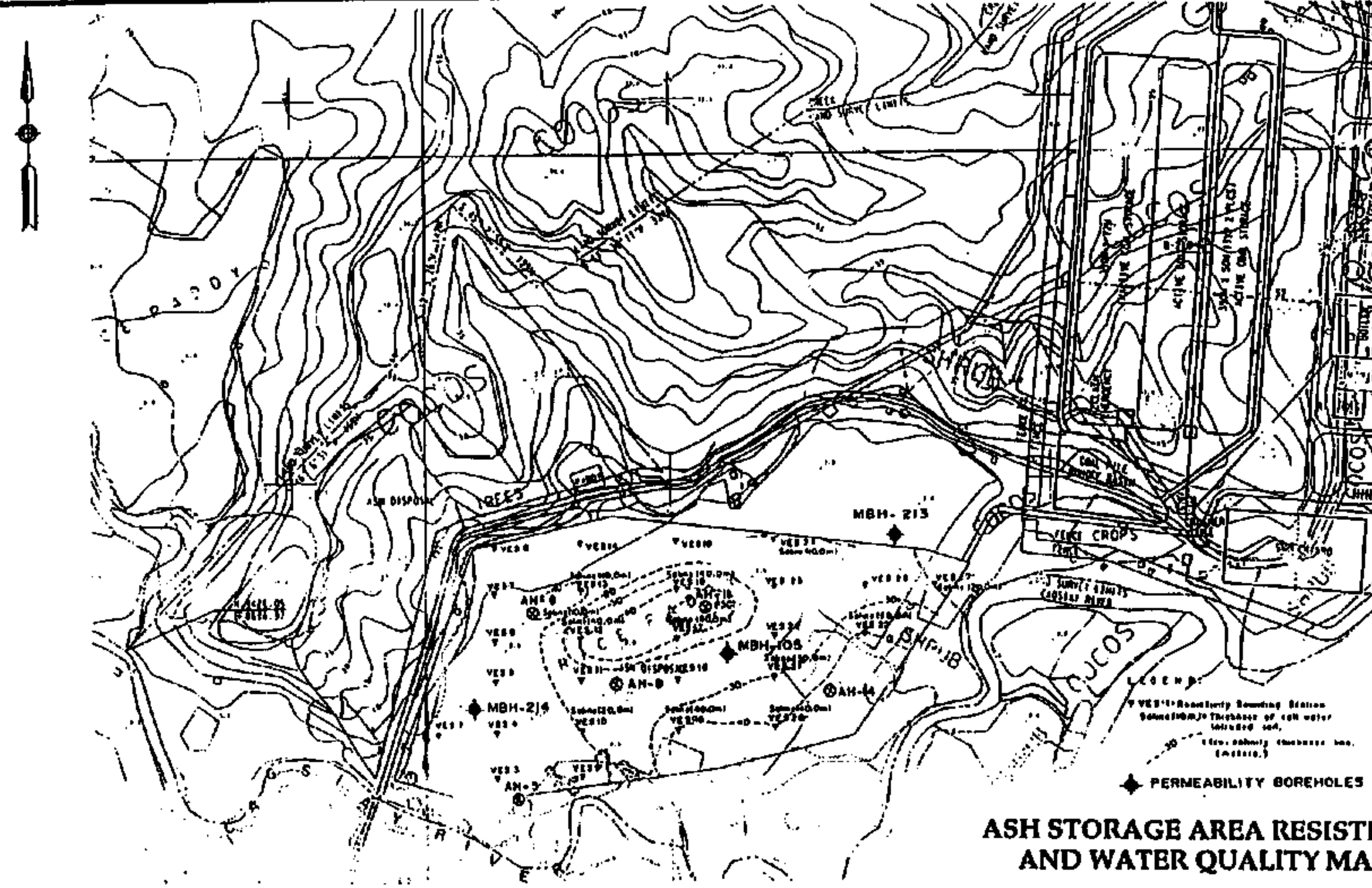

ASH STORAGE AREA RESISTIVITY AND WATER QUALITY MAP

FIGURE III-3-9

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Groundwater Quality Based on Electrical Resistivity

The groundwater at the ash pile has been identified as an area highly susceptible to runoff contamination along certain zones. Using the georesistivity technique described earlier, the measured resistivity values confirm the data from permeability tests in the boreholes. Annex 4, Figures III-3-A to G show saline water intrusion into the rice fields north of Cagsiay River as culled from the electrostratigraphic cross-sections. Fresh water is indicated beneath the saline-contaminated water.

The criterion that soils with apparent resistivities from 0 to 20 ohm-m are contaminated with saline water has been tested in various sites in the Philippines. Using this in the proposed Mauban ash pile, two areas are shown to have been deeply intruded by sea water. The more obvious zone is that along the edge of the river terrace where soils as deep as 40 m below ground surface are saline water laden based on measured values at VES 15, 20 and 25 (Annex 4, Figures III-3-A and C). Another saline water-intruded zone is the middle portion of the terrace where VES-17, 18 and Auger Hole-11 (Annex 4, Figures III-3-C and D) recorded nearly 50 m of salt water intruded area. Towards the inner sectors of the ash pile, there is a significant decrease in salt water content as the soil takes on a more clayey character (Figure III-3-9).

3.8 Ash Pile Permeability Study

3.8.1 Methodology

Permeability is a critical parameter in evaluating the risk of groundwater contamination in the vicinity of the ash pile. Being a measure of the ease with which water passes through the ground, permeability would indicate the risk of runoff from the ash intruding directly into the groundwater.

To calculate the ground permeabilities at the proposed ash disposal site in Mauban, in-situ borehole tests were conducted in the boreholes drilled. Specifically, the falling-head test was employed. A vertical borehole is filled with water up to the brim of the casing collar and the time taken for the water level to fall to its original position is recorded.

The coefficient of permeability, k, is calculated using the formula:

$$k = \frac{A}{F(t_2 - t_1)} * \ln \frac{H_1}{H_2}$$

where: A is the cross-sectional area of the water column,
F is a shape factor which is dependent upon the conditions at the bottom of the borehole.
H_1 and H_2 are water levels in the borehole measured from the water table at times t_1 and t_2.

3.8.2 Results

Boreholes MBH-213 and MBH-214 were drilled at the eastern and western ends of the proposed ash disposal area, respectively. A third hole MBH-105 was situated at the center. Borehole MBH-213 was tested at a depth of 13.0 mbgs while MBH-214 was tested at 16.0 mbgs with static water levels recorded at 0.53 mbgs and 0.84 mbgs, respectively. Borehole, MBH-105, which at time of writing reached a depth of 10.0 m, is a flowing well. Sand/silt/clay soil overburden was encountered in these boreholes and bedrock is at depths greater than 16.0 mbgs.

The calculated coefficients of permeability, k, are 8.1×10^{-5} cm/s for MBH-213 and 1.8×10^{-5} cm/s for MBH-214. No falling head tests could be conducted at MBH-105 since it was freely flowing.

Comparing the computed results versus the table of permeability coefficients for typical rocks and soils, values of k with magnitudes of 10^{-5} cm/s are low discharge rocks/soils with poor drainage. Based on the drilling, the subsurface lithologies are either stratified clay deposits, sand/clay mixtures, very fine sands or organic and inorganic silts.

The soil map (Figure III-3-4) shows the western sector of the Ash Disposal site to be generally clay, while the eastern sector is underlain by silty to sandy clay. Comparing the two sectors, the clay-dominated west end of the site is less permeable ($k = 1.8 \times 10^{-5}$ cm/s).

3.8.3 Conclusions

- A soil overburden between 9.0 m and greater than 25.0 m thick occurs at the borehole sites in the proposed ash disposal area. Soil overburden in the powerblock ranges from 2.0 to 10.0 m. Soil overburden in the uplands area ranges from 0.7 to 7.0 m.
- The ground permeabilities measured at boreholes MBH-213 and MBH-214 have magnitudes of 10^{-5} cm/s denoting subsurface soil strata consisting of very fine sands, organic and inorganic silts, mixtures of sand/clay and stratified clay deposits.
- The soil cover at the ash pile site is mainly composed of clays and silts making drainage and discharge poor. But this subsurface characteristic appears discontinuous due to the occurrence of an artesian well at the center of the study area. The impervious nature of the eastern and western sectors is further verified by the calculated values of the coefficient of permeability, k, with magnitudes of 10^{-5} cm/s.
- Of the two sectors, the west end is more impermeable and ash runoff seepage less likely to occur than at the east end.
- The eastern and western sectors of the proposed ash disposal area are therefore ideal sites since the impervious characteristic of the subsurface strata would limit any seepage of runoff into the groundwater reservoir.
- Installation of a clay layer or impermeable geotextile (HDPE) in the ash disposal area and coal storage area will seal the ground surface to avoid any groundwater contamination.

4.0 TERRESTRIAL ECOLOGY

The scope of this study is consistent with that agreed upon during the scoping meeting which was conducted with the attendance of representatives from the Environmental Management Bureau of the DENR, some members of the Mauban community, the proponents, and the environmental consultants.

4.1 Methodology

4.1.1 Vegetation

Characterization of vegetation of the project area and its environs was undertaken using a combination of primary and secondary data gathering methodologies.

Vegetative sampling was conducted in February 1995. Likewise, aerial photographs were reviewed to provide an overall perspective of the area. Depending on the dominant vegetative cover, various quadrat methods were adopted.

For coconut plantation and mangrove areas, the quadrat method of vegetation sampling was used (Figure III-4-1). A 10 x 10 m quadrat was used to characterize coconuts and trees. A 5 x 5 m quadrat was employed for sampling of shrubs and a 1 x 1 m quadrat for herbs and grasses.

Six plots were laid out inside the proposed plant site and nine plots in the surrounding areas (Figure III-4-2). Additional three plots were also established in the mangrove area. Since rice cultivation is essentially a monoculture, a list of rice varieties being used in the area was obtained through interviews. In addition, yield levels of coconut and rice were determined through interviews with farmers. (A more thorough study on agricultural crops and yields is currently being undertaken. The study will continue for one year with progress reports to be submitted to EMB.)

Sampling was also done in Cagbalete island (Cabalete island). In a one km transect line, all plant species were listed.

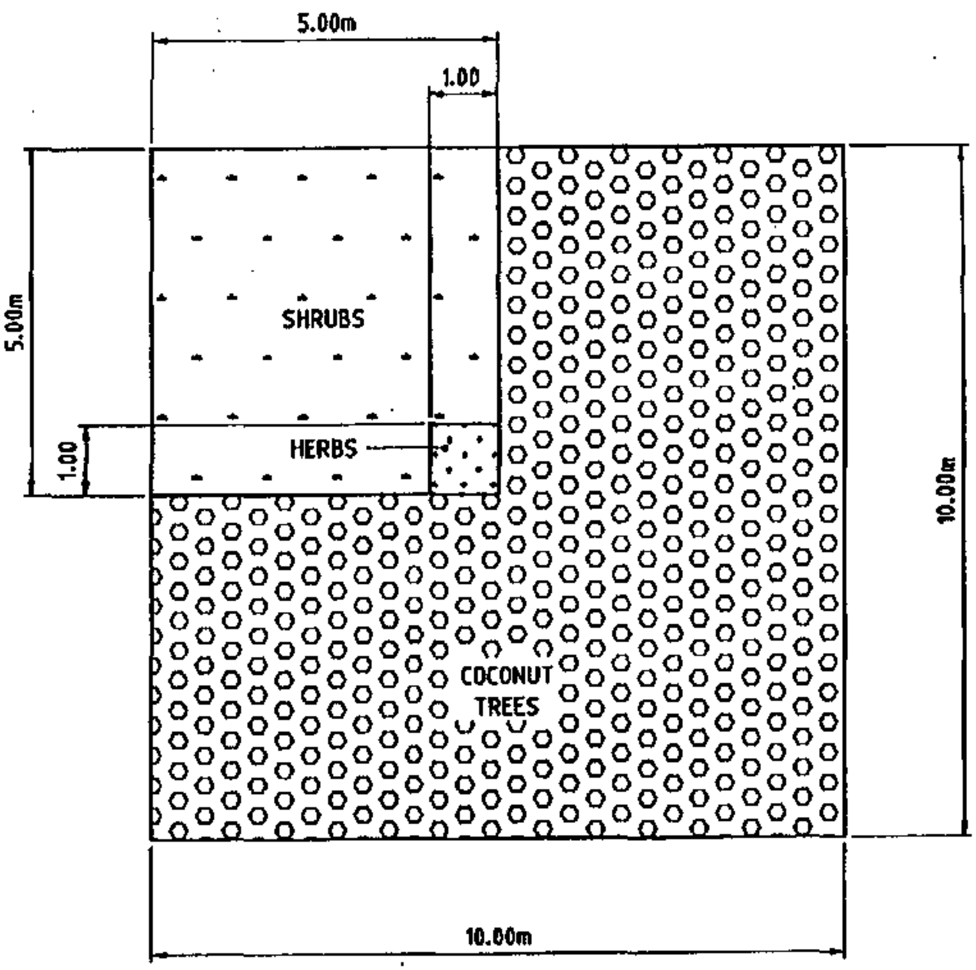
Aerial photographs were examined to determine vegetative cover distribution in the project site and its immediate vicinities. Existing information about the study area were also accessed from different government agencies and available publications.

Based on the data collected, a listing of species encountered was prepared together with their ecological and economic importance. Density was calculated for coconut plantations. Plant diversity in the project site was calculated using the Shannon-Weaver index:

$$H = - \Sigma \frac{N_i}{N} \log \frac{N_i}{N}$$

where:

H - plant diversity index
N_i - number of individuals of the ith species
N - total number of plants



DIMENSIONS OF QUADRATS USED IN VEGETATIVE
SAMPLING IN COCONUT PLANTATIONS

FIGURE III-4-1

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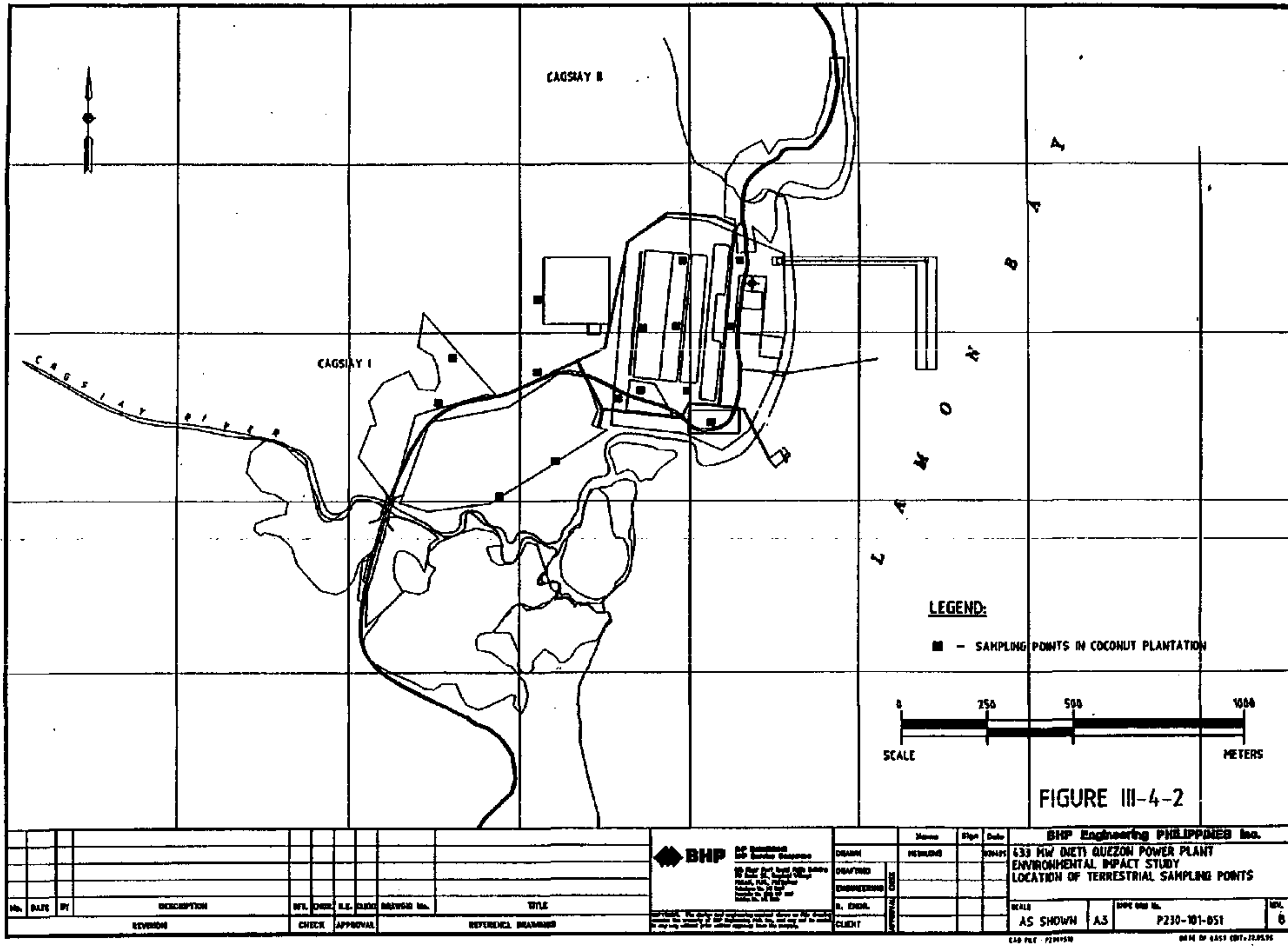


FIGURE III-4-2

4.1.2 Wildlife

Five 1 km transects were established in the project site and vicinities, and another transect in Cagbalete Island approximately 7 km northeast of the project site. Transects I, II, IV, and V are within the primary influence areas, while Transects III and VI are in the secondary influence areas. The primary influence area is the area affected by the site construction, road building and improvement, transmission lines, pier, and housing for personnel, while the secondary influence area is the possible extended area affected during operations.

Transect I follows the shoreline from Interwood Sawmill to the mouth of Cagsiay River. This traverses the proposed pier of the project. Transect II follows the Cagsiay River inland passing along ricefields, fishponds, and coconuts. Transect III traverses the coconut plantation above the ridge marking the boundary of barangays San Lorenzo and Cagsiay. Transect IV passes along a remnant mangrove habitat from the mouth of Cagsiay river to the lighthouse in San Lorenzo. Transect V traverses a coconut plantation in the proposed Cagsiay power plant site while Transect VI is located in Cagbalete Island following the trail that traverses the whole island (see Figure III-4-3).

Observations of diurnally active wildlife species (mostly birds) were conducted along the said transect lines. Observed species and their numbers were recorded in which biodiversity parameters were derived. Reptiles, amphibians, and mammals, which are mostly nocturnally active, were recorded in terms of calls, roosting places, faecal droppings, tracks, and other activity signs. Some snakes and lizards which were disturbed along the transect lines were also recorded. Bats were captured using mist nets, and ground mammals were caught using cage traps.

From the number of birds observed in the transect lines, a species diversity index (H), dominance index (C), and evenness index (e) were derived per transect line. The said parameters were derived using the following formulae:

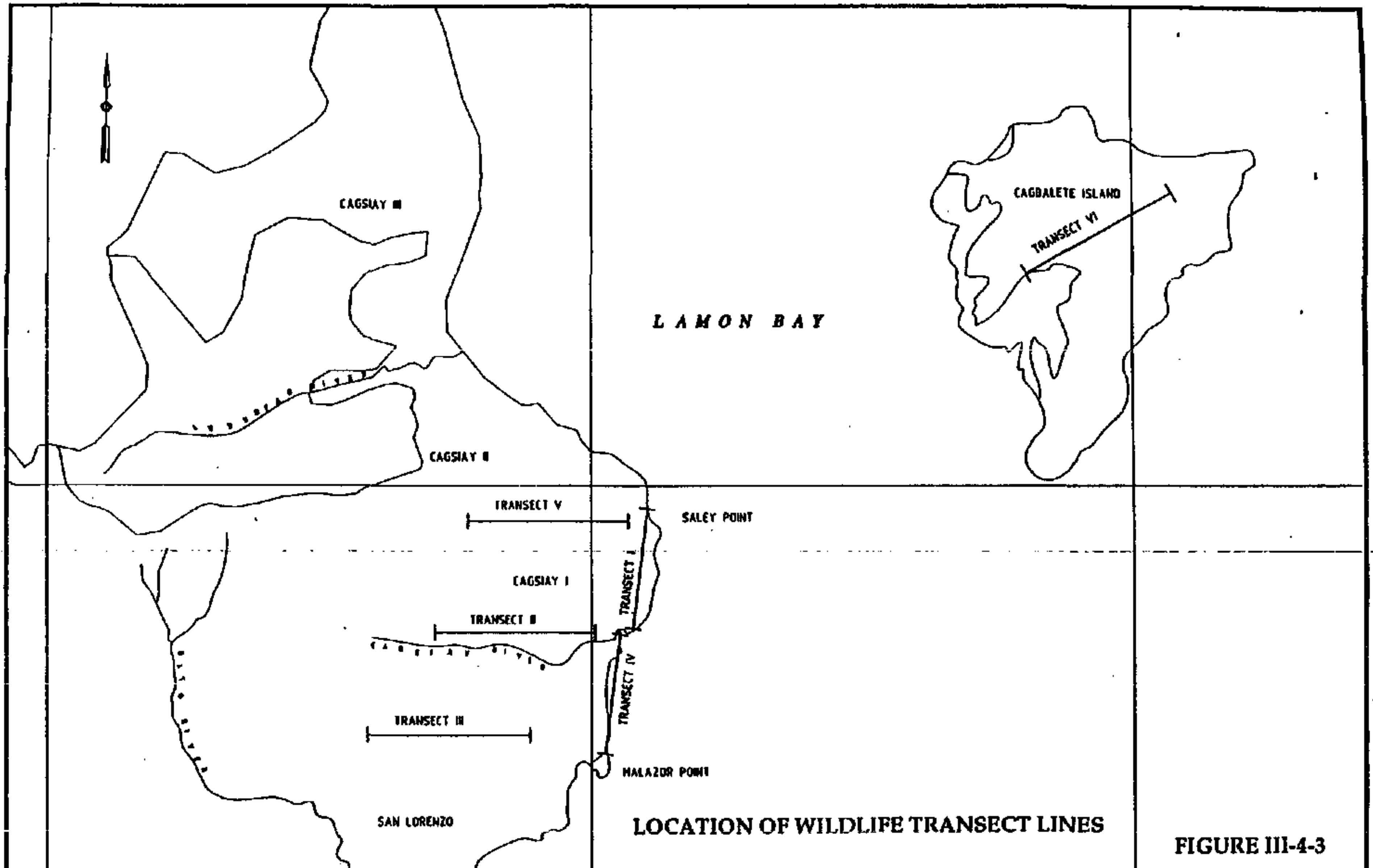
Species Diversity Index	(H)	=	$\Sigma\ [(n_i/N \log (n_i/N)]$
Dominance Index	(C)	=	$\Sigma\ (n_i/N)$
Evenness Index	(e)	=	$H / \log S$ (no. of species)

Biodiversity values will be compared to the table of relative indices whether values represent low or high diversity, dominance, or evenness. The following values are:

TABLE III-4-1
RELATIVE INDICES

Relative Values	Species Diversity	Dominance	Evenness
Very high	3.5000 - 4.0000	0.75 - 1.00	0.75 - 100
High	3.0000 - 3.4999	0.50 - 0.74	0.50 - 0.74
Moderate	2.5000 - 2.9999	0.25 - 0.49	0.25 - 0.49
Low	2.0000 - 2.4999	0.15 - 0.24	0.15 - 0.24
Very Low	1.0000 - 1.9999	0.05 - 0.14	0.05 - 0.14

Listing of wildlife species are grouped into various vertebrate classes (Amphibians, Reptiles, Birds, and Mammals) in alphabetical order with english common names and ecological status included per species.



LOCATION OF WILDLIFE TRANSECT LINES

FIGURE III-4-3

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4.2 Regional Ecology

4.2.1 Vegetation

The municipality of Mauban is located in the province of Quezon, which in turn is part of the Southern Tagalog Region (Region IV). The region has a total land area of 4.7M hectares of which 2.5M hectares are classified as forest lands and the rest as alienable and disposable.

Of the total forest lands, it is estimated that only 1.2M hectares are actually covered with tropical forests. The rest are brushlands which are mainly grasslands and savanna areas. Most of the forest cover are residual Dipterocarp forests, remnants of logging operations that once were dominant activities in the region. Less than 150,000 hectares of virgin Dipterocarp forests can be found in the region, most of these in the island of Palawan. In addition, Region IV also harbors 160,000 hectares of mossy forests. Mangrove forests are also abundant in Region IV. More than 40 percent (51,000 hectares) of all remaining mangrove forests in the Philippines are located in this region.

The Dipterocarp forests are the most important forest resource of the Philippines from the economic and ecological standpoint. These tropical rainforests are part of the Indo-Malayan zone which is one of the largest habitat of these forests in the world. They are characterized by a multistorey structure with up to five layers of canopy. The species of the family Dipterocarpaceae is the dominant vegetation specially in the upper canopy layers. However, the biodiversity of these forests are the highest among all forest types in the world. Hundreds of species can be found in one hectare of land. Because of the high value of Dipterocarp trees (called Philippine mahogany in the world market), most of the forests of Region IV used to be under logging concessions. The rampant exploitation of these forests together with conversion to shifting cultivation farms resulted to their present pathetic condition.

Mossy forests are tropical forests found in higher altitude areas such as in the peaks of Mt. Makiling and Mt. Banahaw. Their most striking feature is the presence of numerous epiphytes consisting of mosses, liverworts, ferns, and orchids. They also have shorter trees than lowland forests. Typical genera are *Podocarpus, Dacrydium, Quercus* and *Eugenia*.

Mangrove forests are found on tidal flats along seacoasts and are usually associated with thick stands of medium-sized and even-aged trees, nipa palms and other herbaceous plants. Evergreen sclerophyllous broad-leaf trees with stilt roots or pneumatophores, knee-roots and viviparous seedlings dominate the ecosystem. Species from the genus *Avicennia, Rhizophora, Ceriops, Nypa* and *Bruguiera* dominate the ecosystem. Mangroves are ecologically vital because they:

- serve as nursery, breeding and spawning grounds of aquatic organisms;
- provide nutrients for mangrove dependent species;
- serve as coastal zone stabilizers;
- trap pollutants; and
- serve as wildlife sanctuaries.

Economically, mangrove forests are sources of various forest products foremost of which are timber and fuelwood. Because of over exploitation and conversion to fishponds, the 140,000 hectares of mangroves left in the Philippines are less than a third of their distribution in the early 1900's.

Alienable and disposable lands are those lands that have been put into uses other than as forest lands. In Region IV, these uses are basically for human settlements and agriculture. In terms of hectarage, coconut and rice are by far the leading agricultural crops. Of the 1.3M hectares of farmlands in Region IV, 542,000 and 416,000 hectares are planted to coconut and rice, respectively. Coconut and rice farms are basically monoculture farms. Rice cultivation is the most extreme case of monocropping where all other vegetation are eliminated by manual weeding and/or the use of herbicides. To a lesser degree, coconut farms are also monocropping. However, other vegetation grow underneath, the diversity of which depends on intensity of maintenance activities.

4.2.2 Wildlife

Mauban is almost devoid of its original terrestrial vegetation, and habitat types. Most of its elevated areas and higher grounds are planted to coconuts. The low lying areas especially along rivers and creeks are planted to rice or converted into fishponds. Some riparian vegetation may occur along river banks and cliffs. With a depauperate vegetation, most of the areas support very few species of wildlife, mostly adapted to disturbed habitats and agricultural lands. The nearest forest areas in Mt. Banahaw in Tayabas and Quezon National Park in Pagbilao are very far from Mauban to be affected by the plant operations.

In terms of various wildlife species recorded within the area, Miranda, 1978 recorded 50 species of birds and 20 species of mammals from Mt. Banahaw and Mt. Cristobal in the Quezon-Laguna area. The EIS done for the Pagbilao Coal-Fired Thermal Plant in 1992 recorded a total of 139 wildlife species, 92 species of which were birds; 16 species were mammals; 22 species were reptiles; and nine species were amphibians. The Pagbilao EIS also included wildlife species recorded from Quezon National Park located between Pagbilao and Atimonan, Quezon. These two areas, Mt. Banahaw-Mt. Cristobal National Park and Quezon National Park, located in the province of Quezon, are major sources of wildlife recruits to repopulate surrounding areas of wildlife.

4.3 Site Ecology

4.3.1 Vegetation

Figure III-4-4 shows the vegetation cover of the proposed plant site and its vicinities. Coconut (*Cocos nucifera*) plantation is the most dominant plant cover of the area. Patches of rice paddy are scattered in flat low-lying areas. A small area of mangrove stand is also present.

Coconut Plantation

As expected, C. *nucifera* is practically the only plant in the upper storey of coconut plantations in the area. Mauban and the whole of Quezon province are primarily coconut-producing areas. The crop has been called the tree of life (botanically, it is not a tree but a palm) because it provides a great variety of products useful to man such as food, housing materials and fuel. In Barangay Cagsiay I, the primary use of coconut is for copra which is the source of coconut oil.

The average spacing of coconuts in the area is 8-10 m so that there is a density of 100 to 150 coconut plants per hectare in fully stocked farms. The actual number of coconuts could be lower than 100 in some farms because of cutting for coco-lumber. Most of the coconuts are very old with ages estimated at over 50 years. One advantage of the crop is the minimal maintenance it needs. Occasional weeding is typically the only tending required.

Because of the soft price of coconut oil in the world market, the price of copra is also low. There are in fact fears that coconut is a sunset industry. This is reflected in the massive cutting of coconut "trees" for coco-lumber all over the country. This phenomenon is also happening in Barangay Cagsiay I although the exact extent cannot be quantified. According to farmers, a coconut trunk is sold to cutters for PHP 300 depending on how close it is from the road.

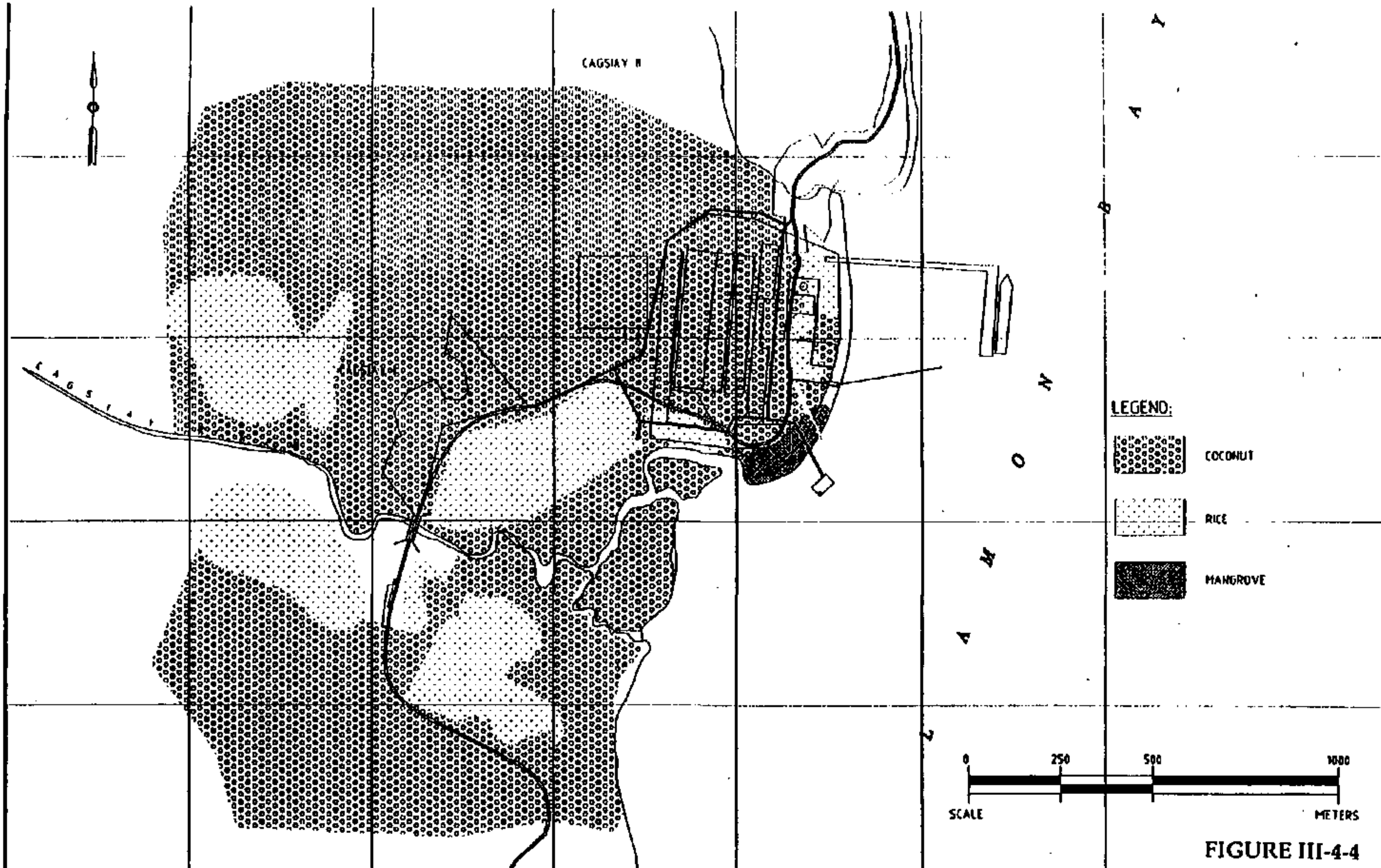

FIGURE III-4-4

BHP Engineering PHILIPPINES Inc.

433 MW (NET) QUEZON POWER PROJECT
ENVIRONMENTAL IMPACT STUDY
VEGETATION MAP

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Coconut is usually harvested for copra once every 3-4 months. Farmers reportedly get an average of 750 kg/ha of copra during harvest.

Vegetative Sampling

Annex 5, Table 1 lists the species of trees, shrubs and herbs aside from coconut that have been encountered during the vegetative sampling. The few large trees observed include balobo (*Diplodiscus paniculata*) and pili (*Canarium ovatum*). Smaller trees were also found but all of them, like the bigger trees, are isolated and far between. In most cases, only one or two individuals were found for each tree species. It could be surmised that these trees are remnants of the forest that used to cover the area. Another possibility is that propagules of these species came from the forests of adjacent barangays. The most noteworthy tree species in the area are small individuals of narra (P. *indicus*) and ipil (I. *bijuga*) which are commercially important. In addition, ipil and kamia (*Hedychium philippinensi*) are endangered plant species as defined by CITES.

Shrubs, herbs and grasses vary in abundance depending on the intensity of weeding operations. Patches of bamboos (kauyan-kiling) were occasionally found specially near the creeks. Bananas are also scattered throughout the coconut farms. Ferns and grasses are also abundant.

The Shannon-Weaver plant diversity index is equivalent to 0.5 indicating that diversity is not high. Most of the plant species that make up the diversity of the area are in fact confined to shrubs and herbs layer.

Rice Paddies

As a common practice in the Philippines, rice paddies are pure monoculture of rice (*Oryza sativa*). There are four most commonly grown varieties in Barangay Cagsiay I, viz., R-5, R-22, C-1, and Maharlika.

Yield levels are variable depending on several factors such as season, variety and inputs. However, these are not accurately monitored. Interviews with farmers revealed that rice paddies typically produce between 120-200 cans or 30 to 50 cavans of palay per hectare worth PHP 10,000-11,000.

One of the reasons for the low yield is the lack of irrigation in the area. Rainfall is the main source of water (rainfed).

Mangrove

Among all provinces in the Philippines, Quezon harbors the largest area of mangrove forests. Of the 140,000 hectares of remaining mangrove forests, more than 30 percent are in Quezon.

In the study site, there are around 2 hectares of mangrove stand. **Annex 5, Table 2** lists the species found in the mangrove area. It will be noted that only 13 species were encountered. Of these species, only A. *officinales* and S. *alba* are major mangrove elements (i.e. taxonomically isolated from terrestrial relatives). The rest are beach and lowland forest species.

Cagbalete Island (Cabalete Island)

Like the Quezon mainland, Cagbalete Island is predominantly planted to coconut with a few spots of rice fields. However, unlike in the mainland, the coconut plantations appear to be less tended. In fact, there were many tree species and shrubs growing under the coconuts.

Annex 5, Table 3 shows the plant species encountered in the one-km transect. Most of the tree species are pioneer second-growth and beach species with little commercial value as timber. However, a few individuals of premium species such as ipil, narra and molave were encountered.

4.3.2 Wildlife

A total of 54 species of wildlife have been recorded in the proposed site at Cagsiay, Mauban, Quezon. These consist of 5 amphibians, 12 reptiles, 34 birds, and 5 mammals. Most ground mammals captured were rodent pest and few shrews. All bats collected were frugivorous types and also pest to fruit crops. The rat species collected is a pest not only to coconuts but also of rice, corn, and other crops.

Compared to other areas, the project site is relatively poor when it comes to wildlife biodiversity. This is supported by the parameter values of Species Diversity Index (H), Dominance Index (C) and Evenness Index (e) for birds as summarized in Table III-4-2. The average value for Species Diversity Index (H) for the six transect lines was 2.06958. Compared to forested areas, the usual species diversity index is more than 3.0000.

TABLE III-4-2
SUMMARY OF BIODIVERSITY PARAMETER VALUES OF VARIOUS BIRD TRANSECTS IN CAGSIAY, MAUBAN, QUEZON

Transects	Habitat	Species Diversity Index (H)	Dominance Index (C)	Evenness Index (e)
Transect I	Shoreline	2.12900 (low)	0.14462 (low)	0.88786 (very high)
Transect II	Cagsiay River	1.77064 (very low)	0.20448 (low)	0.85450 (very high)
Transect III	Coconut Plant	1.95851 (very low)	0.18273 (low)	0.85057 (very high)
Transect IV	Mangrove	1.74674 (very low)	0.24471 (low)	0.79497 (very high)
Transect V	Project Site	2.31068 (low)	0.12264 (very low)	0.90087 (very high)
Transect VI	Cagbalete Is.	2.50192 (moderate)	0.10524 (very low)	0.90238 (very high)
	TOTAL	12.41749	1.00442	5.19115
	AVERAGE	2.06958	0.16740 (low)	0.86519 (very high)

The Dominance Index average value was 0.16740, which is relatively low for forested areas. This is primarily because no single dominating species showed greater number of individuals observed. Thus, the species present in the area are those that are more adaptable to disturbed habitats.

The Evenness Index average value was 0.86519 which is slightly lower than the usual average in forested areas which is 0.90000. This means that the number of individuals are not so even among the various species present. Still the evenness index value is very high, meaning no single species shows preponderance over others.

It is the last two transects, Transect V and VI that showed slightly higher biodiversity values. In Transect V, although planted to coconut, there are a number of areas with thick undergrowth composed of shrubs and ferns while Transect VI, in Cagbalete Island, showed several types of vegetation aside from the coconuts. Tables III-4-3 to 8 show the types of birds observed in Transects I-VI.

Most of the ground mammals caught in the cage traps were ricefield rats (*Rattus mindanensis*), which are also pests to coconuts. The active coco-lumber industry going on in the project site has also increased the population of coconut beetle. Mainly because portions of the coconut trunks for coco-lumber are left behind. Moreover, sawdust piles are excellent medium for coconut beetle larvae.

Table III-4-9 shows the lists of mammals, amphibians and reptiles observed in the different transect areas. A list of wildlife species and their common names is provided in **Annex 5, Table 4.**

TABLE III-4-3
BIRDS OBSERVED IN TRANSECT I -SHORELINE HABITAT IN CAGSIAY, MAUBAN, QUEZON

	Species	n_i	n_i/N	$\Sigma (n_i/N)$	$\Sigma [n_i/N \log (n_i/N)]$
1.	*Zosterops meyeni*	8	0.25806	0.06659	-0.34956
2.	*Collocalia esculenta*	5	0.16129	0.02601	-0.29428
3.	*Halcyon chloris collaris*	4	0.12903	0.01665	-0.26422
4.	*Nectarinia jugularis*	4	0.12903	0.01665	-0.26422
5.	*Pycnonotus goiavier*	3	0.09677	0.00936	-0.22600
6.	*Lalage nigra*	2	0.06452	0.00416	-0.17683
7.	*Bubulcus ibis*	1	0.03226	0.00104	-0.11078
8.	*Centropus viridis*	1	0.03226	0.00104	-0.11078
9.	*Corvus macrorhynchos*	1	0.03226	0.00104	-0.11078
10.	*Ixobrychus sinensis*	1	0.03226	0.00104	-0.11078
11.	*Lanius cristatus*	1	0.03226	0.00104	-0.11078
		N=31		0.14462	-2.12900

Species Diversity Index	(H)	=	2.12900
Dominance Index	(C)	=	0.14462
Evenness Index	(e)	=	0.88786

TABLE III-4-4
BIRDS OBSERVED IN TRANSECT II ALONG CAGSIAY RIVER, CAGSIAY, MAUBAN, QUEZON.

	Species	n_i	n_i/N	$\Sigma\ (n_i/N)$	$\Sigma[n_i/N \log (n_i/N)]$
1.	*Passer montanus*	12	0.30769	0.09467	-0.36266
2.	*Collocalia esculenta*	10	0.25641	0.06575	-0.34897
3.	*Geopelia striata*	6	0.15385	0.02367	-0.28797
4.	*Halcyon chloris collaris*	4	0.10256	0.01052	-0.23356
5.	*Lanius cristatus*	3	0.07692	0.00592	-0.19730
6.	*Pycnonotus goiavier*	2	0.05128	0.00263	-0.15232
7.	*Ceyx argentatus*	1	0.02564	0.00066	-0.09393
8.	*Megalurus palustris*	1	0.02564	0.00066	-0.09393
		N=31		0.20448	-1.77064

Species Diversity Index (H) = 1.77064
Dominance Index (C) = 0.20448
Evenness Index (e) = 0.85150

TABLE III-4-5
BIRDS OBSERVED IN TRANSECT III - COCONUT PLANTATION IN CAGSIAY, MAUBAN, QUEZON

	Species	n_i	n_i/N	$\Sigma\ (n_i/N)$	$\Sigma\ [n_i/N \log (n_i/N)]$
1.	*Hypsipetes philippinus*	10	0.30303	0.09183	-0.36175
2.	*Zosterops meyeni*	8	0.24242	0.05877	-0.34353
3.	*Nectarinia jugularis*	4	0.12121	0.01469	-0.25578
4.	*Loriculus philippensis*	2	0.06061	0.00367	-0.16990
5.	*Megalurus palustris*	2	0.06061	0.00367	-0.16990
6.	*Oriolus chinensis*	2	0.06061	0.00367	-0.16990
7.	*Rhipidura cyaniceps*	2	0.06061	0.00367	-0.16990
8.	*Centropus viridis*	1	0.03030	0.00092	-0.10595
9.	*Dendrocopus maculatus*	1	0.03030	0.00092	-0.10595
10.	*Orthotomus derbianus*	1	0.03030	0.00092	-0.10595
		N=33		0.18273	-1.95851

Species Diversity Index (H) = 1.95851
Dominance Index (C) = 0.18273
Evenness Index (e) = 0.85057

TABLE III-4-6
BIRDS OBSERVED IN TRANSECT IV- MANGROVE HABITAT IN CAGSIAY, MAUBAN, QUEZON

	Species	n_i	n_i/N	$\Sigma(n_i/N)$	$\Sigma[n_i/N \log(n_i/N)]$
1.	*Collocalia esculenta*	16	0.43243	0.18699	-0.36252
2.	*Pycnonotus goiavier*	6	0.16216	0.02630	-0.29500
3.	*Apus affinis*	4	0.10811	0.01169	-0.24050
4.	*Charadrius dubius*	4	0.10811	0.01169	-0.24050
5.	*Halcyon chloris collaris*	2	0.05405	0.00292	-0.15771
6.	*Poliolimnas cinereus*	2	0.05405	0.00292	-0.15771
7.	*Oriolus chinensis*	1	0.02703	0.00073	-0.09760
8.	*Rallus striatus*	1	0.02703	0.00073	-0.09760
9.	*Rhipidura javanica*	1	0.02703	0.00073	-0.09760
		N=37		0.24471	-1.74674

Species Diversity Index	(H)	=	1.74674
Dominance Index	(C)	=	0.24471
Evenness Index	(e)	=	0.79497

TABLE III-4-7
BIRDS OBSERVED IN TRANSECT V - POWER PLANT SITE, CAGSIAY, MAUBAN, QUEZON

	Species	n_i	n_i/N	$\Sigma(n_i/N)$	$\Sigma[n_i/N \log(n_i/N)]$
1.	*Collocalia esculenta*	12	0.23529	0.05536	-0.34045
2.	*Apus affinis*	8	0.15686	0.02461	-0.29057
3.	*Pycnonotus goiavier*	6	0.11765	0.01384	-0.25178
4.	*Geopelia striata*	4	0.07843	0.00615	-0.19965
5.	*Lanius cristatus*	4	0.07843	0.00615	-0.19965
6.	*Nectarinia iugularis*	4	0.07843	0.00615	-0.19965
7.	*Halcyon chloris collaris*	3	0.05882	0.00346	-0.16665
8.	*Chalcophaps indica*	2	0.03922	0.00154	-0.12702
9.	*Corvus macrorhynchos*	2	0.03922	0.00154	-0.12702
10.	*Oriolus chinensis*	2	0.03922	0.00154	-0.12702
11.	*Rhipidura javanica*	2	0.03922	0.00154	-0.12702
12.	*Coturnix chinensis*	1	0.01961	0.00038	-0.07710
13	*Megalurus palustris*	1	0.01961	0.00038	-0.07710
		N=51		0.12264	-2.31068

Species Diversity Index	(H)	=	2.31068
Dominance Index	(C)	=	0.12264
Evenness Index	(e)	=	0.90087

TABLE III-4-8
BIRDS OBSERVED IN TRANSECT VI IN CAGBALETE ISLAND, MAUBAN, QUEZON

	Species	n_i	n_i/N	$\Sigma (n_i/N)$	$\Sigma [n_i/N \log (n_i/N)]$
1.	*Nectarinia jugularis*	8	0.21053	0.04432	-0.32803
2.	*Pycnonotus goiavier*	6	0.15789	0.02493	-0.29144
3.	*Hirundo tahitica*	4	0.10526	0.01108	-0.23697
4.	*Lonchura malacca*	3	0.07895	0.00623	-0.20045
5.	*Artamus leucorhynchus*	2	0.05263	0.00277	-0.15497
6.	*Cisticola exilis*	2	0.05263	0.00277	-0.15497
7.	*Halcyon chloris collaris*	2	0.05263	0.00277	-0.15497
8.	*Geopelia striata*	2	0.05263	0.00277	-0.15497
9.	*Megalurus palustris*	2	0.05263	0.00277	-0.15497
10.	*Bubulcus ibis*	1	0.02632	0.00069	-0.09574
11.	*Centropus viridis*	1	0.02632	0.00069	-0.09574
12.	*Cuculus fugax*	1	0.02632	0.00069	-0.09574
13.	*Egretta garzetta*	1	0.02632	0.00069	-0.09574
14.	*Lanius cristatus*	1	0.02632	0.00069	-0.09574
15.	*Oriolus chinensis*	1	0.02632	0.00069	-0.09574
16.	*Rhipidura javanica*	1	0.02632	0.00069	-0.09574
		N=38		0.10524	-2.50192

Species Diversity Index (H) = 2.50192
Dominance Index (C) = 0.10524
Evenness Index (e) = 0.90238

TABLE III-4-9
LIST OF AMPHIBIANS, REPTILES AND MAMMALS OBSERVED AND COLLECTED IN VARIOUS TRANSECT AREAS IN MAUBAN COAL-FIRED THERMAL PLANT SITE, CAGSIAY, MAUBAN, QUEZON

	Species	Transect Areas					
		I	II	III	IV	V	VI
A.	Amphibians:						
	1. *Bufo marinus*	-	-	-	x	-	-
	2. *Kaloula picta*	-	-	-	-	x	-
	3. *Occidozyga laevis*	-	x	-	-	-	-
	4. *Polypedates leucomystax*	-	-	-	-	x	-
	5. *Rana cancrivora*	x	x	-	x	-	-
B.	Reptiles:						
	(a) Turtle						
	1. *Coura amboinensis*	-	x	-	-	-	-
	(b) Lizards:						
	2. *Cosymbotus platyurus*	-	-	-	-	x	x
	3. *Draco volans*	-	-	x	x	x	-
	4. *Gehyra mutilata*	-	-	-	-	-	x
	5. *Gekko gecko*	x	-	x	-	x	-
	6. *Hemidactylus frenatus*	x	-	-	-	x	x
	7. *Mabuya multifasciata*	x	x	x	x	x	-
	8. *Varanus salvator*	-	x	-	-	-	-
	(c) Snakes:						
	9. *Dendrelaphis pictus*	-	-	x	-	x	-
	10. *Elaphe erythrura*	-	-	x	-	x	-
	11. *Lycodon aulicus*	-	-	-	-	x	-
	12. *Psammodynastes pulverulentus*	-	-	-	-	x	-
C.	Mammals:						
	(a) Bats						
	1. *Cynopterus brachyotis*	x	x	x	-	x	-
	2. *Macroglossus minimus*	-	-	x	x	x	-
	3. *Ptenochirus jagori*	-	-	x	-	x	-
	(b) Rats						
	4. *Rattus mindanensis*	x	x	x	-	x	x
	(c) Shrew						
	5. *Suncus murinus*	-	x	x	-	x	-

5.0 AQUATIC ECOLOGY

The scope of this study is consistent with that agreed upon during the scoping meeting which was conducted with the attendance of representatives from the Environmental Management Bureau of the DENR, some members of the Mauban community, the proponents, and the environmental consultants. The selection of the study sites was based on a preliminary layout prepared for the purpose, augmented by data provided by the site selection criteria detailed below.

5.1 Methodology

5.1.1 Site Selection

In general the study sites were common for the seaweeds, seagrasses, coral reefs, fish and plankton components. This was to ensure higher resolution of the parameters under study. Initial selection of these sites was based on an analysis of the latest SPOT XS and Landsat MSS data on the biophysical features of the coastal environs of southwestern Luzon (1:50,000). The above information was digitally classified, color-coded, and translated into the base map. For the purpose of the present study, the primary concerns were focused on vegetated, non-vegetated, coralline, and turbid areas, mangrove; and coastal population centers. These were considered in relation to the potential impacts of the proposed power plant.

A total of eight study sites were surveyed during the fieldwork conducted on February 10-12, 23-25, and March 11, 1995 (Figure III-5-1). These included: three sites which were located within the primary impact area of the proposed power plant i.e., MS1a (intake), MS2a (outfall), MS3a (jetty area); MS4a (a control station near Malazur Point south of the proposed plant site; MS8a (north of the proposed pier near the Interwood area); and MS5a (a possible site for rehabilitation or habitat protection southwest of Cabalete Island northeast of the proposed power plant site). The seaweed/seagrass/mangrove component of the team surveyed two additional sites in Cabalete Island (MS6a and MS7a) as controls and possible intensified survey areas in the monitoring activities. MS6a was located southwest of the island, fronting the municipality, and MS7a was located west, near the mouth of the river The locations of the sampling stations were determined using a hand-held Global Positioning System (GPS).

5.1.2 Seaweeds, Seagrasses and Mangroves

Rapid Visual Community Survey

From the base map, the potential sites were identified and delimited. Survey and assessment of the macrobenthic seaweed and seagrass communities from these sites were undertaken using the manta board technique for coral communities (English *et al.* 1994). This was, however, slightly modified in order to incorporate an assessment of seaweed and seagrass assemblages (Rapid Appraisal of Plant Structure in Tropical Reefs or RAPSTRE)(Fortes 1992). This technique involves two snorkellers, holding on to the opposite sides of a manta board tied behind a motorized banca (small boat) and towed at a speed of 1 - 1.5 knots over the reef or sand. A tow lasting five minutes over the communities allowed the snorkellers ample time to rapidly describe the habitats semi-quantitatively. Sufficient tows were made to cover and represent the areas of concern identified in the selection of the sites of study. In the present survey, seven sites were studied. Six tows (covering approximately 2 km) parallel the coastline and approximately 100 meters from it were made from Cagsiay 1 down south of the Lighthouse at Malazur Pt. (Figure III-5-1). This was not attempted at Cabalete Island as the water was too shallow during the time of the survey. The time and position of each start and end of a tow were recorded by an assistant on board the boat in order to locate the site under survey. At each stop, the snorkellers described the status of the underwater plant communities on plastic writing slates.

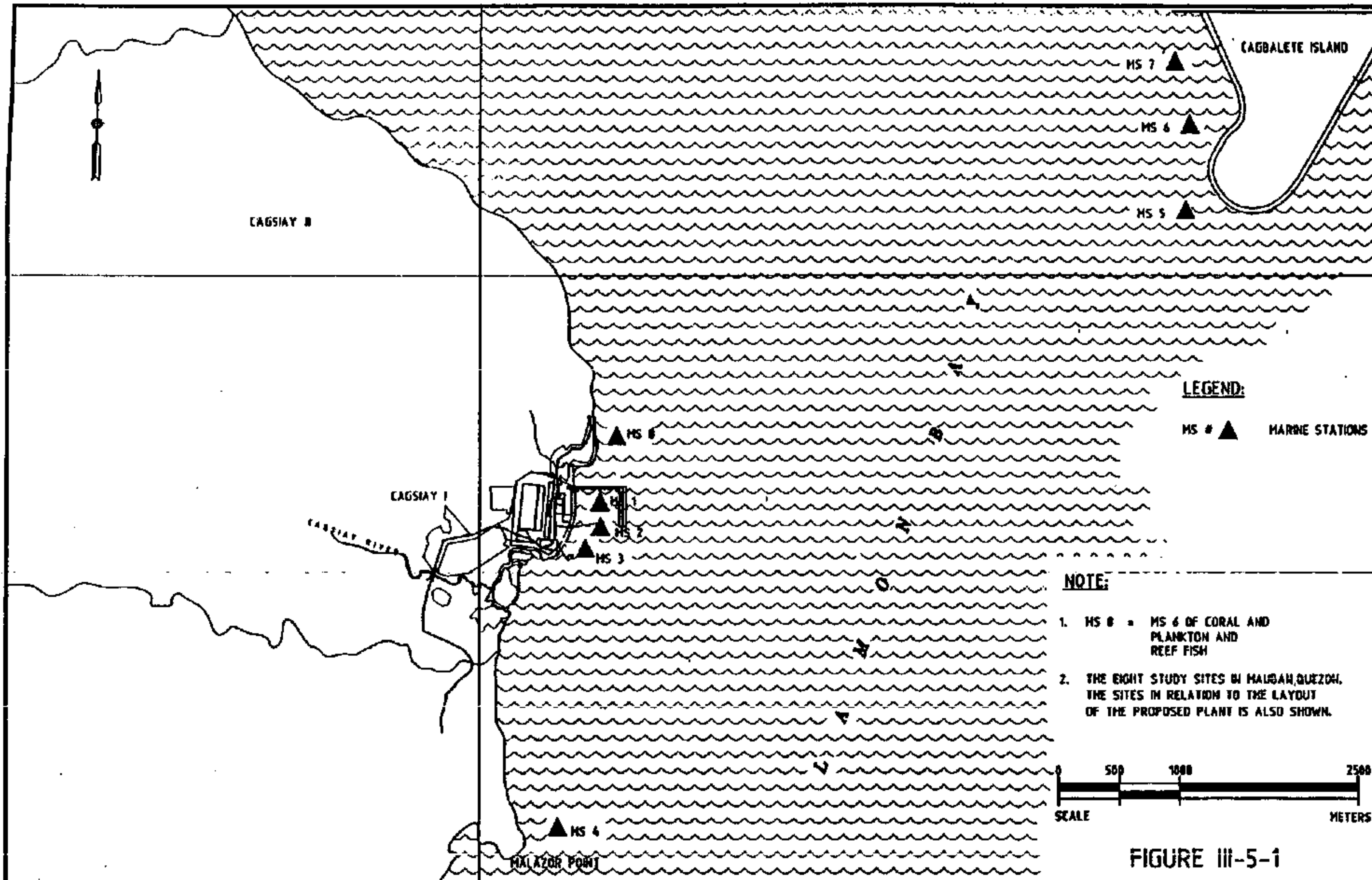

FIGURE III-5-1

BHP Engineering PHILIPPINES Inc.
433 MW (NET) QUEZON POWER PROJECT
ENVIRONMENTAL IMPACT STUDY
MARINE SAMPLING STATIONS

SCALE: AS SHOWN | A3 | P230 101 057

Field Sampling/Laboratory Processing

From the results of the site selection and visual community survey, transect sites were further selected for intensive assessment of community structure (species composition, % frequency of species) and other significant observations. The final selection was confirmed with the help of the boatmen who were themselves chosen due to their wide and first-hand experience and knowledge on the location, kinds, and abundance of the most significant representative communities at the sites.

Assessment was facilitated by using 0.25 square meter brass quadrats divided into twenty five 10x10 cm grids. Data were recorded underwater on slates made for the purpose.

In the case of mangroves, the exposed nearshore habitats fronting the RAPSTRE paths were investigated in terms of observed structural features (species composition, relative abundance), degree of disturbance, patterns of use by the local inhabitants, and restoration/rehabilitation efforts.

In the laboratory, data were transcribed, the identities of the collected specimens confirmed using available taxonomic keys, and representative samples preserved in bottles for future reference. Quantitative data were collated, analyzed and graphically illustrated. Photodocumentation was made of environmentally representative portions of the sites and activities both of the survey team and the local inhabitants.

5.1.3 Coral Reefs

The assessment conducted for coral reefs aimed to: (1) determine the status of coral reefs in the area; (2) determine the percentage cover of live coral, dead coral, soft coral and other benthic life forms; (3) provide a composite listing of corals and associated benthos; and (4) provide data useful in predicting and mitigating probable impacts from power plant activities.

Manta Board Reconnaissance Technique

Rapid visual surveys using the manta board reconnaissance technique was conducted by towing a snorkeller holding a manta board following the contour of the reef slope. Each tow lasts for two (2) minutes with speed of 1-1.5 knots (0.77-1.03 m/s). The manta tow reconnaissance technique allows the snorkeler to observe the coral community and describe it semi-quantitatively by making estimates of the percentage cover of live corals, dead corals, and soft corals using the following scores: 1 = 1-10 percent; 2 = 11-30 percent; 3 = 31-50 percent; 4 = 51-75 percent; and 5 = 76-100 percent. Remarks about the dominant lifeforms and other associated organisms are made for each tow. Aboard the banca, another team member maps the relative path of each tow (Figure III-5-1). This technique enables visual assessment of large reef areas within a short time and is highly recommended for selecting sites for more detailed transect studies (Dartnall & Jones 1986, English *et al.*, 1994).

Line-Intercept Technique

Benthic lifeforms and percentage cover were determined using the line-intercept method described by Dartnall & Jones (1986) and English *et al.* (1994). A 100-m graduated fiberglass tape was laid at preselected depths of 3 m and/or 10 m at each transect site whenever possible. Lifeforms intercepted by the transect line were identified and measured to the nearest centimeter. The coral condition of the study sites were converted into useful qualitative criteria of percentage living coral cover following those of Gomez *et al.* (1981). These are: poor cover = 1-24.9 percent; fair cover = 25-49.9 percent; good cover = 50-74.9 percent; and excellent cover = 75-100 percent. For all the six transect-sites, the

3-m depth was surveyed because beyond this point, no corals were found since the substrate was sandy-muddy.

5.1.4 Plankton

General Water Quality

Although this study deals with the plankton community in the area, general water quality variables were measured at the same time that plankton samples were gathered. This is necessary to explain differences in the structure and behavior of the plankton community in time and space.

Water samples were collected through bottle sampling. General water quality parameters measured include depth and transparency (using 20 cm diameter Secchi disk); pH, temperature, and dissolved oxygen content (DO, using Check Mate 90 DO/pH meter); and salinity (using Atago refractometer, 0 - 100 ppt).

Productivity

Primary productivity of the six stations was measured using the direct method, i.e., light and dark bottle technique. Clear and dark biological oxygen demand (BOD) bottles (300 ml cap) were filled up with seawater and incubated on a bucket filled with the same seawater for four hours. DO content from each bottle was measured using a DO meter. Gross and net productivities were estimated using the formula given in APHA (1989) and Strickland & Parsons (1972):

Net photosynthesis (NP) (mg/l)	=	Light bottle DO (mg/l)	-	Initial DO (mg/l)
Respiration (R) (mg/l)	=	Initial DO (mg/l)	-	Dark bottle DO (mg/l)
Gross photosynthesis (GP) (mg/l)	=	Light bottle DO (mg/l)	-	Dark bottle DO (mg/l)
Gross primary production (mgC/m^3)	=	$GP \times \frac{12}{32} \times 1000 \times k$		
Net primary production (mgC/m^3)	=	$NP \times \frac{12}{32} \times 1000 \times k$		

where: k = photosynthetic quotient, PQ = 1.2

Zooplankton Biomass

Samples for zooplankton biomass were collected using a plankton net (mesh size of 93 µ, 1m length and 0.3m diameter). A meter clearance between the cod end jar and sea bottom was allowed to determine the towing depth. Vertical towing was done by lowering the plankton net at 1 m/s and retrieving at 0.75 m/s. Samples were preserved with 10 percent formalin and submitted to University of the Philippines (UP) Marine Science Institute (MSI) for analysis.

Biomass was estimated using gravimetric method. A 500-ml water sample was filtered using a pre-weighed filter paper with the aid of a glass funnel and an Erlenmeyer flask. Filter paper (with residue) was oven-dried (44°C) for 48 hours. Dry weight of the sample was determined using a Mettler balance (0.0001 g). To compute for biomass:

$$\text{Biomass } (mg/m^3) = \frac{\text{Dry weight (mg) - Pre-weighed filter paper (mg)}}{\text{actual volume filtered } (m^3)}$$

$$\text{volume } (m^3) = \text{mouth area of plankton net } (m^2) \times \text{towing depth (m)}$$

Plankton Density and Abundance

Samples for plankton identification (phytoplankton and zooplankton) using vertical and horizontal tows in the six identified stations were collected. There are two types of collecting plankton samples for qualitative and quantitative purposes. Vertical tow is used to represent composite samples in the water column while horizontal tow represents samples at discrete depth.

Vertical tow - Vertical towing was done by lowering a plankton net (mesh size of 93 µ, 1m length and 0.3m diameter) at 1 m/sec and retrieving at 0.75 m/sec. A meter clearance between the cod end jar and sea bottom was allowed to determine the towing depth. Actual volume filtered can be computed using:

$$\text{volume } (m^3) = \text{mouth area of plankton net } (m^2) \times \text{towing depth (m)}$$

Duplicate samples were collected per station. These were preserved with 10 percent formalin and submitted to UP MSI for sorting, species identification and counting.

Horizontal tow - Horizontal tow was also done to determine differences in phytoplankton and zooplankton species in an area. A flow meter was used in determining the volume of samples filtered in the plankton net. Plankton net used has a mesh size of 93 µ with 0.5 m diameter and 1.5 m length. Towing was done for one minute. Actual volume filtered by horizontal towing can be computed using:

$$\text{volume } (m^3) = \text{no. of revolns} \times \text{impeller pitch (m)} \times \text{mouth area of net } (m^2)$$

Duplicate samples were preserved with 10 percent formalin and submitted to UP MSI for sorting, species identification and counting.

To determine zooplankton density or abundance, a 500 ml sample was sieved through a 500 µ mesh. For plankton greater than 500 µ (or those organisms which did not pass through the sieve), full counting of species was performed while subsampling was done for those organisms with size of less than 500 µ. In subsampling, a stempel pipette was used to collect 1 ml of sample (crosswise stroke without agitating the sample) and placed in a gridded petri dish. Counting of organisms was performed under a binocular microscope.

The following formula was used in the computation of zooplankton density and abundance:

$$\text{Full count of } >500\ \mu\ (no./m^3) = \frac{\text{no. of organisms}}{\text{actual volume filtered } (m^3)}$$

$$\text{Subsample counting of} <500\,\mu\ (\text{no./m}^3) = \frac{\text{no. of organisms}}{\text{vol. of aliquot (ml)}} \times \text{dilution volume (ml)} \times \frac{1}{\text{actual vol filtered (m}^3)}$$

$$\text{Total plankton density (no./m}^3) = \text{density of} >500\mu + \text{density of} <500\,\mu$$

Samples for phytoplankton species identification and counting were examined using a Sedgewick-Rafter counting chamber under a compound microscope. The formula below was used in computing for phytoplankton density:

$$\text{Density of phytoplankton (no./m}^3) = F \times \frac{1}{\text{volume (m}^3)}$$

where: F = no. of cells counted

The mean density values of plankton were used in computing species diversity indices. The following formula were used (Odum 1971):

Shannon's index of diversity:

$$H = \text{sum}\,[(n_i/N) \times \log(n_i/N)]$$

where:

n_i = importance value of each species (i.e., mean density);
N = total importance value of all species

Simpson's index of dominance:

$$c = \text{sum}\,(ni/N)^2$$

where:

ni = importance value of each species (i.e., mean density);
N = total importance value of all species

Pielou's evenness index:

$$e = H/\log S$$

where:

H = Shannon's index of diversity
S = number of species

5.1.5 Reef Fish Communities

Fish visual census was conducted in conjunction with the benthic life form surveys, using the same transect lines laid for these surveys. Preliminary survey (bounce dives) was made to determine possible transect positions before a detailed survey was conducted. The specific study sites were chosen based on the presence of reefs with relatively high coral cover and in areas where greatest impacts are projected and/or no impacts are expected. For each site, a 50 meter transect was laid parallel to the shore. Stations MS1a through MS5a were visited on 11 - 12 February 1995, while MS8a was visited in 11 March 1995.

Data Collection

The quantitative assessment of the fish utilized the underwater fish visual census method developed for the ASEAN-Australia Living Coastal Resources (LCR) Project (English *et al.* 1994). Fish was observed within an estimated five meters on either side of a transect line and 50 m above. The fish were identified to species level whenever possible and their abundance recorded. The individual counts for each specie were summed up at every five meter interval. This method has been shown to provide good estimates of abundance for most reef-associated fish. Fish identification was based on Masuda *et al.* (1984), Randall *et al.* (1990), and Myers (1991).

Three main groups of fishes were identified: "Indicator" species (or those that indicate the status of reefs) from the family Chaetodontidae, Pomacentridae and Pomacanthidae; "Target" species (or the commercially important species) from the families Serranidae, Siganidae, Acanthuridae, Scaridae, Carangidae, Lutjanidae, Caesionidae; and species from the "Major" (or the non-commercially important) families, Labridae, Blenniidae, Gobiidae, Centriscidae. Fish biomass for each site was computed using the conversion constant used by Kulbicki *et al.* (1993), averaging the biomass of all species.

Indices of dominance and diversity were computed as in the plankton component.

5.2 Regional Ecology

5.2.1 Seaweeds and Seagrasses (and Mangroves)

The most comprehensive and recent study on the seaweeds and seagrasses done in the region is that undertaken by EPAI/MSI (1993) on the resource and ecological assessment of Calauag Bay for the Fisheries Sector Program. It resulted in the identification of 56 species of seaweeds: 19 greens; 13 browns; and 24 reds. The most abundant were representatives of the brown algae, with total cover values ranging from 5-79 percent, followed by the reds with cover values ranging from 0.12-14 percent, and the greens, with 0.01-2 percent. Consistent with the findings of the present study, more than 90 percent of the total cover was contributed by five species of *Sargassum* spp.

Thirteen species of macrobenthic seaweeds were similarly reported from Cabalete Island. These are all records from the G. T. Velasquez Phycological Herbarium of the UP Marine Science Institute, dating as far back in time as 1965. Seven among these species are common with those identified in front of the proposed project site. With the exception of that mentioned in the EIS for the Power Plant Project in Pagbilao, no studies exist that deal with the environmental impacts on seaweeds in the region.

In the case of seagrasses, EPAI/MSI (1993) reported eight species from 14 study sites in Calauag Bay. These were all found in the present survey, although only one (*Thalassia hemprichii*) was recorded from near the proposed project site. The rest were found in the Cabalete stations. More importantly, the Calauag study provides the baseline in terms of dynamics of growth, recruitment and mortality of seagrass populations. This could be useful in monitoring activities of the proposed project. In addition, that study was able to delineate the categories of seagrass beds, an aspect useful in the management of the resource. The findings are now one of the bases for declaring the northeastern portion of the bay as a marine sanctuary due largely to the relatively pristine condition of its seagrass beds and because dugongs are still reported in the area. The other more recent study that touched on the environmental aspects of seagrasses is the EIS for the power plant project in Pagbilao.

The mangroves of Mauban belong to the 8,772.4 ha of mangroves for the entire province of Quezon (UNDP/UNESCO 1986). Specifically, they belong to the low-density, logged over category which comprised 32 percent of the vegetation.

As in the case of seaweeds, seagrasses and corals, the study done by EPAI/MSI (1993) in Calauag Bay is the most comprehensive study that dealt with the mangroves in the immediate vicinity of the proposed project site. Using remote sensing technology, Populus & Lantieri (1991) delineated 740 ha as mangrove regrowth (low density) and 190 ha as high density mangrove cover. This study, however, was not complemented by intensive ground truth surveys.

One of the most intensive studies done so far on mangroves in the Philippines has been undertaken in Pagbilao. These studies, dating back to the 1950's, have focused on the community structure, silviculture, provenance trials, productivity, fisheries, and more recently, on the genetic diversity of the plants. The Ecosystem Research and Development Bureau of the Department of Environment and Natural Resources still maintains a laboratory in the area.

5.2.2 Coral Reefs

Coral reefs occur along shallow, tropical coastlines where marine waters are oxygenated, clear and warm, and free from suspended sediments, excessive surface runoff, and pollutants. They have the highest primary productivity of any coastal ecosystem, contributing about 10-15 percent of the total fisheries catch annually (Carpenter 1977; Murdy & Ferraris 1980; McManus 1988; Chua 1991). In the Philippines, the average harvest in coral reefs is around 4-20 mt/km^2/year (Munro & Williams 1985). Reefs also play an important role in maintaining coastline stability by acting as an efficient physical barrier to tidal waves (White 1987). Coral reefs are considered the "rainforests" of the tropical seas. The contribution of coral reefs to the pharmaceutical industry could even be greater if knowledge and advanced technology were able to fully understand their potential. In addition, the aesthetic appeal, biological richness, clear waters and relative accessibility of coral reefs make them popular recreation areas for local and foreign tourists (White 1987).

Based on the results of a survey done in the early 1980's, the coral cover of the Philippines is less than 50 percent with about 70 percent of these coral reefs in fair to poor condition i. e., with less than 50 percent coral cover (Gomez *et al.* 1981). At present the condition is worse, especially in relation to the percentage of coral reefs with fair-poor condition as (80%) reported by Gomez (1991). Siltation, destructive fishing methods, tourism related activities and pollution are the major contributors to this condition (Gomez 1988).

Also in the study of the status of coral reefs in the Philippines (Gomez *et al.* 1981), a fair to good cover in four reefs surveyed in the Province of Quezon was reported. Estimates of living coral cover ranged from 20-29.9 percent in one site, 30-39.9 percent in another site, and 50-59.9 percent in the two other sites.

In a more recent study in Calauag Bay, Quezon (EPAI/MSI 1993), good coral cover (50%) was observed at Gerardo Point (northeast of Alabat Island, and east-southeast of the proposed project site). The coral reef station was characterized by low encrusting, nearly flat foliaceous and massive benthic lifeforms. The study sites at the southwestern tip of Alabat Is. exhibit fair coral cover at 45 percent and 38 percent living coral cover for the shallow (3-m) and deep (5-m) stations, respectively. At the deep station, branching *Acropora* species predominate while at the shallow station both branching and massive *Porites* were the dominant coral species. The eastern portion of Calauag Bay is characterized by a "scallop-like" configuration wherein the reef patches may be sporadically encountered at certain points. Living coral cover range from fair to good (27% to 60%). Dominant coral species include the branching *Porites* and encrusting *Galaxea*, *Montipora* and *Turbinaria*. There was also a notable prevalence of the macroalgae *Lobophora variegata* attached to rocks in the area including the deeper site southwest of Alabat Island.

5.2.3 Plankton

EPAI/MSI (1993) also investigated the plankton in Calauag Bay. Three components of the plankton (phytoplankton, invertebrate zooplankton, and ichthyoplankton) were studied. Primary producers are made up of phytoplankton while invertebrate zooplankton are prey to planktivorous fish and commercially important invertebrates. Secondary production is primarily based on zooplankton, most of which are crustaceans, particularly the copepods.

In the study, phytoplankton biomass was determined in May and August 1992 using the fluorometric method adapted from Parsons *et al.* (1984). This includes fluorescence measurements, chlorophyll a and phaeopigment measurements. Fluorescence profiles indicated maximum fluorescence at 40 or 60 m for deep stations while the same parameter increased with depth in shallow stations during May sampling. However, the August samples did not show any pronounced peaks both for shallow and deep stations (EPAI/MSI 1993).

Profiles of chlorophyll a and phaeopigments obtained in August showed the general fluorescence pattern observed above. Chlorophyll values in February, although higher than in August, did not show any significant differences over the different depths across stations and with time (EPAI/MSI 1993).

A total of 38 zooplankton taxa were identified. Dominant forms included copepod nauplii, copepod copepodites, adult cyclopoids, adult calanoids, larvaceans, adult harpacticoids, chaetognaths, juvenile gastropods, juvenile bivalves and polychaete larvae. These species comprised more than 90 percent of the total numbers caught each sampling period (EPAI/MSI 1993). These findings may indicate either the presence of a well mixed condition of the waters or the relative heterogeneous feature of the medium which may further point to the prevalence of a 'normal' unstressed coastal habitat condition.

Zooplankton densities fluctuated from 14,099 plankters/m^3 at the upper depth (0-20 m) to 648 plankters/m^3 at mid-depth (40-80 m) of the water column. In general, higher biomass was obtained at 0-40 m when compared to that in 40-80 m in May 1992, while the reverse was observed in February 1993 (EPAI/MSI 1993).

5.2.4 Reef Fish Communities

As with the other marine parameters, the most comprehensive study on reef fish in the region, to date, was that undertaken by EPAI/MSI (1993). This study surveyed eight sites spread along the entire length of the bay. The reefs in Calauag Bay were found to be productive, with an average stock of 44 tons/km^2 and a potential yield of 69 tons/km^2/year. 25-59 percent of the annual potential yield was estimated to be sustainable. A total of 297 species from 36 families were identified during the study period.

5.3 Site Ecology

5.3.1 Seaweeds and Seagrasses (and Mangroves)

Twenty-seven species from four major divisions of macrobenthic algae were identified from the seven sites: nine green algae (Chlorophyta); five brown algae (Phaeophyta); 11 red algae (Rhodophyta); and two bluegreen algae (Cyanophyta) (Table III-5-1). Stations MS1a (Plates III-5-1 and III-5-2) and MS2a (Plates III-5-3 and III-5-4) had the highest number of seaweed species (12 each), followed by Stations MS4a (Plates III-5-7 and III-5-8) and MS5a (Plates III-5-9, III-5-10, and III-5-11) each with eight species. Station MS3a (Plates III-5-5 and III-5-6) had seven species while Station MS6a (Plate III-5-12) had six species. The station nearest the mangroves in Cabalete Island (Station MS7a, Plates III-5-14 and III-5-15) had the lowest number with only four species.

TABLE III-5-1
FREQUENCY (%) OF SEAWEEDS AND SEAGRASSES RECORDED FROM THE SEVEN STUDY STATIONS AT MAUBAN (23-25 FEBRUARY 1995)(N=10-15)

	MS1a	MS2a	MS3a	MS4a	MS5a	MS6a	MS7a
Green Algae							
1. Acetabularia sp.					48		
2. Caul. rcemosa		8					
3. C. srtularioides	8	8					
4. D. cvernosa	4						
5. Halim. Macroloba						24	24
6. H. Tuna	12	10		12			
7. H. Velasquezii					12		
8. Microdictyon sp.					28		
9. Neom. Van-Bossae	8	8					
Brown Algae							
1. Dictyota dichotoma	6	8	4			12	4
2. Hormo. trichetra	8			8			
3. Padina sp.	36	28		24			12
4. Sargassum sp.	72	64	44	68		16	
5. Turbinaria ornata	16		12				
Red Algae							
1. Amp. fragilissima				48			8
2. Cer. Spongiosum				8	8	8	
3. Galax. oblongata	12	16	8				
4. Gelidiella acerosa	4						
5. Gracil. salicornia					8		
6. Gracil. Verrucosa				8			
7. Jania capillacea		24	12				
8. Laur.papillosa					12		
9. Laurencia sp.					12		
10. Liagora farinosa	32	24			12	8	
11. Mastophora rosea		8	4	4			
Bluegreen Algae							
1. Lyngbya sp.		8	12				
2. Brachytrichia quoyi							
No. of Species	12	12	7	8	8	6	4
Seagrasses							
Hydrocharitacea							
1. Halophila minor					20		
2. H. ovalis					24		
3. Enhalus acoroides					8		
4. Thal. hemprichii				12	28		
Cymodociaceae							
1. Cymo. rotundata					24		
2. C. serrulata							32
3. Halo. uninervis					60		24
4. Syr. isoetifolium					28		
				1	7		2

Plate III-5-1
Station MS1a: Mangrove trees fronting the study station

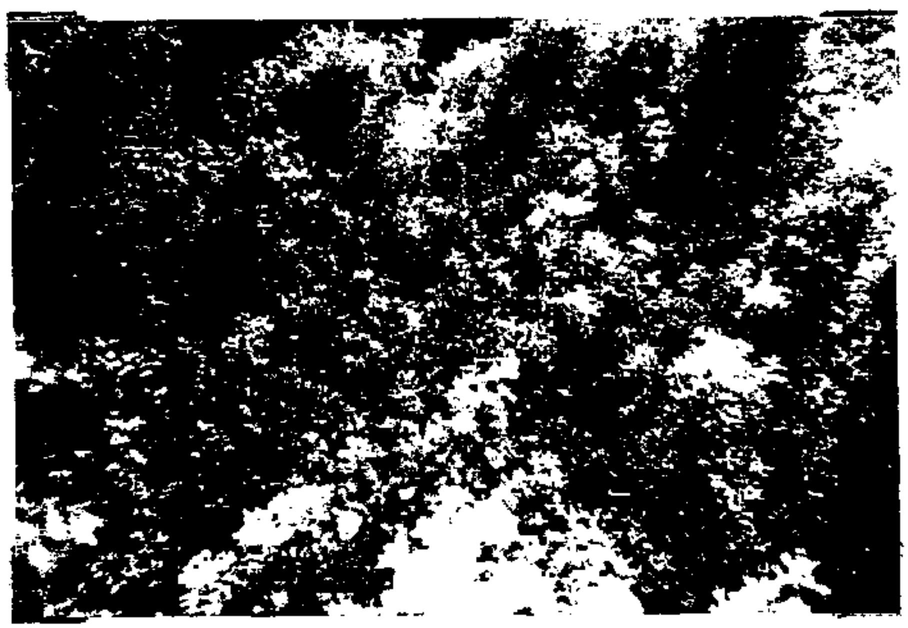

Plate III-5-2
The Seaweed Sargassum sp. colonizing the rocky borders of the reef
(75 m. from the mangroves)

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Plate III-5-3
Station MS2a: Shore vegetation fronting the study station

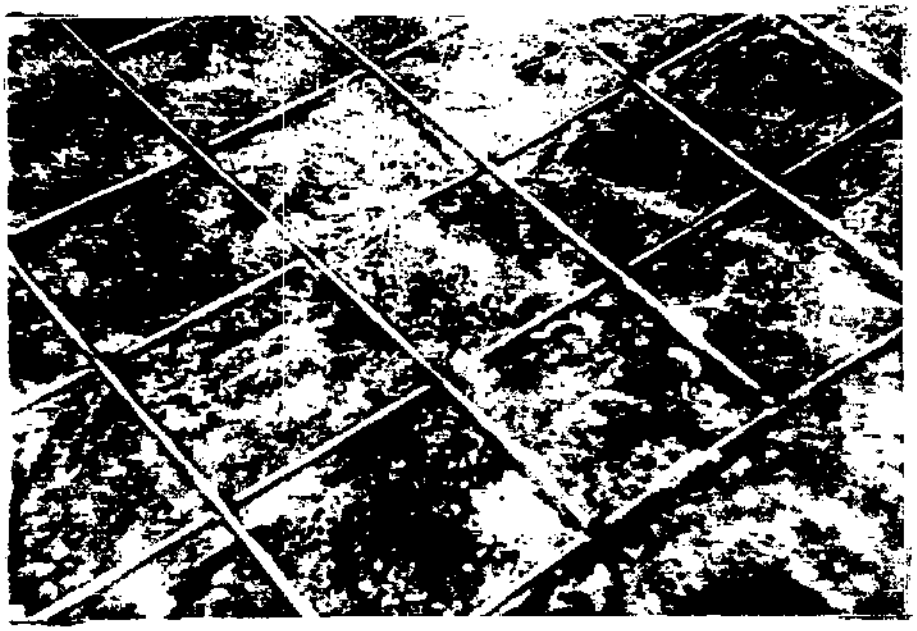

Plate III-5-4
Close-up of the rocky bottom showing dominance of the red seaweeds Liagora sp. (25 m. from the shoreline)

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Plate III-5-5
Station MS3a: Highly wave-exposed mangroves (Avicennia sp. and Sonneratia sp.) fronting the station. The mouth of the river is at the left (not shown)

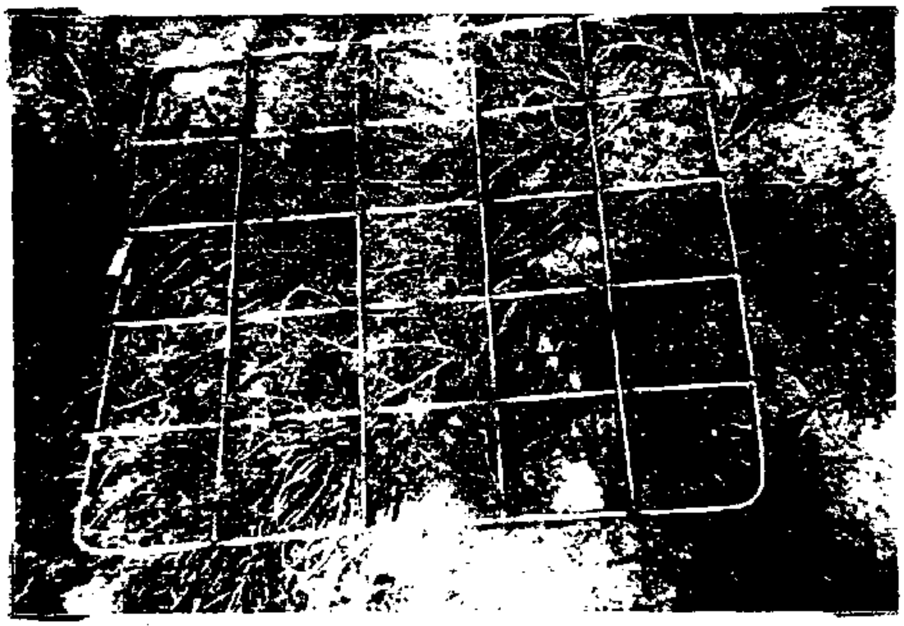

Plate III-5-6
Thalli of Sargassum sp. "defoliated" naturally by developmental processes (75 m. from the shore)

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Plate III-5-7
Station MS4a: The study station is south of the jetty, just where the photographer is standing

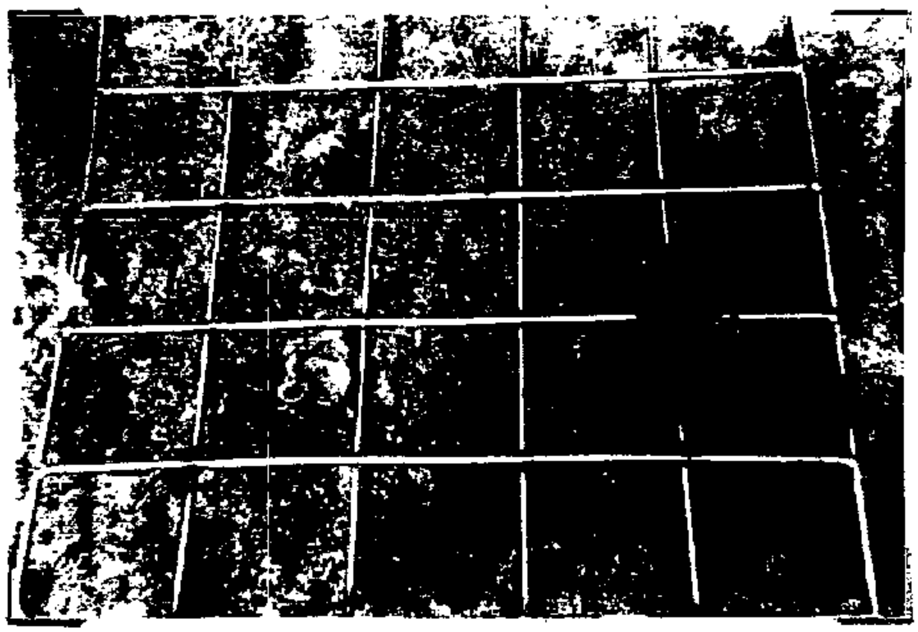

Plate III-5-8
The Seagrass Thallasia hemprichii with Padina sp. and other seaweeds (75 m. from the shoreline, or softer bottom)

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Plate III-5-9
Typical scene at deeper portions after the seagrass bed; dynamite fishing has been an important factor causing the degradation

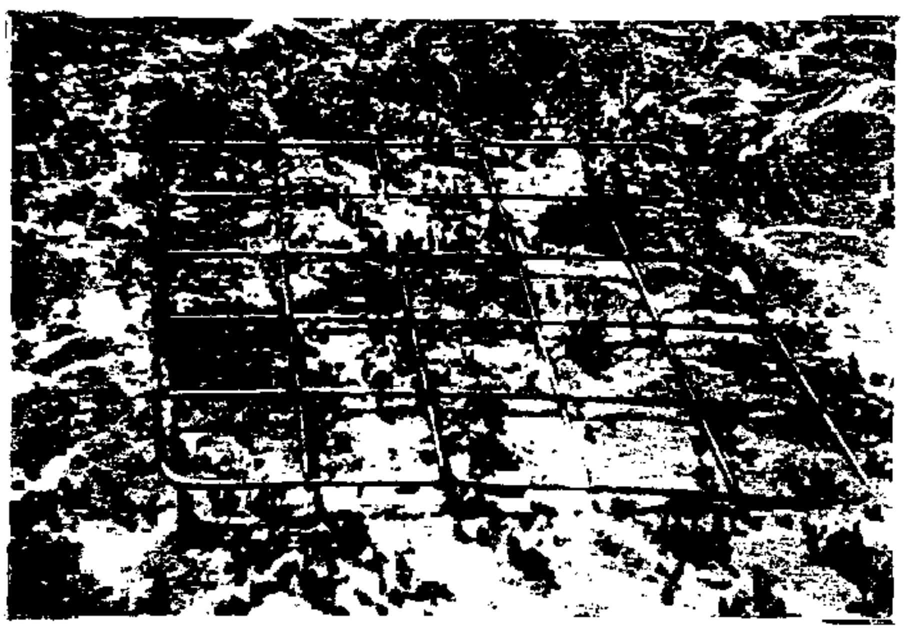

Plate III-5-10
Population of the seagrass <u>Halophila Ovalis</u>, a common sight 10-20 m. from the shore

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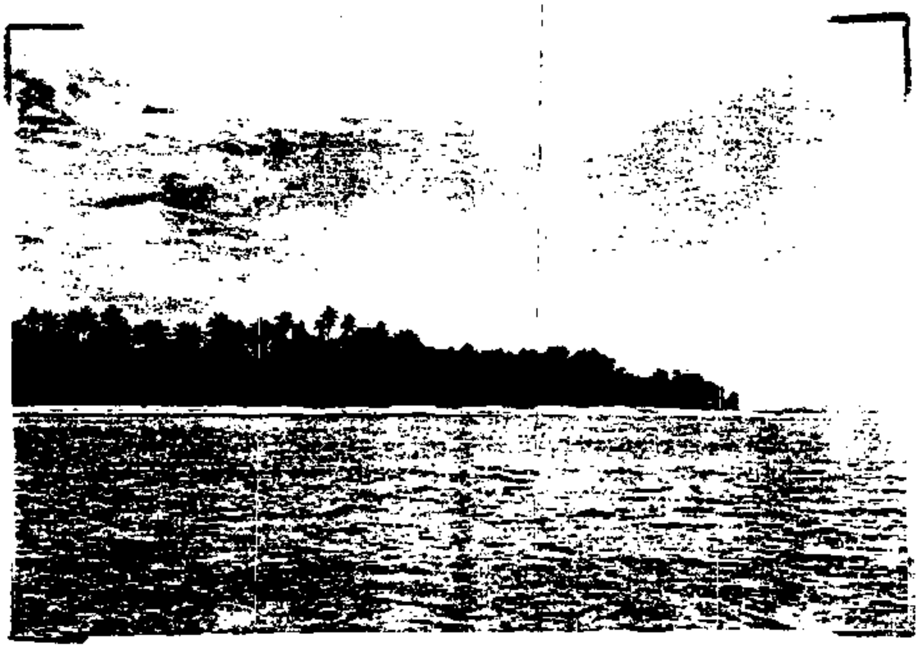

Plate III-5-11
Station MS5a (control station): south of Cagbalete Island eastnortheast of the project site

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Plate III-5-12
Station MS6a: Westsouthwest of Cagbalete Island fronting the main town; note fish aggregating device

Plate III-5-13
This a common sight at depths greater than 4 m., 100 m. from the shore

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NTS	A4	P230 101	A

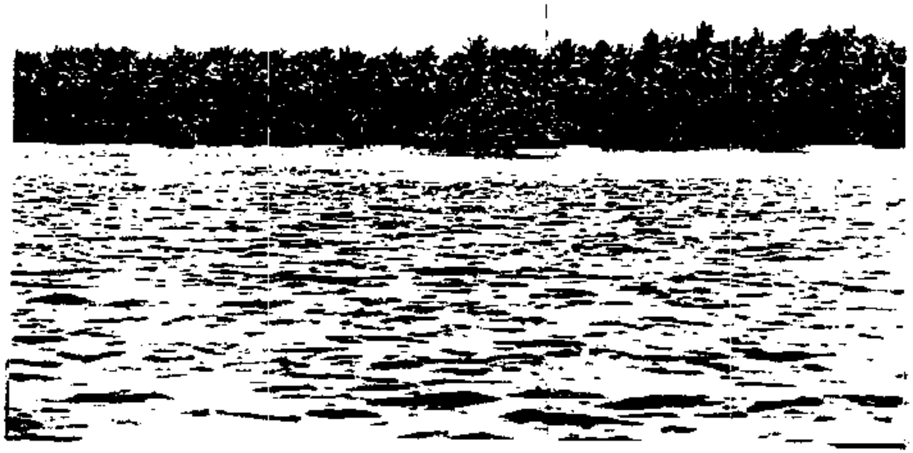

Plate III-5-14
Station MS7a: The station fronts a secondary mangrove patch, beside a river (to the left, not shown)

Plate III-5-15
The long-stemmed Cymodocea serrulata, growing with H. uninervis (50 m. west of river mouth)

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The abundance of seaweeds appear correlated directly with the favorability of the substrate for attachment. The brown seaweed *Sargassum* sp. dominated most of the stations (Table III-5-1), occupying the edges of the fringing reefs that front and run along the length of the coastline near the project site. This species is well adapted to surf due to its flexible and pliant thalli that allow it to bend with the current and waves, as well as with a holdfast which enables it to firmly attach itself on the hard rocky substrate. During the period of study, the species dominated but it is expected that during the warmer months, it will undergo senesce (normal developmental decay) as part of its normal development cycle.

The coast along the project site in Mauban is highly subjected to the onslaught of wind and waves (and its attendant exposure) as evidenced by the presence of lowly, crustose seaweeds (e. g. *Liagora, Jania*) which occupy the first 20-40 m distance nearest the shore. This area is partly exposed during the low tide. The presence of species highly adaptive to inorganic inputs and low light conditions (the bluegreens) further support this observation. The abundance of the other brown seaweed *Padina* sp. colonizing the tops of silted and dead corals is a clear indication of the resulting shift in the community from a once healthy reef type (heterotrophic) to one predominantly autotrophic, suggesting that man-induced perturbation played significant role in modifying the conditions.

In terms of the seagrasses, the coast along the immediate vicinity of the proposed project site was virtually devoid of the plants, that it was only at the control station (Station MS4a) where one species (*Thalassia hemprichii*) was found (Plates III-5-7 and III-5-8). At the stations in Cabalete Island, however, all eight species of seagrasses were found and in great abundance (Table III-5-1). The shallow sandy habitats at Stations MS5a (Plates III-5-9, III-5-10 and III-5-11) and MS6a (Plate III-5-12 and III-5-13) yielded the more pioneering and fast growing species (e. g. *Halophila* and *Halodule*), while the muddy and murky site in Station MS7a (Plates III-5-14 and III-5-15) yielded the abundance (low diversity) of the long-stemmed *Cymodocea serrulata* and the wide-leafed *Halodule uninervis*. These ecomorphs of the species are characteristic of such low light and muddy conditions.

In the case of mangroves, these habitats have been the object of intense use, on top of the natural stresses to which they have been subjected to. Hence, they are mostly depauperate, characterized by the presence of very sparsely distributed stands of *Avicennia* sp. and *Sonneratia caseolaris* fronting the study sites (Plates III-5-1, III-5-3, III-5-5, and III-5-7). The mangroves in Cabalete Island (Plate III-5-14), on the other hand, are relatively more lush, comprising thick but secondary stands of *Rhizophora* sp., mixed with *Avicennia* sp. and *Sonneratia* spp. This condition is brought about largely by the influence of a river which provides the vegetation with the necessary nutrients and topographic relief and protection from wind and waves.

The pattern of use of the mangroves by the coastal inhabitants appear depletive to the point that the natural stocks would eventually be lost in the process. Although reforestation efforts are being undertaken at the site, its maintenance and regrowth are far from what is desired to replenish the fast disappearing and highly degraded stock. Survival rates are relatively low and the high mortality of the seedlings and plants appear to be a result of mismanagement than as a result of silvicultural unfavorability of the site. At the current rate of usage by people which is for firewood and poles for fish traps, coupled with the natural accretional and erosional processes which subject the plants to depths and levels unfavorable for normal growth; it is a conservative estimate that after five years, the mangrove areas along the coastal zone in Mauban and Cabalete would be reduced significantly to half its present size.

5.3.2 Corals

The results of the manta tow surveys conducted in the reef areas southwest of Cabalete Island are shown in Figure III-5-2. It appears that hard coral cover ranges from fair to poor condition. Dead coral cover is more than 50 percent. Manta survey was attempted at the vicinities of the proposed project site at Cagsiay but was aborted due to low visibility in the area.

At each study site, a 100-m transect was laid at a depth of three meters. Beyond this depth the substrate is characterized by sandy-muddy bottom particularly at the immediate vicinity of the proposed power plant.

The results of the benthic life form surveys are summarized in Table III-5-2 and Figure III-5-3. Results of the surveys indicate that living coral cover range from relatively poor to good condition based on the categories set by Gomez, et al. (1981). The average hard coral cover is about 22.8 percent in all the six transect sites (Table III-5-3). Dead coral cover is about 45.5 percent while the abiotic components accounted for 20.9 percent of the benthos (Table III-5-4). Algal cover is about 10.6 percent while other fauna contributed only 0.33 percent. A more detailed discussion on the results of the benthic lifeform survey is presented in the succeeding sections.

- Station MS1a (Pier Area)

The living coral cover at Station MS1a (near the proposed conveyor and pier including the coal unloading facility) is relatively in poor condition at 12.9 percent with the encrusting, massive and sub-massive non-*Acropora* corals and branching *Acropora* species dominating the hard corals. This transect station registered the highest (69.3%) dead coral cover among the transects surveyed in the vicinity of the proposed power plant (Annex 6, Figure III-5-1). The low coral cover may be influenced by the operation or activities of the existing sawmill just about 100 m north of the transect site.

- Station MS2a (Intake Structure)

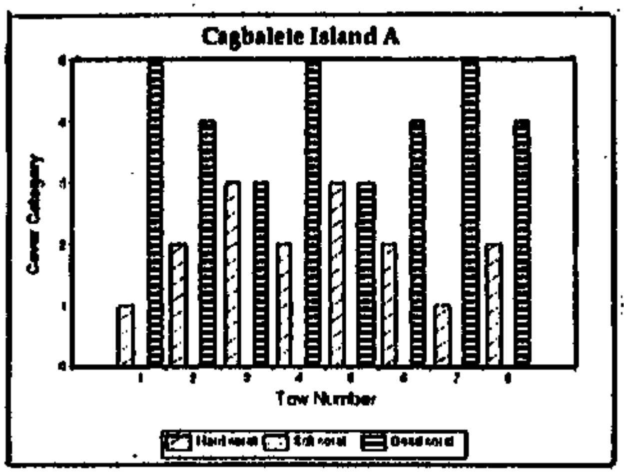
This is the transect near the proposed intake pipe which showed that non-*Acropora* corals, mostly the sub-massive types and tabulate *Acropora* species, dominated the hard corals with percentage cover of 12.4 percent and 14.6 percent, respectively, or equivalent to 27 percent or fair coral condition. Dead coral cover is about 63.6 percent. The living coral cover (including the soft corals) indicated a relatively fair coral condition. Low coral cover in this site may be attributed to destructive fishing methods (i.e., dynamite fishing) as evidenced by some coral damage due to blasting (Plate III-5-16).

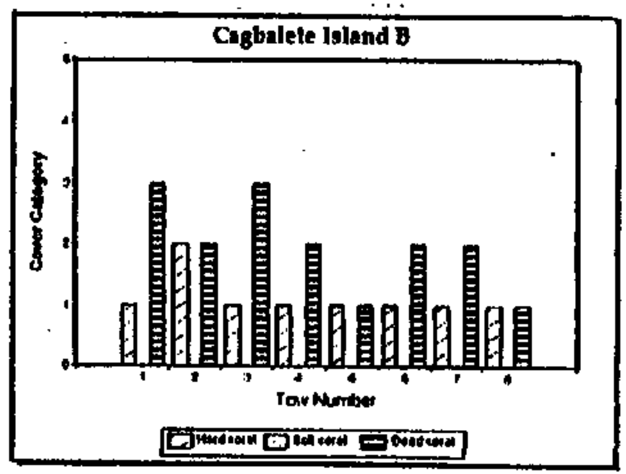
- Station MS3a (Construction Jetty and Outfall)

Station MS3a was established northeast of the proposed construction jetty and discharge pipe. Here, the condition of the reef is relatively 'good' with 58.7 percent living coral cover, the highest cover among all the sites investigated. This condition may be attributed to the presence of mangroves which buffer the reefs from excessive input of nutrients and silt from the nearby Cagsiay River. In addition and compared to the first two stations, MS3a is also the station farthest from the sawmill. The hard corals were represented mostly by tabulate and branching *Acropora* and encrusting and submassive non-*Acropora* species.

- Station MS4a (Control Station - Malazur Point)

The living coral cover at this control station near Malazur Point is about 11.9 percent with the low lying massive types dominating the non-*Acropora* corals. This suggests a poor coral condition in the area. Dead coral cover is about 49.5 percent with relatively high percentage (38.3%) of abiotic components, mostly water. The high percentage of the abiotic category can be attributed to the topography of the transect station.





MANTA TOW ESTIMATES OF PERCENTAGE BOTTOM COVER IN CAGBALETE ISLAND, MAUBAN, QUEZON (1=1-10%; 2=11-30%; 3=31-50%; 4=51-75%; 5=76-100%)

FIGURE III-5-2

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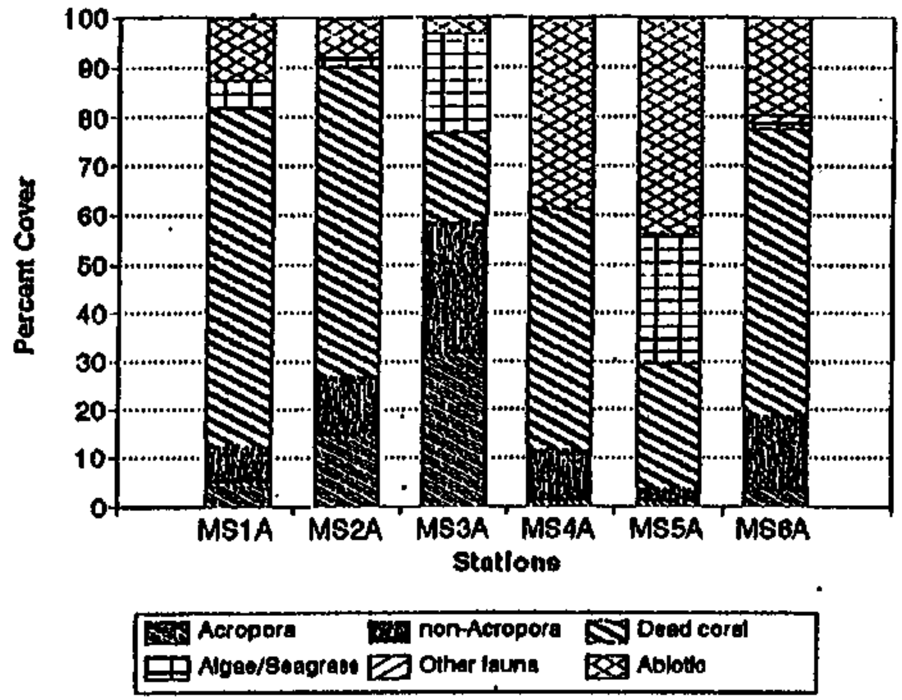
TABLE III-5-2
PERCENTAGE COVER OF BENTHIC LIFEFORMS IN MAUBAN, QUEZON

Station / Lifeform	MS1A	MS2A	MS3A	MS4A	MS5A
Hard coral	12.70	27.00	58.68	11.90	3.72
Acropora	4.74	14.61	31.34	0.96	0.91
ACB	4.74	4.84	5.26	0.68	0.06
ACT	0.00	8.26	3.74	0.28	0.85
ACE	0.00	0.00	0.00	0.00	0.00
ACS	0.00	1.51	22.34	0.00	0.00
Non-Acropora	7.96	12.39	27.34	10.94	2.81
CB	0.00	0.00	0.68	0.54	0.38
CM	2.63	3.77	2.16	7.68	1.95
CE	2.18	1.86	18.10	0.62	0.29
CS	3.02	6.64	6.40	2.10	0.15
CF	0.00	0.12	0.00	0.00	0.04
CMR	0.13	0.00	0.00	0.00	0.00
CME	0.00	0.00	0.00	0.00	0.00
CHL	0.00	0.00	0.00	0.00	0.00
Dead coral	69.25	63.60	18.42	49.50	26.21
DC	31.80	27.89	0.00	49.50	0.54
DCA	37.45	35.71	18.42	0.00	25.67
Algae/Seagrass	5.80	1.31	19.76	0.26	25.88
MA	4.40	1.20	1.10	0.26	7.13
TA	0.00	0.00	0.00	0.00	0.00
CA	0.75	0.11	15.16	0.00	0.00
HA	0.00	0.00	0.00	0.00	0.00
AA	0.65	0.00	3.50	0.00	18.75
SG	0.00	0.00	0.00	0.00	0.00
Other fauna	0.33	0.53	0.00	0.00	0.80
SC	0.19	0.48	0.00	0.00	0.21
SP	0.00	0.00	0.00	0.00	0.37
ZO	0.00	0.00	0.00	0.00	0.00
OT	0.14	0.05	0.00	0.00	0.22
Abiotic	11.92	7.56	3.14	38.34	43.39
S	3.54	1.19	0.72	0.00	1.23
R	4.95	1.30	2.22	0.50	41.51
SI	0.00	0.57	0.16	0.00	0.00
WA	3.43	4.50	0.00	37.84	0.65
RCK	0.00	0.00	0.04	0.00	0.00



SUMMARY OF BENTHIC LIFEFORMS IN MAUBAN, QUEZON

FIGURE III-5-3

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TABLE III-5-3
PERCENTAGE COVER OF HARD AND SOFT CORALS IN MAUBAN, QUEZON

Stations	Hard corals			Soft corals	Total %	Coral cover condition
	Acropora	Non-Acropora	Total			
MS1A	4.74	7.96	12.70	0.19	12.89	Poor
MS2A	14.61	12.39	27.00	0.48	27.48	Fair
MS3A	31.34	27.34	58.68	0.00	58.68	Good
MS4A	0.96	10.94	11.90	0.00	11.90	Poor
MS5A	0.91	2.81	3.72	0.21	3.93	Poor
MEAN	10.51	12.29	22.80	0.18	22.98	Poor

TABLE III-5-4
PERCENTAGE COVER OF MAJOR LIFEFORMS IN MAUBAN, QUEZON

Stations	Major lifeforms						
	Hard corals			Dead corals	Algae	Other fauna	Abiotic
	Acropora	Non-Acropora	Total				
MS1A	4.74	7.96	12.70	69.25	5.80	0.33	11.92
MS2A	14.61	12.39	27.00	63.60	1.31	0.53	7.56
MS3A	31.34	27.34	58.68	18.42	19.76	0.00	3.14
MS4A	0.96	10.94	11.90	49.50	0.26	0.00	38.34
MS5A	0.91	2.81	3.72	26.61	25.88	0.80	43.39
Mean	10.51	12.29	22.80	45.48	10.60	0.33	20.87

Plate III-5-16
Blasted coral reefs or seagrass beds

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- Station MS5a (Cabalete Island)

At Station MS5a (southwest of Cabalete Island), a relatively poor coral cover of 3.72 percent was observed. The living corals were represented mostly by the low lying massive non-*Acropora* species. Dead corals (mostly with algal cover) was about 26.2 percent while abiotic components (mostly rubble) accounted for 43.4 percent. The high percentage of rubble indicates that coral damage is due to blast fishing which is rampant in the area. During the field survey about 10 blasts were recorded in four hours. MS5a also gave the highest algal abundances with a cover value of 25.9 percent. Marcobenthic algal species such as *Padina, Sargassum, Turbinaria, Halimeda and Dictyota* were observed.

- Station MS8a (Northeast of the Interwood)

MS8a is located northeast of the proposed power plant. Results of the survey made in the station also showed poor living coral condition. Hard coral cover was about 18.9 percent and the soft coral species accounted for only 0.2 percent. Non-*Acropora* hard coral species mostly the massive types dominated over the *Acropora* species with 15.5 and 3.3 percent, respectively. Dead coral cover was about 59 percent and the abiotic component comprising 19.4 percent of the benthos. Highest percentage of silt under the abiotic category was noted at this station, indicating that siltation could be one of the factors affecting the status of the local coral reefs.

<u>Analysis of Results</u>

The results of the coral survey at the six stations are comparable with those obtained in Calauag Bay which showed that the coral reefs were in fair to good (27% to 60%) living coral cover condition (EPAI/MSI 1993). The transect stations visited during the field survey were also characterized by low encrusting, nearly flat foliaceous and massive benthic lifeforms. The similarity in the structure of the coral communities in Calauag Bay and in the areas studied in Mauban can be attributed to the same general climatic and water characteristics that prevail in both areas.

Some causes of reef stress cited in the Calauag Bay study were attributed to siltation, overfishing, organic pollution from domestic establishments, illegal fishing, and high wave energy (EPAI/MSI 1993). In the present study areas, high percentages of dead corals were similarly observed. This may also be attributed to blast fishing. In blast fishing, a single blast on the surface of a reef destroys all vertical structures within a 2-m radius (Gomez 1980). The high percentage of rubble particularly at Station MS5a in Cabalete Island suggests that this illegal activity may have contributed to the current state of the coral reefs in the area.

Siltation resulting from deforestation activities and river runoff could also contribute to the current condition of the reefs in the area. Low visibility in the immediate vicinity of the proposed project site at Cagsiay may have influenced the depth limit of corals to only about 3 m. Heavy silt load smothers corals and reduces the amount of light required by corals and marine plants. The operation of a sawmill at the immediate vicinity of the proposed power plant may also have posed some stress to the corals. It can be noted that coral cover increased with distance from the sawmill (i.e., from station MS1a to MS3a).

Exposure to strong waves accompanying typhoons and the northeast monsoon may be a natural cause of destruction of the reefs in the area. Adversely affected coral reefs have different recovery periods. It was suggested for instance that the typhoon-damaged reef in central Visayas may recover after five years to become "good" reefs, with 50-70 percent living coral cover (Alcala & Gomez 1978). Another natural cause of destruction can be attributed to the crown-of-thorns starfish *Acanthaster planci*, a coral predator, noted in Station MS2a. During the period of study, its contribution to reef destruction in the area is probably small since the species occurred singly.

5.3.3 Plankton

Physico-chemical characteristics

The water quality of an aquatic ecosystem consists of the physical component, the chemical variables and the biological productivity. Any activity (man-induced or natural) in the system affects the quality of water. It is from this perspective that the general water quality characteristics and plankton productivity of Lamon Bay were determined in relation to the establishment of the project.

Lamon Bay belongs to the Class SC marine waters. Beneficial uses include recreational water class II (e.g. boating, etc), fishery water class II (commercial and sustenance fishing); and marshy and/or mangrove areas declared as fish and wildlife estuaries (DENR 1990).

Table III-5-5 presents the results of the surveys made in Lamon Bay on 11 - 12 February and 11 March 1995. Transparency or the ability of light to penetrate the water column ranged from 1.5 m in MS8a (upper northeastern part of II) to 5 m in MS4a (opposite the light house in Cagsiay I) and MS5a in Cabalete Island. Light penetration is influenced by the presence of silt, suspended solids and plankton in the water column.

Oxygen is a critical component of an ecosystem because most metabolic processes require this element. Dissolved oxygen (DO) is the form of oxygen needed by aquatic organisms, plants and animals, for them to be able to perform respiration, decomposition and other metabolic activities. DO ranged from a low 1.30 mg/l in MS3a (opposite mangrove area) to 7.50 mg/l in MS8a. The amount of oxygen in an area is primarily affected by the presence of primary producers and consumers, light availability and temperature. The permissible level required by the DENR criteria (1990) should not be less than 5 mg/l. Based on the results, only MS5a and MS8a meet this requirement.

Salinity is a measure of the mass of dissolved salts in a given mass of solution (APHA 1989). The concentration of four major cations: Ca^{+2}, Mg^{+2}, Na^{+} and K^{+}, and four major anions: HCO_3^{-}, CO_3^{-2}, SO_4^{-2} and Cl^{-} usually constitute the total ionic salinity of water for all practical purposes (Limnology Handbook 1990). Salinity varies from 28 ppt (MS2a - MS4a) to 30 ppt (MS1a and MS8a). The concentration of salinity in an aquatic ecosystem may be influenced by the composition of suspended matter in the area.

Water temperatures of 26.2 $^{\circ}$C (MS1a and MS3a) to 28.3 $^{\circ}$C (MS8a) were obtained. The prevailing northeast monsoon may have brought about the cooler water temperature in the Bay. Variation in water temperature may be due to solar radiation and sampling time.

Biological variables

The biological component of an ecosystem consists of the flora and the fauna. The flora or plants present determine the primary productivity of the environment. This is the rate at which radiant energy is stored by photosynthetic and chemosynthetic activities of producer organisms (chiefly green plants) in the form of organic substances which can be used as food materials (Odum 1971). Gross primary productivity is the total rate of photosynthesis including organic matter used up in the respiration during the measurement period, while net productivity is the rate of storage of organic matter in plant tissues exceeding the respiratory use by plants during period of measurement. Primary production provides basic information on the amount of natural food (algae) available to fish at a specific time and place (LLDA 1987).

TABLE III-5-5

RESULTS OF GENERAL WATER QUALITY PARAMETERS MEASURED IN MAUBAN, QUEZON, FEBRUARY 11 - 12 AND MARCH 11, 1995.

STATION	PARAMETERS															
	Depth (m)	Transparency (m)			Temperature (^{o}C)			Salinity (ppt)			DO (mg/l)			pH		
		Feb 11	Feb 12	Mar 11	Feb 11	Feb 12	Mar 11	Feb 11	Feb 12	Mar 11	Feb 11	Feb 12	Mar 11	Feb 11	Feb 12	Mar 11
MS Ia	4.00	2.60			26.20			30.00			2.10			7.91		
MS 2a	5.00	3.50			27.00			28.00			1.90			7.93		
MS 3a	4.00	4.00			26.20			28.00			1.30			7.99		
MS 4a	5.00		5.00			26.70			28.00			4.20			8.05	
MS 5a	5.00		5.00			27.60			29.00			5.60			8.06	
MS 6a	1.50			1.50			28.30			30.00			7.20			8.09

The problem of receiving sufficient light for effective photosynthesis is considerably greater for plants living under water compared to terrestrial ones. Most of the light that strikes the surface of the water is lost through reflection and absorption by water, and only a few percent may actually be available to the suspended plankton for photosynthesis (Payne 1986).

Primary productivity. Gross primary production ranged from 1.1 $gC/m^2/day$ in MS3a to 18.9 $gC/m^2/day$ in MS2a (Table III-5-6). Net production varies from nil in MS1a to 6.8 $gC/m^2/day$ in MS4a. On the other hand, respiration rates were from nil in MS3a and MS5a to 15.4 $gC/m^2/day$ in MS1a. When the rate of respiration exceeds gross production, respiration levels may have come not only from the plants but from bacteria and animals present in the water column (APHA 1989).

Photosynthesis : respiration (P/R) ratios were also calculated from the six sites visited in Lamon Bay. Nil ratio was recorded in MS3a and MS5a while the highest ratio of 2.67 was found in MS4a. P/R ratio greater than 1 indicates that the system is exporting organic matter (Kinsey 1975) and population of autotrophic organisms are enhanced due to fertilizing substances (Stumm & Morgan 1981). On the other hand, P/R ratio less than 1 indicates that the system imports organic matter for nutritional requirements (Kinsey 1975) and heterotrophic organisms are enhanced due to input of biological degradable organic matter (Stumm & Morgan 1981).

Zooplankton biomass. Zooplankton biomass was estimated using the gravimetric method. This varies from 1,271 mg/m^3 to 8,861 mg/m^3 in MS3a (Table III-5-7). Results showed that the site where the highest biomass was measured gave the lowest gross production (1.08 $gC/m^2/day$) (Figure III-5-4). This indicates that food produced (measured through primary production) may have been consumed by the next trophic level giving the consumer organisms the ability to multiply and increase their population. Whereas lowest biomass measured in MS4a may be indicative of low consumer population as shown by the accumulation of food in the area or high gross and net productions 10.8 $gC/m^2/day$ and 6.8 $gC/m^2/day$, respectively (Figure III-5-4).

Plankton density and abundance. The biotic composition present in a community may be expressed in terms of species diversity. This has two concepts: species richness or species density, which is based on the total number of species present, and evenness which is based on the relative abundance of species and degree of dominance. The former is the total number of species usually expressed as species/number of individuals while the latter is the apportionment of individuals among the species (Odum 1983).

Usually a relatively smaller percentage of the community is abundant (represented by large number of individuals, large biomass or productivity) while a larger percentage is rare (have small importance values). While the dominants or few common species account for the energy flow in a trophic level, the large number of rare species largely determine the species diversity of trophic groups and whole communities (Odum 1983).

Tables III-5-8 and III-5-9 present the distribution and abundance of the phytoplankton and zooplankton communities using vertical and horizontal tows from the six stations studied. Due to logistical problems, vertical sampling was done in MS8a. Estimates of species richness, dominance, diversity and evenness are presented in Table III-5-10.

A total of 27 phytoplankton species/taxa and 18 zooplankton species were observed from the six stations. Of the 27 producer organisms, *Trichodesmium* (45.7%), *Chaetoceros* (26.8%), *Thalassionema* (14.0%), *Coscinodiscus* (7.7%) and *Rhizosolenia* (5.8%) comprised the five dominant producer organisms throughout the water column (Figure III-5-5, Table III-5-6). In the upper layer of water, *Trichodesmium* (65.7%), *Chaetoceros* (25.5%), *Leptocylindricus* (3.5%), *Thalassionema* (2.9%) and *Coscinodiscus* (2.4%) (Figure III-5-6, Table III-5-9) were the dominant ones. The ability of an organism to survive and/or reproduce in an area is influenced by several physico-

TABLE III-5-6

ESTIMATES OF PRIMARY PRODUCTIVITY (GC/M2/DAY) MEASURED IN LAMON BAY, MAUBAN, QUEZON, 11 - 12 FEBRUARY 1995.

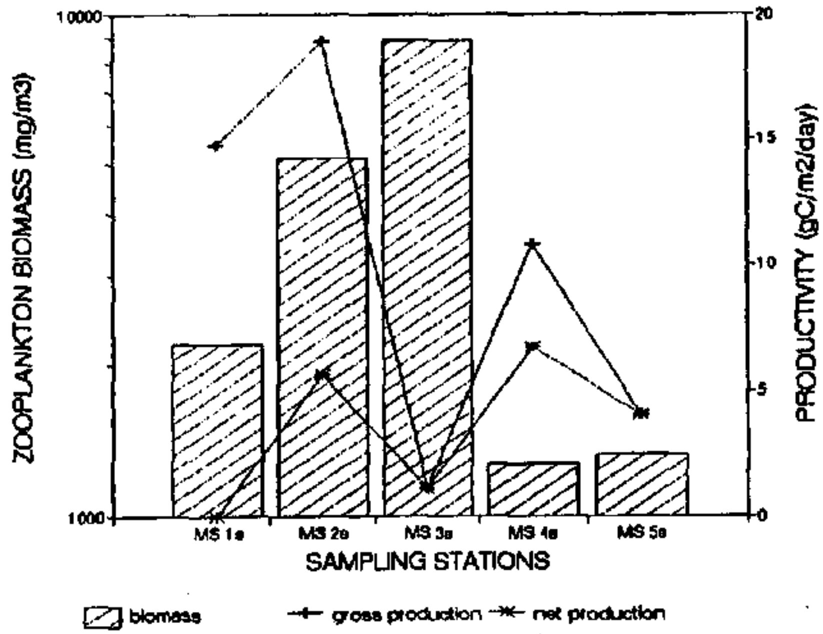
STATION	GROSS PRIMARY	NET PRIMARY (gC/m2/day)	RESPIRATION	P/R ratio
MS 1a	14.74	0.00	15.44	0.96
MS 2a	18.90	5.67	13.23	1.43
MS 3a	1.08	1.08	0.00	0.00
MS 4a	10.80	6.75	4.05	2.67
MS 5a	4.05	4.05	0.00	0.00

TABLE III-5-7

ESTIMATES OF ZOOPLANKTON BIOMASS USING DRY WEIGHT FROM THE 6 STATIONS IN LAMON BAY, MAUBAN, QUEZON, 11 - 12 FEB AND MAR 11, 1995.

STATION	VOLUME	DRY WEIGHT	BIOMASS
	(m3)	(mg)	(mg/m3)
MS 1a	0.2121	468.13	2207.56
MS 2a	0.2121	1091.75	5148.36
MS 3a	0.2121	1879.02	8860.85
MS 4a	0.2827	359.24	1270.53
MS 5a	0.2827	376.26	1330.74
MS 6a*			

*absence of plankton net made sampling not possible.



ZOOPLANKTON BIOMASS AND PRODUCTIVITY ESTIMATES IN LAMON BAY, 11-12 FEBRUARY 1995

FIGURE III-5-4

No.	DATE	BY	DESCRIPTION	DFT.	ENGR.	R.L.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK		APPROVAL		REFERENCE DRAWINGS	

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CLIENT (APPROVED)			

SCALE		BHPE DRG No.	REV.
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TABLE III-5-8

DISTRIBUTION AND ABUNDANCE OF PLANKTON IDENTIFIED THROUGH VERTICAL TOW FROM MAUBAN, QUEZON, (11 - 12 FEBRUARY, 1995).

TAXA	DENSITY (nos./cu.m.)						RELATIVE ABUNDANCE					
	MS1a	MS2a	MS3a	MS4a	MS5a	Mean	MS1a	MS2a	MS3a	MS4a	MS5a	Mean
PHYTOPLANKTON												
Class Bacillariophyta				197.52	1117.19	952.72	1.70	5.29	5.50	1.09	7.59	3.92
Asterionella	613.72	1195.19	1639.98	197.52	1117.19	952.72	1.70	5.29	5.50	1.09	7.59	3.92
Bacillaria	0.00	0.00	44.04	0.00	18.89	12.59	0.00	0.00	0.15	0.00	0.13	0.05
Biddulphia	359.92	133.62	334.75	47.19	313.05	237.71	1.00	0.59	1.12	0.26	2.13	0.98
Chaetoceros	9097.93	5477.75	6497.74	5801.20	65.16	5387.95	25.18	24.23	21.79	31.97	0.44	22.19
Coscinodiscus	893.45	1936.21	2593.92	962.15	1381.92	1553.53	2.47	8.57	8.70	5.30	9.39	6.40
Ditylum	219.24	90.38	171.33	225.22	0.00	141.23	0.61	0.40	0.57	1.24	0.00	0.58
Fragilaria	0.00	69.17	42.43	0.00	77.26	37.77	0.00	0.31	0.14	0.00	0.53	0.16
Lauderia	0.00	0.00	0.00	0.00	112.03	22.41	0.00	0.00	0.00	0.00	0.76	0.09
Leptocylindricus	1253.37	585.43	601.13	158.01	591.33	637.86	3.47	2.59	2.02	0.87	4.02	2.63
Navicula	189.39	132.01	149.32	10.61	51.89	106.65	0.52	0.58	0.50	0.06	0.35	0.44
Nitzchia	36.96	132.01	18.86	380.86	140.33	141.80	0.10	0.58	0.06	2.10	0.95	0.58
Pleurosigma	0.00	38.52	202.73	0.00	0.00	48.25	0.00	0.17	0.68	0.00	0.00	0.20
Rhabdonema	0.00	0.00	24.38	6.51	0.00	6.18	0.00	0.00	0.08	0.04	0.00	0.03
Rhizosolenia	1636.82	1405.80	938.24	797.67	1018.18	1159.34	4.53	6.22	3.15	4.40	6.92	4.77
Skeletonema	159.55	312.73	0.00	27.73	66.04	113.21	0.44	1.38	0.00	0.15	0.45	0.47
Thalassionema	5649.83	1948.80	3290.90	1947.29	1254.58	2818.28	15.64	8.62	11.04	10.73	8.53	11.61
Thalassiosira	642.76	542.20	567.37	333.11	1136.68	644.43	1.78	2.40	1.90	1.84	7.73	2.65
Thalassiothrix	110.80	0.00	0.00	6.51	306.58	84.78	0.31	0.00	0.00	0.04	2.08	0.35
Class Cyanophyta												
Trichodesmium	13978.45	7685.86	11689.44	6483.30	6035.27	9174.46	38.69	34.00	39.21	35.73	41.03	37.79
Class Pyrrophyta												
Ceratium	920.18	637.29	543.00	291.26	804.74	639.29	2.55	2.82	1.82	1.61	5.47	2.63
Dinophysis	73.08	0.00	8.68	0.00	0.00	16.35	0.20	0.00	0.03	0.00	0.00	0.07
Gymnodinium	31.45	21.22	99.01	56.60	0.00	41.65	0.09	0.09	0.33	0.31	0.00	0.17
Peridinium	78.60	37.72	52.66	24.76	0.00	38.75	0.22	0.17	0.18	0.14	0.00	0.16
Phalacroma	79.40	14.14	0.00	0.00	0.00	18.71	0.22	0.06	0.00	0.00	0.00	0.08
Others												
Cocolith	0.00	0.00	69.17	0.00	0.00	13.83	0.00	0.00	0.23	0.00	0.00	0.06
Halosphaera	72.28	179.96	194.91	340.18	219.92	201.45	0.20	0.80	0.65	1.87	1.49	0.83
Phaeocystis	27.53	28.29	39.32	46.59	0.00	28.35	0.08	0.13	0.13	0.26	0.00	0.12
TOTAL	36124.71	22604.29	29813.30	18144.29	14711.04	24279.52	100.00	100.00	100.00	100.00	100.00	100.00

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TABLE III-5-9

DISTRIBUTION AND ABUNDANCE OF PLANKTON IDENTIFIED THROUGH VERTICAL TOW FROM MAUBAN, QUEZON (11-12 FEBRUARY 1995)

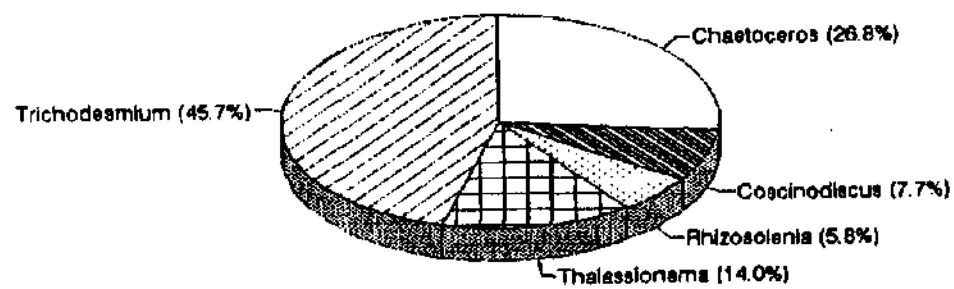
TAXA	DENSITY (nos./cu.m.)						RELATIVE ABUNDANCE					
	MS1a	MS2a	MS3a	MS4a	MS5a	Mean	MS1a	MS2a	MS3a	MS4a	MS5a	Mean
ZOOPLANKTON												
Organisms >500um												
Appendicularians	0.00	70.72	80.15	19.46	38.91	41.85	0.00	0.33	0.13	0.48	0.49	0.20
Calanoid copepod	91.94	188.59	476.19	111.43	86.66	190.96	1.31	0.87	0.77	2.75	1.10	0.93
Cladocerans	0.00	2.36	7.07	0.00	3.54	2.59	0.00	0.01	0.01	0.00	0.04	0.01
Cyclopoid copepod	40.08	21.22	63.65	38.91	77.82	48.33	0.57	0.10	0.10	0.96	0.99	0.24
Decapods shrimp	7.07	0.00	33.00	0.00	0.00	8.02	0.10	0.00	0.05	0.00	0.00	0.04
Echinoderm larvae	63.65	143.80	70.72	10.61	10.61	59.88	0.91	0.67	0.11	0.26	0.13	0.29
Fish egg	9.43	75.44	14.14	0.00	0.00	19.80	0.13	0.35	0.02	0.00	0.00	0.10
Foramineferans	0.00	2.36	183.88	5.31	7.07	39.72	0.00	0.01	0.30	0.13	0.09	0.19
Gastropod egg	11.79	0.00	2.36	0.00	14.15	5.66	0.17	0.00	0.00	0.00	0.18	0.03
Gastropod larvae	0.00	0.00	0.00	0.00	3.54	0.71	0.00	0.00	0.00	0.00	0.04	0.00
Harpaticoid copepod	51.86	28.29	80.15	35.37	77.82	54.70	0.74	0.13	0.13	0.87	0.99	0.27
Hydromedusa	18.86	30.65	16.50	15.92	0.00	16.38	0.27	0.14	0.03	0.39	0.00	0.08
Lamellibranch larvae	0.00	0.00	33.00	0.00	0.00	6.60	0.00	0.00	0.05	0.00	0.00	0.03
Larvaceans	94.30	0.00	0.00	0.00	0.00	18.86	1.34	0.00	0.00	0.00	0.00	0.09
Nauplii	0.00	146.16	0.00	1.77	30.07	35.60	0.00	0.68	0.00	0.04	0.38	0.17
Polychaete larva	25.93	51.86	155.59	10.61	17.69	52.34	0.37	0.24	0.25	0.26	0.22	0.26
Salps	0.00	4.71	25.93	0.00	0.00	6.13	0.00	0.02	0.04	0.00	0.00	0.03
Tintinnids	0.00	0.00	0.00	28.30	0.00	5.66	0.00	0.00	0.00	0.70	0.00	0.03
SUBTOTAL	414.90	766.15	1242.34	277.68	367.88	613.79	5.90	3.55	2.02	6.85	4.67	3.00
Organisms <500um												
Acantharians	0.00	0.00	0.00	175.45	0.00	35.09	0.00	0.00	0.00	4.33	0.00	0.17
Appendicularians	0.00	3072.37	4636.26	0.00	7.43	1543.21	0.00	14.25	7.52	0.00	0.09	7.55
Calanoid copepod	2300.33	8011.08	37661.01	2538.03	3935.27	10889.14	32.73	37.15	61.09	62.65	49.94	53.29
Cyclopoid copepod	893.92	1151.11	3001.65	574.81	1702.33	1464.77	12.72	5.34	4.87	14.19	21.60	7.17
Echinoderm larvae	9.90	0.00	0.00	0.00	0.00	1.98	0.14	0.00	0.00	0.00	0.00	0.01
Fish egg	0.00	31.35	0.00	0.00	0.00	6.27	0.00	0.15	0.00	0.00	0.00	0.03
Foramineferans	0.00	86.52	10973.60	0.00	4.42	2212.91	0.00	0.40	17.80	0.00	0.06	10.83
Gastropod egg	23.57	0.00	141.44	0.00	0.00	33.00	0.34	0.00	0.23	0.00	0.00	0.16
Harpaticoid copepod	915.49	1583.22	3989.86	365.58	1233.64	1617.56	13.03	7.34	6.47	9.02	15.65	7.92
Larvaceans	2174.68	0.00	0.00	0.00	0.00	434.94	30.95	0.00	0.00	0.00	0.00	2.13
Nauplii	253.42	6861.86	0.00	119.38	629.38	1572.81	3.61	31.82	0.00	2.95	7.99	7.70
Polychaete larvae	41.25	0.00	0.00	0.00	0.00	8.25	0.59	0.00	0.00	0.00	0.00	0.04
SUBTOTAL	6612.56	20797.50	60403.82	3773.26	7512.47	19819.92	94.10	96.45	97.98	93.15	95.33	97.00
TOTAL	7027.46	21563.65	61646.16	4050.94	7880.35	20433.71	100.00	100.00	100.00	100.00	100.00	100.00

TABLE III-5-10

AN ESTIMATE OF THE SPECIES RICHNESS, SHANNON INDEX OF DIVERSITY AND PILEOU'S EVENNESS INDEX FROM THE 6 STATIONS IN LAMON BAY, MAUBAN, QUEZON, 11 - 12 FEBRUARY AND 11 MARCH 1995.

Station	Species Richness		Shannon Index of Diversity		Simpson's Index of Dominance		Pielou's Evenness Index	
	Phytoplankton	Zooplankton	Phytoplankton	Zooplankton	Phytoplankton	Zooplankton	Phytoplankton	Zooplankton
VERTICAL								
MS 1a	4.3881	4.4193	0.7835	0.7433	0.2400	0.2400	0.5926	0.5921
MS 2a	4.5933	4.1535	0.8746	0.6862	0.2000	0.2700	0.6615	0.5366
MS 3a	4.9168	3.9667	0.8288	0.5473	0.2300	0.4200	0.6086	0.4207
MS 4a	4.4614	3.8807	0.7744	0.5807	0.2500	0.4200	0.5952	0.4938
MS 5a	4.0790	4.1062	0.9014	0.6150	0.2100	0.3300	0.7181	0.4998
MS 6a*								
HORIZONTAL								
MS 1a	4.3990	5.9276	0.3160	0.5670	0.7057	0.3744	0.3034	0.5090
MS 2a	5.3286	15.6726	0.6577	0.6729	0.3203	0.3597	0.7283	0.6041
MS 3a	3.8001	5.5542	0.4398	0.5725	0.5359	0.4030	0.5652	0.6774
MS 4a	4.6503	12.7517	0.5378	0.8050	0.3940	0.2431	0.4828	0.8436
MS 5a	6.9141	4.9418	0.6871	0.6466	0.3009	0.3403	0.6871	0.7160
MS 6a	5.9072	5.7566	0.4838	0.4606	0.4109	0.4930	0.8036	0.7650

*absence of plankton net did not permit vertical sampling.



RELATIVE ABUNDANCE OF PHYTOPLANKTON USING
VERTICAL TOW IN LAMON BAY, 11-12 FEBRUARY 1995

FIGURE III-5-5

No.	DATE	BY	DESCRIPTION	DFT.	ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK		APPROVAL		REFERENCE DRAWINGS	

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DRAWN			
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ENGINEERING (CHECK)			
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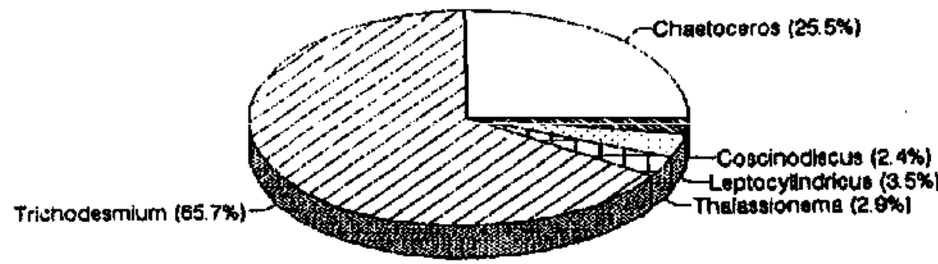

RELATIVE ABUNDANCE OF PHYTOPLANKTON USING HORIZONTAL TOW IN LAMON BAY, 11-12 FEBRUARY AND 11 MARCH 1995

FIGURE III-5-6

No.	DATE	BY	DESCRIPTION	DFT. ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK	APPROVAL		REFERENCE DRAWINGS	

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433 MW (NET) QUEZON POWER PROJECT ENVIRONMENTAL IMPACT STUDY

	Name	Sign	Date
DRAWN			
DRAFTING (CHECK)			
ENGINEERING (CHECK)			
R. ENGR. (APPROVED)			
CLIENT (APPROVED)			

SCALE		BHPE DRG No.	REV.
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chemical factors one of which is nutrients. This is one advantage of *Trichodesmium* over the other species making it dominant. *Trichodesmium* being a bluegreen algae, has the ability to fix atmospheric nitrogen. Thus in terms of nutrient requirements, nitrogen is not a limiting factor enabling the organism to increase its population. On the other hand, *Chaetoceros* is indicative of the clearness of the water column.

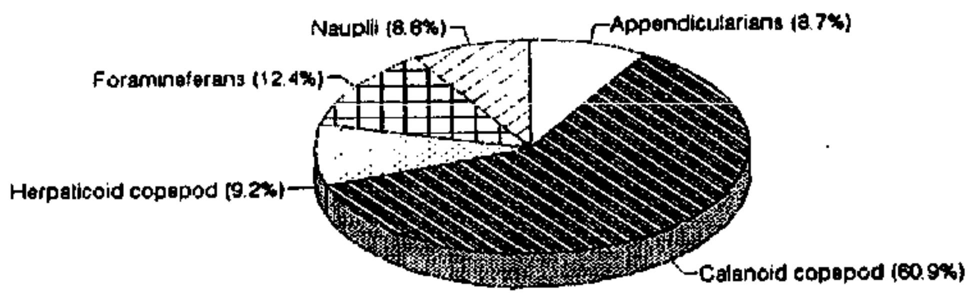
Among the 18 consumer species, calanoid copepod (60.9%), foramineferans (12.4%), herpaticoid copepod (9.2%), nauplii (8.8%) and appendicularians (8.7%) (Table III- 5-6) were observed to be dominant throughout the water column. On the upper depths, calanoid copepod (41.1%), appendicularians (39.5%), cyclopoid copepod (12.8%), lamellibranch larvae (4.7%) and foramineferans (1.9%) (Figure III-5-8, Table III-5-9) were encountered. Analysis of the dominant consumers in Lamon Bay make it comparable to the species of Calauag Bay. Dominance of a species over the others is governed by environmental and physiological processes of the organism.

Species richness gives a measure of the kinds of organisms, plants and animals, that support the food chain relationship. The results of all vertical tows reveal that MS3a has the highest estimate of species richness for phytoplankton and MS1a, for zooplankton. From the same site, zooplankton biomass was highest, indicating that more food is available which leads to higher biomass. The results of the horizontal tows, on the other hand, showed that Cabalete Island has the richest phytoplankton community, while MS2a has the richest zooplankton community. These findings indicate that at least during the sampling period, the coastal waters in the immediate vicinity of the proposed project is still relatively fertile, dynamically and biologically stable, and capable of supporting the 'normal' functions of coastal tropical waters.

Dominance is an expression of the relative abundance of species. Dominant algal species in MS4a (*Trichodesmium*, *Chaetoceros* and *Skeletonema*) are responsible for the high net productivity in the area. Zooplankton species, calanoid, cyclopoid and herpaticoid copepods influenced the high biomass rate in MS3a. The very low DO concentration in MS3a indicates that more consumers are present in the water column since oxygen was being consumed for respiratory purposes. Average relative plankton dominance from the five stations showed that *Trichodesmium* and *Chaetoceros* are the two dominant phytoplankton species from both vertical and horizontal tows (Figures III-5-5 and III-5-6), while calanoid copepod and foramineferans were dominant (from the results of the vertical tows (Figure III-5-7). A bluegreen alga, *Trichodesmium* has the ability to fix atmospheric nitrogen, hence, can easily reproduce, resulting in population increase. On the other hand, *Chaetoceros* indicates clear water column, suggesting that light is available for photosynthesis. Calanoid copepod and appendicularians were the dominant consumer species on the upper depth of the water column.

Ratios between the number of species and importance values of individuals within each species are called species diversity indices. These indices tend to be low in physically controlled ecosystems (i.e., subjected to strong physico-chemical limiting factors) and high in biologically controlled ecosystem. Highest index (Shannon diversity index) for the phytoplankton was recorded in MS5a (Cabalete Island) but this station revealed low dominance throughout the water column (Table III-5-10). This indicates that although there are several kinds of species of phytoplankton in the waters, the number of cells per species is low. Such may be a product of intraspecific and interspecific competition among organisms.

The same behavior was observed for the zooplankton community, i.e., MS1a has the most diverse zooplankton species but with a low dominance throughout the water column (Table III-5-10). On the other hand, MS4a is the station where this pattern was observed in the upper depth.



RELATIVE ABUNDANCE OF ZOOPLANKTON USING VERTICAL TOW IN LAMON BAY, 11-12 FEBRUARY 1995

FIGURE III-5-7

No.	DATE	BY	DESCRIPTION	INT. ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
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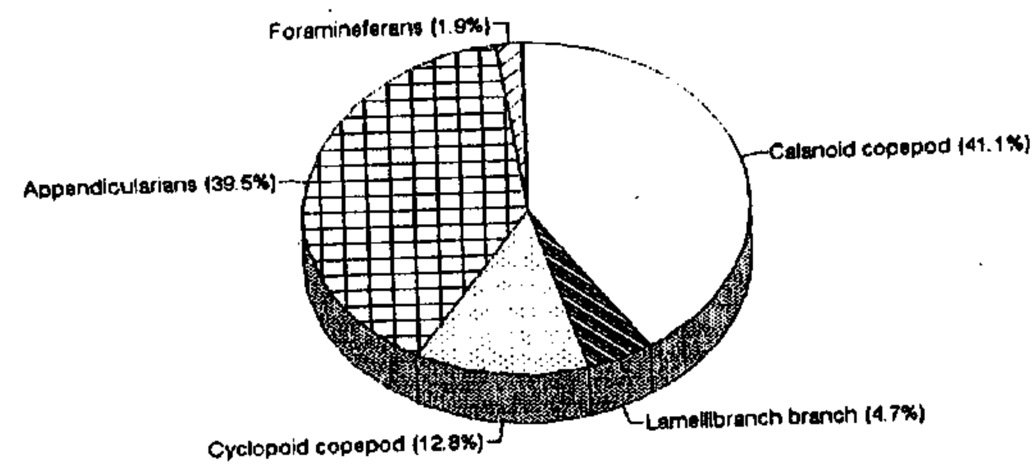

RELATIVE ABUNDANCE OF ZOOPLANKTON USING HORIZONTAL TOW IN LAMON BAY, 11-12 FEBRUARY AND 11 MARCH 1995

FIGURE III-5-8

No.	DATE	BY	DESCRIPTION	OFT.	ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
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5.3.4 Reef Fish Communities

A total of 81 fish species belonging to 23 families were recorded from the 6 sites surveyed (Table III-5-11). Species from the family *Labridae* and *Pomacentridae* were the most common. These were present in all the sites, and in relatively greater numbers than the other species. Labrids and pomacentrids constitute about 42 percent and 31 percent respectively, of the total number of fish encountered. Commercially important or "target" species form the next most abundant group, making up 14 percent of the total (see Annex 6, Table 1). The species included in this group are the usually sought after or target species (e.g. serranids, lutjanids, nemipterids, siganids and scarids). Chaetodontids or butterflyfishes make up only about 2 percent of the total (Figure III-5-9).

The number of species, and the relative abundance of each, varied widely among sites (Table III-5-12). The number of species recorded ranged from 20 to 42. Station MS1a and MS3a showed the lowest numbers of species, while MS2a showed the highest. The densities recorded ranged from 51 to 200 individuals/500 m^2. Preliminary estimates of standing stocks for each site are also presented in Table III-5-12. The lowest standing stock was observed at station MS1a (4.1 tons/km^2), while the highest was observed at stations MS2a and MS5a (16 tons/km^2).

The ten most abundant species were *Pomacentrus bankanensis, Halichoeres hoeveni, Thalassoma lunare, Labrid sp1., Scarus harid, Thalassoma lutescens, Pomacentrus moluccensis, Scarus sordidus, Pomacentrus smithi,* and *Canthigaster amboinensis* (Table III-5-11). The first two species were encountered across all transect sites, while the other eight species except for *Labrid* sp1. and *T. Lutescens* were found in four or five of the six transect sites.

The reef fish communities at the sites surveyed were depauperate, both in terms of species richness and individual abundance. This condition is usually attributed to stress in the system which would include man-induced stress such as fishing, or pollution, and natural stress such as high energy wave action or freshwater discharge. Since fishing using normal and legal methods is minimal in the area, the condition of the fisheries characterized by low species diversities and abundance cannot be attributed to this type of fishing pressure.

The sites MS1a through MS4a and MS8a are situated along the northeastern coast of Mauban. This area faces the Pacific Ocean and is continually exposed to high energy wave action. Two river systems also discharge fresh water into the area. Under such conditions, the area would be subject to excessive wave action and have heavy sediment loading from both the surface water discharge and the scouring of the substrate by wave.

Species that are not adapted to such conditions either suffer high mortality rates or emigrate out of the area. In either case species are lost and the more adapted ones become numerically dominant. This seems to be the case for all the sites surveyed. These sites were characterized by the dominance of labrids and pomacentrids which accounted for 74 percent of the total number of fish encountered during the surveys (Table III-5-11). This strong numerical dominance persisted across all stations, even as the numbers of the other species changed. This is similar to that observed in adjacent areas (e. g. Calauag Bay) where pomacentrids and labrids were also more abundant than other species (EPAI/MSI, 1993).

Member species of both *Labridae* and *Pomacentridae* exhibit a wide variety of feeding preferences and strategies. Most pomacentrids are algal grazers or planktivores; labrids on the other hand, feed mainly on invertebrates. As such, this group requires a wide variety of food items to persist. Since the area is moderately exposed, it tends to offer more variety of food. The continual scouring of the substrate by wave replenishes the food supply by bringing in new material or re-suspending old or previously unavailable material. Probably this is the most influential factor that has affected the numerical dominance of labrids and pomacentrids in the area.

TABLE III-5-11

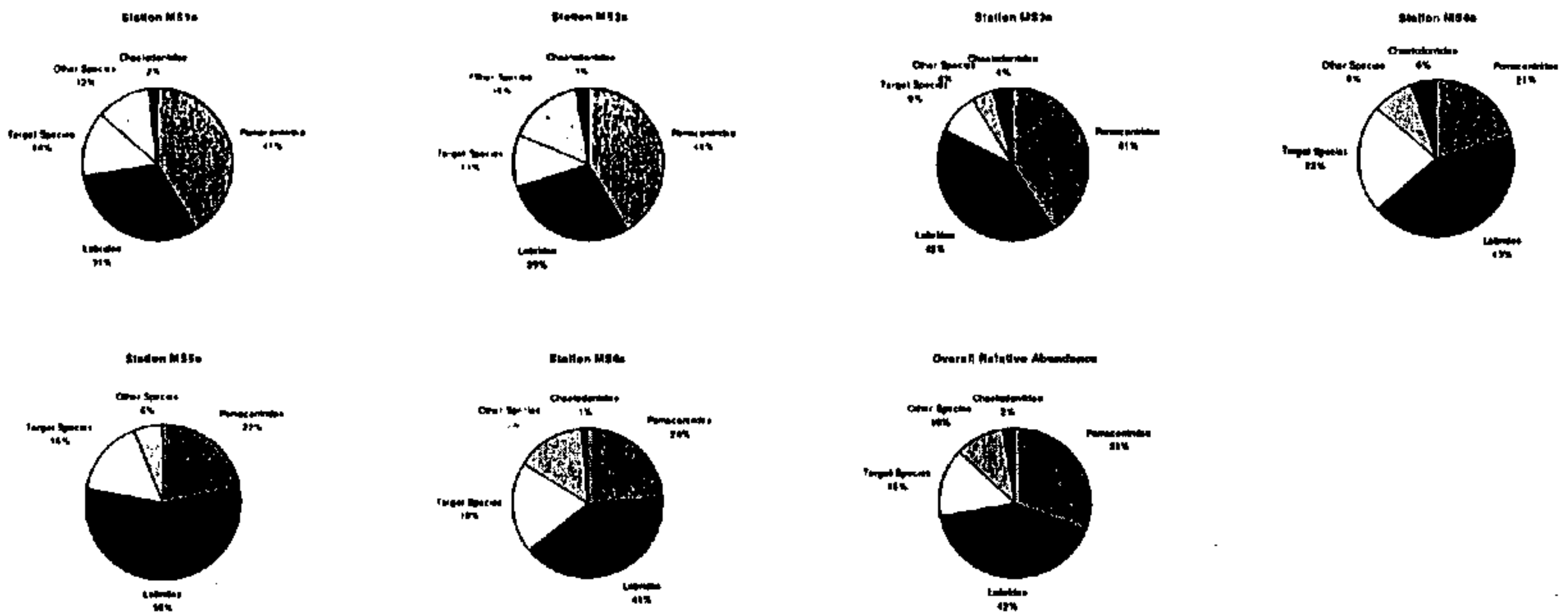
SPECIES ENCOUNTERED AT THE SIX TRANSECTS SURVEY SITES

FAMILY	Species	MS1	MS2	MS3	MS4	MS5	MS6	Total
POMACENTRIDAE	Pomacentrus bankanensis	11	21	29	1	12	16	90
LABRIDAE	Halichoeres hoeveni	5	19	15	16	14	20	89
LABRIDAE	Thalassoma lunare	5	25	24	8	18		80
LABRIDAE	Labrid				1	61		62
SCARIDAE	Scarus harid		1	7	18	10	13	49
LABRIDAE	Thalassoma lutescens				17		18	35
POMACENTRIDAE	Pomacentrus moluccensis	3	11		7	1	8	30
SCARIDAE	Scarus sordidus		11	1	2	10	5	29
POMACENTRIDAE	Pomacentrus smithi	5	12	5				22
TETRAODONTIDAE	Canthigaster amboinensis	1	11	3			5	20
POMACENTRIDAE	Pomacentrus amboinensis		4	10			2	16
TETRAODONTIDAE	Canthigaster compressa	3	4		5	1	2	15
LABRIDAE	Labroides dimidiatus	2	3	3		2	5	15
POMACENTRIDAE	Amblyglyphidodon curacao				2	12		14
CHAETODONTHIDAE	Chaetodon octofasciatus	1	3	2	6		2	14
POMACENTRIDAE	Plectroglyphidodon amboinensis				3	10		13
PEMPHERIDAE	Pempheris oualensis	2	8	2				12
NEMIPTERIDAE	Scolopsis bilineatus	1	1	1	1	3	3	10
APOGONIDAE	Cheilinus quinquelineatus		5		2	3		10
POMACENTRIDAE	Pomacentrus sp.		2			5	2	9
POMACENTRIDAE	Plectroglyphidodon imparipennis		9					9
POMACENTRIDAE	Chromis viridis		8					8
LABRIDAE	Labrichthys unilineata				3	3	2	8
SERRANIDAE	Epinephelus merra	4	1	1		1		7
POMACENTRIDAE	Pomacentrus sp2.				7			7
LABRIDAE	Pseudocheilinus hexataenia		1			2	4	7
LABRIDAE	Stethojulis bandanensis			2			5	7
CENTRICIDAE	Aeoliscus strigatus						6	6
LABRIDAE	Halichores sp.		6					6
LABRIDAE	Cheilinus bimaculatus				1	5		6
POMACENTRIDAE	Dascyllus reticulatus		1			4		5
LABRIDAE	Stethojulis trilineata	1	2	1		1		5
SERRANIDAE	Epinephelus fasciatus		1		1	1	1	4
POMACENTRIDAE	Plectroglyphidodon lacrymatus		4					4
CIRRITHIDAE	Cirrithichthys falco						3	3
POMACENTRIDAE	Pomacentrus sp. (brown)						3	3

TABLE III-S-11 (Continued)

SPECIES ENCOUNTERED AT THE SIX TRANSECTS SURVEY SITES

FAMILY	Species	MS1	MS2	MS3	MS4	MS5	MS6	Total
TETRAODONTIDAE	Canthigaster bennetti					3		3
SIGANIDAE	*Siganus virgatus*		3					3
SCORPAENIDAE	Dendrochirus zebra		1			2		3
POMACENTRIDAE	Abudefduf sexfasciatus		3					3
POMACENTRIDAE	Abudefduf vaigiensis		3					3
POMACENTRIDAE	Paraglyphidodon behni		3					3
LABRIDAE	Coris variegata					3		3
CHAETODONTHIDAE	Chaetodon vagabundus		1	2				3
CHAETODONTHIDAE	Chaetodon trifascialis		2	1				3
BLENNIDAE	Meiacanthus grammistes		2			1		3
BLENIIDAE	Salarias fasciatus						2	2
SCARIDAE	Scarus ovifrons					2		2
POMACENTRIDAE	Pomacentrus vaiuli	1	1					2
POMACENTRIDAE	Stegaster nigricans			2				2
MULLIDAE	Parupeneus barberinoides					2		2
MUGILIDAE	Parapercis clathrata		1				1	2
MUGILIDAE	Parapercis cephalopunctata					2		2
LUTJANIDAE	Lutjanus fulvus		1				1	2
LABRIDAE	Cheilinus trilobatus					2		2
LABRIDAE	Cheilinus diagrammus		1	1				2
GOBIIDAE	Goby					1	1	2
ACANTHURIDAE	Acanthurus (white tail)						1	1
SERRANIDAE	Epinephelus sexfasciatus						1	1
CIRRITHIDAE	Paracirrithys aprinus						1	1
POMACENTRIDAE	Pomacentrus sp. (brown o)						1	1
TETRAODONTIDAE	Canthigaster sp.				1			1
SYNODONTHIDAE	Synodus binotatus		1					1
SYNODONTHIDAE	Synodus sp.					1		1
SYGNATHIDAE	Corythoichthys sp.				1			1
SCARIDAE	Scarus gibbus	1						1
POMACENTRIDAE	Pomacentrus philippinus		1					1
POMACENTRIDAE	Pomacentrus sp3.				1			1
POMACENTRIDAE	Pomacentrus sp1.				1			1
POMACENTRIDAE	Paraglyphidodon melas	1						1
NEMIPTERIDAE	Scolopsis personatus				1			1
MURAENIDAE	Rhinomuraena quaesita				1			1
MUGILIDAE	Parapercis polyopthalma					1		1
LUTJANIDAE	Lutjanus decussatus		1					1
LABRIDAE	Cheilinus fasciatus	1						1
LABRIDAE	Halichoeres hartzfeldii	1						1
LABRIDAE	Halichoeres scapularis					1		1
LABRIDAE	Halichoeres sp.	1						1
LABRIDAE	Bodianus mesothorax			1				1
HAEMULLIDAE	Plecthorhincus chaetodonoides	1						1
ACANTHURIDAE	Acanthurus xanthopterus		1					1
23	81	51	200	113	107	200	134	805



RELATIVE ABUNDANCE OF RECORDED SPECIES GROUPS
(MS1A, MS2A, MS3A, MS4A, MS5A, MS8A)

FIGURE III-5-9

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TABLE III-5-12
SUMMARY OF SPECIES INDICES OBSERVED AT THE SIX SURVEY SITES

Index / Station	MS1	MS2	MS3	MS4	MS5	MS6
Number of Species	20	42	20	24	33	28
Dominance Index	0.0957	0.0583	0.146	0.099	0.1244	0.079305
Shannon-Weaver Dvrsity Index	3.822401	4.609033	3.338459	3.803227	3.920548	4.128037
Evenness	2.937981	2.839387	2.566012	2.75554	2.581832	2.852513
Density per 500 sq. m.	51	200	113	107	200	134
Standing Stock	4080	16000	9040	8560	16000	10720
(kg per sq. km.)						

Other species which have similar feeding preferences as labrids and pomacentrids were also observed in the area. The parrotfish *Scarus sordidus*, for example, ranks sixth in abundance and was also encountered in five of the six sites surveyed.

The standing stock estimates varied among the transect sites. This is interesting as the sites MS1a through MS4a and MS8a are located less than 500 meters from each other. Station MS1a had 4.1 tons/km^2, while MS2a which is just about 200 meters from MS1a had 16 tons/km^2. Substrate cover and quality were basically similar at all sites (see section on corals). The most noticeable difference among the sites was visibility or sediment loading. During the surveys in 11-12 February, highest water visibility at MS1a was 4 - 5 m, while at MS2a it was at least 10 m. Heavy sediment loads smother most organisms including fish. Since fish are mobile, most would tend to emigrate to other areas when there is excessive stress within its home range. This was probably what caused the lower abundance observed at MS1a compared to MS2a.

Compared to similar areas in the adjacent Calauag Bay, the estimated standing stock at all six sites is very low (4-16 tons/km^2 against an average of 44 tons/km^2). The reef fish production that would be expected under such standing stock would range between 6-24 tons/km^2/year. This low fish production rate could be the reason for the low fishing activity in the area.

6.0 SOCIO-ECONOMICS AND PUBLIC HEALTH

The scope of this study is consistent with that agreed upon during the scoping meeting which was conducted with the attendance of representatives from the Environmental Management Bureau of the DENR, some members of the Mauban community, the proponents, and the environmental consultants.

6.1 Methodology

The various data gathering techniques which were used in the preparation of the report for the socio-economic and public health module include the following:

6.1.1 Ocular Inspection of the Project Area

An inspection of the project site and its immediate vicinities was carried out. The following characteristics were observed and noted: location of settlement clusters, distance of houses from each other, road and other physical conditions in the villages. Attention was given to the proposed site of the power plant and its facilities, i.e., in Sitios Sabang, Dinahican and Dalig of Barangay Cagsiay I.

6.1.2 Secondary Data Gathering

Secondary data were gathered. The data were used to provide a description (i.e., socio-economic, demographic and health) of the project site. In addition, data on the regional, provincial and municipal levels based on the reports prepared by various government agencies such as the Provincial/ Municipal Planning and Development Offices, National Statistics Office and the local units of the Department of Health, among others, were reviewed and analyzed.

One limitation to this activity, however, is the difficulty in obtaining the latest and most comprehensive data since most of the reports were several years old.

6.1.3 Key Informant Interviews

Key informants in the study area were identified and interviewed. The following were considered in the selection of key informants:

- occupancy of key political positions; and

- access to information/knowledge about particular issues and concerns relevant to the study.

Among the key informants who were interviewed were: (a) governor of Quezon, (b) bishop of the Diocese of Lucena, (c) provincial health officer, (d) mayor of Mauban, (e) barangay captain of Cagsiay I, (f) municipal health officer (MHO), (g) rural health midwife, (h) NGO (or non-government organization) representatives, (i) parish priest, (j) school teacher, and (k) oldest resident in the barangay.

Unstructured interviews were conducted and covered varied topics including general social and economic conditions, health conditions and problems, migration history and general attitude towards the proposed project.

6.1.4 Socio-economic and Perception Survey

A survey of the residents of Barangays[3] Cagsiay I, Cagsiay II, San Lorenzo and Cagbalete I was carried during 28-31 January 1995 with the assistance of locally hired interviewers who were trained for the purpose. Prior to the survey, an interview schedule (Annex 7A was prepared which consisted of the following question blocks:

- Block A - Socio-economic and Demographic Information
- Block B - Quality of Life in the Community
- Block C - Public Health
- Block D - Observed Changes in the Environment
- Block E - Perceptions Towards the Project

The distribution of the interviewed household[4] heads by barangay is presented in **Table III-6-1.**

A map showing the distribution of interviewed household heads by barangay is shown in **Figure III-6-1.**

Complete enumeration was carried out in the barangay (i.e., Cagsiay I) where the power plant is proposed to be constructed. In particular, household heads interviewed within the DIA were identified based on the housemap and list of affected households which was prepared as of 26 January 1995 by the community relations consultant for the study.[5] In addition, a sample survey (random sampling) of approximately 10 percent of the households in the adjacent barangays such as San Lorenzo and Cagsiay II including Cagbalete I which is located in the island northeast of the project site were covered in the survey.[6] These other barangays were chosen based on their proximity to the project site and that in the future, certain environmental parameters in these areas such as air quality may be monitored once the power plant becomes operational.

To ensure better quality control of the data, interview schedules underwent two stages of editing. First, the interviewers were required to review the completed interview responses after each interview to allow immediate callback should there be any undiscovered error/omission in the record. Second, the survey supervisors checked further internal inconsistencies and data gaps in the interviewers' record of responses. The survey supervisors determined whether subsequent callbacks were warranted.

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[3] "A barangay is the basic political unit . . . A barangay may be created out of a contiguous territory which has a population of at least 2,000 inhabitants . . . " [as defined in the Local Government Code of 1991]

[4] "A household is a social unit consisting of a person living alone or a group of persons who sleep in the same housing unit and have a common arrangement for the preparation and consumption of food . . . " [as defined by the National Statistics Office]

[5] The January 1995 list identified 57 would-be affected houses in the project area. When the list was finalized by the consultant in February 1995, it was established that 64 households (50 dwelling units with 1 household, and 7 dwelling units with 2 households) are residing in the area.

[6] There may be a discrepancy in the number of interviewed household heads as against the data from the National Statistics Office or from the Municipal Planning and Development Office because other household heads are either not available during the time of the survey or refused to be interviewed.

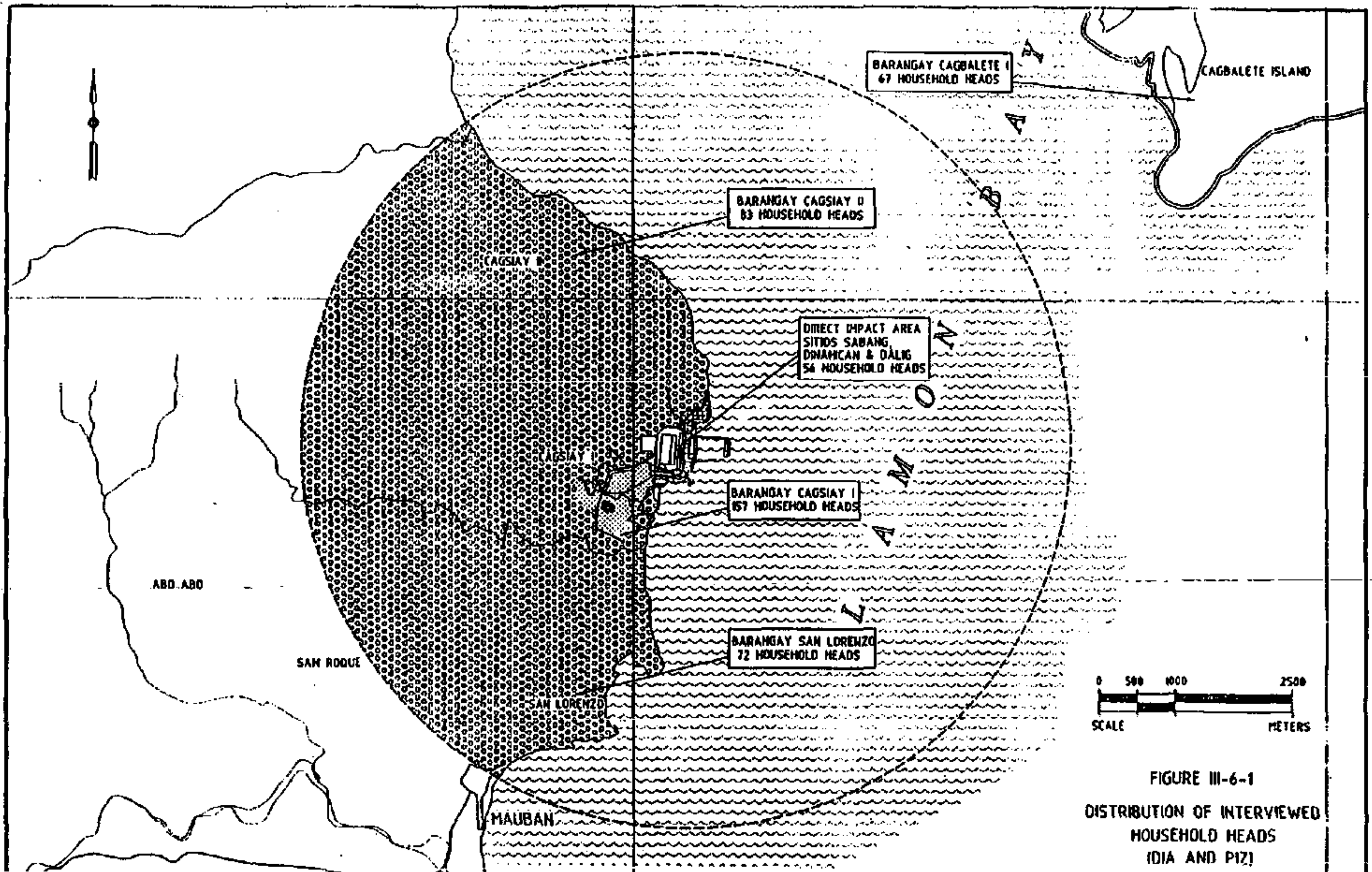

FIGURE III-6-1

DISTRIBUTION OF INTERVIEWED HOUSEHOLD HEADS (DIA AND PIZ)

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All accomplished and checked interview schedules were processed using a Statistical Package for the Social Sciences or SPSS software package.

A perception survey was also conducted in the town proper of Mauban last 13 March 1995. Questionnaires were distributed to approximately *10 percent of the households.* Annex 7B presents the results of the survey. A copy of the questionnaire is also attached.

A follow-up perception survey was carried out on 21-23 May 1995 in the areas previously covered.[7] The data represent the most current perception in the area. The sample population was increased, i.e., from the initial 10 percent to the present 20 percent, because the length of the interview schedule was significantly shortened, thus allowing the interviewers more time to interview other household heads. One hundred percent of the households were targetted in the survey conducted in the host barangay, Cagsiay I.

TABLE III-6-1
DISTRIBUTION OF INTERVIEWED HOUSEHOLD HEADS
BY BARANGAY
(January and May 1995 Surveys)

Barangay	Number of Interviewed Household Heads	
	January Survey	May Survey
Cagsiay I	157	162
DIA (Sitios Sabang, Dinahican and Dalig)[8]	56	51
Cagsiay II	83	108
San Lorenzo	72	155
Cagbalete I	67	163
Total	435	639

6.2 Regional Overview

Region IV, otherwise known as the Southern Tagalog Region, covers an area of approximately 47,000 sq. kms. It composes 15.6 percent of the country's total land area. Eleven provinces and 8 cities can be found in the region.

6.2.1 Regional Population

Region IV is the most populated region of the country. During the last nationwide census of the National Statistics Office (NSO) on 1 May 1990, it registered a population of 8.3 million which was roughly 13.6 percent of the total national population for the same census year.

The region posted an average annual growth rate of 3.0 percent from 1980 to 1990. This rate is higher than that of the national average which is 2.4 percent. By the year 2000, the population of Region IV is projected to grow to 11 million at a projected average annual growth rate of 3.3 percent.

[7] A copy of the interview schedule is presented in Annex 7B including the results of the perception survey in the town proper (or Poblacion).
[8] Discrepancies in the number of interviewed household heads during the two surveys can be noted. Footnote #6 enumerates the various reasons.

Assuming that the region's population is evenly distributed over its total land area, population density would be 176 persons per sq. km. This figure is relatively lower compared to the country's average population density of 202 persons per sq. km.

6.2.2 Regional Economy

The regional office of NEDA (National Economic and Development Authority) has subdivided Region IV into 3 subregions or "planning units" so that "planning and implementation would be more manageable and relevant."[9] These subregions include (1) Aurora, (2) CALABARZON, encompassing the provinces of Cavite, Laguna, Batangas, Rizal and Quezon, and (3) the Island Provinces of Marinduque, Occidental Mindoro, Oriental Mindoro, Palawan and Romblon.

The region ranks second to Metro Manila in terms of contribution to the national income. Its Gross Regional Domestic Product (GRDP) in 1992 accounted for 15.5 percent of the Gross National Product (GNP).

The industrial sector accounted for the highest contribution (42%) to the region's 1992 GRDP. The services sector came next with a 30 percent share while the agricultural services ranked third with a 27 percent share.

6.3 Profiles of Quezon and Mauban

The province of Quezon spans an area of 8,700 sq. kms. which is about 18.6 percent of Region IV's total land area. Among its municipalities is Mauban, the site for the proposed power plant. Mauban spans 416 sq. kms of 4.8 percent of the total provincial area.

6.3.1 Provincial and Municipal Population

Quezon's population during the latest nationwide census totalled 1.4 million. Population projection for the year 2000 is 1.9 million. The population density of the province being 115 persons per sq. km. is less than the regional average.

The municipality of Mauban registered a population of 43,740 which is 3.2 percent of the total provincial population. Population density in the municipality is 105 persons per sq. km.

6.3.2 Provincial and Municipal Economy

Economic Sectors

- Agriculture

Agriculture is the primary source of income in the province of Quezon. It has a total farm area of approximately 281,000 hectares (comprising 32% of the provincial land area). Coconut is the dominant crop which is planted on about 28 percent of Quezon's land area. The municipality of Mauban is considered as one of the municipalities with the largest coconut area having approximately 20,000 hectares of plantation.

Prior to the collapse of copra prices, income from coconut production was large enough for families within the province to send their children to school in Manila. Inspite of the availability of land, there

[9]Regional Development Council, "Draft Regional Physical Framework Plan of Southern Tagalog Region, 1993-2023"

was very little motivation to engage in other means of livelihood or even plant vegetables in the backyards.[10] Coconut production (both copra making and coconut lumber production) is also the number one source of livelihood in the town of Mauban while rice farming is basically for home consumption only.[11]

- Fishery

In Quezon, there are about 34 coastal towns. The largest commercial fishing port is located in Dalahican, Lucena City.

"Galunggong" (23%) and "tulingan" (22%) are the top two species caught (based on the 1991 data from the Dalahican Fish Port).

- Commerce and Industry

Lucena City is the province's commercial and industrial center. A lot of the major firms in the city are coconut oil chemical companies such as the one owned by Colgate-Palmolive Philippines.

Labor Force and Employment

Available employment data provides an overview of the employment situation in the province of Quezon. Data from the National Manpower and Youth Council (NMYC) reveal that around 32 percent of the population aged 15 years old and above are employed in the agricultural sector while approximately 27 percent belongs to the non-agricultural sector. About 38 percent does not belong in the labor force and this is composed of housewives, students, etc. while 2 percent is unemployed (see Annex 7C1).

Based on the NMYC data, as well, Mauban has an estimated population of 1,420 unemployed adults and out-of-school youths.

Income Levels and Poverty Incidence

Data on income levels as of 1991 are only available for the region, which indicated that the minimum average monthly income for a family composed of 6 members to be considered above the poverty level at PHP 4,041.50. The province of Quezon including the province of Aurora account for 24.8 percent of the poor families in the region.[12]

6.3.3 Health Conditions in the Province and Municipality

Health Facilities and Manpower

Quezon has approximately 16 government hospitals and 26 private hospitals/clinics. It has a total bed capacity of 1,670 or a ratio of 1: 878.[13]

There is one district hospital in the municipality of Mauban. Total bed capacity is 25 with a ratio to population of 1: 1,826.[14] There are only 6 Rural Health Midwives (RHMs) serving Mauban's 40

[10] Interview with the Governor of Quezon. Provincial Capitol, 23 January 1995.
[11] Interview with the Mayor of Mauban. Municipal Hall, 27 January 1995.
[12] Regional Development Council, "Draft Regional Physical Framework Plan of Southern Tagalog, 1992-2023"
[13] Based on the 1993 provincial population of 1,466,737 from the Integrated Provincial Health Office, "Health Profile '93 Quezon Province" (IPHO, Quezon: 1994)

barangays. There are 4 private doctors who practice in the town. Assisting in providing health services to the town's population are 40 hilots (traditional healers and birth attendants) and 58 active trained Barangay Health Workers (BHWs) and 30 untrained BHWs. In Barangay Cagsiay I, there is no active BHW although there is a community health development program piloted by LIKAS, a health non-government organization (NGO) based in Lucena City and with national headquarters in Ateneo de Manila University.[15]

Vital Health Statistics

Based on the health data prepared by the Integrated Provincial Health Office in Lucena City, various health indicators [crude birth rate (CBR), crude death rate (CDR), maternal mortality rate (MMR) and infant death rate(IMR)] are on a decreasing trend from 1983 to 1993. In particular, the rate of natural increase (RNI) in the province which is computed as CBR minus CDR is likewise on a decreasing trend, i.e, from 20 in 1983, it went down to 19.1 in 1993.

Vital health statistics for the year 1993 in Mauban as compared to that of Quezon are higher in terms of CBR and CDR, i.e., 26.9 as against 24.8 and 5.9 as against 5.7, respectively. Thus, in terms of RNI for the same year, Mauban's rate is higher than Quezon's by 1.9. Infant mortality and maternal mortality rates, however, are lower compared to the provincial rates, i.e., 17.5 as against 29.5 and 0 as against 0.8.

Nutritional Status

Pre-school children who were weighed in year 1993 in the province and in the municipality were of normal weight, 49 percent and 52 percent, respectively.

Particularly in Mauban, the nutritional status is characterized by the Municipal Health Officer (MHO) as being fair. A typical diet of a household consists of rice, fish and other seafoods. Maubenos (locals) are also fond of cooking their viands with coconut milk or "gata".[16]

Patterns of Morbidity and Mortality

Respiratory disease has consistently been the number 1 cause of morbidity (or illness) based on the 1988 to 1992 average and 1993 in the province of Quezon. For the 5-year average, from 1988 to 1992, pneumonia has been listed as the most leading cause of death in the province. However, In 1993, cardiovascular disease was the leading cause of death with pneumonia which came second.

In Mauban, respiratory disease is not only the foremost cause of morbidity but of death, as well. This can be gleaned from the 1991 to 1993 data which were obtained from the local office of the Department of Health. When the MHO of Mauban was interviewed, he attributed the cause of acute respiratory infections (ARI) among the municipal population to (1) changes in the environment, (2) dust emanating from the bad roads, and (3) most specifically, the presence of viruses. Exposure to smoke while making charcoal has also been perceived as a cause of the high incidence of ARIs. In treating ARIs, home care and the intake of fluids are emphasized.[17] Cases of ARI usually just start with a viral infection, later develops into a cough and further deteriorates into pneumonia, which is

[14] Based on the 1993 municipal population of 45,641 from the Rural Health Unit, "Health Profile, Mauban, Quezon, 1993" (RHU, Mauban: 1994)

[15] Interview with the Public Health Nurse (PHN) of Mauban and the RHM of Barangay Cagsiay I. Rural Health Unit, 25 January 1995.

[16] Interview with the Municipal Health Officer of Mauban. Rural Health Unit, 25 January 1995.

[17] Interview with the PHN and RHM.

prevalent in Mauban, if the appropriate actions are not undertaken in a timely manner.[18] Health personnel treat patients with pneumonia with co-trimoxazole and amoxycillin.[19] Other causes of morbidity like parasitism and diarrheal diseases were seen to be due to the absence of sanitary facilities in most households. In addition, malaria is reported to be present in Cagbalete Island the whole year round. During November to December 1994, a malaria outbreak (50 cases) was reported in Barangay Concepcion mostly among adult farmers in their 20s to 30s.[20]

Data on the leading causes of morbidity and mortality, particularly the number of cases and rates per 100,000 population, as recorded from the Integrated Provincial Health Office of Quezon and the Rural Health Unit of Mauban are appended, refer to **Annex 7C2, Tables 2A to 2H.**

6.3.4 Other Social Services

Education

As of the schoolyear 1992-1993, there are 811 public schools in Quezon. There are only 11 municipalities with private elementary schools and 34 with private secondary schools within the province.

Mauban is one of the 9 municipalities which have colleges/vocational or technical schools. It has 3 high schools and a trade school which is expected to offer a 4-year degree course in 1996.

Housing

In Quezon, 96 percent of the occupied housing units are single houses. Around 67 percent of these occupied housing units are located in rural areas.

In Mauban, 95 percent occupied housing units are of the single type.

Most of the houses in Quezon and in Mauban have cogon/nipa/anahaw roofs (50 percent and 61 percent, respectively).

Wall materials in Quezon are mostly bamboo/sawali/cogon/nipa (45 percent) while in Mauban, wood is utilized by the majority (47 percent).

Water, Power and Fuel Sources

The community water system is the major source of drinking water for the households in both Quezon and Mauban (35 percent and 43 percent, respectively). Deepwell is listed as another water source (18 percent of the households in Quezon and 24 percent of the households in Mauban). Spring, lake, river, rain, etc. are also sources of drinking water, 13 percent of each of the households in Quezon and Mauban.

In Mauban, the waterworks district serves 766 households which consume 10,724 gallons of water daily. Mauban also has a lot of inland and water resources such as spring, river, stream, lake and sea.

18 Interview with the MHO.
19 Interview with the PHN and RHM.
20 Interview with the MHO.

Only 10 municipalities and the city of Lucena are serviced by MERALCO. These municipalities are Candelaria, Dolores, Lucban, Mauban, Pagbilao, Sampaloc, San Antonio, Sariaya, Tayabas, and Tiaong.

Fifty one percent of the households in Quezon utilize kerosene for lighting while 46 percent have electricity for lighting.

Fifty percent of Mauban's households use electricity while 49 percent make use of kerosene for lighting.

Transportation and Communications

Quezon has a total road network of 3,425,717 kms. consisting of the following: (1) 789,286 kms. of national roads; (2) 368,462 kms. of provincial roads; (3) 281,985 kms. of municipal streets; and (4) 1,986 kms. of barangay roads. According to surface types, 14.6 percent is concrete, 2.9 percent is asphalt and 51.6 percent is gravel while 30.6 percent is the unsurfaced or earth type. These figures, however, do not include unmaintained roads.

Almost all coastal municipalities within the province have seaports to transport cargoes and passengers to and from provinces like Mindoro, Romblon and Marinduque.

Mauban is accessible both by land and water. Land transportation is the primary mode of transporting goods from the town to its neighboring municipalities.

All municipalities are equipped with communication facilities. Telegraph services are the most common. Radio communication services, mail services, telephone system, other telegraph facilities are provided by RCPI, Telefast, PT & T, courier services by JRS and LBC-Air Cargo, Inc., all national newspapers and 9 local newspapers are also available. Quezon CATV, Inc. provides entertainment as well as information to the residents of the province.

Approximately 328 households in Mauban have phone facilities. Telephone services are courtesy of the Philippine Long Distance Telephone Company (PLDT). Telegram and telegraphic transfers are also available in the municipality aside from the mail services.

Provincial and Municipal Government Revenues

The municipalities of Quezon earned a total income of PHP 269 million in 1992. Ninety-eight percent of the total income belonged to the special fund while 2 percent belonged to the special education fund. Mauban contributed 4.5 percent to the income of the province.

6.3.5 Perceptions Towards the Project

Interviews with most of the key informants (i.e., local government officials) reveal that perceived benefits from the project include, among others, employment (local hiring) and improvements to the municipality of Mauban. For the host barangay, a key informant opined that the project is likely to offer job opportunities to the local labor force population who do not have regular employment. Improvements, in particular, may mean construction and rehabilitation of roads and provision of other public services such as good quality education and improved health services. Moreover, it is foreseen that the project will attract capital investments and this would definitely boost the provincial government's campaign for agro-industrialization.

Adverse impacts on an ambient air quality and water resources in the area is feared by the key informants as the most likely consequence of project operation. One key informant has even emphasized that, "No one can assure 100 percent safety of the power plant . . . " In addition, they expressed doubt over the willingness of the proponent to install and then maintain pollution control devices since these are definitely going to be very costly. Others, as well, mention the possibility that the socio-economy of the area may be affected. These include, among others, dislocation, loss of livelihood due to the destruction of fishing grounds, changes in the people's lifestyle and increase in social problems.

6.4 Results of the Socio-economic and Perception Survey

The description of the socio-economic and public health conditions as well as the perceptions about the proposed project were based on the social survey complemented by key informant interviews and direct observation.

Tabulation of results from the probable impact zone (PIZ) and from the direct impact area (DIA) are presented in **Annex 7C, Tables 3A to 3I and 4A to 4L**

6.4.1 The Probable Impact Zone (PIZ) - The Vicinities of the Project Site

A sample survey was administered to the household heads within the vicinities of the project site. This includes those living within the PIZ which is the 5-km. zone from the project site. The results of the survey are presented below:

Social and Economic Characteristics

The average household size in the PIZ is 5 (or 5.1). Those belonging to the productive age group compose 55 percent of the population of household members while dependents, i.e., those whose ages range from 14 and below, and 65 and above are about 44 percent and 2 percent, respectively.

Elementary level is the highest educational attainment among the household members residing within the vicinity of the project site (66%). One-fourth of those surveyed have secondary level education while only 2 percent graduated from college.

Household members aged 10 years and older are mostly housewives (26%), students (18%) and jobless (13%). Aside from them, others are employed as laborers/engaged in construction work (12%), farmers (9%) and fishermen (7%).

Land and House Ownership

Most of the respondents own the houses which they currently occupy (89%) and pay rental for the land where their respective houses stand (49%).

A typical house in the area is made of temporary materials such as cogon, nipa and/or bamboo (58%).

Migration and Organizational Membership

Sixty percent of the interviewed household heads are migrants meaning, they are not born in the barangay where they are presently residing. Of these migrants, livelihood (77%) is the most often cited reason why they transferred to the place. A lot of them (59%) as well, have stayed in the area for more than 10 years now.

Organizational membership is only by one-fifth (or 21%) of the household heads surveyed. A lot of these organization members belong to one or two groups which are social (38%), religious (29%) and political (28%) in nature.

Sources, Magnitude and Changes in Income

Fishing (25%), farming (25%) and construction employment/working as laborer (21%) are among the top primary sources of income of household heads in the area.

Most of the household heads' earnings in the area range from PHP 24,001 to PHP 48,000 annually. Average income earned for a month averages to about PHP 3,000.[21]

Aside from their main sources of income, the household heads were also asked if they have other sources of income. Of those interviewed, only 28 percent gave an affirmative answer. When the household heads were asked further what their other sources of income are, among the usual responses were fishing (30%), farming (16%), working in the forest (15%), laborer or construction employment (13%) and selling (11%).

Seventy three percent of the household heads have other household members who are earning while the rest (27%) have none. Total annual household income of these households with other earning members usually range from PHP 48,001 to PHP 96,000 which is roughly PHP 6,000 a month.

Most of the respondents have observed that there was no income change over the past 5 years. Among those who noticed changes in their incomes, however, 57 percent has noticed an increase while the others noted otherwise (43%).

Farming and Related Characteristics

The usual farmland size is about 2 to 5 hectares (47%). Farmland ownership is mostly part-ownership (54%).

Rice and coconut are among the major crops planted by farmers in the area. Based on the last harvest, these crops were harvested in quantities which were mostly less than 10 sacks (coconuts in particular, are measured as copra). Rice is allocated for household consumption (74%) while coconuts are sold after the harvest (93%).

In relation to the planting of coconut trees in the area, the production of coconut lumber is a new source of livelihood which has been introduced just recently. Coconut trees which are located beside the road and are cut down for lumber sell for PHP 300 per board foot.[22]

Fishing and Related Characteristics

Seventy-eight percent of the fishermen in the area fish for their own, 14 percent fish as laborers (paid workers) while 8 percent are both. Fish caught by these fishermen are always partly consumed by the household and partly sold (64%). Fishing activities are usually everyday (34%), every other day (32%) and twice a week (26%).

[21] A caveat should accompany this conclusion because household incomes are based on cash earnings. It should also be noted that most of the households consume their products such as agricultural harvest and fish catch and these are not reflected in their stated income.

[22] Interview with the Barangay Captain of Cagsiay. 25 January 1995.

While 57 percent of the fishermen in the area have their own fishing boats, the other 43 percent do not. A little more than half (52%) of the fishing boats owned are motorized.

Eighty-four percent of the fishermen in the area have their own fishing gear which includes "biwas"/"bingwit"/nylon (44%), "lambat" (20%), "kawil" (9%), "hapin" (8%), "titiw" (6%), etc.

It was discovered based on the key informant interviews that dynamite fishing and trawl fishing are practiced in the waters off the shore of the areas surveyed. These practices are allegedly rampant and started in the 1950s and 1970s, respectively.

Quality of Life in the Community

Residents in the area, particularly those living within Barangays San Lorenzo, Cagsiay I and Cagsiay II, complain about the poor condition of the roads (42%). These roads are unsurfaced making travel extra difficult during the rainy season when roads become muddy.

Wood or charcoal (93%) is oftentimes used as cooking fuel by the residents in the area. As cooking fuel, wood and charcoal can be obtained easily from the nearby forests. Charcoal making is practiced by some of the residents--they get scrap woods from the Interwood Sawmill (one of the 3 sawmills operating near or within Barangay Cagsiay I) and make them into charcoal.

Kerosene is typically used for lighting by a number of households (88%). This is because most of the communities surveyed do not have electricity. Only houses near the town proper of Mauban, i.e., located in Barangay San Lorenzo, have electricity.

Health Status and Conditions

Respondents who have household members who got sick the past year accounted for 59 percent of those surveyed. Data pertaining to illnesses or symptoms experienced by these household members show that fever (19%), influenza (17%), cold (13%) and diarrhea (11%) are among the common causes of getting sick. Oftentimes, consulting a private doctor (49%) and self-medication (25%) are resorted to in treating illnesses.

Spring (40%) and artesian well (36%) provide drinking water to most households in the probable impact zone. It is interesting to note that water quality results show that samples obtained from the area have high bacterial content (see discussion on Section III-2.4.4, Tables III-2-8 and 9).

Lack of private toilet facilities (48%) has been cited by most respondents as a common health problem in the community. In relation to this, survey results reveal that 62 percent of the households do not have private toilet facilities.

Garbage is usually disposed of by burning (57%). A considerable percentage of the households, i.e., 26 percent, throw their garbage anywhere.

Observed Changes in the Environment

Cleaner or more beautiful surroundings (39%) is one of the changes noticed by respondents in the community where they live. This may be attributed to the fencing of houses and cleaning of the backyards by residents in the area. However, others have noticed the denudation of the forest which means that a lot of trees have already been cut (19%). Others have also noticed increase in the number of settlements, an indication of population increase in the area (16%).

Project Awareness, Opinion and Perceived Effects

Residents in the vicinities of the project site are generally aware of the proposed project (83%).

TABLE III-6-2
AWARENESS ON THE PROPOSED PROJECT, PIZ
(January 1995 Survey)

Aware of the Proposed Project	Frequency	Percentage
Yes	313	82.6
No	64	16.9
No Response	2	0.5
Total	379	100.0

The percentage of those interviewed and responded in January 1995 who favor the project are not in favor of the project were equally divided at 44 percent. Results of the most current survey, however, indicate that the percentage of those that favor the project rose approximately 14 percent. Other responses such as, not favor and depends have decreased as noted by the table below:

TABLE III-6-3
ATTITUDE TOWARDS THE PROPOSED PROJECT, PIZ
(January and May 1995 Surveys)

Attitude Towards the Project	28 - 31 January 1995 Survey		21 - 23 May 1995 Survey	
	Frequency	Percentage	Frequency	Percentage
Favor	166	43.8	340	57.8
Not Favor	165	43.5	195	33.2
Depends/No Response	48	11.9	53	9.0
Total	379	100.0	588	100.0

Forty-eight percent of those interviewed have family members who are interested to work for the Quezon Power Project. An almost equal percentage (46%), however, responded otherwise.

TABLE III-6-4
HAS FAMILY MEMBERS WHO ARE INTERESTED TO WORK
FOR THE PROJECT, PIZ
(January 1995)

Has Family Members Who are Interested to Work for the Project	Frequency	Percentage
Yes	180	47.5
No	175	46.2
No Response	24	6.3
Total	379	100.0

The proposed project is perceived by the respondents to bring an equal level of benefit and harm to the community (41%). Most of them, as well, opined that the project will bring benefits or advantages to the community (34%).

TABLE III-6-5
OPINION OF THE PROPOSED PROJECT, PIZ
(January 1995)

Opinion of the Project	Frequency	Percentage
Benefit the Community	127	33.5
Not Benefit the Community	29	7.7
Harmful	55	14.5
Both Benefit and Harm	**156**	**41.2**
Do not Know/No Response	12	3.2
Total	379	100.0

6.4.2 The Direct Impact Area (DIA)

The following provides a discussion on the results of the survey conducted in January 1995 and May 1995 among the households within the perimeter boundaries of the proposed project. These households have been identified as directly affected because they will be required to relocate as a result of project development.

Social and Economic Characteristics

The average household size in the directly affected area is approximately 6 (or 5.7). About 54 percent of the household members belong to the economically active group (i.e., those whose ages range from 15-64) while 44 percent are 14 years old and below and 2 percent are 65 years old and above. Roughly, there is a 1:1 ratio of economically productive household member as against an economically dependent member. Males outnumber the females with a ratio of 107 males for every 100 females.

The highest educational attainment among the household members is elementary level (69%). Twenty-three percent attained secondary level education, whereas, college graduates accounted for only 1 percent of the household members. The school closest to the DIA is the Barangay Cagsiay I Elementary School which is about 1 km. away. In order to reach the school, schoolchildren either walk along rugged trails or ride jeepneys plying the route.

Land and House Ownership

Most of the residents are owners of the houses which they occupy (91%). A lot of them as well, use the lots for free (57%).

Similar to the usual construction materials of houses in the adjacent areas, three-fourth (75%) of the houses in the DIA are made of light materials, i.e., cogon, nipa or bamboo.

Migration and Organizational Membership

Fifty-nine percent of the household heads surveyed are migrants or were born in places outside Barangay Cagsiay I. Those who migrated to the place reasoned that they did so primarily because of livelihood (68%). The average length of stay of these migrants in the barangay is 18 years.

Twenty-seven percent of the respondents belong to an organization or association in the area. Organizational membership is highest in social organizations (57%).

Sources, Magnitude and Changes in Income

The primary sources of income of household heads in the area include farming (46%) and working as laborers/construction employment (25%). Aside from those mentioned, income sources also include employment (9%), fishing (9%), working as helper (5%), coconut farm working or copra production (2%), wood working (2%) and storekeeping (2%).

The average monthly income derived by the household heads from their primary occupation is estimated at PHP 3,000. It is noteworthy that as of 1991 in the Southern Tagalog Region, NEDA has set the minimum average monthly income for a family of six at PHP 4,042. Assuming that the computation of monthly income is based solely on cash earnings, standard of living of the families within the DIA may be considered below the poverty level.

The household heads were also asked if they have other sources of income. Of the 56 who were interviewed, half of the responses are "meron" (there is) while the other half are "wala" (none). Out of the 28 household heads who have other sources of income, 31 percent work as laborers or in construction-related activities. Furthermore, there is one person who, aside fishing, receives an honorarium as a member of the CAFGU (Civilian Armed Force Geographical Unit).

Only 29 percent of the households have other household members who are earning. Half of the total number of households with other earning household members have an income of around PHP 48,001 to PHP 96,000 a year.

When the respondents were asked regarding changes in income over the past 5 years, most of them said they did not notice any change in their income (64%). Fifty-five percent of those who noticed an income change mentioned that their incomes became smaller.

Farming and Related Characteristics

Farmlands tilled within the affected area usually measure 2 to 5 hectares (43%). Forty-six percent of the farmlands are leased while 40 percent is shared/partly-owned.

Quantities of rice during the last harvest were mostly less than 10 sacks (38%) while that of coconuts were usually 10 to 20 sacks (40%). Fifty-six percent of the rice harvest was consumed by the household while 44 percent was both sold and consumed by the household. Coconut, especially copra, was sold (87%) and only 2 percent of the harvest was consumed by the household.

Fishing and Related Characteristics

Fishermen in the affected area are basically self-employed (90%). This means that they fish on their own and either sell or consume at home their catch or do both. Those who sell and consume the fish they have caught account for 52 percent of the fishermen, 38 percent allot all the catch for the consumption of the household and only 10 percent of them sell everything.

Seventy-one percent of the fishermen have their own fishing boats. Only twenty percent of these owned boats, however, are motorized.

All of the fishermen fish within the Lamon Bay. Thirty-eight percent of the fishermen fish twice a week, 33 percent fish every other day, 10 percent fish everyday while the rest fish occasionally.

Ninety percent of the fishermen have their own fishing gear. "Biwas"/"bingwit"/nylon (50%), "lambat" (21%) and "hapin" (14%) are the usual types of fishing gear owned.

Quality of Life in the Community

The community members within the affected area echo the usual complaint of the residents in the adjacent barangays, i.e., the poor condition of the roads (58%).

Majority of the households within the DIA utilize wood/charcoal for cooking (89%) while the remaining 11 percent cook using gas/stove. There is no electricity in the area, hence, almost all of the residents make use of kerosene as a lighting facility (93%). Only 1 household uses a generator and spends approximately PHP 2,250.00 a month for fuel.

Health Status and Conditions

Sixty-three percent of the respondents have household members who got sick the past year. Based on the survey, the symptoms/illnesses which had been experienced the most are colds (14%) and influenza as well as asthma (13% each) and these are basically respiratory in nature.

Consultation with a private doctor (31%), referral to traditional healers (25%) and self-medication (20%) are among the practices employed by the community members in treating their illnesses.

Common health problems cited by the respondents include the lack of private toilet facilities (60%) while around 34 percent of the affected households have the antipolo type or closed-pit type of toilet facility, 59 percent households have none. Garbage from the households are usually disposed of by burning (77%).

Observed Changes in the Environment

Respondents have noticed that members of their neighborhood have become more conscious of the beautification (2%) and cleanliness of their backyards and surroundings (2%).

Project Awareness, Opinion and Perceived Effects

Residents within the DIA are all aware of that the power plant is proposed to be constructed in Barangay Cagsiay I. When they were asked further what their sources of information are, 57 percent mentioned public discussions and 25 percent responded that they got the information from the officials of their barangay.

TABLE III-6-6
AWARENESS ON THE PROPOSED PROJECT, DIA
(January 1995)

Aware of the Project	Frequency	Percentage
Yes	56	100.0
No	0	0.0
Total	56	100.0

TABLE III-6-7
SOURCES OF INFORMATION
ABOUT THE PROPOSED PROJECT, DIA
(January 1995)

Source of Information about the Project	Frequency	Percentage
Public Discussions	32	57.1
Barangay Officials	14	25.0
Family Members	2	3.6
Provincial Officials	2	3.6
Other Government Agency/Personnel	2	3.6
Surveyors	2	3.6
Others	2	3.6
Total	56	100.0

The attitude of the affected residents towards the proposed project in January 1995 survey showed that only 34 percent are in favor of it (50%). Those who said that they are in favor of the project and 16 percent expressed uncertainty or refused to give a response.

TABLE III-6-8
ATTITUDE TOWARDS THE PROPOSED PROJECT, DIA
(January and May 1995 Surveys)

Attitude Towards the Project	28 - 31 January 1995 Survey		21 - 23 May 1995 Survey	
	Frequency	Percentage	Frequency	Percentage
Favor	19	33.9	43	84.3
Not in Favor	28	50.0	6	11.8
Depends/No Response	9	16.1	2	3.9
Total	56	100.0	51	100.0

A more current follow-up perception survey conducted in May 1995 indicates significant changes in the people's attitude towards the project as a result of the proponent's community relations efforts. Around 91 percent of those covered during the January survey were interviewed again. This time, the results indicate that the percentage of those who are in favor of the project increased to roughly 2.5 times. There used to be 34 percent of the total number of respondents who expressed that they are in favor of the project while those who favor the project presently account to 84 percent of those surveyed. Likewise, those who are not in favor of the project decreased from 50 percent to 12 percent. The percentage of those who are uncertain has dropped as well, from 16 percent to 4 percent.

Figure III-6-2 presents a diagram comparing the people's responses regarding their attitude towards the project during the 2 surveys which were conducted.

Based on the January survey, most of the community residents are of the opinion that the project will both bring benefit and harm to the community (48%). Perceived good effects from the project are (1) employment, 54 percent; (2) electricity, 27 percent; and (3) improvements in the barangay, 18 percent. On the contrary, perceived adverse effects from the project include (1) pollution, 60 percent, (2) destruction of the environment, 18 percent; and (3) loss of livelihood, 8 percent; (4) declining health quality, 8 percent.

During the latest perception survey, the usual reasons why the respondents favor the project include: (1) benefits to community such as electricity and improvement of roads, 40 percent; (2) submission (feeling that they cannot do anything but accept the situation), 25 percent; (3) progress/improvement of the community, 18 percent; and (4) employment, 16 percent. Aside from those who favor the project, there are some respondents who expressed that they are not in favor of the project because of the following: (1) fear that the project's impacts may bring destruction of the environment, 83 percent; and (2) not being fully aware of the project, 17 percent.

TABLE III-6-9
OPINION OF THE PROPOSED PROJECT, DIA
(January 1995)

Opinion of the Project	Frequency	Percentage
Benefit the Community	11	19.6
Not Benefit the Community	7	12.5
Harmful	8	14.3
Both Benefit and Harm	27	48.2
Do not Know/No Response	3	5.4
Total	56	100.0

TABLE III-6-10
PERCEIVED POSITIVE EFFECTS FROM THE PROPOSED PROJECT, DIA
(January 1995)

Perceived Good Effect from the Project	Frequency	Percentage
Employment	12	54.5
Electricity	6	27.3
Improvements in the Barangay	4	18.2
Total	22	100.0

FIGURE III-6-2
ATTITUDE TOWARDS THE PROPOSED PROJECT, DIA
(January and May Surveys)

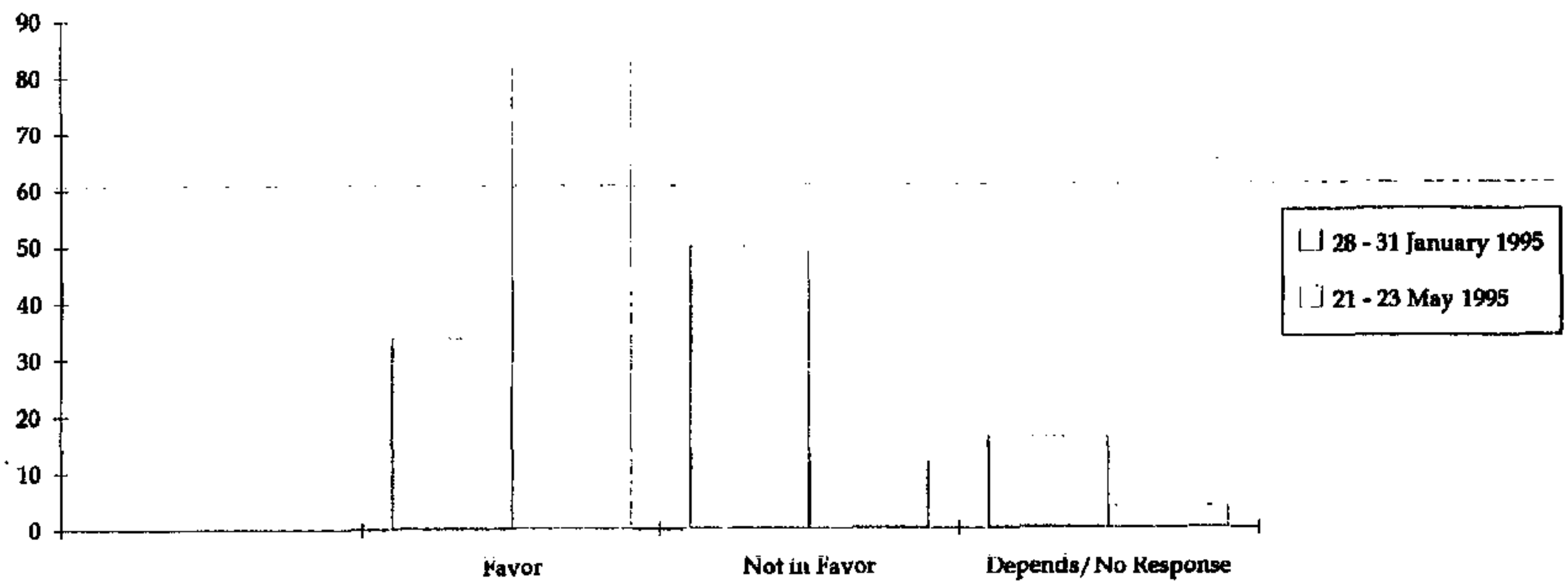


FIG3-6-2

TABLE III-6-11
PERCEIVED NEGATIVE EFFECTS FROM THE PROPOSED PROJECT, DIA
(January 1995)

Perceived Bad Effect from the Project	Frequency	Percentage
Pollution	23	60.5
Destruction of the Environment	7	18.4
Loss of Livelihood	3	7.9
Adverse Health Effects	3	7.9
Others	2	0.9
Total	38	100.0

The following presents the responses to the question, "Sa mga proyektong katulad nito, may ilang pamamahay ang kinakailangang lumipat ng tirahan o sakahan upang magbigay daan sa pagtatayuan ng planta. Kung sakaling kakailanganin ng proyektong ito ang lupang kinatatayuan ng inyong bahay o lupang inyong sinasaka, kayo po ba ay papayag na lumipat? Bakit po?" (Projects such as this *would require several households to transfer residence or farmland to give way to the construction of* the plant. Should this project require the land where your house stands or your farmland, will you agree to relocate? Why?)

An almost equal percentage gave positive as well as negative responses, 45 percent and 41 percent, respectively. A considerable percentage, 14 percent, is either not sure of their answer or refused to answer the question. (Figure III-6-3 is a pie-chart representation of the responses.) However, based on the recent upturn in the perception of the project as noted by the study conducted in May 1995, it is expected that if the above question was raised at this time, a significantly higher response of perceived positive effects from the proposed project would result.

TABLE III-6-12
WILLINGNESS TO RELOCATE, DIA

Willingness to Relocate	Frequency	Percentage
Yes	25	44.6
No	23	41.1
Depends/No Response	8	14.3
Total	56	100.0

When the respondents were probed why they are willing to relocate, computation of their multiple responses yielded that they are willing to relocate because they believe that a relocation site will be provided to them (26%). Most of the answers also include expression of submission, meaning, the residents accept their fate that they cannot do anything about the situation (15%) and others say that since they do not own the land (15%) they are willing to relocate.

FIGURE III-6-3
WILLINGNESS TO RELOCATE, DIA
(January 1995 Survey)

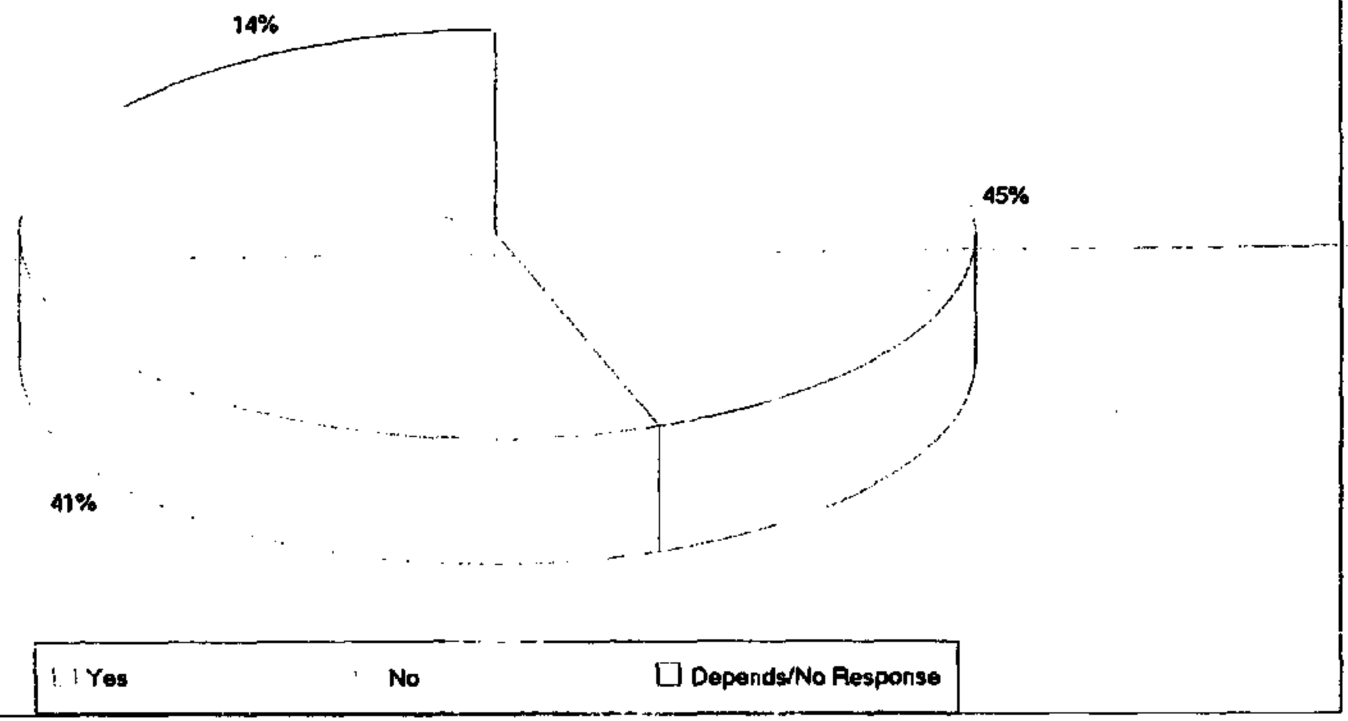


TABLE III-6-13
REASONS WHY WILLING TO RELOCATE, DIA
(January 1995)

Reason Why Willing to Relocate	Frequency	Percentage
Relocation site	7	25.9
Submission (Cannot do anything about the situation)	4	14.8
Land is not owned	4	14.8
Fair price	2	7.4
Everyone else will be transferred	2	7.4
Others	8	29.6
Total	27	100.0

Various reasons cited by those who are not willing to relocate are potential loss of livelihood (35%) and fear that there will be no place for them to go to (31%). Other responses include fondness of the place (12%) and the probability that they will become squatters in other places (8%).

TABLE III-6-14
REASONS WHY NOT WILLING TO RELOCATE, DIA
(January 1995)

Reason Why Not Willing to Relocate	Frequency	Percentage
Livelihood is there	9	34.6
No place to go	8	30.8
Already fond of the place	3	11.5
Will become squatters	2	7.7
Others	4	15.4
Total	26	100.0

Uncertainty on relocation is in general dependent as to whether there is a relocation site for those who will be relocated (50%). Other responses are reflected in Table III-6-15.

TABLE III-6-15
REASONS WHY NOT SURE OF RELOCATING, DIA
(January 1995

Reason Why Not Sure of Relocating	Frequency	Percentage
Depends on the relocation site	4	50.0
Depends on results of negotiations	1	12.5
Depends on landowner	1	12.5
Depends if they really need to go	1	12.5
Depends on the price/ Demands of the people	1	12.5
Total	8	100.0

Payment of lost property (38%) is the foremost type of assistance which the relocatees would require from the project proponents. Other assistance mentioned include the provision of a resettlement site (37%) and employment (25%).

TABLE III-6-16
ASSISTANCE FROM THE PROPONENT, DIA
(January 1995)

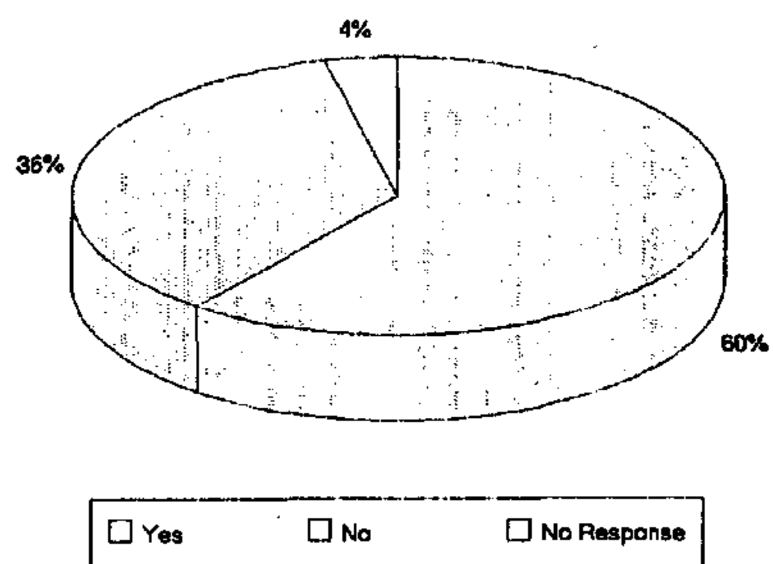
Assistance from the Proponent	Frequency	Percentage
Payment of Lost Property	23	38.3
Relocation Site	22	36.7
Employment	15	25.0
Total	60	100.0

Most of the affected households have family members who are interested to be employed in the project (61%).

TABLE III-6-17
WITH FAMILY MEMBERS WHO ARE INTERESTED
TO WORK FOR THE PROJECT, DIA
(January 1995)

With Family Members Who are Interested to Work for the Project	Frequency	Percentage
Yes	34	60.7
No	20	35.7
No Response	2	3.6
Total	56	100.0

FIGURE III-6-4
WITH FAMILY MEMBERS WHO ARE INTERESTED
TO WORK FOR THE PROJECT, DIA
(January 1995 Survey)



7.0 LAND AND RESOURCE USE

The scope of this study is consistent with that agreed upon during the scoping meeting which was conducted with the attendance of representatives from the Environmental Management Bureau of the DENR, some members of the Mauban community, the proponents, and the environmental consultants.

7.1 Methodology

7.1.1 Delineation of Impact Zones

The study area was categorized into three impact zones, as follows: (a) direct impact area (DIA), (b) probable impact zone (PIZ), and (c) twenty five kilometer radius impact zone (25-KRIZ).

The DIA is the site of the proposed project which consists of a coal-fired electric generating plant and related equipment, having an approximate generating capacity of 433 MW (net). This covers a land area of approximately 100 hectares (has) which includes the ash disposal area.

The PIZ is the area within the five kilometer zone of the project site, partly covering barangays Cagsiay I and Cagsiay II. For discussion purposes, the adjacent barangays of Bato, San Lorenzo, Soledad and Poblacion are also included in the PIZ.

The 25-KRIZ covers the municipalities of Mauban, Atimonan, Lucban, Pagbilao, Perez, Real, Sampaloc, and Tayabas in the province of Quezon; and, the municipalities of Cavinti, Kalayaan, Luisiana, Lumban, and Paete in the province of Laguna.

7.1.2 Land Use Survey

Topographic maps prepared by the National Mapping and Resource Information Authority (NAMRIA), with scale of 1:50,000 were basically used to derive the physical characteristics of the impact zones. The topographic maps were then compared with other thematic maps such as the soil maps, land use maps and slope maps of the Bureau of Soils and Water Management (BSWM). Confirmation was done through the conduct of a foot survey within the DIA and a windshield survey within the PIZ and the 25-KRIZ. An aerial survey was likewise conducted for the DIA and PIZ.

7.1.3 Map Preparation

For the 25-KRIZ, the following maps were prepared, (a) existing land use map and (b) land use plan map. Similar maps were prepared for the PIZ.

7.1.4 Data Collection

Appropriate data were collected to characterize the study area. Primary data on the number of affected families and structures/dwelling units were supplied by the study group on Socio-economics and Public Health.

Secondary data were gathered from concerned agencies.

Data presentation varies depending on the impact zone viz-a-viz availability of information. Presentation will be discussed in the appropriate sections of this report.

The 1990 census on population of the National Statistics Office (NSO) was utilized as the data base on population. Any projections made were, therefore, based on the said 1990 census.

7.2 *Description of the Existing Environment*

7.2.1 Direct Impact Area

Population

As reported by the study group on Socio-economics and Public Health, a total of 64 households are within the DIA, accounted according to sitios: 28 households in Sitio Dalig, 17 households in Sitio Dinahican and 25 households in Sitio Sabang.

Physical Characteristics

- Composition and Location

The DIA is located in Sitios Dinahican, Dalig and Sabang within Barangay Cagsiay I.

- Land Area

The DIA which is the project site itself consists of approximately 100 has.

- Slope

The DIA has slopes characterized as predominantly undulating to hilly (Slope Class D) and steeply hilly to mountainous (Slope Class F).[23]

- Soil

The DIA is predominantly composed of Alaminos clay.[24]

Existing Land Use

The DIA is composed primarily of ricelands about 13 has. and the rest are mostly coconut lands.

Further, *clusters of houses made of predominantly light materials line the gravel road within the DIA.*

The Cagsiay River borders the project site.

[23] The different slope classes and their corresponding characteristics are: Slope Class A (0-3% slope), level to gently sloping; Slope Class B (3-8% slope), gently sloping to undulating; Slope Class C (8-18% slope), undulating to rolling; Slope Class D (18-30% slope), rolling to hilly; Slope Class E (30-50% slope, hilly to steeply hilly; and Slope Class F (50% and above), steeply hilly to mountainous. Generally, lands with 0-18% slope are best suited to agricultural, urban and rural settlements, residential, industrial, institutional and infrastructure development. Those areas with 18-50% slope are suited to perennial crops, pasture and agro-forestry; and those areas with slope gradient of more than 50% are solely for forest development.

[24] The classification of the different types of soils are according to the landforms and landscapes identified and delineated in the maps prepared by the BSWM under the Land Resource Evaluation Project. These are further subdivided into land management units which are used as basic units for integration. Classification of different soil types and rock formation are necessary as a basis for the determination and evaluation of a specific area for agricultural and non-agricultural suitability.

7.2.2 Probable Impact Zone

Population

As mentioned in Section 7.1.4, the 1990 census on population was utilized. The total population data was used even though only portions of some barangays are actually in the PIZ.

Barangay Poblacion registered the highest population at 15,697 in 1990 and 16,882 in 1995 while Barangay Bato had the least population at 243 in 1990 and 261 in 1995, as shown in Table III-7-1. Population of Cagsiay I in 1990 comprised 3 percent of the total population in Mauban and 6 percent of the PIZ population.

Population within the PIZ consists of 56 percent of Mauban's total population in 1990.

TABLE III-7-1
POPULATION BY BARANGAY
1990 and 1995
(Probable Impact Zone)

Barangay	Population (1990)	Population (1995)
Bato	243	261
Cagsiay I	1,396	1,501
Cagsiay II	1,901	2,044
San Lorenzo	3,081	3,314
Soledad	2,025	2,178
Poblacion	15,697	16,881
Bagong Bayan	3,750	4,033
Daungan	4,052	4,358
Lual	1,546	1,662
Mabato	1,676	1,802
Rizaliana	1,170	1,258
Sadsaran	3,503	3,768
TOTAL for PIZ	24,343	26,180

Source: National Statistics Office

Physical Characteristics

- Composition and Location

The probable impact zone is the area within five kilometers of the project site, covering partly or wholly the different barangays as mentioned in Section 7.1.1.

- Land Area

The PIZ covers twelve barangays, six of which are located within the Poblacion area. The PIZ covers approximately 35 percent of Mauban's total land area.

TABLE III-7-2
AREA, By Barangay
(Probable Impact Zone)

Barangay	Land Area
Bato	371.79
Cagsiay I	2061.74
Cagsiay II	10139.70
San Lorenzo	473.18
Soledad	1149.16
Poblacion	
Bagong Bayan	45.105
Daungan	45.105
Lual	45.105
Mabato	45.105
Rizaliana	45.105
Sadsaran	45.105
Total for Probable Impact Zone	**14,466.20**
Total for Mauban	**41,600.00***

* National Statistics Office.

Source: Comprehensive Development Plan of Mauban

- Slope

Except for Barangay Poblacion and small patches in Barangay San Lorenzo which have slopes of 0-3 percent, all other barangays within the PIZ have slopes of 3-8 percent, characterized by undulating to rolling terrain.

- Soil

Alaminos clay dominates the PIZ. It is present in Barangays Cagsiay I and II, San Lorenzo and Soledad, while Bato and Poblacion have a mixture of Bigna loam and San Manuel sandy clay.

Existing Land Use

- Built-up Areas

Like other municipalities in the country, concentration of settlements in Mauban is located in the Poblacion. Likewise, other barangays have patches of settlements in their respective areas. Residential use is the dominant land use in the Poblacion interspersed with a small number of institutional uses, e.g., church, municipal hall, schools, etc., and commercial establishments, e.g., eateries/restaurants. (See **Figure III-7-1**).

It is noted that the municipality has three sawmills, one of which is located at the northern perimeter of the proposed project site.

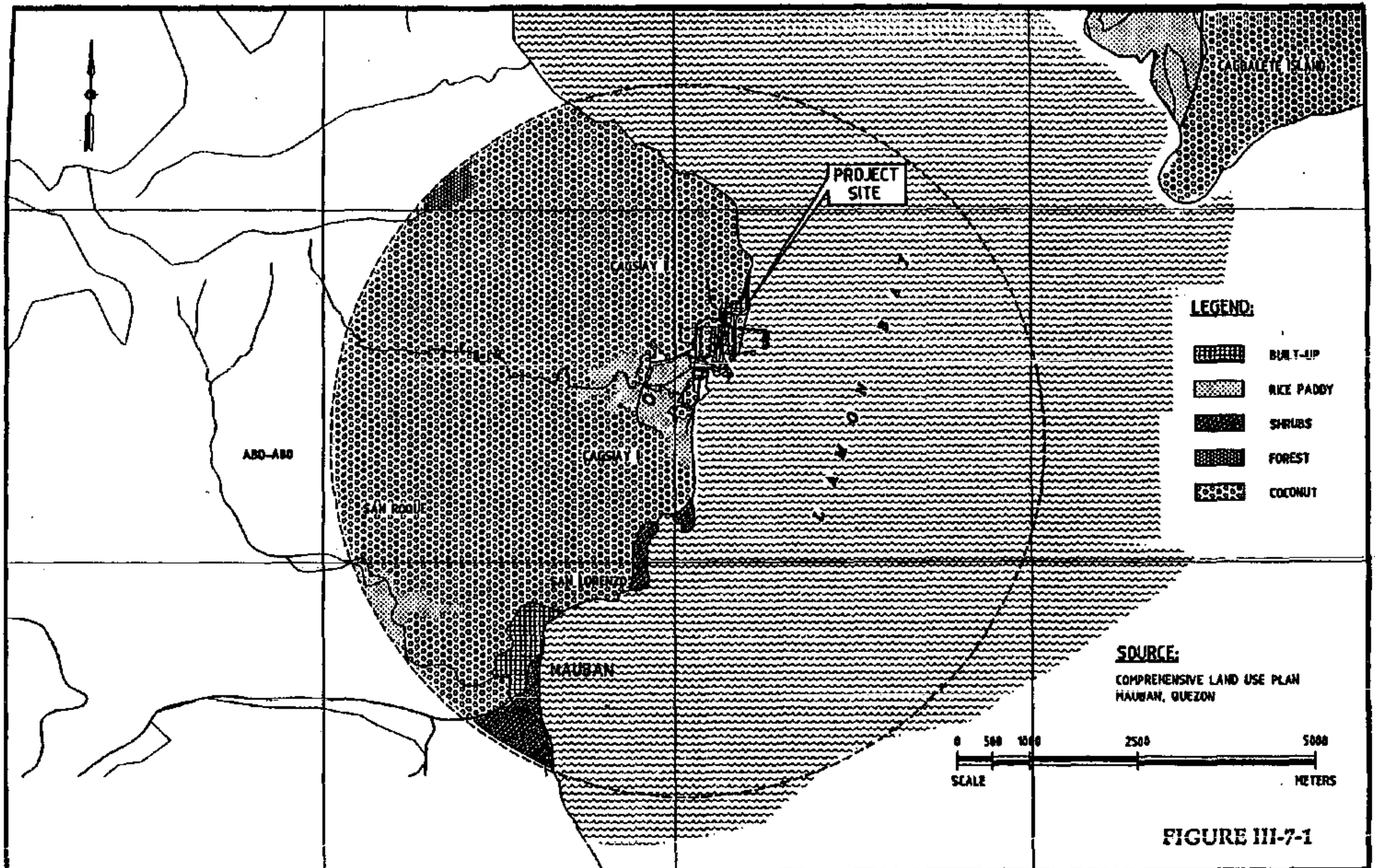


FIGURE III-7-1

BHP Engineering PHILIPPINES Inc.

433 MW (NET) QUEZON POWER PROJECT
ENVIRONMENTAL IMPACT STUDY
EXISTING LAND USE MAP
5 KM. PRIMARY IMPACT ZONE

SCALE		DWG No.	REV.
AS SHOWN	A3	P238 101 004	A

- Agricultural Use

The municipality of Mauban is basically an agricultural town, the major agricultural crop of which is coconut.

- Roads

Due to presentation of available information, data on roads and bridges shall be discussed at the municipal level.

Mauban has a total road length of 64.3 km of which, about 33 km or 51.4 percent are classified as provincial roads, 16.4 km or 25.6 percent are municipal and 14.8 kilometers or 23 percent are barangay roads. As to type of pavement, 14 km are concrete and 50.2 kilometers or 78.2 percent are gravel.

Table III-7-3 presents the inventory of roads in Mauban.

TABLE III-7-3
INVENTORY OF ROADS
Municipality of Mauban, 1992

	Length by Type of Pavement, kms.				
	Conc.	Asphalt	Gravel	Earth	Total
Provincial	0.100	-	32.898	-	32.998
Municipal	11.528	-	4.910	-	16.438
Barangay	2.412	-	12.403	-	14.815
Total	14.04	-	50.211	-	64.251

Source: Socio-Economic Profile of Quezon, 1990-1992

- Bridges

Total length of bridges in Mauban is 281 km, 55 percent of which are provincial bridges and the rest are municipal/barangay bridges.

Concrete bridges comprise more than 50 percent of the total bridges in the municipality. See Table III-7-4.

TABLE III-7-4
INVENTORY OF BRIDGES
Municipality of Mauban

	Length by Linear Meters				
	Concrete	Steel	Bailey	Timber	Total
Provincial	72.00	-	45.00	38.00	155.00
Municipal/Barangay	108.00	-	6.00	12.00	126.00
Total	180.00	-	51.00	50.00	281.00

Source: Socio-Economic Profile of Quezon, 1990-1992

- Irrigation System

Two barangays within the Probable Impact Zone are serviced by Communal Irrigation System. The total service area is 127 hectares, 28 hectares of which are in Barangay Cagsiay and 99 hectares in Barangay Bato. Only the communal irrigation system in Bato is operational while that of Cagsiay is not.

TABLE III-7-5
COMMUNAL IRRIGATION SYSTEM, 1994
(Probable Impact Zone)

Barangay	Services Area (has.)	Irrigation Wet	Dry	Remarks
Cagsiay I	28	-	-	not operational (for rehab.)
Bato	99	99	55	operational
Total	127	99	55	

Source: National Irrigation Administration, Region IV

- Tourist Spots

There are five tourist spots within the Probable Impact Zone, two of which are located in Cagsiay I, while the others are located in Poblacion. See Table III-7-6.

TABLE III-7-6
TOURIST SPOTS
(Probable Impact Zone)

Location	Name of Tourist Spots	Brief Description
Rizaliána (Pob)	Rizal Hill Park	Has a height of 50 feet
Lual	Little Baguio	With cave called Adam & Eve with 3 dancing pavilions at the top
Poblacion	Calvario	-
Cagsiay I	Bulwagin Beach White Sand Beach	-

Sources: Comprehensive Development Plan of Mauban; and 1984-2000 Socio-Economic Profile of Quezon, 1990-1992

- Water Resources

The main sources of water, either for domestic and irrigation purposes are the five springs, four of which are located in Bato and the other in Barangay Soledad. There are two creeks, one in Bato and one in Soledad.

7.2.3 Twenty Five Kilometer Radius Impact Zone

Data on the 25 KRIZ's physical characteristics and existing land uses were culled from the different thematic maps and confirmed by a windshield and aerial survey.

<u>Population</u>

- Number of Population

Population in the study area was 342,872 in 1990 representing 12 percent of the total population in the provinces of Laguna and Quezon. The municipalities of Laguna located within the study area experience on the average, 22 percent population increase while the municipalities of Quezon had, on the average, a 23 percent increase, between 1980-1990.

The three most populated municipalities within the study area during the censal year 1990 were Tayabas, Atimonan, and Mauban. On the other hand, the three least populated municipalities were Perez, Sampaloc and Kalayaan.

- Population Density

Mauban's urbanization level is higher compared to that of Quezon.

Municipalities within the study area in the province of Quezon had, on the average, an urbanization level of 40 percent while municipalities in Laguna had on the average a considerably higher urbanization level of 79 percent.

The study area or the 25 KRIZ had a higher urbanization level than those of the provinces of Quezon and Laguna.

$$\text{Gross Population Density} = \frac{\text{total population}}{\text{total land area}}$$

$$\text{Urbanization Level of Household Population} = \frac{\text{Urban household population}}{\text{total household population}}$$

<u>Physical Characteristics</u>

- Composition and Location

The 25-KRIZ is composed of 13 municipalities, eight in Quezon, covering the municipalities of Mauban and Sampaloc, and partly the municipalities of Atimonan, Lucban, Pagbilao, Perez, Real, and Tayabas; and five municipalities in Laguna, covering partly, Cavinti, Kalayaan, Luisiana, Lumban and Paete.

TABLE III-7-7
TOTAL NUMBER OF POPULATION
By Municipality, 1975, 1980, 1990 and 1995
(25 KRIZ)

Municipality	1975	1980	1990	1995
QUEZON	1,025,902	1,129,277	1,372,455	1,513,028
Mauban	32,653	37,814	47,043	47,043
Atimonan	37,483	39,894	46,651	50,447
Lucban	23,044	25,826	30,130	32,544
Pagbilao	29,304	31,681	41,635	47,729
Perez	5,789	7,551	8,609	9,192
Real	13,231	14,463	20,475	24,362
Sampaloc	8,874	9,365	11,132	12,137
Tayabas	37,756	42,137	54,355	61,734
Sub Total	188,134	208,731	260,030	285,188
LAGUNA	803,750	973,104	1,370,080	1,625,695
Cavinti	11,463	13,222	15,131	16,186
Kalayaan	8,501	10,247	13,118	14,842
Luisiana	12,346	12,199	14,241	15,387
Lumban	14,842	17,360	19,773	21,089
Paete	14,733	16,383	20,579	23,064
Sub-Total	61,885	69,411	82,842	90,568
Total for the Study Area	**250,019**	**278,142**	**342,872**	**375,756**

Source: National Statistics Office

TABLE III-7-8
LAND AREA, GROSS DENSITY, URBANIZATION LEVEL AND URBAN HOUSEHOLD POPULATION
By Municipality, 1990
(25KRIZ)

municipalities	Urban Household Pop. (1990)	Total Household Pop. (1990)	Land Area (Has.)	Gross Pop. Density	Urbanization Level
QUEZON	451,379	1,369,719	870,660	1.58	32.95
Mauban	15,681	43,710	41,600	1.05	35.87
Atimonan	12,001	46,643	16,680	2.80	25.73
Lucban	22,612	30,114	6,930	4.35	75.09
Pagbilao	11,131	41,612	17,100	2.43	26.75
Perez	3,290	8,605	5,860	1.47	38.23
Real	5,994	20,453	56,380	0.36	29.31
Sampaloc	6,872	11,042	7,380	1.51	62.24
Tayabas	17,178	53,985	31,830	1.71	31.82
Sub Total	94,759	256,164	183,760	1.40	36.99
LAGUNA	1,018,062	1,368,708	175,970	7.79	74.38
Cavinti	7,428	15,073	7,040	2.15	49.28
Kalayaan	13,116	13,116	4,660	2.82	100.00
Luisiana	10,117	14,192	6,380	2.23	71.29
Lumban	14,765	19,773	9,680	2.04	74.67
Paete	20,576	20,576	3,240	6.35	100.00
Sub-Total	66,002	82,730	31,000	2.67	79.78
Total for the Study Area	160,761	338,894	214,760	1.58	47.44

Source: National Statistics Office

- Land Area

The study area (or the area within the 25-KRIZ) covers about 55,994.6 hectares representing 26.07 percent of the twelve municipalities, total land area of 214,760 has. Table III-7-9 presents the area covered by the 25-KRIZ and the total municipal land area by municipality.

TABLE III-7-9
LAND AREA, By Municipality
(25 KRIZ)

Municipality	Total Municipal Land Area (has.)	Area Covered by 25 Km. Radius Impact Zone*
QUEZON	870,660	
Mauban	41,600	41,600.00
Atimonan	16,680	119.85
Lucban	6,930	219.54
Pagbilao	17,100	144.19
Perez	5,860	5,280.00
Real	56,380	181.80
Sampaloc	7,380	7,380.00
Tayabas	31,830	483.74
Sub-Total	183,760	55,409.12
LAGUNA	175,970	
Cavinti	7,040	199.98
Kalayaan	4,660	32.70
Luisiana	6,380	183.20
Lumban	9,680	151.94
Paete	3,240	17.68
Sub-Total	31,000	585.50
Total for the Study Area	**214,760**	**55,994.62**

* Estimated from Map

Source: National Statistics Office

- Slope

The municipalities of Lucban, Sampaloc, Tayabas, Real and Atimonan have slope classification of C (8%-18%, undulating to rolling), D (18%-30%, rolling to hilly), and E (30%-50%, hilly to steeply hilly) while Pagbilao has undulating and steeply hilly to mountainous slopes.

Perez has slopes of 18-30 percent (rolling to hilly) and 50 percent above (steeply hilly to mountainous).

More than 50 percent of Cagbalete Island has slopes of 3-8 percent (gently sloping) while the remaining areas have slope ranges of 0-3 percent (level to gently sloping) and 8-18 percent or undulating to rolling.

Municipalities in Laguna have dominant slope characteristics of 8 percent-18 percent (undulating to rolling).

- Soil Physiography

The dominant landforms of Mauban are volcanic hills which are described as basaltic hills, high and low relief with basalt as parent material and andesite hills, high relief with andesite as parent material. The other landforms are Mauban is sedimentary hills with shale, sandstone, siltstone, low relief and shale, sandstone, high relief with shale, sandstone and siltstone as parent materials.

Cagbalete and Perez are dominated by sedimentary hills with shale, sandstone, siltstone as parent materials.

All other municipalities covered in Quezon have volcanic hills with andesite hills, high relief and basaltic hills, low and high relief with andesite and basalt as parent materials. Others have sedimentary hills with limestone hills, high and low relief and shale, sandstone, siltstone low relief with limestone and shale, sandstone and siltstone as parent materials.

Six municipalities covered in Laguna (Sta. Maria, Famy, Siniloan, Pakil, Cavinti, Luisiana and Lumban) have pyroclastic hills, low and high relief and andesite hills, low and high relief. Paete and Kalayaan have slightly dissected pyroclastic plateaus.

Land Classification

In 1993, DENR data showed that alienable and disposable lands (A & D)[25] in the study area occupied 126,423 hectares, comprising approximately 59 percent of the total municipal land area while forestlands[26] comprise approximately 40 percent.

Natural Resources

- Forest Resources

There are three (3) forest reserves in the 25 KRIZ, namely: (a) Caliraya Forest Reserve with an area of 12,858 hectares covering Tayabas and Laguna; (b) Mt. Malaraya Forest Reserve with an area of 1,287 hectares is situated in Batangas, Laguna and Tayabas; and, (c) Famy-Infanta Forest reserve which is situated in Famy, Siniloan, Infanta and Tayabas covers an area of 13,026 hectares.

- National Parks

Two (2) national parks are located in the 25 KRIZ, namely, the Quezon National Park with an area of 983 hectares which covers Atimonan, Padre Burgos and Pagbilao, Quezon and the Mts. Banahaw-San Cristobal National Park, with an area of 11,133 hectares which covers San Pablo, Liliw, Nagcarlan, Rizal and Majayjay in Laguna and Lucena, Lucban, Sariaya, Candelaria and Dolores in Quezon.

[25] Alienable and disposable lands are those lands of the public domain which have been the subject of the present system of classification and declared as not needed for forest purposes.

[26] Forest land include the following sub-categories: (a) public forest which is the mass of land of the public domain which has not been the subject of the present system of classification for the determination of which lands are needed for forest purposes and which are not; (b) permanent forest or forest reserve which comprises lands of the public domain which have been the subject of the present system of classification and determined to be needed for forest purposes; and (c) forest reservations which are forest lands reserved by the President of the Philippines for any specific purposes.

TABLE III-7-10
STATUS OF LAND CLASSIFICATION, By Municipality
(25 KRIZ)

Municipality	Total Municipal Land (Has.)	Total Alienable and Disposable Lands (Has.)	Total Forestlands (Has.)
QUEZON	870,660	170,613	400,042
Mauban	41,600	28,342	12,658
Atimonan	16,680	16,030	-
Lucban	6,930	6,880	-
Pagbilao	17,100	14,171	2,678
Perez	5,860	5,104	756
Real	56,380	6,085	49,615
Sampaloc	7,380	7,380	3,028
Tayabas	31,830	18,884	12,186
Sub-Total	183,760	102,876	80,921
LAGUNA	175,970	135,720	40,253
Cavinti	7,040	5,511	0
Kalayaan	4,660	4,698	0
Luisiana	6,380	4,380	2,038
Lumban	9,680	5,680	4,038
Paete	3,240	3,278	0
Sub-Total	31,000	23,547	6,076
Total for the Study Area	214,760	126,423	86,997

Source: Department of Environment and Natural Resources, Region IV

- Watersheds

Two (2) watershed areas are located within the 25 KRIZ. These are the Banahaw Watershed Forest Reserve which is located in Pagbilao and Mauban and the Atimonan Watershed Forest Reserve in Atimonan. These watershed areas cover 465 hectares and 368 hectares, respectively.

- Mineral Resources

There are seven (7) mining companies in the study area, three (3) of which are located in Atimonan. The BMG Development Project in Mauban has the biggest reserve of 156,000,000 MT followed by Quezon Mineral Processing Corporation in Atimonan with a total reserve of 150,700,000 MT. Table III-7-11 shows the list of mining companies, the mineral produced and the total reserves per company in Quezon. The municipalities in Laguna have clay and sand, as shown in Table III-7-12.

TABLE III-7-11
MINING COMPANIES/OPERATORS/CLAIMOWNERS
Quezon, 1992
(25 KRIZ)

	Mineral	Total Reserve (Mt)	Average Grade	Status Operation
1. Quezon Mineral Processing Corp. Atimonan	limestone (lime raw material)	150,1700,000		Stopped
2. Fuji Mining Corp. Ibaba, Atimonan		1,244,203	98.1% Ca C03	Producing
3. Lawique, Tayabas Quezon Lime and Dev't Co. Inc.		3,556,205		Producing
4. Sta. Catalina, Atimonan Ananias K. Diokno, Jr.	Limestone Marbleized	59,416,400		Geodically Investigated
5. BMG Dev't Project Laging Bayan, Mauban		40,500,000		Geodically Investigated
6. BMG Dev't Project Laging Bayan, Paglubog		156,000,000		Geodically Investigated
7. Tayabas Cement, Co. Inc. Dingalan, Gen. Nakar Marao, Pagbilao Grande Island, P. Burgos		49,600,000		Status Unknown

Source: Department of Environment and Natural Resources, Region IV

TABLE III-7-12
MINERAL RESOURCES, By Municipality, 1994
(Laguna - 25 KRIZ)

Municipality	Mineral	Area in hectares	Remarks
1. Cavinti	Gravel and sand	50	without operation
2. Kalayaan	White clay	100	without operation
3. Luisiana	White clay	50	without operation
4. Lumban	Sand	50	with operation

Source: PENRO, Sta. Cruz, Laguna

- Water Resources

Surface Water

There are four (4) main rivers in the study area: Maapon River in Sampaloc has the biggest catchment area with 88 square kilometers, while the Ibia River has the smallest catchment area with 15 square kilometers. Table III-7-13 presents the main rivers in the study area.

TABLE III-7-13
MAIN RIVERS
(25 KRIZ)

River/Location	Catchment Area Sq. Kilometers	Annual Average Discharge Cu. M/S	Specific Discharge Cu. M/Sq. Km.
Maapon River (Sampaloc, Sampaloc)	88	5.78	0.07
Ibia River (Ayaas, Tayabas)	15	1.80	0.12
Dumaca A. River (Alsam, Ayaas, Tayabas)	54	6.36	0.12
Dumaca A. River (Lakawan, Tayabas)	74	10.52	0.14

Source: The Master Plan Study on CALABARZON APPENDIX D: WATER Resources

Ground Water

The municipality of Mauban has the most number of wells in the study area. These wells have depths of 39 meters, as shown in Table III-7-14.

TABLE III-7-14
GROUND WATER POTENTIAL
(25 KRIZ)

Municipality	No. of Wells (nos.)	Average Specific Capacity (lps/m)	Well Depth (m)	Area (mbgs)	Area
QUEZON	584				
Mauban	16	0.98	39	4.01	14,247
Atimonan		-		-	
Lucban	1	-	20	-	*
Pagbilao	13	0.15	35	5.31	46,849
Perez		2.07		0.61	*
Real	1	-	10	2.90	*
Sampaloc	3	0.21	37	6.10	*
Tayabas	4		27		
LAGUNA	407				
Cavinti	1		29	13.11	*
Kalayaan	1		37	2.74	*
Luisiana	1		64	7.62	10,608
Lumban	3		29	3.25	*
Paete					

* No shallow well
mbgs - meter below ground surface
lps - liter per second

Source: CALABARZON MASTER PLAN STUDY

Existing Land Use

Different land uses are generally categorized into: (a) settlements or built-up areas, (b) agricultural areas, and (c) forest areas. (See Figure III-7-2).

Residential, commercial, industrial and institutional land uses are the sub-categories of settlements or built-up areas. Agricultural land uses include those areas used for crop cultivation, inland fisheries, live stock production, pasturelands and grasslands. Forest lands include public forests, permanent forests, forest reservations, mineral lands, national parks, game refuge and bird sanctuaries.

Different settlements/built-up areas are as follows:

- Residential Use/Housing

The total occupied housing units in 1990 within the study area were 65,509, with Tayabas registering the highest at 10,801; comprising approximately 16 percent of the total occupied housing units. On the other hand, Perez had the least number with only 1,675 occupied housing units or 2.5 percent of the total number.

It is noted that single-detached dwelling units comprised 93 percent of the total occupied housing units in the study area.

Housing units with floor areas of 10-19 square meters comprised 22 percent of the occupied dwelling units in the study area. These figures indicate the preference of a large segment of the population for single detached dwelling units even with a relatively small floor area.

See Tables III-7-15 and III-7-16.

- Institutional Use/Education

There are 185 schools in the study area, 26 of which are private schools.

Four of the thirteen municipalities within the study area do not have public secondary schools, as follows, Perez and Sampaloc in Quezon and Kalayaan and Paete in Laguna.

There are only six (6) tertiary schools, four (4) of which are private schools.

See Table III-7-17.

- Institutional Use/Health

There are four (4) government hospitals in the study area which are located in Mauban, Atimonan, Sampaloc and Luisiana. Four (4) private hospitals are located in Quezon. Each municipality has one rural health unit.

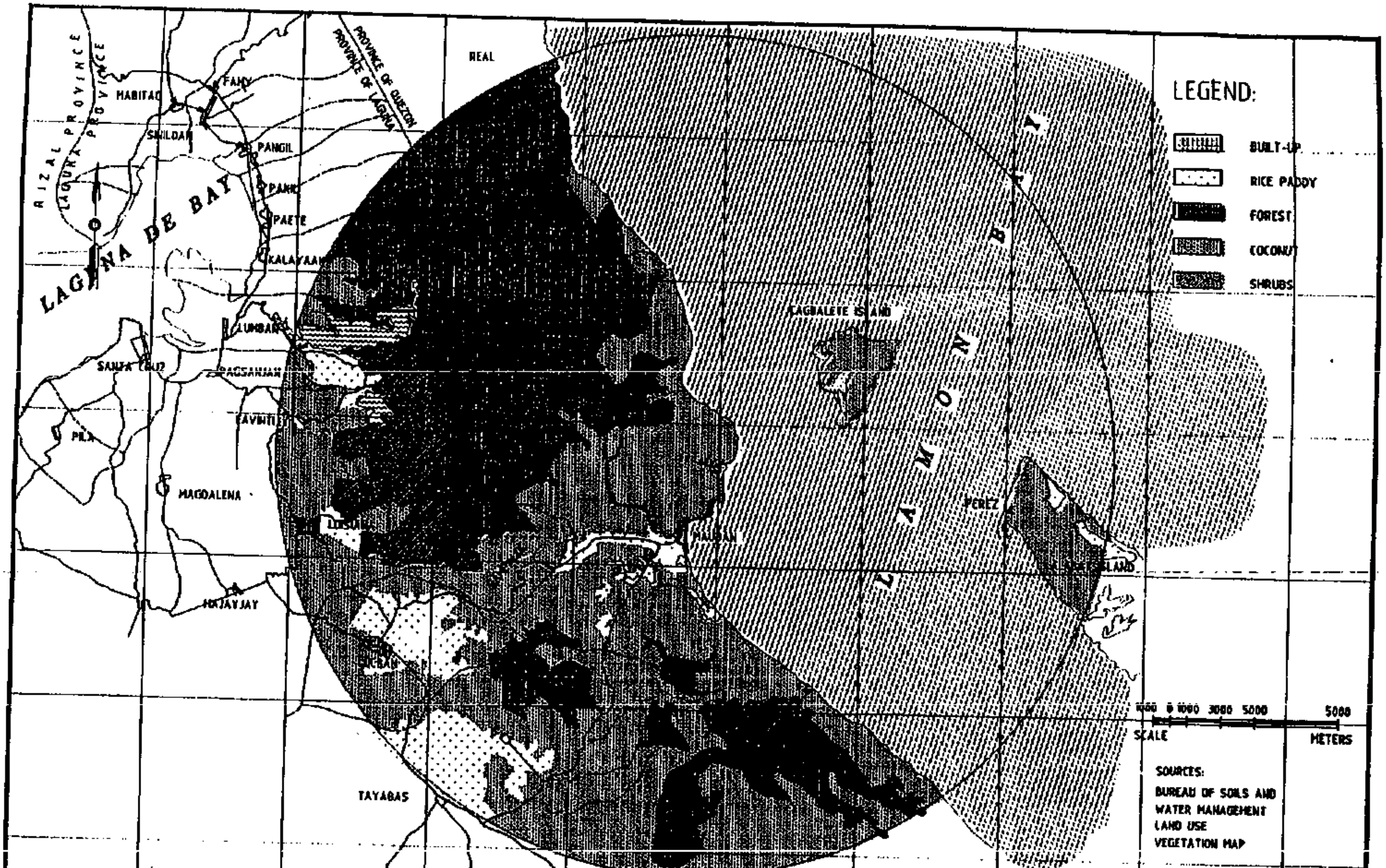


FIGURE III-7-2

BHP Engineering PHILIPPINES Inc.

433 MW (NET) QUEZON POWER PROJECT
ENVIRONMENTAL IMPACT STUDY
EXISTING LAND USE MAP
25 KM. REGIONAL IMPACT ZONE

SCALE		BHPE DWG No.	REV.
AS SHOWN	A3	P230 101 004	A

TABLE III-7-15
NUMBER OF HOUSING UNITS AND TYPE OF BUILDING
By Municipality, 1990
(25 KRIZ)

Municipality	Total Occupied Housing Unit	Type of Building						Not Reported
		Single House	Duplex	Multi-Unit Residential (3 units or more)	Commercial/ Industrial/ Agricultural	Institutional Living Quarter	Other Housing Unit	
QUEZON	260,031	248,615	4,918	5,876	448	45	121	8
Mauban	8,359	7,917	70	341	21	3	7	
Atimonan	9,185	8,716	207	230	22	7	2	1
Lucban	5,433	4,811	366	237	17		2	
Pagbilao	8,540	8,121	71	236	13	3	6	
Perez	1,675	1,647	7	20		1		
Real	3,799	3,681	62	34	19	2	1	
Sampaloc	2,116	1,898	73	137	8			
Tayabas	10,801	9,583	707	466	37	1	6	1
Sub-Total	49,818	46,374	1,563	1,701	137	17	24	2
LAGUNA	259,115	227,947	14,284	15,811	755	42	200	76
Cavinti	3,163	3,096	43	8	15	1		
Kalayaan	2,426	2,294	86	75	7			
Luisiana	2,692	2,562	87	39	4			
Lumban	3,694	3,516	105	70	2		1	
Paete	3,680	2,991	343	326	16	1	3	
Sub-Total	15,691	14,459	664	518	44	2	4	0
Total for the Study Area	65,509	60,833	2,227	2,219	181	19	28	2

Source: National Statistics Office

TABLE III-7-16
OCCUPIED HOUSING UNITS, BY FLOOR AREA
By Municipality, 1990
(25 KRIZ)

Municipalities	Total Occupied Housing Units	Floor Area of the Housing Units (in square meters)								
		less than 10	10-19	20-29	30-49	50-69	70-89	90-119	120-8	Not Reported
QUEZON	260,031	57,935	70,824	47,393	37,060	16,455	10,160	7,513	12,690	
Mauban	8,359	2,058	2,120	1,311	1,155	627	322	362	404	1
Atimonan	9,185	1,288	2,355	1,760	1,546	814	536	344	541	
Lucban	5,433	150	471	820	1,197	829	663	475	828	1
Pagbilao	8,450	1,561	2,116	1,848	1,538	486	299	219	383	
Perez	1,675	182	386	279	387	193	107	75	66	
Real	3,799	793	1,273	789	449	190	129	58	118	
Sampaloc	2,116	48	324	433	571	269	197	134	140	
Tayabas	10,801	1,306	2,905	2,252	2,052	922	535	367	462	
Sub-total	49,818	7,386	11,950	9,412	8,895	4,330	2,788	2,034	2,942	1
LAGUNA	259,115	36,982	50,312	45,561	47,768	31,188	16,906	12,564	17,810	24
Cavinti	3,163	259	713	747	767	317	195	94	71	
Kalayaan	2,462	356	581	489	457	190	119	81	189	
Luisiana	2,692	57	286	285	583	412	34	319	406	3
Lumban	3,694	207	388	563	721	576	409	349	481	
Paete	3,680	214	452	571	656	503	328	340	616	
Sub-Total	15,609	1,093	2,420	2,655	3,184	1,998	1,392	1,183	1,763	3
Total	65,427	8,479	14,370	12,067	12,079	6,328	4,180	3,217	4,705	4

Source: National Statistics Office

TABLE III-7-17
NUMBER OF PUBLIC AND PRIVATE ELEMENTARY, SECONDARY AND TERTIARY SCHOOLS
By Municipality
(25 KRIZ)

Municipality	Elementary		Secondary		Tertiary	
	Public	Private	Public	Private	Public	Private
QUEZON						
Mauban	25	1	1	2	1	
Atimonan	26		5	1		2
Lucban	12	2	2	1	1	
Pagbilao	16		2	1		
Perez	12			1		
Real	16		1			
Sampaloc	7	1		1		
Tayabas	32	1	2	2		
Sub-Total	146	5	13	9	2	2
LAGUNA						
Cavinti	15		2	2		1
Kalayaan				1		
Lusiana	8		1	1		
Lumban	12	1	1	1		
Paete	4			2		1
Sub-Total	39	1	4	7		2
Total for the Study Area	185	6	17	16	2	4

Source: Department of Education, Culture and Sports, Region IV
*Alabat Perez District

Table III-7-18 presents the number of health service facilities within the 25 KRIZ.

- *Industrial/Commercial Use*

In 1993, a total of 3,531 establishments were registered in the study area, comprising approximately 13 percent of the total number of establishments in the provinces of Laguna and Quezon. The manufacturing sector comprised 39 percent of the total number of establishments.

TABLE III-7-18
NUMBER OF HEALTH SERVICE FACILITIES
By Municipality, 1994
(25 KRIZ)

Municipalities	Number of Gov't. Hospital	Private	Rural Health Unit	Barangay Health Station
QUEZON (Province)	17	25	42 1_/	181 1_/
Mauban	1	-	1	)
Atimonan	1	1	1	)
Lucban	-	1	1	)
Pagbilao	-	1	1	) No data
Perez	-	-	1	)
Real	-	-	1	)
Sampaloc	1	-	1	)
Tayabas	-	1	1	
Sub-Total	3	4	8	
LAGUNA (Province)	10	28	36 2_/	233 2_/
Cavinti	-	-	1	4
Kalayaan	-	-	1	3
Luisiana	1	-	1	4
Lumban	-	-	1	4
Paete	-	-	1	4
Sub-Total	1	-	5	19
Total for the Study Area	5	4	13	19

Source: 1_/ = DOH, Region IV, 1994
2_/ = Provincial Health Office, Sta. Cruz, Laguna

Tayabas has the highest number of establishments within the study area, 43.6 percent of which were engaged in the wholesale and retail trade sector.

It is noted that Paete had the most number of manufacturing establishments, which may be attributed to the number of wood carving industries Paete is known for.

The presence of establishments is an indicator of the urbanization level and development in a locality.

See Table III-7-19.

TABLE III-7-19
NUMBER OF ESTABLISHMENTS, BY MAJOR INDUSTRY GROUP
By Municipality, 1993

Municipality	Total	Industry Major Group								
		Agriculture Fishing and Forestry	Industry Mining and Quarrying	Manufacturing	Electricity Gas and Water	Construction	Wholesale and retail Trade	Transportation Communication and Storage	Financing Insurance Real Estate and Business Services	Community, Social and Personal Services
QUEZON	10,11 1	20	5	2,040	19	13	4,658	114	342	2,900
Mauban	375	1	1	82	1	-	156	5	9	120
Atimonan	381		-	62	1	-	197	4	16	101
Lucban	354	1	1	106	1	1	117	5	10	112
Pagbilao	315	1	-	76	-	-	100	15	7	116
Perez	67	-	-	19	-	-	36	-	-	12
Real	91	1	-	20	-	-	44	-	1	25
Sampaloc	63		-	20	1	-	20	2	2	18
Tayabas	740	1		241	-	1	323	5	15	154
Sub-Total	2,386	5	2	626	4	2	993	36	60	20,398
LAGUNA	16,01 3	47	7	4,044	24	33	6,495	58	735	4,570
Cavinti	114	-	-	85	-	-	6	-	1	22
Kalayaan	75	-	-	43	1	-	9	1	2	19
Luisiana	193	-	-	115	-	-	40	1	1	36
Lumban	149	-	1	74	2	-	26	-	3	43
Paete	614	-	-	420	-	-	70	-	12	111
Sub-Total	1,145	0	1	737	3	1	151	2	19	231
Total for the Study Area	3,531	5	3	1,363	7	3	1,144	38	79	877

Source: National Statistics Office

- Agricultural Use

Croplands

Coconut is the major agricultural crop raised within the 25 KRIZ, covering approximately 105,401 hectares.

Among the thirteen municipalities, Pagbilao, has the highest percentage at 91 percent coconut areas versus the total municipal land area, as shown in Table III-7-20.

TABLE III-7-20
TOTAL AGRICULTURAL AREA
By Municipality
(25 KRIZ)

Municipality	Irrigated	Rainfed	Upland	Total	Coconut (Ha.)	Corn Yellow Corn
LAGUNA 1_/						
Cavinti	480.55	89.3	-	569.85	919.80	-
Kalayaan	351.50	-	-	351.50	1,200.00	-
Luisiana	384.50	10.0	-	394.50	2,644.60	-
Lumban	767.00	-	-	767.00	-	-
Paete	132.00	-	-	132.00	-	-
Sub-Total	2,115.55	99.3		2,214.85	4,764.40	-
QUEZON 2_/						
Mauban	413.00	470.00	-	883.00	30,367.00	-
Atimonan	160.00	515.00	-	675.00	18,489.87	-
Lucban	964.00	596.00	-	1,560.00	4,607.00	-
Pagbilao	674.00	141.01	23.13	838.83	15,567.00	10.75
Perez	70.00	181.75	7.23	258.98	4,957.00	-
Real	58.20		-	58.20	20,301.00	-
Sampaloc				-	-	-
Tayabas	1,953.01	306.00		2,271.00	11,305.00	16.00
Sub-Total	4,292.90	2,209.76	42.36	6,545.01	105,593.87	26.75
Total for the Study Area	**6,408.45**	**2,309.05**	**42.36**	**8,759.86**	**105,401.27**	**26.75**

1_/ Provincial Agriculture Office, 1994, Sta. Cruz, Laguna
2_/ Socio Economic Profile, Quezon CY 1990: 1992

Irrigation System

The Communal Irrigation System of the National Irrigation Administration (NIA) serviced approximately 4,238 has., as shown in Table III-7-21.

Fishery Resources

The study area has both freshwater and brackishwater fishponds.

Municipalities in Quezon except Atimonan and Real have a number of freshwater fishponds covering an area of approximately five hectares. On the other hand, only Pagbilao has brackishwater fishponds. See Table III-7-22.

Meanwhile, all the municipalities in Laguna within the 25-KRIZ have fishponds/fishcages.

TABLE III-7-21
COMMUNAL IRRIGATION SYSTEM
By Municipality, 1994
(25 KRIZ)

Municipality	Service Area (Ha.)	Irrigated Area (Ha.)	
		Wet	Dry
QUEZON	9,583	8,364	7,012
Mauban	409	362	281
Atimonan	124	69	69
Lucban	948	945	945
Pagbilao	370	370	295
Perez	21	21	21
Real	65	65	47
Sampaloc	225	225	213
Tayabas	1,624	1,607	1,298
Sub-Total	3,786	3,664	3,169
LAGUNA	4,408	4,212	4,286
Cavinti	124	64	64
Kalayaan	118	118	118
Luisiana	No data		
Lumban	107	107	107
Paete	103	103	103
Sub-Total	452	392	392
Total for the Study Area	**4,238**	**4,056**	**3,561**

Source: NIA, Region IV

TABLE III-7-22
AREA AND YIELD OF FISHPOND/FISHCAGE
By Municipality, 1994

Municipality	Fishpond		Fishcage	
	Area (has.)	Yield	Area (has.)	Yield/Hr. (in Mt)
Laguna:	(No available data for the Province)			
Cavinti	-	-	9.0	40.0
Kalayaan	3.9	No data		
Luisiana	2.0	No harvest yet		
Lumban	0.5	No data		
Paete	4.57	1.0 MT.	1.2	1.0
Total (Study Area)	10.97	1.0	10.2	41.0

Source: Provincial Agriculture Office, Sta. Cruz, Laguna

For municipalities in Quezon, only Pagbilao has both brackishwater and freshwater fishponds while Mauban, Lucban, Sampaloc and Tayabas have freshwater fishponds.

TABLE III-7-23
AREA AND YIELD OF FISHPOND
By Municipality, 1990
(Quezon - 25 KRIZ)

Municipality	Brackishwater		Freshwater	
	Area (Has.)	Yield (in MT)	Area (Has.)	Yield (in MT)
Quezon	26,614.23		5.8324	
1. Mauban			.05000	0.11
2. Atimonan				
3. Lucban			3.3705	7.48
4. Pagbilao	841.41	466.420	.2884	0.43
5. Real				
6. Sampaloc			.7390	1.66
7. Tayabas			.4160	1.03
Total (Study Area)	841.41	466.420	4.8639	10.71

Source: Socio-economic Profile, , Quezon CY 1990-1992

- Tourist Spots

A number of beach resorts are found in the province of Quezon while springs/waterfalls are situated in Laguna, as shown in Table III-7-24.

TABLE III-7-24
TOURIST SPOTS
(25 KRIZ)

Location	Name of Tourist Attraction
LAGUNA 1_/	Lake Caliraya
Cavinti and Lumban	Dos Lagos
	Lagos del Sol
Cavinti	Karirita Resort
	San Juan Falls
	Nayong Kalikasan
Cavinti	Benditang Tubig
	Matabungcacalis
	Tatlong Krus
QUEZON 2_/	
Mauban	Bulwagin Beach
	White Sand Beach
	Rizal Hill Park
	Calvario
Atimonan	Victoria Beach Resort
	Caliwara Beach Resort
	HGV Beach Resort
	184 Beach Resort
	Munting Paraiso
	Angeles Beach Resort
	Maling River
	Quezon National Bank
	Maria Cristina Park
	Bonifacio Park
Lucban	Mt. Banahaw
	May-it Spring
	Pahiyas Resort
Pagbilao	Cala de Oro Resort
	Kalilayan Island
	Talon ng Malikboy
	Tutay Buhangin Beach
Perez	Angas Beach
	Ponce Beach Resort

TABLE III-7-24
TOURIST SPOTS
(25 KRIZ)

Continuation . . .

Location	Name of Tourist Attraction
Real	Balute Beach Capolong Beach Kinalumbukan Beach Balibaguhin Falls Cawagan Falls Sunny Junction Pandan Beach Mag-asawang Bato Islet
Sampaloc	Boho Falls Mahangin Falls Hangga Falls Tangol Cave Caldong Falls Kakate Beach Tabag Beach Bataan Waterfalls I/II
Tayabas	Mainit Spring Alitao River Nawawalang Paraiso Resort

1_/ Source: Consolidated Laguna Agricultural Social Services and Infrastructure Concerns Program, Part II, May 1991

2_/ Source: Socio-economic Profile, Quezon, CY 1990 -1992.

Roads

Data as to type of pavement is available only for Quezon. Gravel and earth type of pavement comprise 87.93 percent of total road length, as shown in Table III-7-25. Obviously, the condition of the roads in any given locality determine to some extent the development in that area.

TABLE III-7-25
SUMMARY OF ROAD INVENTORY
BY TYPE OF PAVEMENT
(QUEZON - 25 KRIZ)

Classification	Length by Pavement (Kms.)				
	Concrete	Asphalt	Gravel	Earth	Total
National	No Data				
Provincial	9.720	1.430	98.979	-	110.179
Municipal	40.397	6.218	17.751	1.628	65.994
Barangay	18.524	0.200	165.188	274.134	458.046
Total	68.641	7.848	281.918	275.762	634.219

Source: Department of Public Works and Highways

The study area has a total road length of approximately 1,079 kilometers (km.). Barangay roads comprise 56.39 percent of the total road length, municipal roads with 8.84 percent, provincial roads with 13 percent, and national roads comprising 21.8 percent of the total road length. Refer to Table III-7-26.

Bridges

Due to difference in data presentation on bridges, characteristics/tables of the bridges within Quezon and Laguna will be shown separately. Refer to Tables III-7-27 and III-7-28.

In Quezon, concrete bridges comprise 70 percent of the study area's total bridge length.

- Communication Facilities

All the municipalities within the study area have either radio or telegraph facilities, however, only five municipalities have telephone facilities. See Tables III-7-29 and III-7-30.

As to cable TV connection, all municipalities have this facility, except Pagbilao and Real in Quezon, as shown in Table III-7-31.

TABLE III-7-26
INVENTORY OF ROADS
By Municipality and By Classification
(25 KRIZ)

Municipality	National (kms.)	Provincial (kms.)	Municipal (kms.)	Barangay (kms.)	Total (kms.)
QUEZON	789.285	368.462	281.982	1,985.987	3425.716
Mauban	17.306	32.998	16.438	14.815	81.557
Atimonan	27.794	17.994	8.374	36.518	90.680
Lucban	27.455	10.217	11.384	121.085	170.141
Pagbilao	24.872	29.207	11.720	65.418	131.217
Perez	17.500	0.187	3.066	10.337	31.090
Real	37.360	4	5.635	47.160	94.155
Sampaloc	14.000	-	3.687	45.100	62.787
Tayabas	28.755	15.713	8.756	127.950	181.174
Sub-Total	195.042	110.316	69.060	468.383	842.801

TABLE III-7-26
INVENTORY OF ROADS
By Municipality and By Classification
(25 KRIZ)

Continuation . . .

Municipality	National (kms.)	Provincial (kms.)	Municipal (kms.)	Barangay (kms.)	Total (kms.)
LAGUNA	349.480	205.87	234.10	648.02	1,437.96
Cavinti	24.63	8.16	4.30	37.99	75.08
Kalayaan	5.08	7.51	12.27	6.53	31.39
Luisiana	10.23	12.60	2.77	49.33	74.93
Lumban	12.72	1.30	6.15	13.23	33.40
Paete	5.14	0.50	3.83	42.82	52.29
Sub-Toal	57.8	30.07	29.32	149.90	267.09
Total for the Study Area	252.842	140.386	98.38	618.283	1,109.891

Sources: Department of Public Works and Highways, Laguna
Socio-Economic Profile of Quezon, 1990-1992

TABLE III-7-27
INVENTORY OF BRIDGES
By Municipality
(QUEZON-25 KRIZ)

Municipalities	Conc.	Length Steel	Linear Balley	Meters Timber	Total
Provincial					
Mauban	72.00	-	45.00	38.00	155.00
Atimonan	362.58	-	12.00	-	374.58
Lucban	-	-	-	-	-
Pagbilao	98.50	-	-	-	98.50
Perez	-	-	-	-	-
Real	-	-	-	-	-
Sampaloc	-	-	-	-	-
Tayabas	244.50	-	-	12.00	256.50
Sub-Total	777.58	-	57.00	50.00	884.58
Municipal/Brgy.					
Mauban	108.00		6.00	12.00	126.00
Atimonan	No data	available			
Lucban	0.0783		-	-	0.0783
Pagbilao	No data		-	-	-
Perez	-	-	-	58.60	58.60
Real	230.00	58.50	21.00	106.00	415.50
Sampaloc	80.00	40.00	12.00	252.00	384.00
Tayabas	549.00			89.00	638.00
Sub-Total	967.0783	98.50	39.00	517.60	1,622.1783
Total	1,744.6583	98.50	96.00	567.60	2,506.7583

Source: Department of Public Works and Highways, Quezon

TABLE III-7-28
INVENTORY OF BRIDGES
By Municipality
(Laguna - 25 KRIZ)

Name of Road Section	Name of Bridge Location	Number of Span	Length/ Span (meter)	Total Length (meter)
Paete	Paete Bridge	1	1-10.80	10.80
Kalayaan Pob. Road	Kalayaan Bridge	1	1-6.80	6.80
Paete-Pakil-Famy Pob.	Paete Bridge	1	1-5.70	5.70
Cavinti-Lumot-Caliraya	Cavinti Bridge	4	2-15.30	59.80
	Cavinti Overflow	1	1-16.00	16.00
Cavinti-Luisiana Road	Caluycoy Bridge	1	1-15.20	15.20
Cavinti-Luisiana Road	Dape Bridge	1	1.20.00	20.00
Cavinti-Luisiana Road	Maapon Bridge	1	1-15.00	15.00

Source: Summary List of Existing Bridge and Structure, 1992,
DPWH, Sta. Cruz, Laguna

TABLE-III-7-29
TELECOMMUNICATION FACILITIES
By Municipality, 1994
(25 KRIZ)

Municipality	Facilities	Services Rendered
QUEZON		
Mauban	radio	social telegram; telegram
Atimonan	radio	social telegram; telegram
Lucban	radio	social telegram; telegram
Pagbilao	radio	social telegram; telegram
Perez	radio	social telegram; telegraphic transfer
Real	telegraph	telegram
Sampaloc	radio	social telegram; telegram
Tayabas	telegraph	social telegram; telegram

TABLE-III-7-29
TELECOMMUNICATION FACILITIES
By Municipality, 1994
(25 KRIZ)

Continuation . . .

Municipality	Facilities	Services Rendered
LAGUNA		
Cavinti	radio	social telegram; telegram
Kalayaan	telegraph	telegram
Luisiana	radio	social telegram; telegram national telegraphic transfer service
Lumban	telegraph	social telegram; telegram
Paete	telegraph	telegram

Source: Bureau of Telecommunications

TABLE III-7-30
EXISTING AND AUTHORIZED TELEPHONE FACILITIES
As of December 1994
(25 KRIZ)

Municipalities	Operator	Type of Exchange	Capacity	Working Lines
QUEZON				
Mauban	PLDT	SXS	400	326
Atimonan	Gen. tel. System	SXS	500	511
Lucban	Lukban Tel. Sys.	Digital (N.T.SL-1)	1,000	491
Pagbilao	-	-	-	-
Perez				
Real	-	-	-	-
Sampaloc	-	-	-	-
Tayabas	PLDT	SXS	197	197
LAGUNA				
Cavinti	-		-	-
Kalayaan	-		-	-
Luisiana	-		-	-
Lumban	PLDT	CABLEX	-	-
Paete	PLDT	EMD	300	281

Source: National Telecommunications Commission

TABLE III-7-31
CATV OPERATORS
As of October 1994
(25 KRIZ)

Operator	Area	Contract Number	Date of Provisional Authority
Rosita Veran CATV Services	Atimonan	87-115	2-06-90
Quezon CATV, Inc.	Tayabas	89-133	8-28-91
Southeast Cable TV, Corp.	Mauban	90-138	8-05-91
Sampaloc CATV System Corporation	Sampaloc	92-071	7-28-92
Winercan, Inc. (Lucban Cable TV)	Lucban	93-290	
Banahaw Utilities Corp.	Lucban	93-292	12-10-93
Aljar Cable TV & Satellite Network	Lucban	93-310	8-05-93
Laguna Cable Network	Victoria, Pila, Pagsanjan Nagcarlan, Lumban, Cavinti, Kalayaan	93-341	
Cable Concepts, Inc.	Lumban	93-388	
Pacific Coast CATV, Inc.	Paete	93-258	
Cable Concepts, Inc.	Paete	93-445	
Laguna Cable Network	Paete, Pakil, Pangil Siniloan, Mabitac, Famy Sta. Maria	93-293	10-04-83
C.P. CATV Cable Corp.	Luisiana		

Source: National Telecommunications Commission

Power Supply

The energy requirements in the study area is served by MERALCO and three cooperatives.

Five municipalities in Quezon are served by MERALCO while Atimonan and Perez are served by First Quezon Electric Cooperative. Real on the other hand is being served by Quezon II Electric Cooperative, Inc. Of the five (5) municipalities covered in Laguna only Luisiana is served by MERALCO while Kalayaan, Cavinti, Lumban and Paete are served by First Laguna Electric Cooperative (FLECO). See Table III-7-32.

A reliable power supply is one factor which triggers development in an area.

As shown by the NSO data in Table III-7-33, 64 percent of households in the study area used electricity for their lighting needs.

Water Supply

As to the main source of drinking water, 58 percent of households in the study area use faucets connected to the community's water system while 15 percent still depend on springs, rain, etc. while the rest get water from wells (either tubed/piped) or shallow (24%) or through peddlers (3%). See Table III-7-34.

TABLE III-7-32
STATUS OF ENERGIZATION
By Municipality, 1993
(25 KRIZ)

Municipality	Coverage	Barangays Energized	Total Actual Connection
QUEZON			
A. MERALCO			
Mauban	-	-	3,303
Lucban	-	-	4,816
Pagbilao	-	-	4,320
Sampaloc	-	-	1,374
Tayabas	-	-	6,194
Sub-total	-	-	20,007
B. First Quezon Elect. Coop.			
Atimonan	42	34	6,817
Perez	11	9	899
Sub-Total	53	43	7,716
C. Quezon II Electric Cooperative Inc.			
Real	14	-	1,688
Sub-Total	14	-	1,688

TABLE III-7-32
STATUS OF ENERGIZATION
By Municipality, 1993
(25 KRIZ)

Continuation . . .

Municipality	Coverage	Barangays Energized	Total Actual Connection
LAGUNA			
A. MERALCO			
Luisiana	-	-	2,835
Sub-Total			2,835
B. First Laguna Elect. Coop. (FLECO)	-		
Cavinti	19	13	2,186
Kalayaan	3	3	1,749
Lumban	16	16	1,309
Paete	9	9	3,397
Sub-total	47	41	.8,641

TABLE III-7-33
NUMBER OF HOUSEHOLDS BY TYPE OF FUEL USED FOR LIGHTING
By Municipality, 1994
(25 KRIZ)

Municipality	Total Households	Electricity	Fuel Used for Lighting			
			Kerosene (Gas)	Liquified Petroleum Gas (LPG)	O.I.	Others
QUEZON	265,762	123,357	136,214	4,444	457	1,290
Mauban	8,760	4,332	4,303	125	-	-
Atimonan	9,832	6,346	3,415	50	11	10
Lucban	6,177	4,823	1,309	36	-	9
Pagbilao	8,598	4,167	4,128	210	20	73
Perez	1,705	787	906	12	-	-
Real	3,860	1,578	2,223	50	-	9
Sampaloc	2,324	1,748	467	55	13	41
Tayabas	11,163	7,094	3,773	217	21	58
Sub-total	52,419	30,875	20,524	755	65	200
LAGUNA	269,342	230,282	36,386	2,223	142	309
Cavinti	3,345	2,298	1,037	10	-	-
Kalayaan	2,555	1,858	689	-	8	-
Luisiana	3,033	2,695	338	-	-	-
Lumban	3,816	3,102	684	30	-	-
Paete	4,210	3,746	454	10	-	-
Sub-Total	16,959	13,699	3,202	50	8	-
Grand Total	**69,378**	**44,574**	**23,726**	**805**	**73**	**200**

Source: National Statistics Office.

TABLE III-7-34
NUMBER OF HOUSEHOLDS BY MAIN SOURCE OF DRINKING WATER
By Municipality, 1994

Municipality	Total Households	Main Source of Drinking Water							
		Own Use Faucet Community Water System	Shared Faucet Community Water System	Own Use Tubed/Piped Deep Well	Shared Tubed/ Piped, Deep Well	Tubed/Piped Shallow Well	Dug Well	Spring, Lake River, Rain, etc.	Peddler
QUEZON	265,762	45,011	49,149	15,324	31,338	17,399	67,392	34,318	5,831
Mauban	8,760	1,182	2,614	207	1,854	256	1,313	1,161	173
Atimonan	9,832	1,164	1,572	823	1,570	572	1,153	2,820	158
Lucban	6,177	4,310	657	28	43	30	105	852	152
Pagbilao	8,598	1,997	2,547	180	546	209	904	729	1,486
Perez	1,705	50	212	46	104	31	945	317	
Real	3,860	957	1,058	28	304	58	416	1,039	
Sampaloc	2,324	1,292	725	10	21		24	252	
Tayabas	11,163	4,365	3,596	79	182	139	1,410	1,340	52
Sub-Total	52,419	15,317	12,981	1,401	4,624	1,295	6,270	8,510	2,021
LAGUNA	269,342	100,427	57,643	31,110	51,513	11,750	5,393	9,780	1,726
Cavinti	3,345	877	938	51	361		128	990	
Kalayaan	2,555	845	1,003	10	237		47	400	13
Luisiana	3,033	815	1,301	49	42	8	551	258	9
Lumban	3,816	1,049	1,290	587	516	118	48	208	
Paete	4,210	2,127	1,495	99	199	64	45	171	10
Sub-Total	16,959	5,713	6,027	796	1,355	190	819	2,027	32
Grand Total Study Area	69,378	21,030	19,008	2,197	5,979	1,485	1,089	10,537	2,053

SOURCE: NATIONAL STATISTICS OFFICE

8.0 ARCHAEOLOGY

This Archaeology Study is aimed at:

- providing basic data on the presence or absence of archaeological remains in the proposed project site and its fringes.
- recommending measures on archaeological reconnaissance that may be required to satisfy the mandate of preservation law.

The scope of this study is consistent with that agreed upon during the scoping meeting which was conducted with the attendance of representatives from the Environmental Management Bureau of the DENR, some members of the Mauban community, the proponents, and the environmental consultants.

8.1 Methodology

In the course of the study, various approaches undertaken to satisfy the following objectives are:

- Gathering of secondary historical data and folkloric materials for possible archaeological association.
- Examination of the systemic context and archaeological context of artifacts.[27]
- Employment of the sociological process through interviews in order to analyze the possible social phenomenon of the past in relation to the extant social animation.[28]
- Visits to museums and historical sites for association and possible range of artifacts which may turn up in the area.
- Verification of any recovered cultural materials by local people and its site of recovery.

8.2 Location and Folklore

8.2.1 Location

Located in the central district of Quezon Province, the municipality of Mauban is bounded on the west by the Sierra Madre Range. The eastern parcel of the municipality is bounded by Lamon Bay. This local condition effectively divides the town into (2) two geo-economic regions: the coastal-fishing areas of Lamon Bay, inclusive of Cagbalete Island and the inland-agricultural areas of the town. These geo-economic areas of the municipality are generally located within latitude 14°10' to 14°20' and of longitude 121°40' and 121°45'.

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[27] Systemic context refers to artifacts participating in a behavioural system while archeological context refers to artifacts that interact only with the natural environment (Formation Processes of Archeological Record, Michael B. Schiffer, 1987, pp. 3-4).

[28] Dr. Jesus Peralta, explicated the import of this method in, Field Manual in Archaeology (Revised Edition) Anthropological Papes No. 1, National Museum, Manila, 1978).

Five (5) stations were established as general areas of investigation which are:

- Plant site - the Direct Impact Areas (DIA)
- Cagsiay Elementary School and Bulwagin Beach which are approximately 1 km and 1.5 km away from the DIA, respectively.
- Barangay Cagsiay II, Barrio Siete which is approximately 4 km away from the DIA.
- Barangay Cagbalete I in Cagbalete Island.

8.2.2 Folklore and Oral Tradition

The quasi-history of Mauban is well perpetuated in both the written and oral traditions of the locals. Government records, i.e., the municipality and public library, account for folkloric texts which are passed on as historical texts with little variation from local traditional lore.

Among these quasi-historical texts are:

The etymology of *Mauban* came from *Malauban*, an indigenous tree specie. Originally, the current town was known as *Pinagbayanan*. *Pinagbayanan* was located about three (3) kilometers from the present town center. A semi-permanent church structure was the focus of socio-religious activities. When the image of Saint Buenaventure, the town's patron saint disappeared, it was said that it miraculously appeared nestled on a *Malauban* tree. Such phenomena were said to have occurred a couple of times that the locals considered it as a sign to transfer the town center to where the *Malauban* tree was. Thus, the new settlement evolved to be the center of the new town now known as *Mauban* - a contraction of *Malauban*.

Another quasi-historical account on how Mauban got its name was borne out of political trappings but devoid of religious undertone.

On the western shore of Lamon Bay, there were five (5) human settlements namely, *Cagsiay*, *Daungang Dumagat*, *Luya-Luya*, *Tubog* and *Pinagbayanan* - as the socio-political center. Around this time, in early 17th century, these areas were vulnerable to ferocious invasions by the Moros. Save for *Daungang Dumagat* the other places were vitiatingly conquered. The leader of *Pinagbayanan*, Baltazar Palad, politically arranged for the defense of his area by tapping a brave local warrior, Gat Pagil Jr., who ably defended the place. Gat Pagil did not only defend the town with valor but also championed the settlement of the native *Dumagats* in *Pinagbayanan*. Gat Pagil was endearingly addressed by the locals as Gat Uban because of his grey hair. The monicker later became *Mauban* in reference to Gat Pagil whose memory of heroic exploits lives on by naming the current *Pinagbayanan* as *Mauban* with his statue enshrined in the town center (Plate III-8-1).

8.3 <u>Historical Sites and Events</u>

Historically, the current Mauban is not the original town center but the area of *Luya-Luya* which is an older settlement. The native inhabitants were Christianized by 1583, but were under a continuous threat from the Moslems. Under this condition, the settlement was transferred to *Pinagbayanan* the current town for defense purposes. Migration from Laguna by 1678, offset the balance of population resulting in migrant domination of the area sending the native Dumagats to the fringes of the community centers.

By 1678, Moro plundering was not uncommon in the port of Mauban that a stone wall was built from the present site of Tabacalera extending to Gomez St. Accompanying the urbanization of Mauban, Captain Linis dela Cruz built a concrete canal and now known as *Public Bath*.

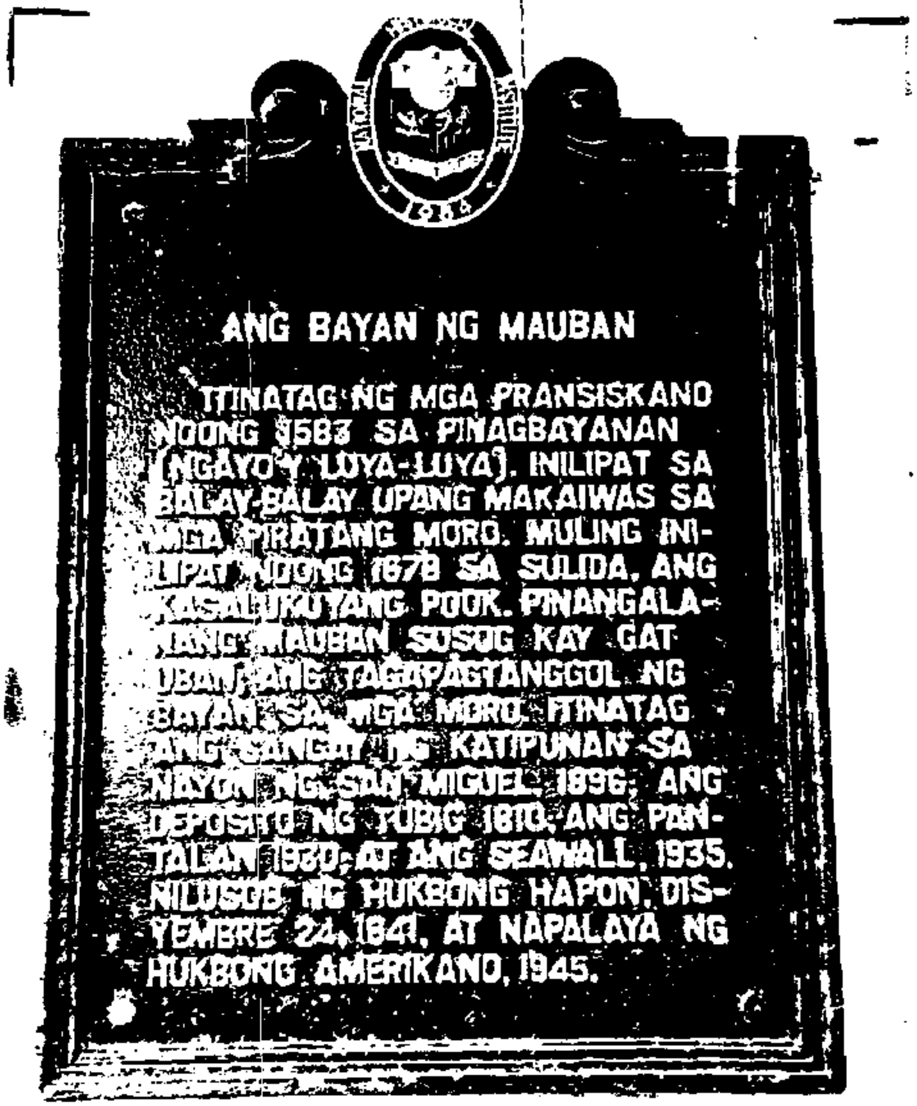

Plate III-8-1A
Historical Marker in the Municipal Hall of Mauban Quezon

THE TOWN OF MAUBAN

Established by the *Franciscans* in 1583 in *Pinagbayanan* (known today as Luya-Luya). Transferred to *Balay-Balay* to evade the *Moro* pirates. Transferred again in 1678 to *Sulida*, the present site. Named *Mauban* in honor of *Gat Uban*, the defender of the town from the *Moros*. Establishment of the branch of the *Katipunan* was in district *San Miguel*, 1896; the water reservoir in 1810; the port in 1930; and the seawall in 1935. Invaded by the Japanese Imperial Army in 24 December 1941 and liberated by the Americans in 1945.

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Plate III-8-1B
Statue of Gat Pagil (addressed as Gat Uban)
Daungan (facing sea shore), Mauban, Quezon

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Public Bath was the social center of public activities and was improved in 1810, by building a circular concrete tank under the leadership of Captain Pedro Buenaventura.

Recognizing the socio-historical impact of the *Public Bath*, it was upgraded in the mid-1930's. However, the *Public Bath* was partially destroyed in World War II when it was used as a gun emplacement by the Japanese forces.

Among the prominent events in the history of Mauban were the building of the town church and convent in 1773 which was later damaged by an earthquake in 1820 and rebuilt in 1830. However, on July 4, 1879, the town was badly damaged by another earthquake which effectively reduced the old belfry to ruins with the church and convent.

Between 1887 to 1889, the town people mustered pecuniary contributions and human labor to build a completely new church which was inaugurated in 1891. Although this church building was modest in structure compared to the old one, it weathered World War II, only to be battered by a strong typhoon in 1947.

The current area of the school building was known to be a landing site of the Japanese Imperial forces which pillaged the town in 1941. Also, the shores of Barangays Cagsiay I and II were scenes of engagement for Japanese and USAFFE armies in the Province of Quezon.

Today, the church in Mauban significantly strengthens the continuing tradition of the local people, taking an active participation in the religious and political life of the municipality not only as a structure but as a community.

8.4 Archaeological Sites and Significant Events

8.4.1 The Galleon Trade

Among the significant events of the Spanish Period in the country was the burgeoning international commerce between China, the Philippines and Mexico through the *Galleon Trade* (See Figure III-8-1).

Galleon ships carried loads of silk, gold, silver and porcelain from China. From the Philippines, agricultural and forest produce were the chief merchandise. These were highly valued by the continental *Latinos* of the *Americas* (Acapulo, Mexico).

William Schurz cited the active *Galleon* trading between 1565 until 1815.[29] To date, the significance of the Galleon Trade is not only historical but archaeological, with numerous wrecks on its navigational routes caused by *force majeure*, i.e. stormy weather, sea piracy, etc. Eliciting economic activities and enlivening social mobilization, the Galleon Trade gave rise to new settlements in its ports of call. Following the usual navigational route of the Galleon prior to their approach to the Pacific high seas, Schurz[30] mapped it as follows:

- from Cavite in Manila Bay, out through one of the bocas between Mariveles and Corregidor;
- thence SSW keeping clear of Fortune Island to the left and high Ambil to the right;

[29] William Lythe Shurz, The Manila Galleon, 1959.

[30] Ibid.

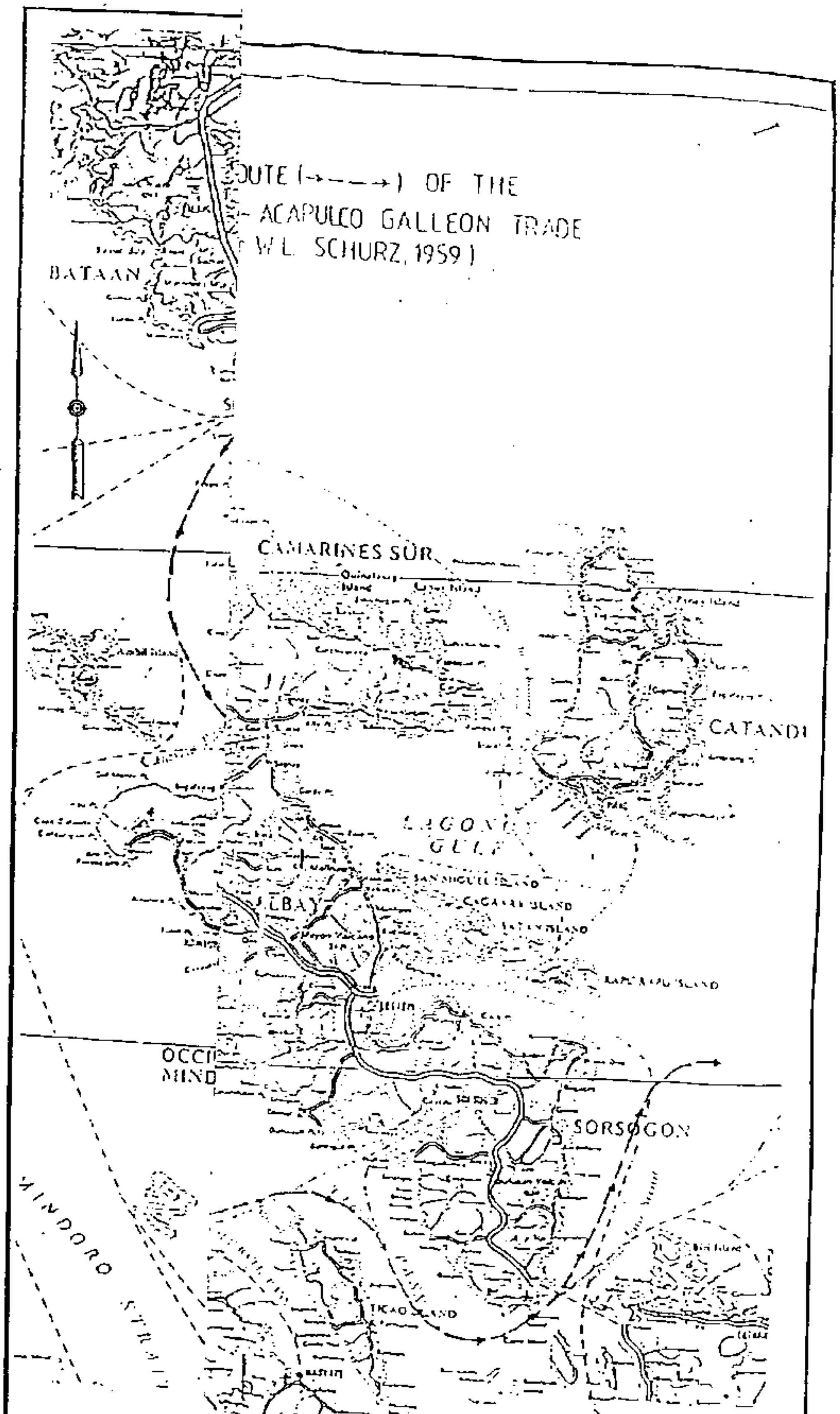

FIGURE III-8-1

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- past cape Santiago on the Luzon Coast and east between Mindoro and Maricaban, by the Punta de Escarero or Tide Rip Point where currents run strong; and under Isla Verde outside Suba-ang Bay within which there was a fair anchorage in case of need;

- SE & E down the Mindoro coast by Punta Gorda de Polo;

- E by SE between the Tres Reyes and the Dos Hermanos thence by the wide Bocana Bay between Marinduque and Banton out unto the *tablazo* or open water above Sibuyan;

- SE & E between Burias and Masbate turning E and E around the Punta de San Miguel and Punta del Diablo coasting around the east side of Ticao and anchorage at San Jacinto, from thence, working seaward with the monsoon;

- Eight leagues with the dangerous Naranju to starboard and the shoal of Calantas to fort;

- NE by then E N E seven leagues around Capul; and

- NE with Sorsogon Coast to port and San Bernardino to starboard and NE and E seven leagues to the embocadero with San Bernardino now to port and the island of Biri to starboard at this point the rapid currents required skillful pilot work – the Galleon was now in the open sea.[31]

8.4.2 Reported Sites

Henry Otley Beyer,[32] a primemover of Philippine Archaeology reported of accidental finds in Quezon Province and among the sites within the Regional Impact Zone. These are:

- in the old Kamahangin, Barrio Siete which is part of the current Cagsiay II where Sawankhalok Celadon ware of 14th to 15th century dates were found.

- in Cagbalete Island, Dr. Marina Pastrana of the U.P. Department of Botany reported to Beyer accidental finds of human skeletal remains, wooden coffins and broken ceramics. It was reported that the finds were in a cave, heavily disturbed by its owners for private collection.

8.5 Discussion of Primary Results

Local informants pointed to different areas that merited a surface investigation. Such reported areas are:

- Cagsiay I Elementary School approximately 100 meters from the school grounds towards the shoreline, in the residential areas. The area was a site of treasure hunting activities in the late 1980s to early 1990s. One of the locals who participated in the activities was employed as a guide/informant[33] who led us to the area which was used as an airborne landing site in World War II. Evidences of treasure hunting are still apparent with two dug out areas left

[31] Ibid., Also, cited in Bailen, Cabanilla, Yambot report on an Archaeolgical Study of Pagbilao Grande (BHP Engineering Phil., 1993).

[32] Henry Otley Beyer, Outline Review of Philippine Archeology by Island Provices 1959. Although did not had any full scale numerous sites in the country and took cognizance of its importance. His book is a compedium of such sites.

[33] Nick Tampok, a local resident and reputed to have actively participated in local treasure hunting positively identified the areas which were substantiated by other residents.

uncovered (See **Plate III-8-2A and 2B**). These areas are within the residential domain of local residents. The investigation yielded several pieces of Blue and White - late Ming type ceramics, vestiges of the treasure hunting activity. However, since the concept of treasure hunting is finding "bars of gold" and with the haphazard mode of the diggings, the artifacts were destroyed, broken or simply thrown.

- Bulwagin Beach of Cagsiay I, north and about 250 meters from the lighthouse and about 1.5 km South of the Project site. Investigation yielded a neolithic stone tool with coral accretion found in a contemporary refuse dump and burning site. Thorough surface search yielded no other find and its location is not *in situ* since its accretion suggests a factor of contemporary deposition of which it may have come from a locale near the sea shore. (**See Plate III-8-3A and 3B**).

- Barrio Siete, northern part of Cagsiay II and about 4 km northwest of the project site. Cagsiay II was a suggestive lead as provided by op. cit. the Beyer material[34]. Furthermore, an account of treasure hunting was reported by local residents which was led by an "americano" in early 1994. There is no known further identity of the "americano" except for his complexion since the diggers he employed were not local residents. The site of treasure hunting was in a rock shelter covered by lush tropical vegetation (See **Plate III-8-4A and B**). Local residents who observed the digging reported that the treasure hunter did not find any artifact and the activity was finished in only two (2) days. Primary investigation yielded negative results in the area where the previous treasure hunting occurred. The rock shelter was located in a short but steep terrain near of the shoreline.

- Cagbalete Island, Barangay I, northeast and beyond the Regional Impact Zone of the project site. The island of Cagbalete is mainly populated by Post World War II migrants from the Vsayas and Luzon. Migration to the area began in the early 1950s where migrants recall that "local residents in the island only numbered about four households." However, a steep rise in migration paved the way to higher population growth which began in the early 1970s to mid-1980s. An interview with the older residents and early settlers suggested no knowledge of any cave in the island and substantiated by Barangay Captain Antonio Tolentino. It was supported that treasure hunters who are non-residents occasionally visit the island but there were no reported "successful activity." Moreover, ground surface inspection with the local residents yielded negative results of archaeological suggestion or possible association. However, the local residents gave an account of Perez Island, southeast of Cagbalete Island and east of the Project site (beyond a given 20 km radius) which may possibly be the area reported by Dr. Marina Pastrana.

- The Project Site located in Cagsiay I is mainly an agricultural area of rice, interspersed with coconuts. The residents are conventionally engaged in farming and fishing. These two (2) economic activities pose surface disturbance to any archaeological environment;

- Significant findings are reported when prominent families of Mauban and occasional visitors buy antiquarian objects brought by local residents to the town center. Such antiquarian objects (old pottery, ceramic jars, fancy jewelry with semi precious stones, old furnitures and the like) when damaged are viewed without utilitarian value and selling of these are readily accommodated by local collectors.

[34] Loc. cit., Beyer.

Plate III-8-2A
The dug out areas left uncovered by treasure hunters in Cagsiay I, Mauban Quezon

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Plate III-8-2B
Several pieces of blue and white late ming ceramics found in *Cagsiay I, Mauban Quezon*

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Plate III-8-3A
The lighthouse in Bulwagin Beach of Cagsiay I

Plate III-8-3B
Neolithic Stone with coral accretion found in a contemporary refuse dump and burning site

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Plate III-8-4A
One of the site of diggings
Cagsiay I, Mauban Quezon

Plate III-8-4B
Cagsiay I local resident, guide and key informant

BHP Engineering PHILIPPINES Inc.
433 MW (NET) QUEZON POWER PROJECT ENVIRONMENTAL IMPACT STUDY

SCALE		BHPE DRG No.	REV.
NTS	A4	P230 101	A

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CAD FILE
DATE OF PLOT

IMPACT ASSESSMENT AND MITIGATING MEASURES

IV. IMPACT ASSESSMENT AND MITIGATING MEASURES

1.0 AIR QUALITY AND NOISE

1.1 Construction Impacts and Mitigating Measures

Construction activities which include clearing, grubbing, earth moving and increased traffic at the proposed plant site as well as along the proposed access road will increase the concentration of total suspended particulates in the air. Dust will be generated along the unpaved access road which will initially be used for transporting construction materials and construction workers. This potential expected increase in ambient TSP concentration, however, will be minimized by the frequent rain showers experienced in the area. During dry days, road surfaces will be sprinkled with water to reduce dust generation which mitigate potential adverse impacts.

The ambient levels of SO_2 and NO_x are likewise expected to increase slightly due to the operation of construction equipment such as generators, compressors, bulldozers, payloaders and trucks. However, these levels are not expected to be significant since these emission sources will, in large part, only be operated intermittently. Likewise, the plan to use a jetty to deliver construction materials will further reduce this impact.

1.2 Combustion Air Quality Impacts and Mitigation

The proposed plant will use a single reheat type boiler which will generate steam to be directed to a single steam turbine generator. Additionally, an auxiliary boiler will be operated at start up for soot blowing the main boiler. Since the auxiliary boiler will fire diesel fuel oil for only several days in a year, it will have a minimal impact on the environment. Stack emissions produced from both boilers will be directed towards a common stack. The facility emissions include Sulfur Dioxide (SO_2), Nitrogen Dioxide (NO_2) and Total Suspended Particulates (TSP).

To minimize emissions from the plant, an acid gas scrubber, low NO_x burners and an electrostatic precipitator (ESP) will be installed to lower SO_2, NO_2 and TSP concentrations, respectively. These pollution control devices will be installed to meet or better the Philippine air standards.

1.2.1 Stack Releases

Three (3) types of coal which will meet the coal requirements of section II, 3.2.1 are proposed to be used as fuel. These are classified as coal 1, coal 2 and coal 3. The analysis of these coals are shown in **Table IV-1-1.** The QPP has the capability to continuously combust these coals at both 50% and 100% of design capacity. As a result, emission characteristics were determined based on these two operating scenarios.

Exit flue gas characteristics were developed utilizing the coal analysis referred above. Emission rates were calculated using the volumetric flue gas rates at normal conditions for both scenarios. As per DENR regulations, normal condition is defined to be at 25°C and 1 atmosphere.

Flue gas and stack emission characteristics are shown in **Tables IV-1-2, IV-1-3,** respectively.

$\underline{SO_2}$

Based upon the combustion calculations for each of proposed coals and the utilization of the acid gas scrubber, coal 2 was determined to potentially emit the highest SO_2 emission rates at 244.6 gm/sec. This would occur for a 100% load. The resulting concentration of coal 2 is 600 mg/ncm. As shown in Table IV-1-3, SO_2 emission rates for coals 1 and 3 were 195.8 gm/sec and 237 gm/sec at 100% load, respectively. When converted, resulting concentration would be 511 mg/ncm and 600 mg/ncm, respectively. These emission concentrations are all below the Philippine standard of 700 mg/ncm. With the worst case emission at 600 mg/ncm, all three coals can then be utilized and still comply with the prescribed Philippine standard.

TABLE IV-1-1
COAL ANALYSIS

Parameter	Coal #1	Coal #2	Coal #3
Proximate Analysis (as received)	Weight % Typical (range)	Weight % Typical (range)	Weight % Typical (range)
Total Moisture	24.5 (23.0-28.0)	16.0 (16.0-20.0)	14.0 (12.0-16.0)
Ash	1.2 (0.8-2.3)	7.3 (5.5-9.0)	6.0 (4.0-7.0)
Volatile Matter	37.0 (35.0-40.0)	24.7 (22.0-27.0)	39.0 (37.0-42.0)
Fixed Carbon	37.0 (35.0-40.0)	52.0 (48.0-53.0)	40.5 (by difference)
Sulfur	0.1 (0.05-0.15)	0.27 (0.20-0.45)	0.5 (0.3-0.8)
Higher Heating Value kcal/kg	5200 (5000-5400)	5920 (5650-6100)	6200 (600-6450)
Higher Heating Value Btu/lb	9354 (8994-9713)	10649 (10163-10973)	11153 (10793-11602)
Ultimate Analysis (as received)	Weight % Typical (range)	Weight % Typical (range)	Weight % Typical (range)
Carbon	54.41 (54.0-57.0)	63.50 (59.0-64.8)	62.8
Hydrogen	2.94 (2.0-4.0)	3.49 (59.0-64.8)	4.2
Oxygen	16.18 (14.5-18.5)	8.05 (6.05-9.70)	11.4
Nitrogen	0.69 (0.4-1.0)	1.43 (1.30-1.60)	1.2
Sulfur	0.1 (0.05-0.15)	0.27 (0.18-0.45)	0.5

TABLE IV-1-2
FLUE GAS CHARACTERISTICS AND
COAL CONSUMPTION RATE

Parameter	Facility Load	COAL TYPE		
		Coal 1	Coal 2	Coal 3
Flue Gas Flow Rate (ACMS)*	100% 50%	539.2 267.9	541.8 269.1	527.9 262.2
Flue Gas Velocity (m/sec)	100% 50%	28.85 14.33	29.0 14.40	28.25 14.03
Stack Gas Exit Temperature (°k)	100% 50%	358.66 356.39	340.89 338.67	341.44 339.22
Coal Consumption, ton/hr	100% 50%	235.1 117.5	189.0 94.5	181.5 90.8

* ACMS - Actual cubic meter per second.

TABLE IV-1-3
STACK EMISSION CHARACTERISTICS

	Facility	SO_2		NO_X (as NO_2)		TSP	
Coal Type	Load	mg/ncm	gm/sec	mg/ncm	gm/sec	mg/ncm	gm/sec
Coal 1	100%	511	195.8	1000	383.4	150	74.6
	50%	511	97.9	1000	141.17	150	37.3
Coal 2	100%	600	244.6	1000	407.7	150	75.6
	50%	600	122.4	1000	203.9	150	37.8
Coal 3	100%	600	237.0	1000	394.9	150	72.5
	50%	600	118.5	1000	197.4	150	36.2

NO_2

NO_2 emissions are a stronger function of combustion design, i.e., air flow, mixing, etc. rather than coal type. The QPP will incorporate low-NO_X burners which will minimize NO_X emissions below the Philippine standard of 1000 mg/ncm for any coal combusted. At 100% load, the highest mass emission rate of NO_X was determined to result from the combustion of coal 2 at 407.7 gm/sec. NO_X emission from coal 1 and coal 3, at 100% load, were determined at 383.4 gm/sec and 394.9 gm/sec, respectively. However, because different volumetric flow rates occur from the combustion each coal, the resulting NO_2 concentration remains at 1000 mg/ncm.

Particulate (TSP)

Particulate emissions will be controlled by the scrubber and electrostatic precipitator. Based upon the combustion calculations for each of the proposed coals, coal 2 was considered as the worst case with a TSP emission rate of 75.6 gm/sec. This would correspond to an emission concentration of 150 mg/ncm. TSP emission rates from coal 1 and coal 3 were 74.6 gm/sec and 72.5 gm/sec at 100% load, respectively. Likewise, these would correspond to a 150 mg/ncm TSP concentration. As provided by DAO No. 14, the maximum allowable stack emission for TSP is 150 mg/ncm. The performance of the ESP on all three coals complies with this standard.

1.2.2 Air Dispersion Modelling

The Model

The model used for determining the ground level concentration resulting from the proposed project's emissions is the SCREEN 2 model of the US Environmental Protection Agency (US-EPA). This model essentially follows Pasquill and Smith (1983). It calculates the plume dispersion by the Gaussian diffusion theory. This model also takes into account the rise of the plume at various atmospheric stability conditions. It also considers the lateral and vertical dispersion of the plume under the influence of stability, buoyancy and surface roughness. The model calculates the dispersion at 54 possible combinations of wind speed and stability categories for each downwind distance, thereby, determining the worst-case scenario. It must be stressed that this type of model (screening model) usually yields very conservative results. The model assumes constant meteorological conditions, i.e. wind speed and atmospheric stability remains unchanged through out the study period. In actuality, wind speed/atmospheric stability fluctuate and, therefore, reduce the potential impact of the plume on specific receptors. As a result, it is clear that actual impacts will be well below the values generated by the SCREEN 2 model.

The Simulated Scenarios

As previously stated, maximum emission rates in gm/sec for all constituents studied occurred for coal 2. To develop a worst case scenario in regard to the maximum potential impact on ambient air quality, the most conservative stack gas characteristics, i.e., lowest stack flue gas flow rates and temperature, from the combustion of coal 3, were combined with coal 2 maximum emission rates. Stack gas characteristics are shown in Table IV-1-4. In this manner, ambient air quality impacts are truly overestimated since the most conservative stack gas characteristics provide the least dispersion potential. In actuality, ambient air quality impacts would be lower since actual dispersion would be higher for the higher stack gas flow rates predicted for coal 2.

This procedure of combining maximum emissions with stack characteristics leading to the least dispersion potential were repeated for both 50% and 100% design loads. This already considers the reduction of the emissions due to the scrubber and ESP.

Results of the various scenarios modelled are shown in Annex 8A and are discussed in the following sections.

The model input parameters used in simulating the worst case scenario are as follows:

TABLE IV-1-4
SCREEN 2 MODEL INPUT PARAMETERS

Parameters	Operating Condition	
	100% Load	50% Load
Stack gas flow rate, ncm/s	527.9	262.2
Stack gas exit velocity, m/s	28.25	14.03
Stack height, m	150	150
Stack inside diameter, m	4.88	4.88
Stack gas exit temperature, °K	340.89	338.67
SO_2, gm/sec	244.6	122.4
NO_x, gm/sec	407.7	203.9
TSP, gm/sec	75.6	37.8
Urban/Rural Option	Rural	Rural

- Ground Level SO_2 Concentrations

For the 100% load operating condition, the worst case SO_2 ground level concentration (GLC) is 318 ug/ncm.This is predicted to occur at a distance of 1100 m. away from the stack. For a 50% load, the resulting GLC would be 253 ug/ncm This is also predicted to occur 1100 m. downwind from the stack location. Both worst case concentration were determined at an atmospheric stability class A (very stable) with a 1 m/s wind speed for the 50% load and 1.5 m/s for the 100% load case. The average wind speed in the area is 2 m/s. At these higher wind speeds, the GLC is expected to be more thoroughly dispersed than at lower wind speed. Thus, in actual conditions, lower ground level concentrations will be experienced than predicted by the SCREEN 2 model.

This worst case scenario for both 100% and 50% load complies with the prescribed 1 hour Philippine ambient air standard of 340 ug/ncm. Combining the contribution of the stack with that of the average ambient air quality measured in the area, which is 2 ug/ncm, the total SO_2 concentration in the area would be 320 ug/ncm for 100 percent load and 255 ug/ncm for a 50% operating load condition. These are still within the allowable limit.

- Ground Level Particulate Concentrations

For the Total Suspended Particulate concentration, the maximum one-hour ground level concentration for the worst case scenario is 98 ug/ncm. This is for a 100% operating load condition. This is estimated to occur at downwind distance of 1100 m. from the stack. For a 50% load, the predicted one-hour maximum concentration is lower than 100% load. The maximum one-hour TSP concentration for a 50 % load is 78 ug/ncm. This is also expected to occur 1100 m from the stack. All GLCs were observed at stability class A at an approximate wind speed of 1 m/s for the 50% load and 1.5 m/s for the 100% load case. Thus, at a prevailing wind speed of 2 m/s, the actual concentrations measured should be lower than stated above.

Average baseline TSP levels measured in the area is 93 ug/ncm. Combining the baseline concentration with that generated by the plant would result in a total ambient air concentration of 191 ug/ncm for a 100% load and 171 ug/ncm for a 50% load. The maximum allowable limit based on DAO No. 14 is 300 ug/ncm. The maximum total concentration calculated, 191 ug/ncm, is still well below the standard provided. As such, the plant easily complies with the prescribed ambient air requirements.

- Ground Level NO_2 Concentrations

The same model was also applied to predict ground level NO_2 concentrations. At the point of emission, the NO_x emitted consists of NO and NO_2, 90-95% of which is NO while the remaining 5-10 % is NO_2. All the NO will eventually be converted into NO_2 upon reaction with O_2. However, its conversion rate is unpredictable depending on the locality and the atmosphere. In conformance with DENR discussions, it was conservatively assumed that the NO_2 concentration at the point of maximum ground level concentration is equivalent to 20 percent of NO_x. The 10-15 percent buffer makes the estimate conservative for regulatory purposes.

Maximum one-hour NO_x concentrations predicted for both operating loads are 106 ug/ncm and 84 ug/ncm for 100% and 50%, respectively. Both concentrations were determined to occur at a distance of approximately 1100 m. from the stack. Also, both concentrations were obtained at stability class A having a wind speed of 1 m/s for the 50% load and 1.5 m/s for the 100% load. At wind speeds higher than this, the resulting ground level concentration is expected to be lower than the above concentrations.

These concentrations still comply with the one-hour Philippine standard (DAO No. 14) for NO_2 which is 260 ug/ncm. Upon adding the average baseline NO_2 concentration of 10 ug/ncm with the GLC, the total NO_2 level will be 116 ug/ncm and 94 ug/ncm for 100% and 50% loads, respectively. The total concentrations still comply with the Philippine standard.

Table IV-1-5 shows the total predicted ground level concentrations of the various parameters together with average background levels and Philippine standards.

Based on the climatological data of Infanta and Tayabas, the most prevalent wind in the area is north and northeasterly winds. Some southwest winds are also experienced.

TABLE IV-1-5
PREDICTED MAXIMUM ONE-HOUR AVERAGE GROUND LEVEL CONCENTRATIONS FROM COAL COMBUSTION

Parameters	Worst Case Scenario (ug/ncm)		Baseline levels (ug/ncm)	Maximum Total Ambient Conc. (ug/ncm)	Philippine Standard (ug/ncm)
	100% Load	50% Load			
SO_2	318	252	2	320	340
NO_x	530	420	-	-	-
(NO_2)	106	84	10	116	260
TSP	98	78	78	176	300

During northerly winds, which occurs 17% in a year, the area most affected by the plant's emission, which is 1.1 km from the stack, would be Lamon Bay. During northeasterly winds (which prevails 22% in a year), the maximum GLC is predicted to occur in the rice field areas southwest of the proposed plant site in Barangay Cagsiay I. No residential areas were observed to be located 1.1 km from the site.

- Effect of Prevailing Wind Directions

Some southwest winds are also experienced (about 4%). The maximum GLC during this period will also fall within Lamon Bay. Pollution rose diagram for the different wind directions are shown in **Annex 8B.**

- Location of Critical Receptors

Critical receptors observed in the area are the residential communities in Cagsiay I and II. These are located approximately 1.6 km southwest and 0.3 km north-northeast from the stack location, respectively. Also, located within Cagsiay I is a school, which is approximately 1.65 km southwest of the stack.

At approximate distances of 1.6 km and 1.65 km, the maximum one-hour predicted ground level concentration due to stack emissions are 252 and 247 ug/ncm for SO_2, 84 and 82 ug/ncm for NO_2 and 78 and 76 ug/ncm for TSP, respectively, operating at 100% load. These predicted concentrations in combination with existing background data are all below the prescribed standards and again, given the conservative nature of the model, actual impacts, will most likely be lower than these predicted values.

South-southwest winds have the potential to affect Cagsiay II at 0.3 km from the stack location. However, it is important to consider that south-southwest winds only occur approximately 2% in a year. Also, at 0.3 km distance from the stack, the resulting GLCs due to stack emissions are negligible with less than 0.1 ug/ncm concentration for the three parameters. Thus, dispersion of stack emissions have negligible effect on Cagsiay II residents.

- Predicted Long Term Concentrations

The predicted 24-hour Ground Level Concentrations can be estimated based on the one hour average concentrations obtained. *Table IV-1-6* shows the predicted 24-hour concentration for SO_2, NO_2 and TSP for the various coals proposed to be used for the plant. Comparing these results with the Air Quality Index indicate that the resulting concentration will still be fair even if the overall emission including fugitive dust emission is considered.

TABLE IV-1-6
PREDICTED MAXIMUM 24-HOUR AVERAGE
GROUND LEVEL CONCENTRATION FROM COAL COMBUSTION

Parameters	Worst Case Scenario (ug/ncm)		Baseline levels (ug/ncm)	Maximum Total Ambient Conc. (ug/ncm)	Philippine Standard (ug/ncm)
	100% Load	50% Load			
SO_2	127	101	2	129	180
NO_x	212	168	-	-	-
(NO_2)	42	34	6	48	150
TSP	39	31	52	91	230

1.2 Fugitive Emission, Air Quality Impacts and Mitigation

1.2.1 Prediction of Fugitive Emissions

An area source model using SCREEN 2 software was also used to predict the downwind concentration of fugitive dusts generated from the two (2) active coal stockpile due to wind erosion. No modeling of the inactive storage pile was required due to the fact that this pile is compacted and sealed to prevent fugitive dust emissions or spontaneous combustion. Similarly, no modeling for the ash pile was conducted since the combined ash stream of fly ash, bottom ash and scrubber residue will agglomerate and hence will not be a source of fugitive dust.

Each active coal stockpile was assumed to have an area of 19,500 m^2 and maximum pile height of 17 m or a total area of 39,000 m^2. The modelling was conducted for all stability classes. The surface wind speed was assumed at 2 m/s which is the prevailing wind speed in the area.

Based on the characteristics of the coal to be used, 10% of the total coal to be supplied would have a size approximately greater than 0.05 mm. This conservatively covers the fine ash component of the coal that can be dispersed into the air, thereby, becoming fugitive dust when blown by the wind. Assuming that 10% of the coal present in the stockpile will be dispersed, the resulting model shows a maximum GLC of 34 ug/ncm from each stockpile. This maximum concentration occurred at stability class B (moderately stable) and a wind speed of 1 m/s. This is expected to occur 105 m from the center of the stockpile. This level is almost 1/3 of the existing ambient TSP levels in the area. However, this distance is still within the plant site, thus, limiting the exposure to plant personnel.

The total TSP ambient air quality impact can be predicted by combining impacts from stack emissions and the coal stockpile for every 100 m distance. The stack location was considered as the point of origin with the stockpile located 200m downwind from the stack. The resulting maximum one-hour TSP level was determined to occur at approximately 1100 m. from the stack since stack TSP impacts dominate. The total TSP concentration contributed by the plant (both fugitive and point source) was determined to be 151 ug/ncm. Combining the baseline TSP level, and the maximum one-hour TSP concentration from the plant results in a maximum one-hour GLC of 229 ug/ncm. The maximum one-hour allowable TSP level is 300 ug/ncm, which can be complied with by the plant.

The nearest residential area from the stockpile is located approximately 330 m northeast at Barangay Cagsiay II. At this distance, the predicted particulate concentration due to both the stack and the stockpile is 62 ug/ncm. Combining the projected contribution of the stack, fugitive emissions and the baseline particulate concentration will result in a total concentration of 140 ug/ncm. This complies with the prescribed standard of 300 ug/ncm.

However, Cagsiay II community will only be affected by the coal stockpile dispersion during the prevalence of south-southwesterly winds. This wind direction rarely occurs in the area (about 2%). During southwest winds, the community could be slightly affected. Based on the climatological data, this wind pattern usually occur during the months of June to August. Also, experienced during these months are frequent rainfall. Thus, the occurrence of rainfall would minimize fugitive dust emissions reaching residential areas.

For Cagsiay I, which is located 1.4 km. southwest from the coal stockpile, the resulting TSP GLC due to fugitive emissions are is 24 ug/ncm. The resulting total ambient air quality impact level when TSP from fugitive source is combined with stack and baseline data is 204 ug/ncm. This is still within the prescribed standard of 300 ug/ncm. Cagsiay I will mainly be affected during northeastern winds which is one of the prevalent wind directions in the area. During northerly and northeasterly winds, Cagsiay I could slightly be affected by the coal stockpile. However, since the area does not have a pronounced dry season, the frequent rain showers would reduce the emissions coming from fugitive dust.

These impacts can be further mitigated by constructing wind breakers and/or a buffer zone around the perimeter fence to minimize wind erosion and to act as buffer for any fugitive dust. This could be in the form of high solid perimeter fence or planting of grown trees.

Other mitigating measures that will be adopted by the OQP is to ensure that compaction of coals are performed at the stockpile area. This would further minimize the occurrence of fugitive dust emission. Workers near the stockpile area will also be required to strictly comply with the wearing of personal safety equipment like goggles and masks . Signs will be placed in very conspicuous areas to remind workers of the required safety precautions.

1.2.2 Spontaneous Combustion

Spontaneous combustion in the coal yard occurs when heat accumulates usually at the bottom or near the bottom of the stockpile, giving rise to light smoke. This process is mainly due to the volatile matter (VM) content of the coal, the temperature inside the pile, the length of storage and stock pile ventilation speed.

The VM of the possible coals to be used ranges from 7%- 40%. These types of coal are relatively prone to spontaneous combustion. Coal inactive inventory will also be maintained at a minimum of 45 days requirement at the maximum load.

To minimize spontaneous combustion, OQP will monitor the temperature of the coal pile. Once the temperature exceeds 90°C, water will be sprinkled at the stockpile or the coal will be repiled.

1.3 Noise Assessment/Mitigation

1.3.1 Construction Impacts and Mitigation

Generation of noise due to the operation of heavy equipment and increased frequency of vehicular traffic will increase the noise level in the area. Vibration levels will also increase due to these activities. These impacts are, short, intermittent and temporary during the construction period.

To minimize noise and vibration disturbance caused by project construction activities, it is recommended that any blasting or pile driving activities, to be carried out only during the day. Table IV-1-7 details the various noise levels intermittently generated by the different construction equipment while Table IV-1-8 shows the attenuation of the noise generated by the various equipment at different distances.

TABLE IV-1-7
TYPICAL NOISE EMISSIONS OF CONSTRUCTION EQUIPMENT [dB(A)]

Equipment	Typical Sound Pressure Levels at 15m from the Source
Air Compressor	75-87
Backhoe	71-92
Compactor	72
Concrete Mixer	75-88
Concrete Pump	82
Crane	76-88
Front Loader	72-81
Generator	72-82
Grader	80-93
Jackhammer	81-97
Paver	87-88
Pile Driver	95-105
Pump	70-90
Tractor, Bulldozer	78-95
Truck	83-93
Vibrators	68-81

Source : Canter, Larry W., 1977; Environmental Impact Assessment, McGraw Hill, New York, 331 pp.

TABLE IV-1-8
EXPECTED NOISE LEVELS AT VARIOUS DISTANCES FROM CONSTRUCTION EQUIPMENT [dB(A)]

Equipment	Distance			
	30 m	60 m	120 m	240 m
Air Compressor	69-81	63-75	57-69	51-63
Backhoe	65-67	59-81	53-75	47-69
Compactor	66	60	54	48
Concrete Mixer	69-82	36-76	57-70	51-64
Concrete Pump	76	70	64	58
Crane	70-80	64-74	58-68	52-62
Front Loader	66-75	60-69	54-63	48-57
Generator	66-76	60-70	54-64	48-58
Grader	74-87	68-81	62-75	56-69
Jackhammer	75-91	69-85	63-79	57-73
Paver	81-82	75-76	69-70	63-64
Pile Driver	89-99	83-93	77-87	71-81
Pump	64-84	56-78	50-72	44-66
Tractor, Bulldozer	72-89	66-83	60-77	54-71
Truck	77-87	71-81	65-75	59-69
Vibrators	62-75	56-69	50-63	44-57

Source: National Pollution Control Commission (1978). Rules and regulations of the National Pollution Control Commission. Official Gazette, No. 23, Vol. 74

Vehicular movement along the access road could disturb residents located near the road. Thus, traffic should be maximized during the day to limit exposure of the residents to noise. The plan to use a construction jetty to deliver construction materials will further minimize traffic and mitigate its consequent impacts.

1.3.2 Operational Noise Impacts and Mitigation

Once the plant becomes operational, noise will be generated by the turbine generator and several equipment inside the plant. Noise generated by these equipment will be designed to comply with the 75 dB(A) daytime, 70 dB(A) morning and evening and 65 dB(A) nighttime noise standards at the property line. It should be noted that current noise levels measured on the area ranged from 41-57 dB(A). These levels exceed the noise standard for agriculture but is within the standard for heavy industries which will be applicable to the QPP.

1.4 Conclusions and Recommendations

The use of coal type 2 with minimum stack flue gas flows are considered as the worst case scenario. For all operating scenarios, maximum one-hr and maximum 24-hour predicted ground level concentrations in combination with fugitive dust and background levels are below the Philippine DAO No. 14 standards. Thus, coal type 2 can be used and still comply with the standards. Likewise, since emission levels of coal 2 and coal 3 are lower than coal 2, any of the three coals can be used without violating Philippine air standards.

Continuous emission monitoring system measuring the constituents of SO_2, O_2, NO_x and opacity will ensure that the scrubber, low NOx burner and electrostatic precipitator to reduce the stack emissions to 600 mg/ncm for SO2, 1,000 mg/ncm for NO2 and 150 mg/ncm for TSP, and at the same time comply with the requirements of DENR Administrative Order No. 14.

For the noise generated by the plant, it is suggested that a vegetative buffer zone be planted around the perimeter to attenuate the noise emitted by the various equipment in the plant.

2.0 OCEANOGRAPHY, HYDROLOGY AND WATER QUALITY

2.1 Oceanography

2.1.1 Thermal Plume Impacts

One of the expected impacts of the project to oceanography is the localized increase of seawater temperature due to heated water discharges from the cooling system of the power plant. The DENR maximum allowable temperature rise beyond the mixing zone is 3 °C where the mixing zone is determined by mathematical modelling.

In order to determine the area within which the increase in temperature exceeds 3 °C, a thermal plume model was applied. The model input parameters are as follows:

Discharge Rate	=	18.37 m^3/s
Maximum Discharge Temperature	=	38.3 °C
Discharge Velocity	=	2.6 m/s
Discharge Pipe Diameter	=	3 m
Discharge Angle	=	60° and 120°
Maximum Ambient Seawater Temperature	=	30 °C
Ambient Sea Current	=	5 cm/s

For the given location of outfall as shown in Figure IV-2-1 and cross current directions of Northeast and Southwest, the results of the thermal plume model are given in Annex 3B.

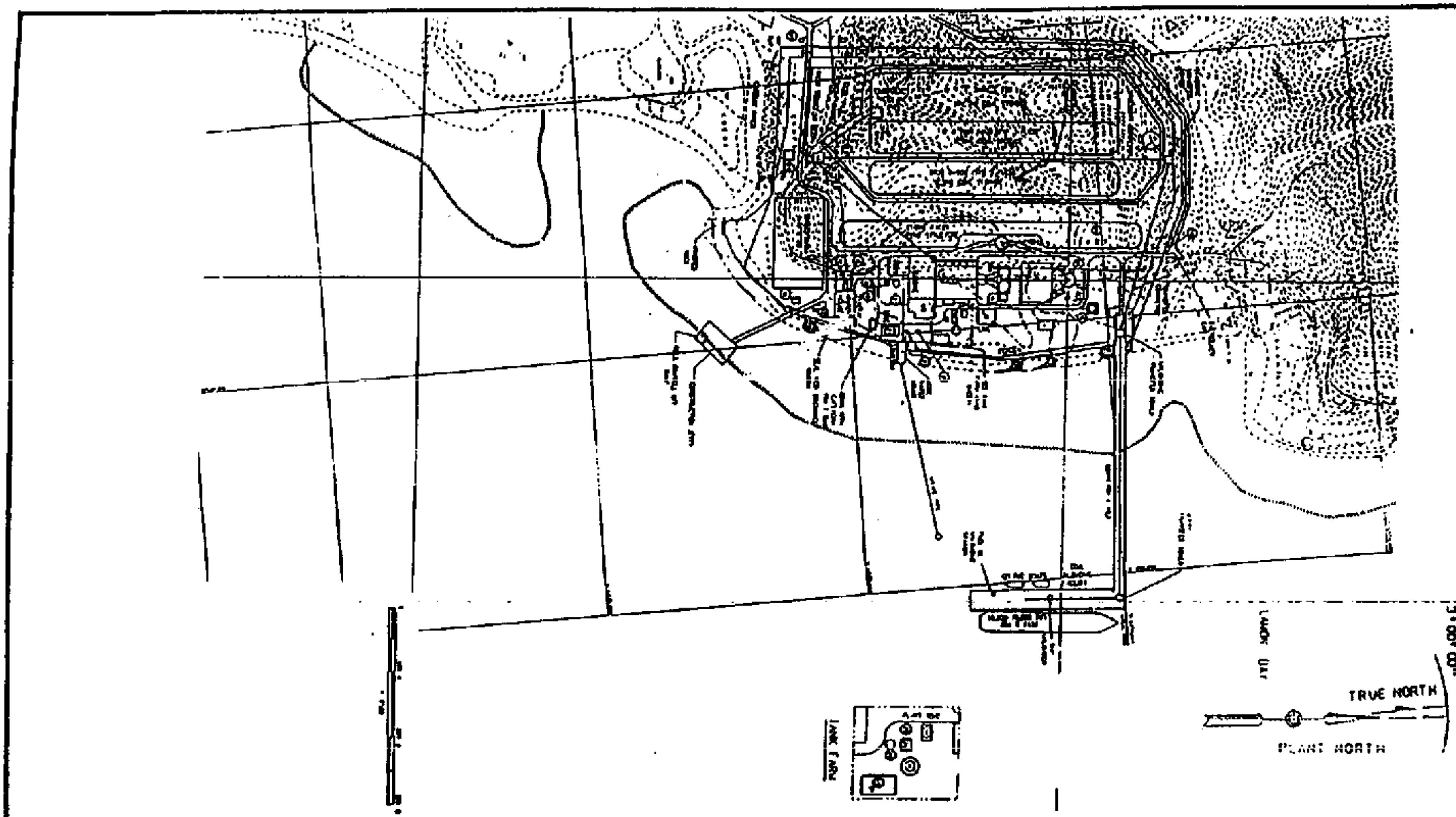
The results showed that the predicted temperature increase of 3 °C occurs from the outfall point to a downstream distance of about 30 m with a plume width of about 27 m. At this point the plume depth extends to about 3.4 m with an average dilution ratio of 1:4.9. The minimum dilution (at plume centerline) is 1:2.45. The isopleths of temperature changes are plotted in Figures IV-2-2 and IV-2-3.

For a given ambient current direction, the area of the plume having temperature excess of 3°C and higher is about 235 m^2. If the downstream distance of 30 m is swung around for 180° angle, this will sweep an area of about 400 m^2 which is the mixing zone area. These modelling results, however, are conservative since the cooling process in the discharge pipe from the power plant (condenser) to the coastline (outfall point) was not taken into consideration.

The coastal area which will experience at least 1°C rise in temperature for a given plume position is about 11,819 square meters. The downstream distance at which the thermal plume decreases its temperature to a value 1°C higher than the ambient temperature is 179 m. At this distance, this rise of 1°C in temperature is felt down to a depth of 6.52 m. from the sea surface.

2.1.2 Mitigating Measures

In order to prevent an increase of mixing zone area, the temperature of the cooling water at the outfall point will be maintained at its design value of 38.3 °C or less. This temperature reflects a maximum increase of 8.3°C at the full thermal load of the facility corresponding to a maximum 3°C increase at the edge of the mixing zone. Ambient sea temperatures range from 26° - 30°C. As a result, the cooling wear discharge will range between 34.3 and 38.3°C. The maximum 3°C temperature increase at the edge of the mixing zone will mitigate the effects of increased seawater temperature in conformance with classification SC criteria.



LOCATION MAP OF OUTFALL

FIGURE IV-2-1

No.	DATE	BY	DESCRIPTION	DFT. ENGR.	R.E. CLIENT	DRAWING No.	TITLE
REVISION				CHECK	APPROVAL	REFERENCE DRAWINGS	

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CLIENT			

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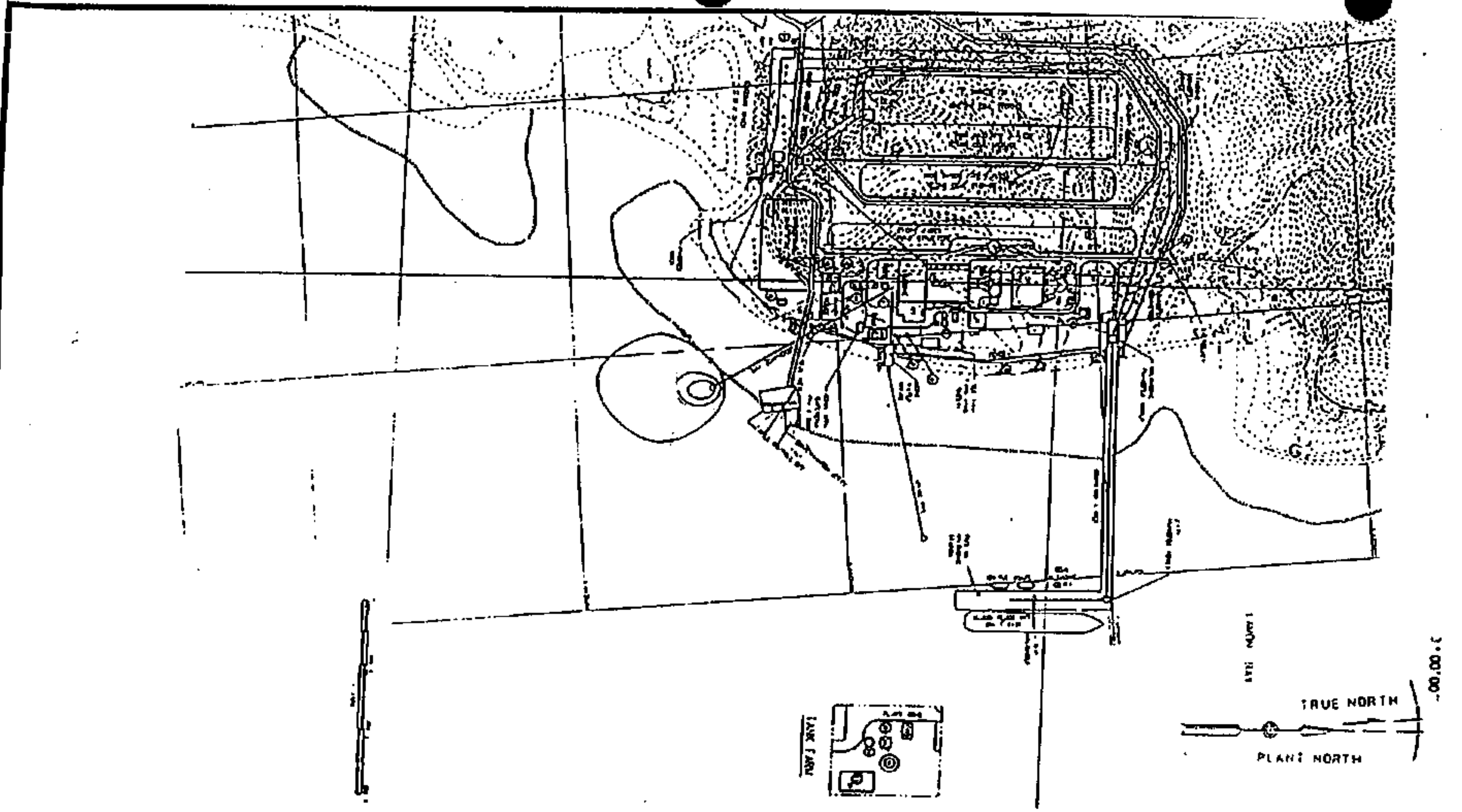
433 MW (NET) QUEZON POWER PROJECT ENVIRONMENTAL IMPACT STUDY

SCALE		BHPI DRG No.	REV.
AS SHOWN	A4	P230 101 039	A



ISOPLETHS OF TEMPERATURE CHANGES

FIGURE IV-2-2

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ENVIRONMENTAL IMPACT STUDY

SCALE		BHPE DRG No.	REV.
NTS	A4	P230 101	A

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BHP Service Companies

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DRAWN			
DRAFTING			
ENGINEERING			
R. ENGR.			
CLIENT			

No.	DATE	BY	DESCRIPTION	INT. ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK	APPROVAL		REFERENCE DRAWINGS	

CAD FILE

DATE OF LAST EDIT:

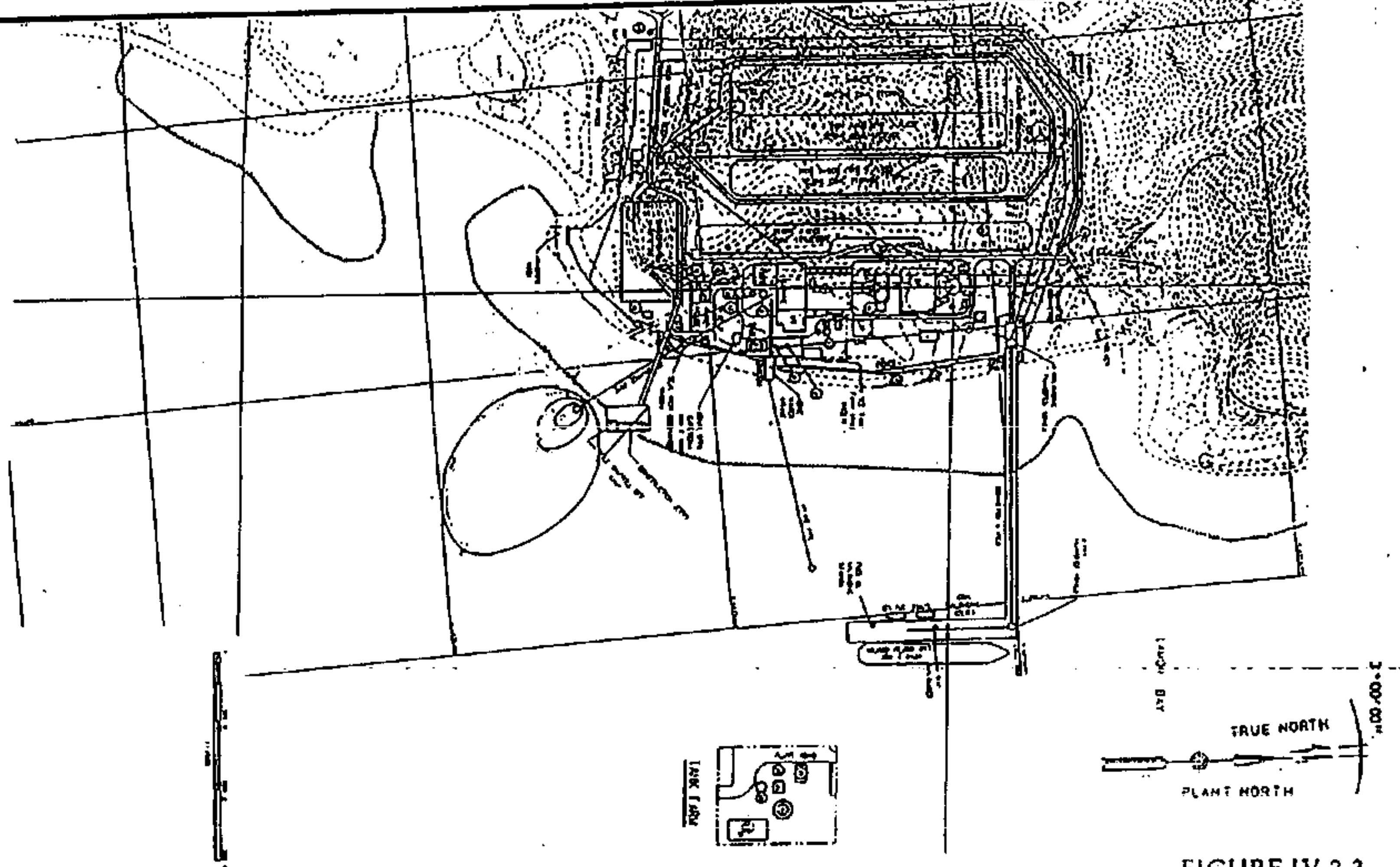


FIGURE IV-2-3

ISOPLETHS OF TEMPERATURE

No.	DATE	BY	DESCRIPTION	INT. ENGR.	ENGR.	R.E.	CLIENT	DRAWING No.	TITLE
REVISION				CHECK		APPROVAL		REFERENCE DRAWINGS	

BHP Engineering PHILIPPINES Inc.

433 MW (NET) QUEZON POWER PROJECT ENVIRONMENTAL IMPACT STUDY

	Name	Sign	Date
DRAWN			
DRAFTING (CHECK)			
ENGINEERING (CHECK)			
R. ENGR. (APPROVED)			
CLIENT (APPROVED)			

SCALE		BHPE DRG No.	REV.
NTS	A4	P230 101	A

CAD FILE :

DATE OF LAST EDIT:

2.2 Hydrology

2.2.1 Impacts

Based on the area's consumption rate of 190 lpd per capita, the total annual demand projected for the year 2000 is estimated to be 668 MCM/yr which include industrial and domestic uses. As noted earlier, groundwater storage is about 13,500 MCM with a safe yield of about 900 MCM/yr based on groundwater recharge. Therefore, the available groundwater after the projected demand is about 232 MCM per year.

For the project, the fresh make up water requirement is less than 1.0 MCM/yr. This could be amply supplied by available groundwater resources without tapping the surface water resources. Use of ground water by the QPP will avoid any adverse impact to the present use of surface water by local irrigation, fish pond and other domestic requirements.

2.2.2 Mitigating Measures

The fresh make up water requirements of the proposed power plant can amply be supplied by the existing groundwater resources in the area through deep wells. Design and location of wells will be properly studied to prevent saline water intrusion and drying-up of nearby shallow wells. A water use permit will be acquired from the NWRB prior to construction of deep wells.

2.3 Water Quality

2.3.1 Impacts and Mitigation Measures During Construction Phase

During the construction phase, earthworks and dredging could result in silted run-off from the excavated areas. Since the project site experiences rainfall throughout the year, rivers in the surrounding area like Cagsiay river and eventually Lamon Bay could be susceptible to siltation.

To prevent siltation of the rivers and the bay, the natural drainage course will be maintained and kept free from debris to prevent silt from being discharged into the river. Blocking of these drainage patterns will be avoided. Provision of temporary drainage canals with silt traps or basin will be done to intercept washed out soil particles particularly in areas of excavation. Where natural depression is available, surface run-off will be directed into it by a temporary ditch to allow settlement of suspended solids.

Spillage and washings of oil and grease from heavy construction equipment can produce thin film on the surface of water which can reduce the rate of re-oxygenation of the stream and consequently affect the biological life in water. To minimize this potential impact, temporary containment canal around the perimeter of the motor pool will be constructed. The run-off laden with oil spills will be directed to an oil-water separator to remove oil from the water.

These impacts are expected to be short term and temporary implementation of good housekeeping and construction practices will easily mitigate these potential impacts. A waste dump area will be designated to contain all appropriate spoils. All biodegradable solid wastes will be collected and disposed regularly. Non-biodegradable materials which can be recycled such as bottle, scrap metals, etc. can be collected and sold.

Temporary camps for work site personnel will be provided with proper sanitation facilities.

2.3.2 Impacts and Mitigating Measures During Operations Phase

Boiler Blowdown Discharge

Boiler blowdown is required to protect the steam boiler from accumulating precipitates which can eventually reduce its efficiency. Common impurities are:

1. Soluble gases like H_2S, CO_2, O_2;
2. Suspended solids in the form of sediments sludge of scales
3. Dissolved, colloidal solids such as oil, grease, fats, salts of Ca, Mg, Na, SO_4 Cl, Fe, Mn and Silica(SiO_2)

If discharged directly without treatment, such boiler blowdown can cause turbidity in water due to accumulated precipitates inherent with the waste. Also, the temperature water discharge may be higher which could affect replenishment of DO of the receiving water body.

Chemical Cleaning Discharges

Normally, boilers are chemically cleaned to remove scale formations. The waste derived from this cleaning can be acidic.

If discharged directly without treatment, these discharges can cause turbidity in the receiving water body resulting in aesthetic impacts. If directly discharged to the receiving body of water, the normal DO and pH in the water might be affected which in turn will affect less tolerant fish species and marine biota.

Electro-Mechanical Discharge

These wastes are characterized by oil containing washings of equipment during maintenance and surface run-off laden with grease and oil due to spillage and droppings. Such waste have an impact on the physiochemical characteristics of the receiving body of waters if discharged directly to the receiving body of water.

Domestic Sewage

These are liquid wastes generated by the proposed housing area and other domestic water uses within the plant. If discharged without treatment, Sewage is unsightly, odorous, depletes DO, causes turbidity and affects recreational use of the water.

Runoff from Coal Storage and Ash Disposal Site

During heavy rainfall and without lining of the coal storage area and ash disposal site runoff from these areas could find its way to the groundwater.

2.3.3 Mitigating Measures

The effluents generated during the operation of the plant will either be reused, or if discharged will undergo treatment in the wastewater treatment facility. The waste water generated from the boiler blow down and chemical cleaning will be directed to the reject water system at the plant. This water will be reused at the plant as dilution water for the scrubber system and water for coal dust suppression.

Prior to wastewater discharge, wastewater treatment consists of pH adjustment, oil separation and suspended solids removal. A plant discharge sump will receive wastewaters generated on site and treat them for suitable discharge to the sea via the circulating cooling water system, along with treated water from the sewage treatment plant.

Wastewater flows from the plant that may be contaminated with oil will flow to an oil-water separator. The waste oil will flow by gravity to an oil storage compartment provided with the separator. The oil free water from the oil water separator will be discharged to the plant discharge sump for subsequent discharge with the circulating cooling water system.

The sewage system will consist of a gravity drainage system that will collect all sanitary waste generated to a single lift station that will pump the sewage to an onsite treatment package unit. Treated sanitary waste will be chlorinated and discharged to circulating water dischage system. Accumulated sludge will be trucked manually. The combined facility effluent will comply with the Philippine standards, DAO No. 35 for marine water as shown in Table IV-2-1.

TABLE IV-2-1
EFFLUENT STANDARDS

Parameters	Effluents	Philippine Standard Marine Water (Class SC)
Temperature	3°C maximum rise	3°C maximum rise
pH	6-9	6-9
COD/mg/L	200	200
Oil and Grease, mg/L	10	10
Chromium (Hexavalent) mg/L	0.2	0.2
Cadmium, mg/L	0.1	0.1
BOD, mg/L	100	100
Total Suspended Solids, mg/L	150	150
Lead, mg/L	0.5	0.5

The Coal Pile and Ash Disposal areas are equipped with a clay liner or equivalent to reduce the permeability of the underlying area to less than $1x10^{-6}$ cm/sec. Runoff from these areas are collected and neutralized prior to being discharged to the sea. This collection and treatment system will mitigate and significantly reduce the potential for adverse impacts to groundwater and surface waters.

3.0 GEOLOGY, SOILS AND TERRAIN

3.1 Potential Impacts Relating to Design

3.1.1 *Foundation*

One of the most critical aspects of the project at this stage is the evaluation of its stability vis-a-vis the ground upon which the appurtenant structures will be built. For this purpose, a detailed geotechnical subsurface investigation has been initiated by BECHTEL which supplements the soils investigation conducted by BHP, presented in Section III, 3.0.

The plant site can be divided into three (3) distinct areas in terms of geologic and geotechnical classification, viz.:

- the Powerblock Area,
- the Ash Disposal Area Adjacent to the River, and
- the Uplands Area.

Powerblock Area

This area occupies the 150 to 200-m wide north-south strip that is bounded by the uplands to the west and Lamon Bay to the east. Existing ground levels range from 0 to about 2m MSL.

Nine (9) soil sample and rock core borings were performed in this area, ranging in depth from 15 to 35m . Soil thickness varies from 2 to 10m. The soils along the western side of the area are typically light brown, very stiff to hard, sandy silts; most probably derived from the weathering of the underlying rock. The soils beneath the center and eastern portions of the area are of marine origin, consisting of gray, dense to very dense sand and gravel, made up mainly of coral fragments. The top 1m or so of the marine soil is frequently clayey and much softer.

Bedrock in the powerblock area is the Unit I metasedimantary rock described in part III (Section 3.0). A layer of coralline limestone, up to 4m thick, was encountered between the bedrock and the marine soils in two of the borings. No voids or cavities in the limestone were found in the borings.

Ground water levels in the powerblock area are close to sea level.

Ash Disposal Area Adjacent to River

This approximately 16 hectare site occupies an area between the Cagsiay River and the uplands area. The eastern half of the site is planned for five year ash storage while the western half will be for future ash storage. The site is low lying (generally between El. 1 to 2m MSL) and is presently used for growing rice.

Three (3) soil sample and rock core borings were conducted at the proposed ash disposal area. Subsurface conditions indicated by the borings were significantly different from those in the powerblock area, and reflect recent thick soil deposits from the river. Bedrock (Unit I metasedimentary rock) was encountered at about 9m depth in the most easterly boring, but was absent to below 25m depth in the middle and western borings.

The top 7 to 9m are alluvial deposits consisting of 1 or 2m thick layers of brownish gray to gray, sandy or silty clays; clayey sands and silty and gravelly sands. The cohesive deposits are typically soft to medium stiff while the granular deposits are loose to medium dense. These alluvial deposits are underlain by the Unit I rock in the east, and by about 9m of soft to medium stiff, dark gray, organic, clayey silt in the middle and western portions. The organic silt is underlain by at least 9m of dense to very dense, brownish-gray, clayey sand.

Ground water levels in the ash disposal area are close to sea level.

Uplands Area

The uplands area extends to the west of the powerblock area and to the north of the riverside ash disposal area, reaching as high as 80m close to the housing colony. This area includes the active and inactive coal handling and storage areas, part of the switchyard, a future ash disposal area, and the housing colony.

Eight (8) soil sample and rock core borings were made in the uplands area. Depth to bedrock ranged from 0.7m to 7m. The overlying soil consisted generally of hard, brown, clayey or sandy silt most probably derived from weathering of the underlying Unit I bedrock.

Water levels recorded in the uplands area were generally deeper than 10m.

3.1.2 Potential Impacts During Construction

During construction, the main effects on the environment are related to the earthworks required to prepare the site for construction. These effects are short-term in character.

Excavations and Backfills

- Powerblock Area - Final grade in the powerblock area will be around El. +8m MSL, as dictated by the estimated flood level. Thus, the powerblock structures will be founded on several meters of compacted structural fill that will be placed to attain final grade.

  Prior to placing the fill, the 1m or so of softer surficial clayey soil will be removed, where present.

- Ash Disposal Area Adjacent to River - The ash disposal area will be backfilled to an elevation sufficient to protect the area from flash flooding of the Cagsiay River. Soil dikes will provide erosion control during construction.

- Uplands Area - The majority of foundations to be constructed in the coal handling and storage areas will be on cut materials, and will, therefore, be mostly on Unit I bedrock. In other areas, foundations will be either on the hard silt/clay material or on bedrock.

The jointed and stratified nature of Unit I bedrock increases the risk of slope failures in the cuts that may be excavated at the plant site. Blasting in this type of highly indurated rock, even if controlled, subjects the rock to excessive shattering because of the closely spaced and steeply dipping joints and bedding planes. Where the dip and strike of the cut slope are unfavorable, the potential for rock slope failures should be examined carefully during and after construction.

The volume of material to be excavated will be controlled such that the cut materials from the uplands area will be balanced with the fill material used for the powerblock and ash disposal areas.

Siltation

The rock to be excavated is not adjacent to the coastline and is also away from any major surface runoff channel. It will not be problematic to control the effluents from reaching the shoreline and the bay. Siltation can thus be minimized except in the areas to be backfilled to raise its elevation above flood levels. In these areas, siltation will be controlled by proper erosion control measures.

3.1.3 Potential Impacts During Operation

Long Term Settlements and Bearing Failure

- Powerblock Area - The 1m soft, surficial clayey soil will be removed in the powerblock area, prior to placing any fill. Also, the underlying natural soils will be proofrolled to compact any loose spots caused by the excavation. These soils are hard to very dense and will thus provide a suitable base for the compacted fill. Bearing failure and long term settlements are remote possibilities in this area. Nevertheless, foundation design will be analyzed extensively during detailed design investigations.

- Ash Disposal Area Adjacent to River - The combination of generally soft or loose in-situ soils, high ground water and high seismic forces result in the following potential problems which will have to be addressed:

  - Low factor of safety against bearing capacity failure under non-seismic conditions.
  - Settlement of the ash to below the ground water table under non-seismic and seismic conditions.
  - Liquefaction of the granular alluvial deposits during the design earthquake.
  - Slope stability of the ash pile and the underlying soil during the design earthquake.

If the full weight of the completed ash pile was applied to the soils in their present condition, then the factor of safety against a bearing failure would be lower than acceptable. In the eastern portion of the site, the 9m or so of alluvial soils overlying bedrock would be overstressed. In the remainder of the site, not only the alluvial soils but also the underlying organic silt could cause bearing problems.

- Uplands Area - Unit I bedrock will be the major foundation material in the uplands area. Hence, bearing failures and long term settlements are not expected.

Seismicity

The risk due to earthquakes earlier presented in part III (Section 3), is probably better classified as a long term problem. However, it is one that must be taken care of in the design and construction stages of the project.

Apart from the existence of regional tectonic elements that are the main sources of severe ground-shaking, there is the geotechnical condition to consider. As is now well documented, the destructive effects of earthquakes are brought about mainly by the shaking of the ground rather than the rupturing along the fault line. The intensity of ground shaking is a direct function of the terrain, and the thickness and type of soil foundation. Ground shaking could also lead to the liquefaction of the fine, uniformly graded sands and silts.

Volcanic Eruptions

Mt. Banahaw is not classified as an active volcano. Although it is part of the chain of Quaternary volcanoes of Luzon, it is one of the few that has not shown any sign of activity. Both Taal Volcano to the west and Mayon Volcano to the south of Mt. Banahaw are currently showing symptoms of activity.

In any event, the project site is not within the slopes of Mt. Banahaw. Hence, no drainage system directly connected to the volcano reaches Mauban, much less the site at Cagsiay. The crater of the volcano however, is some 2,160 meters high and approximately 30 kilometers from the site.

Eruption of this volcano of the same nature as Mt. Pinatubo may spew ashes and pyroclastics that could reach the project site. However, any ensuing laharic flows brought about by river borne pyroclastics are not likely to reach the plant site as there are intervening high grounds (59 to 500+M high) and rivers (Maapon and Bato Rivers). There are no other drainage systems linking Mt. Banahaw volcano's slopes and the plant site.

Coal Ash Disposal

The potential for flow of runoff from the ash storage area into the water table and into the Cagsiay River as base flow needs to be addressed. Initial testing of the permeability of the subsurface in the on-going geotechnical drilling at the proposed ash disposal site shows the presence of permeable (coefficient of permeability, $k = 8 \times 10^{-5}$ cm/sec) sands along the edge of the rice field. Coal ash if disposed of directly on the ground at this side of the of the ash storage area may lead to the escape of leachates into the Cagsiay channel and subsurface.

Farther inland, the part of the ash storage area abutting the high ground is essentially clay in character and was tested to be of low permeability ($k = 1.7 \times 10^{-5}$ cm/sec).

Flooding

Cagsiay River is the only channel of significant size draining the higher grounds, behind the plant site. It is almost certain that this is prone to flashflooding during monsoons and typhoons. However, the final design elevation of the ash disposal area will be above the flood elevation. Included in its path and low enough to be flooded at its present elevation is the ash disposal area. Unfortunately, there are no flood records kept by the municipality that can be used to determine flood heights and return periods.

The short but intermittent rivers (Dalig Creek, Miniana Creek) that drain into the plant site have very limited watersheds. These however, could be subject to flash flooding and would directly affect the plant site at Saley Point.

3.2 Mitigating Measures

3.2.1 Foundations

At this feasibility stage of the project, design analysis must focus attention on seismicity. The proximity of a known active segment of the Philippine Fault makes seismic acceleration analysis a must in the foundation design. Not only should this involve bedrock acceleration but also amplification by the soil and infrastructure resonance. All facility design will be in accordance with the Philippine Codes and this will mitigate any adverse effects of seismic activity.

3.2.2 Excavation

If blasting is to be done, this should be carried out in a controlled manner. Slopes that need to be cut in the highly fractured and stratified Unit I rock should be pre-split to effect as little disturbance as possible, and thus, enhance its stability. This is most applicable in the uplands area.

3.2.3 Backfill

Areas to be backfilled, particularly the powerblock area near the shoreline, must be provided with adequate perimeter armor stones and other coarse materials before the finer-grained soils are placed. If this backfill is to be subjected to bearing stress, an adequate number of compaction tests must be done to determine the proper moisture content and degree of field compaction during emplacement.

The source of backfill materials for the load-bearing areas must be carefully chosen to attain adequate bearing capacity.

3.2.4 Long Term Settlement

Concerning the three distinct areas of the plant site, the mitigating measures for them follow.

- Powerblock Area - The fill materials to be used in the powerblock area to attain final grade will consist of crushed rock excavated from the upland area at the coal storage locations. This fill will be placed in thin layers and compacted to close to maximum density with several passes of a heavy vibratory roller. The degree of compaction will be confirmed by field and laboratory testing. Perimeter armor stone will be placed in critical areas at the shoreline to protect compacted fill during typhoons.

  The compacted crushed rock structural fill underlain by the hard or very dense soils and then rock will enable the powerblock structures and equipment to be founded on shallow footings or mat foundations placed in the fill. The fill will be placed and re-excavated to accommodate the foundations. The foundation materials will provide adequate bearing capacity, and will limit settlements to well within the normally accepted tolerances for power plant structures.

- Ash Disposal Area Adjacent to River - The soft to medium stiff in-situ clays and silts will consolidate under the weight of the stored ash. The final subsurface investigation will determine the consolidation characteristics of these soils, and their degree of consolidation. If the soils are normally consolidated (i.e., they have not experienced any loading greater than the present overburden), initial estimates indicate that settlement could be as much as 1 to 2m in the middle and eastern portions of the site, and about half of that in the eastern portion. It will be necessary to raise the site grade sufficiently prior to ash placement to prevent the ash from settling to or below ground water level.

  The computed settlement will be taken into account when planning the initial ash placement elevation. Also, any liner to be installed will be designed to accommodate the effects of liquefaction settlement. The layer of well-compacted material that will be placed to raise grade will help protect the liner from differential settlement in the underlying layers.

- Uplands Area - no long term settlement is expected in this area since the subsurface is primarily Unit I rock.

3.2.5 Bearing Failure

- Powerblock Area - The remedial measures discussed in section 3.2.4 for the powerblock area are also designed to preclude bearing failure.

  Although the preliminary borings did not identify any solution cavities in the coralline limestone, additional borings and seismic surveys will be made in the final foundation investigation to confirm the absence of such cavities. It should be noted that the coralline limestone appears to be of limited thickness and lateral extent in the powerblock area, and the top of the limestone will be at least 10m below the base of the plant foundations. Thus, even if cavities are encountered in the final investigation, analyses may well indicate that these will be adequately bridged by the overlying materials. Remedial measures such as grouting will only be required if extensive and/or large cavities are identified.

  None of the soils in the powerblock area (after excavation of the thin layer of surficial softer material and compaction of the structural fill) are susceptible to liquefaction.

- Ash Disposal Area Adjacent to River - Ash piles are built up gradually, in cells, over a period of months and years. Thus, the soft alluvial clays and organic silts that have the potential for causing bearing problems will have time to consolidate and gain strength under the slowly increasing load. The rate of strength gain with time will be a function of the permeability of the cohesive materials and the drainage path length in those soils. If computations during the final subsurface investigation show that the rate of strength gain is insufficient to provide acceptable bearing capacity, then vertical strip drains (or equivalent) will be installed to accelerate consolidation of the compressible soils and hence increase the rate of strength gain. Suitable instrumentation will be installed to measure the dissipation of pore water pressures in the clays and silt due to the ash load, and hence confirm the rate of strength gain of the materials.

  Under the high accelerations postulated for the design earthquake, the granular soils in the alluvial layer under the ash pile may undergo liquefaction. The most susceptible soils are the sands and gravelly sands, and possibly the silty sands, depending on the amount of silt. The clayey sands and the underlying organic clayey silt will probably not liquefy.

  There are two factors that will help mitigate the effects of liquefaction. The first is the confinement afforded by the ash pile. This large area of uniform overburden will not only provide a degree of densification to the susceptible soils, but will also increase the ratio of total to effective overburden pressure at the critical depths, and hence reduce the over-all susceptibility to liquefaction. Secondly, the soils that are most likely to liquefy appear to be, from the data obtained so far, in relatively thin layers (1m or so) sandwiched by cohesive soils that should not liquefy. Thus, it seems probable that the effects will be more of densification and corresponding settlement rather than complete collapse of the soil mass associated with thick layers that experience liquefaction.

  With regards to the slope stability of the piled ash, the mixing of the scrubber sludge with the fly ash will strengthen the final mixture being placed in the disposal area. Therefore, a slope failure through the ash pile itself is not anticipated to be the critical failure mode. Rather, a base slip failure that includes the ash pile and the softer underlying soils is deemed more probable. The factor of safety against such a failure is a function of many variables, including the ash unit weight and strength, the in-situ soil strengths, the height of the ash pile, and the angle of the side slopes of the pile. Under seismic conditions, additional lateral forces that approximate the weight of the pile times the seismic acceleration come into play. Although a smaller factor of safety is usually acceptable for seismic conditions, it seems probable that the seismic case will be the critical one, given the high design seismic acceleration level of the site.

  The following steps will be taken to assure that the ash disposal area is adequately designed to protect against a major slope failure during the design earthquake, keeping in mind that a seismic failure is considered a long-term event.

  - The long-term strength of the ash mix will be estimated from test results on mixes from plants that use similar coal and have similar treatment processes.

  - Accurate strength properties of the in-situ soils will be determined during the final subsurface investigation. Design strengths will be modified to take into account consolidation or densification due to the ash pile.

  - Slope stability will be assessed using computer analyses that include the design seismic acceleration. The height and the slopes of the pile will be modified until a configuration that produces an adequate factor of safety is achieved.

- *If the analyses indicate that the satisfactory pile height and slope angle are too little to* provide sufficient storage volume, then consideration will be given to improving the in-situ soils, using processes such as vibro-compaction.

- Uplands Area - the majority of foundations in the coal handling and storage areas will be on cut materials, and will therefore be mostly on the Unit I bedrock. In the other areas, foundations will be either on the hard silt material or on bedrock. These foundation materials will provide adequate support in terms of bearing capacity and settlement. These materials are not susceptible to liquefaction.

3.2.6 Flash Floods

The ash disposal area along the banks of the Cagsiay River will be adequately insulated from flood events to prevent any ash from being carried into Lopez Bay. There are two measures that can be taken, viz., raising the elevation of the site by backfilling or building an embankment around the ash storage area. Both measures will be undertaken prior to any ash disposal, river gauges will be installed to measure maximum flood heights. This can be the basis of initial design of the flood protection structures.

3.2.7 Runoff Contamination

Runoff from the ash storage area will be collected in the perimeter ditches and conveyed to collection ponds prior to release during the period of active ash placement in a cell. The ditches and ponds will be lined with compacted clay or geomembrane to prevent any migration of runoff into the sediments along the Cagsiay River. Following completion of ash placement in each cell, the ash will be covered with topsoil and seeded to provide a vegetative cover and the permanent area drainage installed.

The coal storage area and the ash disposal area will be constructed with clay liners or equal, with a permeability of $1x10^{-6}$ cm/sec. This will mitigate the potential for coal and ash runoff that may penetrate the Cagsiay Channel or subsurface areas.

4.0 TERRESTRIAL ECOLOGY

4.1 Identification of Impacts

4.1.1 Vegetation

The predicted impacts of the proposed power plant on the terrestrial vegetation is shown in Figure IV-4-1. This network analysis elaborated in the discussion that follows:

Without the QPP Power Plant

Without QPP, it is expected that the vegetation in the area will remain largely the same. As timber supply nationwide and in the province further dwindles, the pressure to convert coconut trees to coco-lumber will likewise intensify. Increasing population in Mauban and adjacent towns will also lead to an increased demand for coco-lumber. It is, therefore, expected that even without the project there will be an uptrend in the cutting of coconut trees for coco-lumber. However, for lack of alternative land-use, it is projected that replanting of coconut trees will take place after cutting. This trend is already happening in Barangay Cagsiay I. Thus, the net effect will be the perpetuation of coconut cover. One advantage of this development is that younger coconut plants will replace older ones whose productivity have declined. It is noteworthy to mention that since the people have become aware of the proposed project site, the cutting of coconut trees for coco lumber has intensified.

Minimal impacts are expected on the rice fields. Productivity may decrease given the current situation of salt water intrusion as discussed in the Geology Section. In the long term, some of the flat lands now devoted to rice may be converted to human settlement areas. However, with the small population of Barangay Cagsiay I, this is still an unlikely scenario in the near future.

The small patch of mangrove area may eventually disappear even without the project. All over the country there is severe pressure on mangrove areas due primarily to conversion to fishponds and overcutting for fuelwood. In Cagsiay, the mangrove trees may eventually disappear as fuelwood becomes scarce. In fact, it is noteworthy that the mangrove area does not have new recruits.

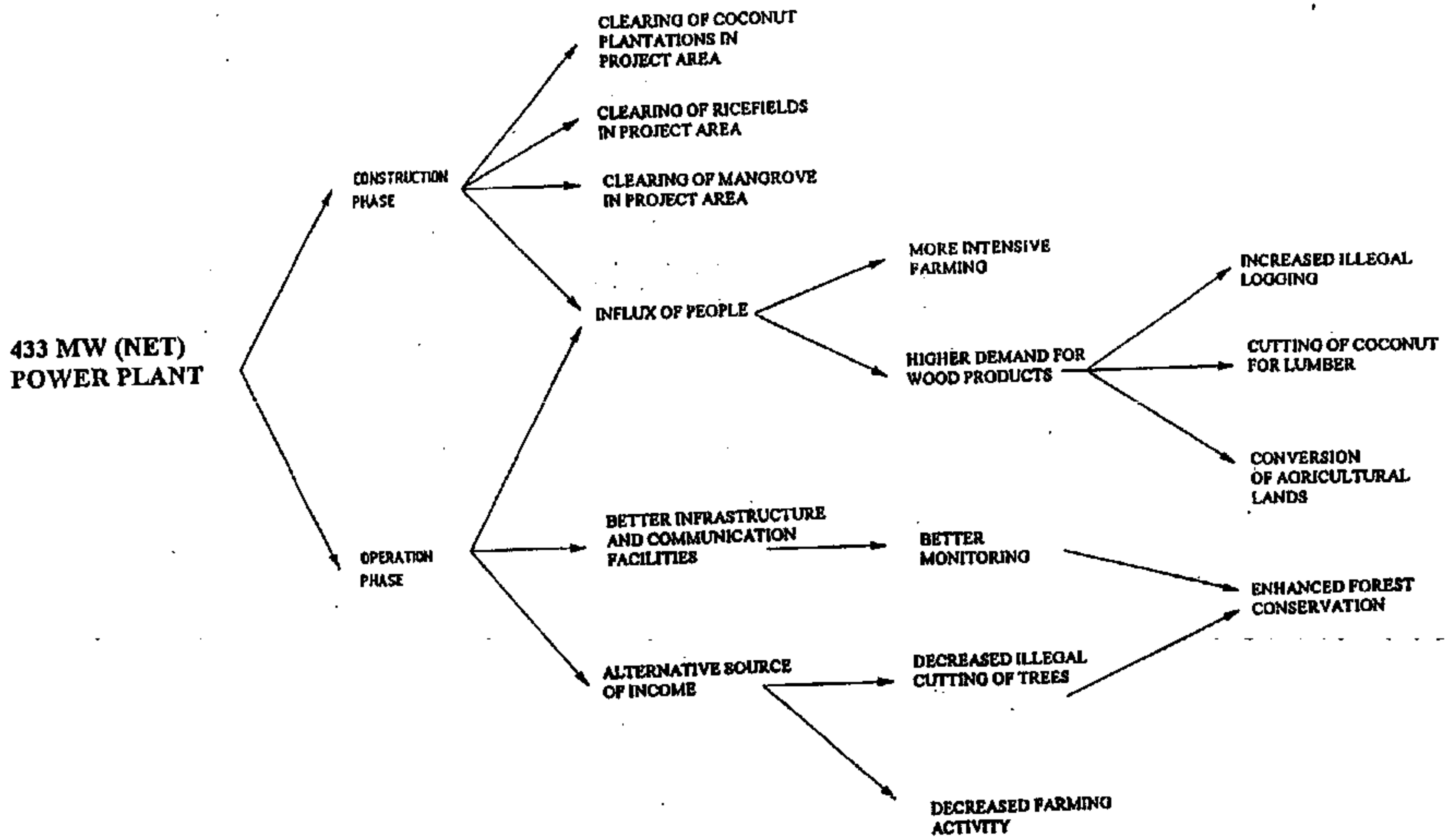
Exploitation of Surrounding Forests

At present, there are three sawmills in Mauban. The existence of sawmills in the town appears to be an anomaly because there is no operating timber concession in the entire province of Quezon. The nearest forests, which are in the Sierra Madre, are protected by the University of the Philippines land grant. Therefore, it is likely that there is illegal cutting of trees in nearby forested areas. In fact, U.P. officials have regularly reported timber poaching in forests in and around the land grant to the DENR. This could indicate that a system of illegal cutting of trees exists in the area. Such a system may blossom into a more organized operation if the demand and price perks up as a result, potential economic growth in the region due to the power plant operation.

Construction Phase

- Impact on Coconut Plantations

As mentioned in the existing environment, Section III, the proposed power plant site is mainly dominated by coconut plantations. The construction of the power plant will entail clearing the vegetation in the coconut lands (Figure III-4-4). This is a residual impact of plant development. However, the plant species that will be eliminated are all abundant in the surrounding areas and none of them are rare or threatened. Ipil and kamia, which are endangered plant species, are found in the



PREDICTED IMPACTS OF THE PROJECT ON VEGETATION

FIGURE IV-4-1

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vicinities of the plant site. For healthy Ipil and Kamia plant species that are encountered at the project site during clearing, efforts will be made to avoid or transfer these trees.

- Conversion of Ricefields to other use

The proposed 13 hectares ash disposal site is currently being used as rainfed rice fields. The development of the ash disposal area will require the conversion of the rice field to give way to the plant. Thus the vegetation in this area will be cleared. However, since rice cultivation is essentially monocropping, there will be no loss of biodiversity in the process. This will, however, result in the loss of rice production of some 480 - 800 cavans.

- Impact on Mangrove Areas

The small patch of mangrove area described earlier will eventually be lost since it is very close to the proposed plant site (Figure III-4-4). Based on the survey, however, this area only has two species of major mangrove elements (i.e. A. *oficinale* and S. *alba*). Given, the fact that no recruits were evident, it is surmised that even without the project, the area will eventually decimate. Furthermore, it must be noted that the plant species encountered are found in other mangrove areas in the province and other parts of the Philippines.

Operation Phase

- Increased Cutting of Coconut "Trees" for Lumber

Just like the construction phase, better infrastructure and economic opportunities created by the project will result in the immigration of people during the operation of the plant. This will lead to a greater demand for construction materials. The high price of wood will make coco-lumber an attractive option specially for low-income groups. Combined with the low price of copra, the net effect will be more cutting of coconut "trees" for coco-lumber. Since coconut is the primary vegetative cover in most of Mauban, cutting of coconuts will leave those areas bare. Specially in hilly areas such as those in Cagsiay I and surrounding barangays, accelerated soil erosion may result if not properly addressed.

- Conversion of Rice Fields and Coconut Lands to Residential Areas

The increase in population brought about by the power plant operation will be accompanied by an upswing in demand for housing facilities. In addition, residents who will likely have higher income will also desire better living conditions. These two factors will spur housing development around the project area. Conversion will likely occur first in low-lying rice lands. However, since most of Mauban are hilly, coconut lands may eventually be converted to subdivisions particularly the beach/ocean front areas.

- Impacts on Productivity

Based on the air quality modelling, It is estimated that the maximum concentration of the stack emissions from the plant will be at around 1.1km. However, these emissions are below the ambient air quality standards. Thus, there should not be any impact of the power plant emissions on vegetation and vegetative cover.

- Cultivation of Cash Crops

An increase in the population coupled with a higher standard of living will bring about increased demand for vegetables and other high value crops. The improvement of roads going to and inside

Mauban will also make possible the transport of perishable products. Farmers in Mauban and adjacent towns may seek to capitalize on these developments by intensifying crop cultivation. For example, instead of planting rice, farmers may opt to raise vegetable legumes. This could be beneficial as it may bring a higher income to farmers.

- Impacts on Cagbalete Island

Cagbalete island is around two kilometers away by sea from the proposed power plant. The highest stack concentration is expected to be around 1.1 km. from the plant. Thus, there will be minimal effect on the flora of the island which are mainly coconut. It has been observed that the coconut plantations of the island are more diverse than in the mainland because of lack of weeding. With an expanded market in the mainland as a result of the power plant, farmers could intensify crop production. The undergrowth of coconut plantations may be cleared to increase production thus lessening bio-diversity.

- **Conservation of Forest Resources**

The operation of the power plant will improve access to the area as better roads are constructed. There will also be better communication facilities. The combined effect of all of these could be to strengthen forest protection activities. DENR personnel could more easily reach the area. The operation of the sawmills can be more easily monitored and violations checked by the DENR. It will also be more difficult to transport forest products as there will be more people who will notice. However, these potential benefits will not happen automatically. The DENR, LGU officials and the local communities should take advantage of the opportunities presented by improved infrastructure to intensify their efforts against illegal logging.

The power plant will also provide alternative source of income for the people of Mauban and surrounding towns. People engaged in illegal forest extraction activities may abandon these practices in favor of legitimate jobs in the plant or in other occupations related to it. The proponent will ensure that priority is given to qualified residents of Cagsiay I and adjacent barangays in hiring of personnel to attain the positive effects desired.

- **Reduced Dependence on Farming**

There is also likelihood that the alternative source of income coming from the power plant operation and the downstream business it will spawn could reduce dependence on farming. In such a situation, it is likely that farming activity will decline. Coconut plantations may actually become more biologically diverse with reduced maintenance activities such as weeding, etc.

4.1.2 Wildlife

Without the project, the impact on the area will be largely due to the vigorous coco-lumber industry. The left-over coconut trunks and sawdust generated during the production of coco-lumber will provide an excellent medium for the coconut beetle larvae to develop at the same time increasing rat population which feeds on these larvae. This would adversely impact on the coconut crop in the area.

With the project, the impacts in the area during the construction phase would be some displacement of local species of wildlife. These wildlife species will migrate upland among from the project site. Minimal impact is expected due to construction.

During operation, no impact on wildlife is expected.

4.2 Mitigating Measures

4.2.1 Vegetation

- Healthy ipil and kamia trees will be either protected or transferred to other sites if some individuals are found in the area to be developed.

- After clearing of coconut trees, reforestation as mandated by DOE will be implemented.

- Demand for housing will increase with the expected migration. Conversion of agricultural areas to other uses is therefore unavoidable. To minimize adverse effects to the ecosystem, it is recommended that land-use planning be initiated by the local government to identify zones suitable for housing.

- The emissions will be controlled by use of acid gas scrubber and electrostatic precipitator. The levels will satisfy the emission standards and ground level concentrations of the Philippine government.

- To study long-term impacts on crop yield, study of current yield levels has commenced which will serve as baseline data to determine any changes in production levels once the plant becomes operational. Once the plant is in operation, monitoring of crop yields will be done to measure if there will be changes in yield and the factors affecting the same.

- The proponents will landscape the area around the power plant after the construction work is complete with vegetation that are aesthetically desirable. Locally growing plant specimens will be used to enhance and beutify the area.

4.2.2 Wildlife

Reforestation would be carried out to replace trees that are cut in the project site as required by DOE. Reforested species will be native of the area and preferably fruit trees so that fruit-eating wildlife species can take advantage of the trees.

Snap trapping of rats in the vicinity of the pier and around the power plant site will be implemented. This will be done to reduce the pest population of rodents if brought in accidentally long ships delivering coal and other cargo.

5.0 AQUATIC ECOLOGY

5.1 Assessment of Impacts on Aquatic Environment and Resources

This section provides an assessment of the probable impacts of the proposed power plant on the seaweed, seagrass, mangroves, coral reef, plankton, and reef fish communities in the immediate vicinity of the project site in Mauban. Two scenarios were presented: impacts related to existing non-project activities (i.e., without the project) and impacts related to site preparation, construction and operation (i.e., with the project).

From the design of the project facilities at the site, certain activities will be more important than others in relation to their effects on the environment. While activities that relate to the construction and maintenance of the construction jetty and the pier coal unloading may have important impacts, those related to the intake and discharge structures are expected to have the more significant and direct impacts on the coastal and marine environment in the immediate vicinity. These will be emphasized in this section. The extent of these impacts is dependent largely upon the intensity and duration of the activity, quality and siting of structures relative to the shore vegetation, reefs, and their benthic communities, and the forcing factors (e.g., current and wind patterns).

5.1.1 Existing Environmental Impacts (without the project)

The present environmental condition at the proposed project site is such that without the proper means and the proper timing of amelioration, the condition will deteriorate to a point where no amount of effort that is humanly possible would be sufficient to improve the situation. This scenario has been brought about by both natural and man-induced perturbations. Plate IV-5-1 shows that, as typified by the mangroves, wind and wave stress are factors whose effects on the ecosystems have currently been increasing in magnitude. This is observable in many parts of the country and the region, probably linked or associated with the current global climatic and sea level changes which are as yet poorly understood. The status of the coral, seaweed and seagrass communities similarly point to the fact that the area was once a rich and diverse habitat, only to be modified by intense impact from waves from the northeast, in addition to the stresses imposed by activities of the coastal population.

At its current state, the latter form of impact appears even more debilitating primarily due to its cumulative effect. Plates IV-5-4 and IV-5-5 show that the resources of the area are being subjected to intense pressure. This is compounded by activities to meet the basic need for food (Plate IV-5-2) and mobility (Plate IV-5-3) to improve living conditions. On the other hand, there have been no significant signs that the coastal population are conscious that their environment is the source of a major part of their livelihood, so that they relentlessly continue to degrade its waters. As in other coastal areas being developed for industrial purposes, the impacts of existing pollutive and resource depletive activities at the project site are difficult to separate from the possible impacts of the proposed project activities.

5.1.2 Impacts of Construction and Operation of Intake and Discharge Structures, Construction Jetty and the Coal Unloading Pier

The activities involved in the preliminary design of the intake structures are: underwater excavation of a trench; installation of a pipe in the trench; construction of an offshore (between 275 and 300 m from the shore line) low velocity (0.3 m/sec) discharge structure at an approximate depth of 10.5 m (MLLW), and injection of a biofouling chemical agent into the offshore intake.

Plate IV-5-1
Secondary growth of mangroves due primarily to stress from wind and waves

Plate IV-5-2
Artisanal fishermen (near project site)

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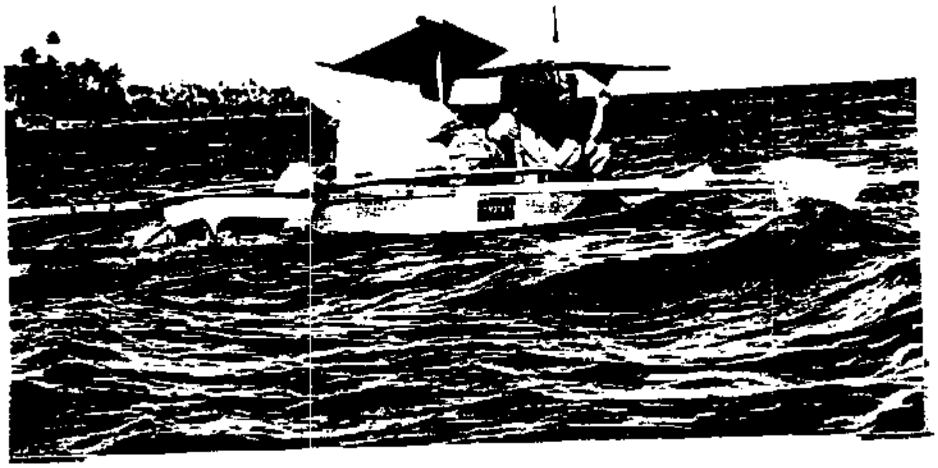

Plate IV-5-3
Boat traffic and its attendant activities

Plate IV-5-4
Garbage from domestic establishments

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Plate IV-5-5
Sawmills with their direct discharges into the sea

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Closely similar to the activities involved in the design of the intake structures, those to be undertaken in the construction and operation of the discharge structure would involve: underwater excavation of a trench; installation of a 3 m inside-diameter pipe in the trench; installation of riprap to cover the pipe; discharge of the cooling water via the pipe near the water surface; and maintenance activities, e.g., biofouling. In consideration to the nature and magnitude of the activities proposed and under the environmental conditions that exist, the expected negative impacts of these activities are expected to be minimal, short-term and localized.

Habitat Disturbance/Destruction

Trench excavation and construction of the low velocity intake and discharge structures, the jetty and pier entail removal of substrate sand and coral structures which would include some attached benthos (seaweeds and invertebrates). An additional 10 meters on both sides of the structures would be leveled by the equipment laying these structures. This will result in a possible reduction of 5-10 percent in the reef habitat in the directly affected areas available to fish and other organisms because of the loss of topographic complexity and refuges in the directly affected areas. Areas which will be most vulnerable to the disturbance are Stations MS2a and MS3a.

A bottom area of at least 400 m^2 reaching a depth of about 4 m downstream from the point of discharge will be directly affected by the thermal plume. This is directly in front (seaward) of MS3a.

The disturbed bottom and its biota, however, are expected to stabilize with time, the structures adding relief in the form of substrate that could be colonized by denizen and estranged communities, eventually compensating for the earlier decrease in biodiversity. In some instances, when uniform conditions are created and maintained, the long-term and overall result is an increase in species biomass abundance. It is uncertain at this point in time whether the resulting species composition is of ecological or economic importance.

Siltation/Sedimentation

Increased turbidity reduces light penetration and dissolved oxygen content in the water. It may be detrimental to primary producers (seaweeds, phytoplankton, seagrasses, zooxanthellae that reside in coral structures) because these organisms require light for photosynthesis and photomorphogenesis. Likewise, the resulting sediment load increases nutrient levels in the water column which may cause localized heavy loads of nutrients to the detriment of sensitive organisms like plankton and seaweeds. Unless controlled, sediments generated by the laying and construction of the intake and outfall structures can impact coral reefs (Maragos 1993). It may also happen to the other benthic communities. Poor water quality as a result of suspended solid loading from domestic and industrial activities will lead to a decline in primary productivity due to decreased light penetration. Transparency will be affected by the amount of suspended silt and other matter. This may change the composition of the flora and fauna of the aquatic ecosystem. This change, however, could either be positive or negative, depending upon the composition and role of the new recruits.

Siltation may result from both inland earth moving activities and limited excavation offshore unless properly controlled. In addition, sedimentation from naturally occurring erosion in the area will continue. Siltation and turbidity that may occur from these activities if uncontrolled, would affect an area several times larger than the direct impact area itself. Considering the current patterns in the area and the location of the proposed power plant relative to the mouth of Lamon Bay, sediments suspended by excavation or introduced by runoff could be carried to the head of the bay and affect the areas along its path.

Reef fish are adapted to living in reef habitats having relatively clear water. Disturbances, whether natural or man-induced, are known to cause siltation or suspension of sediments (e.g., storms, freshwater runoff, dredging, etc.) and reduce the number of species and individuals. This results from either emigration of species to less disturbed areas or higher mortality or both. In addition, recruitment and survival of new recruits are also adversely affected.

It is possible that the recruitment and survival of organisms in the reef which either serve as hosts/shelter or prey to fish can be adversely affected by siltation and high turbidity (Te 1992). High deposition of silt may also smother fish eggs and other benthic organisms, diminish food source as a result of the reduction in the availability of light for plant photosynthesis, and destroy habitats including coral reefs. Sedimentation may influence numerous biological relationships among fish, algae, sessile invertebrates and their coral habitat (Rogers 1990; Craik *et al.* 1990, in Te 1992). When suspended loads or concentrations become higher than 100 mg/l, they are considered fatal to benthic organisms such as corals (Te 1992). However, some species of Pacific corals (e.g., some species of *Acropora, Porites, Psamocora, Montipora, Astrepora, Favia, Favites, Leptastrea, Lobophyllia, Fungia, Plerogyra,* and *Physogyra)* can withstand episodes of heavy sedimentation (Maragos 1993) but during heavy sedimentation rates, they exhibit high mortality and low productivity.

In consideration that sediment and silt control measures will be in place, and that suspended solids loading are expected to be below 60 mg/L, no adverse impacts should occur during construction activities.

In the long term, siltation will be more controlled or even natural erosion will be minimized with the stabilization of slopes, and enforcement of effective policy regulating the incidence of illegal logging in the upstream forests. As a result, activities associated with the construction of the QPP will produce positive siltation/sedimentation effects.

Habitat Modification

The construction of the proposed power plant will result in the modification of portions of the marine habitat in the area. The installed structures would change the bottom contour and this is expected to change the local bottom topography. Depending upon the direction and strength of the prevailing current (i.e., northeasterly at ebb, southwesterly at flood except at points close to the shoreline where the currents tend to flow the bathymetry of the area), greater sediment accumulation or deposition is expected at the more protected sides of the structures. Here, shallow-rooted and transitory plant communities and sedentary fauna are expected to be established. These communities have higher turnover rates when compared to those established in the more exposed sides, giving relatively greater contribution to the energy pool of the resulting microhabitats. The differential deposition would result in a concomitant differential distribution and composition of species of biota.

Coral reefs have been shown to be highly resilient. Disturbed reefs are rapidly recolonized by both algae and fish. Structures introduced in a reef are likewise rapidly colonized. It is from this observation that the idea of "artificial reefs" (concrete structures of various shapes and sizes) was born. Algae and encrusting fauna readily attach to the surface of the structure depending on factors like size, shape, complexity, surface area and texture, available nutrients, light, etc. The encrusting organisms attract others higher on the food chain and a fish community may develop.

From the data, the area that might be affected has a living coral cover of 27% (Station MS2a) and 59% (Station MS3a), respectively. These areas (especially the latter station) comparatively exhibit high coral cover and they are of fair to good quality.

In the case of seaweeds and seagrasses, Station MS2a (and Station MS1a) had the highest number of species (=12, seaweeds only, no seagrasses; Table III-5-1). However, these seaweeds are the pioneering types, quick to colonize almost all kinds of available substrates and water conditions. Habitat modification likewise provides these opportunistic organisms new niches for occupancy where they could start new colonies or communities. As to which types will be dominant is not certain at this time.

5.1.3 Impacts of Power Plant Operation

The most direct impact of the proposed plant's operation will be the continuous use of seawater containing organisms at the intake pipe, the introduction of warm effluent at the discharge pipe, localized discharge of effluents, physical disturbance, chlorination, and provision of additional substrates for attachment of organisms.

Entrainment and Impingement of Marine Organisms

Entrainment is defined as the capture and inclusion of organisms in the cooling water stream and can be distinguished into two modes: (1) pump plant or intake entrainment is the process by which organisms are pumped through the plant and discharged to the receiving water; and (2) plume entrainment, a physical process by which organisms in the receiving water are incorporated into the discharge plume without having passed through the plant. In the former, effects occur in the region defined by a point immediately inside the intake screens and the point of discharge to the receiving water while in the latter, no serious damage is involved since the stress is immediately relieved as the waters move onward (FAO 1984).

The intake structure will continually take in water for cooling at a velocity of 0.3 m/sec. Organisms that will be entrained in the plant may include bacteria, phytoplankton, zooplankton, fish eggs and larvae (e.g., planulla, planktonic larval stage of corals) small enough to pass through the screen. Entrainment may subject the organisms to changes in mechanical (pressure, abrasion, velocity sheer and turbulent acceleration), thermal (elevated temperature) and chemical (chlorination) stresses thus a possible decrease in their population is probable. In zooplankton, mortalities and physical disintegration resulting from contact with the cooling system's pumps vary with cooling system construction, but mostly contribute less than 25%.

During the study period, the highest gross primary production and highest number of zooplankton species were recorded in Station MS2a. This station is nearest to the proposed water intake structure where marine organisms will most likely be affected. Corals do not thrive in this area since 64 percent of the coral cover is dead. Low coral cover has been attributed to dynamite fishing. It is thus possible that a reduction in production and overall diversity would not result at the site. Minimal entrainment of their planulla larvae is possible during summer when corals spawn. Therefore, minor percentage of the large and more fragile zooplankton population (about 5-15%, FAO 1984) may be affected. The latter also reported some observations on the extent of entrainment mortality. In general, there is delayed mortality among organisms following entrainment, i.e., photosynthetic activity of phytoplankton, or survival of zooplankton over 48 hours.

It should be noted that only a small percentage of the coastal waters at the site will actually be taken in at any one time at the intake pipe. It would follow that a similarly small percentage of the organisms in the waters would be entrained during this time. In addition, a study done in Samchonpo Power Plant project in Korea showed that biomass at the discharge area actually increased with increased temperature since some species which cannot tolerate the temperature were displaced or eliminated, while reproduction and growth of the more tolerant and survivor species were stimulated (Yi 1987).

As far as reef fish are concerned, the proposed colling water rate of abstraction will render fish larvae prone to entrainment. To date, very few studies have been done to quantify fish losses due to entrainment with power plant cooling water. The impacts on zooplankton as a group, however, have been studied in a number of cases. A substantial reduction in the numbers of entrained zooplankton occurs in the cooling system. Antifouling toxicants potentially inflict the most mortality, which can be as high as 100% of the directly affected populations (but almost negligible in relation to the total populations). Mortality was found to be positively correlated to the length of the cooling-water channels.

Based on a literature survey, entrainment losses could result from any of the following: temperature stress; physical damage and disintegration caused by impingement and pressure changes and pumps; and mortality from chemicals used as antifouling agents (Karas 1992).

Impingement is the occurrence of occasional large catches of fish or macro-invertebrates on intake screens (FAO 1984). Operation of screening may lead to capturing of a large number of juvenile fish which cannot resist the intake flow. However, since this consequence is variable in species and quantity the effect of impingement is less than that of entrainment. The former is dependent on the seasonal availability of fish, season and climatic conditions, tidal state and time of day (FAO 1984).

Discharge of Thermal Effluents

With the project, about 235 m^2 of the reef area including its bottom cover may be affected by a 8.3°C temperature rise from the projected discharge of thermal effluents. This maximum temperature change could occur immediately at the area, while a mixing zone which will have temperatures above 3°C will affect an area of 400 m^2. The 3°C rise is the maximum tolerable shift in ambient temperature level for most species. Maximum possible discharge temperature (undiluted) was estimated at 38.3°C. The temperature limit in most zooplankton species is at 32-38°C and high mortalities can result if these temperatures are reached in the cooling water (but almost negligible in relation to the total population). However, the outfall structure will be placed in MS3a whose average water temperature (thermal effluent) will correspondingly increase the water temperature to 35.3°C in the direct vicinity of the outfall. Since there are organisms which can tolerate this temperature regime, they could actually increase their population (Yi 1987). Higher temperature hastens the growth and reproduction of some organisms such as macroalgae and phytoplankton. But the unwanted bloom of these organisms may deplete dissolved oxygen supply thereby causing alteration in the marine ecosystem. The faster respiration rate of decomposers at increased temperature will also cause an imbalance in the dissolved oxygen level.

Thermal discharges are known to bring about changes in benthic communities. Studies in Hawaii (Jokiel & Coles 1974) revealed loss of zooxanthellae pigments of hermatypic corals 140 m from the outfall. The observed temperature elevation was about 2-3°C above ambient. Zooxanthellae act as the symbiont responsible for food production in the hermatypic coral symbiosis. Larger more foliose seaweeds could easily be bleached and killed by this temperature. It is expected that without the proper mitigation, the seaweed community would shift towards a bluegreen algal structure, to the detriment of the grazers which require other more preferred leafy forms. The increase in algal biomass could be the source of nutrients and organic matter to naturally fertilize the area.

Impacts of thermal effluents on fishes may be positive or negative. Many adult fishes are seldom directly affected by thermal effluents because they can avoid them. Those closely associated with corals disappear with their hosts -a negative impact both ecologically and economically. Corals killed by elevated temperatures are quickly colonized by algae and fouling species which result in the replacement of benthic carnivores by herbivores so that the biomass of fishes can be even greater

(Neudecker 1987). This is a positive impact. The presence or absence of coral-associated fishes such as chaetodontids has been used as an indicator of the extent of thermal effects on a reef community.

Discharge of Other Effluents and Other Impacts

Any resulting reduction in water clarity limits the production and survival of organisms in coastal areas. Discharge of other effluents if untreated, (e.g., domestic refuse, saw mill discharges, Plates IV-5-4 and IV-5-5) which affect the tolerance limits of biota may reduce water quality and then seaweed, seagrass, and plankton growth. However, all wastewaters from QPP will be treated prior to being combined with the thermal discharge from the cooling water system.

Changes in the water column due to mechanical, thermal, chemical stresses and the plume entrained water is possible. Since plankton are free-flowing organisms, water current will move them to other areas although they will also be exposed to short-term changes. However, there are no evidences that support ecological significance on the changes in plankton population since one has to consider the natural mortality and replacement rate of many phytoplankton species (FAO 1984). For fish and other macroinvertebrates, their swimming ability will allow them to seek areas of preferred thermal requirement for survival.

The most observable effects of any stress appear to be a reduction in the population size and distribution of organisms. Of the major pollution-related effects, reduced available light resulting from eutrophication is by far the greatest threat to plant and to some extent, animal populations. The most serious source of nutrient loading along the coast will be people; increased population density increases the problem. In order to solve the problem of eutrophication in the waters at the project site, nutrient loading will be reduced. Wastewater treatment facilities that will be installed by the power plant will greatly reduce nutrient loading and eventually eutrophication in the area.

Physical Disturbance

In many parts of coastal Mauban, blast fishing is a popular albeit extremely destructive fishing technique. Within one hour of the study period alone, ten blasts were heard. The blasts create blowouts and depressions in coral reefs and seagrass beds (Plate III-5-11). In blowout areas which impact seagrass beds, it takes 5-15 years for reestablishment (Patriquin 1975). Such processes limit successional development of the habitat as evidenced by the absence of a well developed epifauna and flora, characteristic of advanced developmental stage, disrupt sedimentary structures, and may result in deposits much coarser than those characteristic of the sandy seagrass carpet.

In coastal population or market centers, boat traffic causes scouring of shallow coral reefs and grass beds. This is brought about by the boats themselves or by the anchors and poles used to maneuver the boats at low tide. It also suspends sediments, contributing significantly to the increase of water turbidity and a decline in its quality.

With the project, communication facilities and increased accessibility will improve monitoring of these illegal activities. This is expected to reduce the practice of blast fishing. Moreover, the availability of alternative livelihood would lessen the pressure for such unsustainable fishing techniques.

Chlorination

A major operational problem for power plants is the establishment of communities on intake and discharge structures and microbial fouling of condenser tube surfaces (Neudecker 1987). Fouling reduces flow, clogs plumbing, reduces heat transfer efficiency and consumes entrained organisms. Microfouling results from the attachment of bacteria, protozoans, and microalgae to material surfaces, whereas macrofouling communities are generally composed of epiphytic algae, anemones, annelids, ascidians, ectoprocts, molluscs, and sponges. The distribution and abundance of coral reef fouling organisms is primarily related to the physical factors of surface orientation and the availability of light and nutrients, as well as the biological factors of predation and competition.

Studies have shown that chlorine concentration exceeding 2 mg/l are lethal to marine organisms. The power plant proposes to use chlorine intermittently and at lower concentrations (0.5 mg/l). This is expected to greatly minimize any adverse impacts. Long-term studies are not available on the effects of low concentrations of chlorine on marine organisms.

Additional Substrates for Recruitment

The construction of submerged structures as support of the jetty and the pier will initially inhibit the growth of marine organisms as these are considered disturbances or blockages against the normal flow of propagules. Through time (about 1-2 years after construction), however, these structures are expected to provide additional substrate for benthic organisms as well as artificial shelters to other marine forms. After the first wave of colonizers (e.g., microorganisms and algae), the growth of larger life forms (e.g., barnacles, sponges and corals) may result. This is the initial stage in the successional process in the overall development of the coastal ecosystem. It is important that the structures are durable so that they can sustain the growth and development of benthic communities.

5.2 Mitigating Measures and Recommendations

In order to mitigate the expected impacts on the coastal and marine environment at the proposed project site, the following actions are proposed. It should be noted, however, that at present, the environment is being subjected to various depletive and environmentally unfriendly pressures that no matter how effective the recommended measures are, if these are not complemented by committed action programs on the part of the local government and private interest groups, the success of the former would be limited in both space and time. The existing condition in coastal Mauban is such that it is generally difficult to separate which impacts come from which establishments along its coasts.

5.2.1 Minimizing Impacts of Excavation Activities

Physical barriers such as silt screens and earthen berms will be used during construction to control soil erosion.

5.2.2 Minimizing Thermal Effects

The best way to minimize thermal effects on marine life is by selecting the best available site and adopting the most appropriate design. The proposed outfall structure is designed such that thermal effects can be minimized by using the minimum increase in temperature possible, by minimizing transit times, and by promoting rapid mixing and dilution. Also, positioning the outfall near the edge of steep submarine topography will negate any adverse impacts on the corals.

5.2.3 Reducing Entrainment and Impingement Losses

The intake pipe will be cleaned frequently to keep it free from obstructions that could reduce the pipe diameter and increase the intake velocity. This would arrest the velocity to the designed 0.3 m/sec and thus reduce the rate of entrainment and impingement of marine organisms.

There are three basic approaches to minimizing entrainment, entrapment, and impingement effects (Neudecker 1987; FAO 1984): reducing entrapment and impingement initially (e.g. intake diversions, velocity caps); concentrating entrapped fishes within the intake structure and removing them before they are impinged; and fish-return systems for impinged individuals.

The use of various stimuli, such as bubble screens, chain curtains, chemicals, lights, and sounds, to deter fishes from intakes have not proven effective. Only low velocity intakes have shown substantial value in deterring marine fishes from intakes. Horizontally, low velocity intake is utilized to create a horizontal flow pattern because marine fishes seem to be better at detecting and avoiding horizontal rather than vertical flow. This type of flow patterns function as a behavioral barrier are used in conjunction with onshore screens that provide a physical barrier to those individuals which do enter the intake. In some cases, it may be necessary to include systems to return impinged fishes to the source water. While behavioral barriers have not been generally proven effective, physical barriers, and fish salvage systems have reduced impingement mortality at several plants.

5.2.4 Minimizing Chlorination Effluents

As indicated, the proponents will limit the use of chlorine to levels below 0.5 mg/l to minimize adverse impacts. Perioding monitoring of effluent chlorine levels will be performed to ensure this practice mitigates the potential impacts on marine organisms.

5.2.5 Implementation of Complementary Measures

The activity-specific measures recommended above could succeed only if there is awareness and understanding of the basic principles of environmental science hand in hand with the application of these in safeguarding the livelihood base and other interests of the concerned populace. There is thus the need for complementary measures to backstop the specific mitigating activities. These measures include: intensive efforts dealing with public awareness on environmental protection and management of the existing impacts (including marine parks and reserves); and a functional monitoring program. In the former efforts, the proponents could support existing government initiatives as in the establishment of marine parks/reserves in the region. This is a common management strategy to conserve or protect coral reefs in Southeast Asian countries (White 1988) although their effectiveness is often in question (Gomez & Yap 1982).

6.0 SOCIO-ECONOMICS AND PUBLIC HEALTH

6.1 Impact Identification and Assessment

6.1.1 Socio-economic Impacts of the Project

Displacement of Residents

Prior to construction activities, the site for the proposed power plant and its facilities will be cleared. This will then require the displacement of dwelling units and other structures within the directly affected area. Approximately 321 people will be relocated.[35]

The breakdown of the number of households that will be affected by the project is presented below.

TABLE IV-6-1
AFFECTED DWELLING UNITS/HOUSE STRUCTURES, DIA
05 FEBRUARY 1995

Affected Dwelling Unit/House Structure	Number of Households
Dwelling unit/house structure with one (1) household	50
Dwelling unit/house structure with two (2) households	14
Dwelling units/house structures (owners are not staying in the area)	(3)
Total	64

The following has been identified for the direct impact area.

- land and their owners
- houses and their owners
- non-housing structures and their owners
- crops and their owners

All affected parties will be either paid directly by the proponent based on agreed prices or the proponent will resettle affected households. The relocation package will be guided by the following objectives:

- *to provide just and fair compensation to those whose homes, land and crops will be directly affected by the project; and*

- *to minimize the economic dislocation and uplift the living conditions of directly affected households by providing livelihood opportunities.*

The project will also cause the economic displacement of household heads, particularly those whose main sources of income include farming and its related activities. There are about 26 farmers and 1 agricultural farm worker (engaged in copra making) who would be displaced with the clearing of farmlands, pig pens, chicken houses and copra dryers/furnaces in the area. It is also foreseen that the

[35] Based on the 28-31 January 1995 Socio-economic and Perception Survey conducted by BHPE.

project will disrupt the fishing ground of 5 fishermen from the DIA who fish in the waters off Barangay Cagsiay I.[36]

Training and livelihood programs would be offered to interested members of the affected households. These will be undertaken to prepare members of the population to qualify for jobs for the project and/or prepare them for alternative sources of livelihood resulting from economic dislocation. QPI has just launched a skills training and community enhancement program to start-off its commitment to the community in cooperation with the Manuel S. Enverga Memorial College of Arts and Trade. A Memorandum of Agreement (refer to Annex 7D) was signed last 20 May 1995 by representatives of the project proponent, the participating school, the host municipality and of Barangays Cagsiay I, Cagsiay II and San Lorenzo.

Based on the project's program on resettlement and compensation, the following will be undertaken:

- *training through the local vocational school will be undertaken on carpentry, masonry, basic electricity, general mechanics, welding, office skills, sewing and similar skills, to prepare them for job opportunities during project construction.*
- *training and initial assistance in the formation and operation of business enterprises that will be engaged in the operation of small-scale business enterprises which can supply long-term services to the operating plant as well as to the construction site.*
- *provision of loan to establish alternative livelihood like putting up small-scale business like a store, purchase of tricycle, etc. which will have to be repaid under a repayment scheme to be developed*

A copy of the resettlement and compensation program for the project is attached, refer to Annex 7E.

Employment Generation

Work force requirements during the construction phase of the project will attract unemployed members of the labor force (aged 15 years old and above). In the province of Quezon as a whole , unemployed males account for 0.6 percent (approximately 5,000) of the 1993 labor force population of the province. The project may also offer employment opportunities to unemployed males within Quezon who account for 0.6 percent (approximately 5,000) of the 1993 labor force population of the province. In particular, the services of a number of unemployed individuals and out-of-school youths in Mauban who are estimated to total 1,420 may be tapped.[37]

The project will provide employment to approximately 2,400 skilled, semi-skilled and unskilled workers for 40 months during the project's construction stage.

During the power plant's operation and maintenance phase, various jobs will be offered to fill in posts for (a) managers, supervisors and engineers; (b) technicians, operators and assistants; and (c) helpers, janitors, messengers and clerks. About 220 personnel will be employed during the operation of the plant.

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[36] Ibid.

[37] Provincial Planning and Development Office of Quezon, "1994 Socio-economic Profile of Quezon" (Lucena City). Based on the data from the National Manpower and Youth Council.

Linkage with the Local Economy

Section 5 (d) of the "Department of Energy Act of 1992" states that, *"All energy resource developers and power producers shall source their supplies and service requirements from within the host LGU (local government unit) provided such supplies and services are available therein at competitive price, delivery/service schedule, quantity and quality."*

Based on the above-mentioned directive, local firms will be encouraged to market their services as suppliers and contractors for the project.

Spin-off economic activities during construction are also expected. These activities would include setting up canteens and "sari-sari" (variety) stores for the construction workers as well as offering boarding and lodging services for migrant workers.

Consumer spending is expected to increase with the project especially during the construction period. This is foreseen to occur in places where household incomes will be spent like Lucena City. Moreover, investments are also expected to increase due to the availability of power that can fuel manufacturing industries to be established in the area. This will have a longer-term beneficial impact on the economy than just consumer spending.

Population Impacts

Direct employment requirements would determine impacts on the population. The local population will increase, particularly during the construction phase when significant workers are required.

The influx of workers to the project site will create heavy demands for services like housing, health services, water supply, waste disposal, law enforcement and recreation. In particular, the concomitant social problems which might result from in-migration (e.g., crimes) as well as threat from the insurgency will require law enforcement services.

Events that are likely to happen with worker requirements are as follows: (a) arrival of project personnel, construction workers including their dependents; (b) arrival of non-project people; (c) increased demand for social services; and (d) establishment of new communities.

The coming in of people not connected with the project who are likely to engage in various economic activities during project construction is also foreseen.

Impacts to the Public Sector

As a private enterprise, the proponent is bound to pay local taxes and secure local permits. Business taxes resulting from project activities will also add to the revenues of the local government unit.

Real estate property tax rate in Mauban was estimated at PHP 345,000 for the year 1994.[38] As stated in the Local Government Code of 1991, the project is expected to contribute 34 percent of the real property it will have to pay to the municipality. It is thus foreseen that there will be an increase in real property tax collection in the municipality of Mauban.

Under the proponent's Build-Own-Operate arrangement with MERALCO, the host municipality and host province will benefit from the project in compliance with the conditions set in the 1991 Local Government Code and Department of Energy (DOE) Act of 1992. These benefits are summarized on Table IV-6-2.

[38] Municipal Planning and Development Office of Mauban, "Socio-economic Profile of Mauban".

TABLE IV-6-2
BENEFITS TO THE HOST COMMUNITY

Source of Benefit	Benefit to the Community
Local Government Code	
Franchise Tax	0.5 percent of Gross Profit
Real Property Tax	1 percent of Assessed Value
DOE Act Implementing Rules and Regulations	
Electrification Fund	PHP 0.0025/KWh of Total Electricity Sales
Development and Livelihood Fund	PHP 0.0025/KWh of Total Electricity Sales
Reforestation, Watershed Management, Health and/or Environmental Enhancement Fund	PHP 0.005/KWh of Total Electricity Sales
Skills Development	Host/Developer/DOE Agreement
Load Dispatch	25 percent of Capacity

Infrastructure Development

The accessibility of the project site and its adjacent communities will be enhanced. Roads from Poblacion (town proper), Mauban to the site which pass through Barangays San Lorenzo and Cagsiay I would be upgraded.

6.1.2 Public Health Impacts of the Project

The rapid increase in population density, especially during construction, may strain accommodation and contribute to lack of sanitary facilities. However, proper sanitary conditions will be provided to the construction employees which will largely mitigate against deteriorating health quality in the area.

6.2 Mitigating Measures and Recommendations

6.2.1 Mitigating Measures for the Socio-economic Impacts

Formulation of an Acceptable Resettlement and Compensation Program

Since the proponent will provide either the resettlement or compensation to the directly affected parties, the actual outcome should result in the uplifting of the living conditions of the affected households and providing them opportunities to sustain this changed lifestyle.

Skills and Livelihood Trainings

Pursuant to Section 5 (3) (b) the implementing rules and guidelines of the DOE Act of 1992, "*. . . development of skills pertinent to energy generation or electrification and skills in reforestation and other agro-industrial skills . . .*" will be promoted. In so doing, the following will be taken into consideration:

- project manpower requirements may be provided by trained and qualified members of the local population, or
- alternative sources of livelihood may be offered to the affected people as well as to the residents of the nearby communities.

One such program is being implemented at the present time, see Annex 7D for details.

Hiring Policy

> *"Qualified members of the community and people affected and qualified bona fide residents of the host barangay and the host municipality or city shall be given preference in employment . . ."* [Section 5 (3) (c), "DOE Act of 1992"]

The company's hiring policy will prioritize interested and qualified locals. A skills or vocational training program will be initiated in coordination with the Mauban Trade School. This will enable the locals to upgrade their present levels of skills and to prepare them for jobs in the plant or elsewhere. (Refer to Annex 7D for more details).

Management should guard against allocating the bulk of new jobs to those who do not belong to the host municipality.

Community Relations and Information Dissemination Campaigns

With regard to information dissemination campaigns for the project, several public hearings have been held with government and socio-political-civic organizations. Among these are:

- two (2) public hearings in the town of Mauban in November and December 1994 aimed at providing information about the project, including the capability and experience of the project proponents, the environmental procedures that will be followed as well as to elicit comments from the people about their concerns and issues relating to the project;
- barangay meeting in Cagsiay I;
- scoping meeting with DENR and Mauban LGU at the EDSA Plaza Hotel;
- public hearing with the Sangguniang Panlalawigan; and
- meeting with the Bishop of the Diocese of Lucena.
- visits of concerned residents, oppositors, students, etc. to the Calaca Coal-Fired Plant where the operation of the plant was discussed and shown.

Resolutions endorsing the project are appended in the report, refer to Annex 7F.

The project proponent is actively involved in community affairs. Also, regular meetings and dialogues will be sustained, (a) to erase public misconception on the project, (b) to answer the residents' queries on the project; (c) to inform the local population of possible job scarcities during project construction and operation, and (d) to update the residents of the results of periodic monitoring activities.

Community Relations During Operation

The long-term goal of the proponent's community relations program is to provide electrical power in as unobtrusive a manner as possible and to assist the affected community's efforts to maximize the economic development potential that can be spurred by the existence of the facility in Mauban. The proponent recognizes that the siting of a major industrial facility such as a power plant in a rural community can dramatically affect the quality of life of the residents, and is committed to helping provide as a smooth a transition for the people as possible.

To ensure that residents of the impacted areas benefit most from the project, the proponent will provide skills development, preference in employment, procurement of local supplies and services, livelihood, reforestation and environmental enhancement benefits to the local community consistent with the requirements of the Department of Energy's Regulations No. 1-94. The proponent has a longstanding history of working in partnership with community officials and residents to integrate its facilities into the locality and to develop and support community programs that will enhance the quality of life. To this end, the proponent will place particular emphasis on programs geared towards environmental improvements and the education of children.

Openness and two-way communications between the facility operator and the local community will be emphasized because the proponent places a high value on providing trusted service to the community.

As part of an ongoing outreach and dialogue and in addition to the required Department of Energy benefits, voluntary environmental and educational community projects and for the purposes of addressing issues of concern that may arise regarding facility operations, the company will provide ongoing liaison to the local community through its facility management to ensure that residents have a means of obtaining information about the facility's operational process.

Through various community relations activities, the proponent will demonstrate its commitment to establishing and maintaining a long-term relationship with the people of Mauban based on mutual trust and respect. The proponent takes seriously its role a partner with the community to achieve a harmonious and improved quality of life.

6.2.2 Mitigating Measures for the Public Health Impacts

To prevent adverse health impacts especially with the influx of people during construction, the following will be adopted for the construction crew.

- provision of adequate sanitary facilities
- provision of a safe drinking water system
- monitoring for water and food supplies in coordination with the rural health office
- provision of adequate housing space

7.0 LAND AND RESOURCE USE

The power crisis in 1993 that resulted in 8-10 hour blackouts in Metro Manila and several areas in Luzon was generally a bane to the growing Philippine economy. This situation clearly manifests the need of urban centers for an efficient and stable power supply.

The major benefit of the Quezon Power Project potentially will be accelerated urbanization and industrialization of the study area's urban centers, rural municipalities and MERALCO service areas.

7.1 Probable Impacts Within the DIA and PIZ

7.1.1 Construction Phase

Land Use/Urbanization

Based on the approved Comprehensive Development Plan of Mauban, the proposed project site is presently zoned agricultural. (See Figure IV-7-1).

Conversion of croplands planted with coconuts and rice is the primary impact of the proposed power plant on the DIA and the PIZ. Also, insignificant numbers of mangrove stands dotting the beach area fronting the project site will likewise be affected.

A total of 64 families residing in small clusters of settlements in Sitios Dinahican and Dalig of Barangay Cagsiay I will be directly affected/displaced by the project. While a "small-scale out-immigration" is anticipated due to the relocation of the affected families, quite a sizeable number of project personnel, construction workers and their dependents, if any, will fill in the void. Entry of these workers/project personnel constitute an abrupt increase of population into the DIA and PIZ which would mean a corresponding increase in number of dwelling units/structures.

Facilities and Utilities

The increased population will require services/utilities such as water, health services, sanitation facilities, and even additional classrooms.

Due to the transport of equipment, supplies and materials and the influx of people to the project site and the outlying barangays, the roads within the Poblacion will experience increased traffic. Due to the generally poor condition of roads in the adjacent municipalities of Sampaloc, Tayabas and Lucban, sea transport of equipment and construction materials is planned. This will also reduce and mitigate any traffic congestion problem. Traffic sizes will be posted on specific streets, designated for the passage of heavy-equipment, proper coordination in this regard will be done with the Office of the Mayor.

7.1.2 Operational Phase

Population

During the operational phase of the project, population will have stabilized due to (a) return of construction workers to their respective places of residence and (b) natural increase in population due to migration within the municipality. Because of the location of the proposed project, Cagsiay I will receive the influx of these migrants. The Poblacion will likewise be at the receiving end of these migrants.

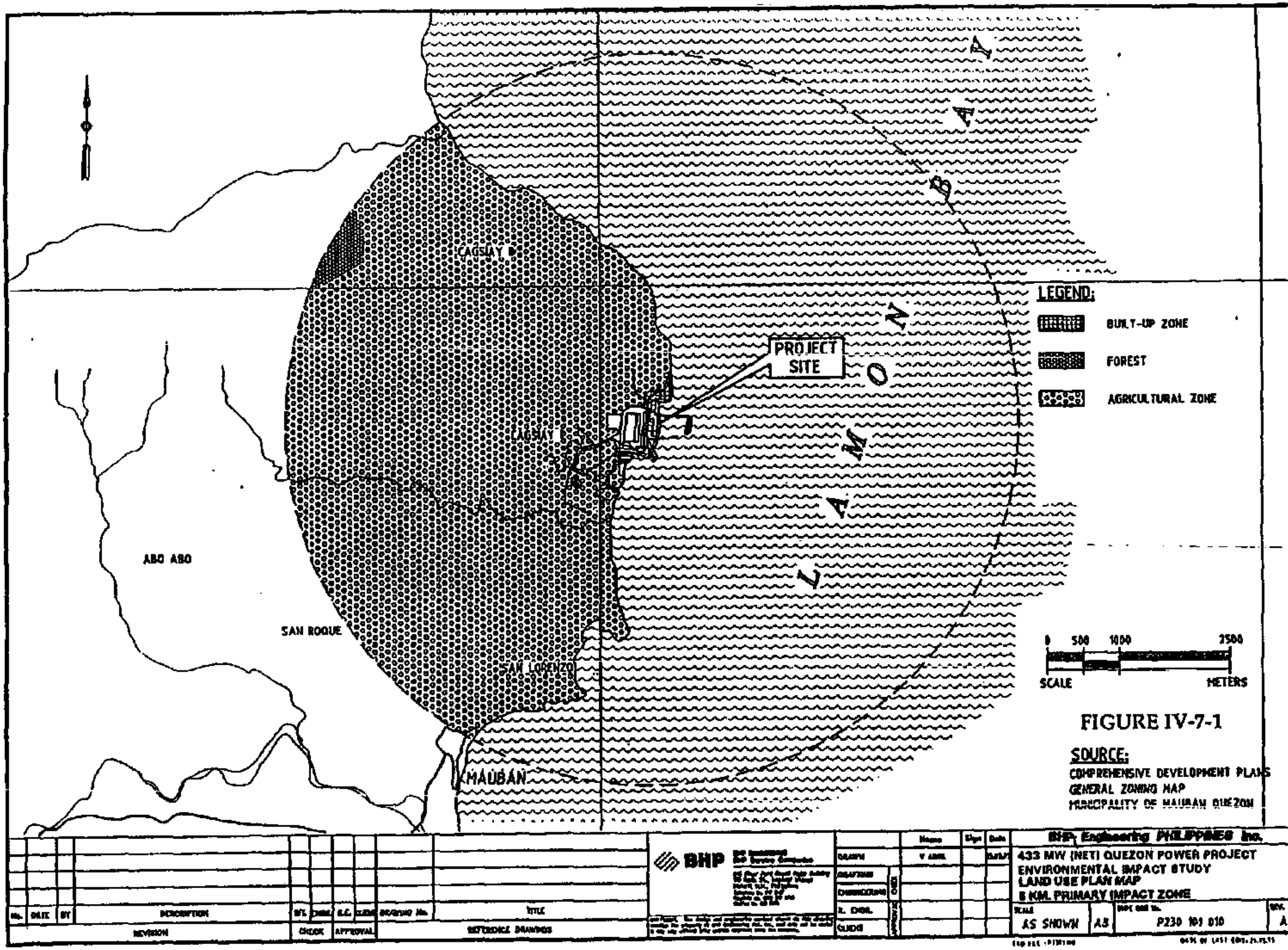


FIGURE IV-7-1

SOURCE:
COMPREHENSIVE DEVELOPMENT PLANS
GENERAL ZONING MAP
MUNICIPALITY OF MAUBAN QUEZON

Land Uses

Residential areas will expand in Barangay Cagsiay I and Poblacion due to the migrants and natural population increase. The situation will result in an increased demand for fuel wood which could lead to indiscriminate cutting of trees.

Expansion of the residential areas may encroach into the agricultural sites of the municipality. Thus, the Zoning Ordinance of Mauban will require review and updating to ensure that the change brought about by the project is considered in planning activities. Local taxes paid by the proponent will assist in enforcing the resulting zoning plan.

Also, the commercial establishments, e.g. eateries and "sari-sari" stores will need additional areas because of said population increases. All these should be considered in the formulation of the zoning plan by the municipality.

Aside from the increased demand for residential and commercial areas, demand for social services such as health, education, recreation, etc. will likewise increase.

Makeshift structures/dwelling units and small commercial establishments may proliferate within the immediate vicinity of the project site. Thus, the local government, particularly the Barangay Chairman and the Municipal Planning and Development Coordinator (MPDC) may need to monitor possible squatting problems. Prevention of the possible entry of these squatters could be looked into through an effective monitoring scheme. Another matter which must be looked into and monitored very closely is the possible encroachment of squatters into the municipality's forest/public lands. Local taxes paid by the proponent will assist the municipality into monitoring these activities and manage the responsibility of securing these lands from squatters.

Urbanization

Establishment of an Electrification Fund as required by DOE will benefit barangays of Mauban. This fund in combination with the multiplier effect of energization will result in accelerated urbanization for the benefit of the municipality.

7.2 Probable Impacts within the 25 KRIZ

The construction phase of the power plant project will have minimal impact within the 25-KRIZ. Thus, the following discussions will be focused on the potential impacts of the project during its operational phase.

7.2.1 Urbanization/Settlement Pattern

Population is a significant factor in a locality's pace of development. As mentioned, the 1990 census of population was used as the basis in projecting the population for the years 1995, 2000 and 2020, as shown in **Table IV-7-1.**

Proximity of the study area to the country's foremost metropolitan center has greatly influenced its urban growth and settlements development.

Based on the National Urban Development and Housing Framework, 1993-1998 (Housing and Land Use Regulatory Board, 1994) the municipalities within the 25 KRIZ have been identified as to its role in the Southern Tagalog Region's Hierarchy of Settlements, to wit: Atimonan and Mauban are identified as minor urban centers while the municipalities of Cavinti, Kalayaan, Luisiana, Lumban and Paete in Laguna and Alabat, Lucban, Pagbilao, Real, Sampaloc and Tayabas in Quezon are identified as satellite municipalities.

TABLE IV-7-1
PROJECTED POPULATION
1995, 2000 AND 2020
(25 KRIZ)

Municipality	1990 (Census Data)	1995	2000	2020
QUEZON	1,372,455	1,513,028	1,656,685	2,229,686
Mauban	43,740	47,043	50,592	62,935
Atimonan	46,651	50,447	54,515	68,865
Lucban	30,130	32,544	35,140	44,259
Pagbilao	41,635	47,729	54,717	82,436
Perez	8,609	9,192	9,806	11,920
Real	20,475	24,362	28,966	48,739
Sampaloc	11,132	12,137	13,241	17,134
Tayabas	54,355	61,734	70,056	102,506
Sub-Total	256,727	285,188	317,033	438,794
LAGUNA	1,370,000	1,625,696	1,928,902	3,222,229
Cavinti	15,131	16,186	17,302	21,157
Kalayaan	13,118	14,842	16,792	24,320
Luisiana	14,241	15,837	16,624	20,965
Lumban	19,773	21,089	22,490	27,282
Paete	20,579	23,064	25,833	36,334
Sub-Total	82,842	90,568	99,041	130,058
Grand Total	339,569	375,756	416,074	568,852

Based on this hierarchy, the municipalities of Mauban and Atimonan will have small service areas and will render production and marketing related services to the agricultural areas as well as provide basic social services to outlying municipalities. Meanwhile, satellite municipalities will provide the very basic services, facilities and utilities that its population will require on a regular basis, such as health centers, primary and secondary schools, etc. the catchment area shall be the municipality in its entirety.

Needless to say, the power sector, specifically, the Quezon Power Project will play a major role and provide impetus to the attainment of the above-cited human settlements hierarchy.

7.2.2 Land Use Plan Preparation/Updating

Pursuant to the Local Government Code of 1991, all cities and municipalities shall prepare their respective comprehensive land use plans in consideration of an approved provincial land use plan. (See Figure IV-7-2).

In keeping with this directive, the municipalities of Real and Tayabas should now prepare their respective comprehensive land use plans. Meanwhile, the rest of the municipalities should update their CLUPS considering the overall urbanization/industrialization effects due to the QPP. (Refer to Table IV-7-2).

TABLE IV-7-2
PLANNING PERIOD AND STATUS OF MUNICIPAL COMPREHENSIVE DEVELOPMENT
(25 KRIZ)

Municipality	Planning Period	Date of Approval/ Resolution Number
Quezon		
Mauban	1985-2000	10-21-91/Res. 494, S. 91
Atimonan	1983-2000	5-04-83/Res. 123, S. 83
Lucban	1982-2000	11-03-82/Res. 94, S. 82
Pagbilao	1984-2000	10-21-91/Res. 94, S. 82
Perez	1985-2000	6-6-85 R-233 S. 85
Real	-	-
Sampaloc	1984-2000	9-6-85/Res. 252, S. 85
Tayabas	-	-
Laguna		
Cavinti	1984-2000	5-09-85/Res. 241, S. 85
Kalayaan	1984-2000	9-06-85/Res. 252, S. 85
Lusiana	1983-2000	12-13-84/Res. 219, S. 84
Lumban	1984-2000	6-06-85/Res. 244, S. 85
Paete	1989-2000	-

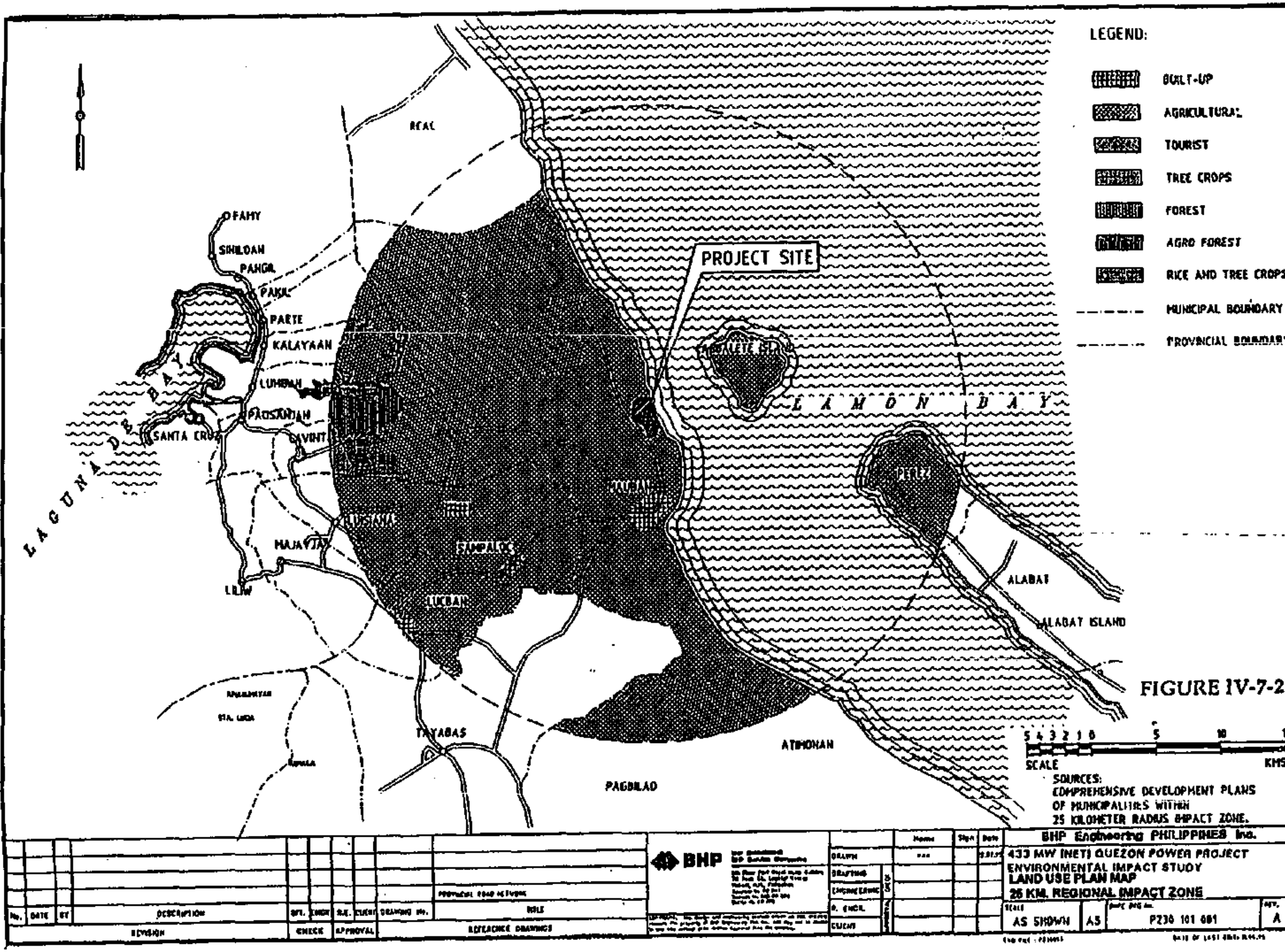
Source: Housing and Land Use Regulatory Board.

As part of the CALABARZON (Cavite, Laguna, Batangas, Rizal, and Quezon), the 25 KRIZ shall be influenced by the Linear Urban Growth Corridor Development strategy which was specifically designed to provide a framework for the planned growth of the CALABARZON area.

7.2.3 Facilities/Utilities

The Urban Development and Housing Framework has identified the following municipalities within the 25-KRIZ as priority areas for shelter development and implementation of R.A. 7279: Paete, Atimonan, Tayabas and Lucban. As mentioned in the previous section, the expansion of residential areas is anticipated. For the aforecited four (4) municipalities low cost/socialized housing will have an increased demand.

Further, facilities and utilities will have to be provided. These will include health services, schools and additional road requirements.


LEGEND:
BUILT-UP
AGRICULTURAL
TOURIST
TREE CROPS
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AGRO FOREST
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PROVINCIAL BOUNDARY
PROJECT SITE
LAMON BAY
LAGUNA DE BAY
REAL
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SOURCES:
COMPREHENSIVE DEVELOPMENT PLANS
OF MUNICIPALITIES WITHIN
25 KILOMETER RADIUS IMPACT ZONE.
BHP Engineering PHILIPPINES Inc.
433 MW (NET) QUEZON POWER PROJECT
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LAND USE PLAN MAP
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FIGURE IV-7-2

7.2.4 Service Requirements

As mentioned in a previous section, the 1990 census of population shall be used as basis in the projection of the population's service requirements.

These shall include hospital services, protective services and area requirements for industrial and residential uses, as shown in the succeeding tables.

TABLE IV-7-3
TOTAL AREA REQUIREMENTS FOR RESIDENTIAL AND INDUSTRIAL USES
1995, 2000 AND 2020

Land Requirement	Population		
	1995	2000	2020
Residential	752.51	832.13	1,137.70
Industrial			
Light	300.63	332.86	455.08
Medium	939.39	1,028.86	1,422.11
Heavy	1,503.05	1,682.29	2,275.42

TABLE IV-7-4
RESIDENTIAL AREA REQUIREMENTS, By Municipality
1995, 2000 and 2020
(25 KRIZ)

Municipality	1995	2000	2020
QUEZON	3,026.05	3,313.37	4,459.37
Mauban	94.09	101.18	125.87
Atimonan	100.89	109.03	137.73
Lucban	65.09	70.28	88.52
Pagbilao	95.46	109.43	164.87
Perez	18.38	19.61	23.84
Real	48.72	57.93	97.48
Sampaloc	24.27	26.48	34.27
Tayabas	124.47	140.11	205.01
Sub-Total	571.37	634.05	877.59
LAGUNA	3,251.39	3,857.80	6,444.46
Cavinti	32.37	34.60	42.31
Kalayaan	29.69	33.58	48.64
Luisiana	30.77	33.25	41.93
Lumban	42.18	44.98	54.56
Paete	46.13	51.67	72.67
Sub-Total	181.14	198.08	260.11
Grand Total	752.51	832.13	1,137.70

TABLE IV-7-5
INDUSTRIAL AREA REQUIREMENTS, By Municipality
1995, 2000 and 2020
(25 KRIZ)

Municipality	1995			2000			2020		
	Light	Med.	Heavy	Light	Med.	Heavy	Light	Med.	Heavy
QUEZON	1,210.42	3,782.57	6,052.11	1,325.35	4,141.71	6,626.74	1,783.75	5,574.21	8,918.74
Mauban	37.63	117.61	188.17	40.47	126.48	202.37	50.35	157.34	251.74
Atimonan	40.36	126.12	201.79	43.61	136.29	218.06	55.09	172.16	275.46
Lucban	26.03	81.36	130.18	28.11	87.85	140.56	35.41	110.65	177.04
Pagbilao	38.18	119.32	190.92	43.77	136.79	218.87	65.95	206.09	329.74
Perez	7.35	22.98	36.77	7.84	24.51	39.22	9.54	29.80	47.68
Real	19.49	60.91	97.45	23.20	60.91	115.86	38.99	121.85	194.96
Sampaloc	9.71	30.34	48.55	10.59	33.10	52.96	13.71	42.83	68.54
Tayabas	49.38	154.33	246.94	56.04	175.14	280.22	82.00	256.26	410.02
Sub-Total	228.13	712.97	1,140.77	253.63	781.07	1,268.12	351.04	1,096.98	1,755.18
LAGUNA	1,300.56	4,064.24	6,502.78	1,543.12	4,822.26	7,715.61	2,577.78	8,055.57	12,888.92
Cavinti	12.95	40.46	64.74	13.84	43.25	69.21	16.92	52.89	84.63
Kalayaan	11.87	37.11	59.37	13.43	41.98	67.17	19.46	60.80	97.28
Luisiana	12.31	38.47	61.55	13.30	41.56	66.50	16.77	52.41	83.86
Lumban	16.87	52.72	84.36	17.99	56.22	89.96	21.82	68.20	109.13
Paete	18.45	57.66	92.26	20.67	64.58	103.33	29.07	90.83	145.34
Sub-Total	72.45	226.42	362.28	79.23	247.59	396.17	104.04	325.13	520.24
Grand Total	300.58	939.39	1,503.05	332.86	1,028.66	1,664.29	455.08	1,422.11	2,275.42

TABLE IV-7-6
HOSPITAL REQUIREMENTS, By Municipality
1995, 2000 and 2020
(25 KRIZ)

Municipality	1995	2000	2020
QUEZON			
Mauban	Municipal	Municipal	Municipal
Atimonan	Municipal	Municipal	Municipal
Lucban	Municipal	Municipal	Municipal
Pagbilao	Municipal	Municipal	District
Perez	Extension	Extension	Extension
Real	Extension	Municipal	Municipal
Sampaloc	Extension	Extension	Extension
Tayabas	Municipal	Municipal	District
LAGUNA			
Cavinti	Extension	Extension	Extension
Kalayaan	Extension	Extension	Extension
Luisiana	Extension	Extension	Extension
Lumban	Extension	Extension	Municipal
Paete	Extension	Municipal	Municipal

TABLE IV-7-7
PROTECTIVE SERVICES REQUIREMENTS, By Municipality
1995, 2000 and 2020
(25 KRIZ)

Municipality	1995	2000	2020
QUEZON	1,513	1,657	2,230
Mauban	47	51	63
Atimonan	50	54	69
Lucban	65	70	88
Pagbilao	48	55	83
Perez	9	10	12
Real	24	29	49
Sampaloc	24	26	34
Tayabas	62	70	103
Sub-Total	329	365	501
	16	3,858	6,444
LAGUNA	16	17	21
Cavinti	49	60	81
Kalayaan	31	33	42
Luisiana	42	45	55
Lumban	77	86	121
Paete	215	241	320
Sub-Total	544	606	821
Grand Total			

Standard:
1 policeman per 300 population for highly congested areas
1 policemen per 500 population for semi-urbanized
1 policemen per 1000 population for rural areas

TABLE IV-7-8
LETTER CARRIER REQUIREMENTS, By Municipality
1995, 200 and 2020
(25 KRIZ)

Municipality	1995	2000	2020
QUEZON	303	331	446
Mauban	9	10	13
Atimonan	10	11	14
Lucban	7	7	9
Pagbilao	10	11	16
Perez	2	2	2
Real	5	6	10
Sampaloc	2	3	3
Tayabas	12	14	2
LAGUNA	325	386	644
Cavinti	3	3	4
Kalayaan	3	3	5
Luisiana	4	3	4
Lumban	4	4	5
Paete	5	5	7

*Standard: 1 letter carrier/5000 population

8.0 ARCHAEOLOGY

8.1 Impact Assessment

The National Museum, a lone government agency tasked to provide guidelines and assists in the protection and preservation of the country's cultural heritage critically analyzes the importance of a site relative to research in Philippine pre-history. Dr. Jesus Peralta, Assistant Director of the museum stated that,

> "It is not the collection value of the artifacts to be found or the commercial value of these, but rather the contribution and the research will make in the development of knowledge about Philippine prehistory" (Field Manual in Archaeology).

The areas investigated for the proposed project, specifically, the plant site does not pose immediate disturbance of any probable impact on any archaeological site.

It is not unusual that discovery of major archaeological sites are carried by accidental discoveries by treasure hunters as in the Panhutungan site in Placer, Surigao del Norte.

Indirectly, with the rise of the Quezon Power Project, an increase in economic activities may reinforce the notion for the existence of treasure and antiquarian buying in Mauban. These kinds of economic activities may more likely happen during the phase of power plant construction. Furthermore, in the construction phase of the plant, accidental encounters and discoveries of artifacts *in situ* may be possible since its fringes was an integral area during the Japanese invasion of World War II.

In applying the principle of historical-archaeological correlates, the findings from research for the Mauban Municipality suggests that artifacts of archaeological import is under the systemic context in the hands of collectors. What may be more likely in the archaeological context are "isolates"[39] which do not preclude the existence of a significant archaeological site.

Clearly, the back of the current Cagsiay I Elementary School grounds which was heavily disturbed by treasure hunters is a historically significant site. Based on the history of the municipality, and the cultural deposition in the place (Cagsiay I Elementary School) suggest a possible archaeological site. However, with its heavy disturbance there is a possibility that artifacts, especially, ceramic shards in the area is indicative of a loci of a secondary site rather than a primary original site.

8.2 Mitigating Measures

- In the construction phase of the power plant, activities that may be carried out in the substrate (or the surface of the natural sediments) are critical whereby detritus of artifacts may be found. These detritus are commonly formed by geochemical and geophysical forces. During construction, random checking for the existence of any archaeological detritus will be conducted.

- Since sediments carrying cultural deposits are manually transported by human and natural forces locations of any artifacts found must be properly documented employing the Archaeological Form No. 2A as used by the National Museum for archaeological site survey and the artifacts found should be properly bagged using the archaeological Form No. 8A for

[39] William S. Marmaduke and Laverne Conway, Cultural Survey: Cultural Resources on Potential Argricultural Development Lands on the Gila River Indian Reservation 1984. (Central Arizona Project, Bureau of Reclamation)

bagging slip. Accordingly, in the event that a historical artifact is identified the National Museum will be notified to ensure proper care and handling.

- Prior to the initial construction phase, to undertake these specimen-handling measures, personnel engaged in excavation work will be required to undergo orientation seminars provided by an archaeologist and coordinated with the Archaeology Division of the National Museum of the University of the Philippines' Department of Anthropology.

MONITORING PLAN

V. MONITORING PLAN

1.0 AIR QUALITY AND METEOROLOGY

Pre-Construction

Ambient air quality is being monitored monthly at seven locations for one year. Quarterly ambient air quality reports will be submitted to DENR as agreed to in the January scoping meeting.

Operations

In order to assure compliance with Philippine emission standards and ambient air quality, the QPP will monitor both facility operations as well as ambient air quality. During operations, the QPP will be *equipped with portable air samplers for taking ambient air quality measurements for* SO_2, NO_2, and TSP. Plant personnel will be trained to perform air quality sampling and meteorological data handling.

Facility personnel will continuously monitor plant operations to ensure proper operation of the facility. Operational parameters will include at a minimum, steam temperature and pressure, flue gas temperatures, reagent concentration to the scrubber, and spark voltage applied to the electrostatic precipitator.

Stack gas emissions will be monitored by a continuous emission monitoring (CEM) system. The CEM will measure the concentration of SO_2, O_2, NO_x and Opacity on a continuous basis. A dedicated computer will log and store CEM data for comparison against Philippine emission standards.

2.0 OCEANOGRAPHY, HYDROLOGY AND WATER QUALITY

2.1 Oceanography

During the operations phase, the temperature at the cooling water outfall will be monitored weekly including the time of peak load of the QPP. The seawater temperature at the end of the jetty will also be monitored weekly.

2.2 Hydrology

Groundwater prior to operations will be monitored monthly for a period of one year at three locations. Quarterly reports of groundwater data will be submitted to DENR. During operations, groundwater quality from deep wells providing plant freshwater requirements of the project site shall be monitored for salinity to detect possible saline water intrusion in coastal aquifers. Nearby shallow wells will also be monitored for possible drying up that may be attributed to the construction and operation of the deep wells of the project. The frequency of deepwell monitoring will be quarterly with reports submitted to the Environmental Management Bureau (EMB) also on a quarterly basis.

2.3 Water Quality

It is important that water quality monitoring be conducted before, during and after construction and particularly during plant commissioning and operation.

At present, preconstruction water quality monitoring is being conducted monthly for a period of one year at 3 marine stations and 4 surface water stations. Constituents analyzed are in accordance with the scoping meeting with DENR.

During construction, it is proposed that storm water discharges be monitored monthly for TSS and oil and grease.

Monitoring of the efficiency of silt traps and sedimentation ponds especially during the construction period will be done every week. This will ensure that siltation of water bodies is minimized.

During facility operations, it is proposed that treated wastewater effluent and a representative sample of cooling water intake be monitored quarterly for Temperature, Total Suspended Solids, pH, COD, Oil and Grease, Chromium, Cadmium and Lead to ensure compliance with all DENR standards.

The containment of oil spills from the motor pool and fuel tank will be inspected regularly, e.g. every delivery period and bi-weekly. This will minimize the potential for oil and grease effluent discharges.

3.0 GEOLOGY, SOILS AND TERRAIN

Detailed geotechnical subsurface investigations have been initiated as noted in Section III and IV, to develop a basis for safe foundations designs.

During construction, care should be taken to regularly monitor and inspect all cut slopes. This will enable early detection of development of any slope cracks and to allow immediate establishment of remedial measures and avoid large-scale slope failure. However, even as all slope reinforcement measures have been established, the finished slopes shall still be monitored regularly to determine effectiveness of the measures.

During construction and facility operation, drainage and collection system, including stilling basins, should be regularly monitored to assess effectiveness of the system and to enable corrective measures as necessary to minimize siltation.

4.0 TERRESTRIAL ECOLOGY

4.1 Vegetation

As an initial step, it is recommended that the present vegetative cover of Cagsiay 1 and its vicinities be incorporated in the land-use map of the area. Land-use planning and zoning should be conducted by government officials in consultation with the local residents to determine areas that should be reserved for agriculture. Future developments will only be approved if they conform to the municipal land-use plan.

Baseline data on yields and agricultural practices is currently being undertaken in conformance with the scoping meeting with DENR and will continue until the end of this year. This study shall establish the following for the major crops in identified maximum emission impact areas:

- growth rate determination
- statistical analysis of growth rate measurements
- historical crop yield for productivity
- current nutrient levels in fresh leaf samples
- fruiting and foliage health and span

In addition, monitoring for the following will be undertaken as follows:

- growth rates (to commence 1 month after the planting season and after the conclusion of the baseline study)
- productivity levels (will only be during harvest season, at most twice a year/crop)
- fruiting and foliage health (semi-annually coinciding with the wet and dry season)
- biodiversity (semi-annually)

Yield levels of agricultural crops in the vicinity of the power plant could be monitored to ascertain magnitude of losses, if any, due to the initial year of power plant operation. This could be done by a team composed of representatives of the power plant operator, farmers and Department of Agriculture (DA) personnel together with crop production specialists.

4.2 Wildlife

Terrestrial pollutants of the coal-fired thermal power plant mostly include gases such as sulfur dioxide, nitrogen dioxide and suspended particulates of ash and coal dust. These pollutants, if emitted at rates significantly above DENR standard could affect the aerial sweepers or aerial feeding birds such as, the swiftlets, and swallows. However, since continuous monitoring of stack gas concentrations of opacity, SO_2 and NO_x is performed, no wildlife monitoring is proposed.

5.0 AQUATIC ECOLOGY

Monitoring for the present parameters used in describing the structure of seaweed, seagrass, mangrove, coral reef, plankton and reef fish communities will continue for first year of operation. This monitoring commenced immediately after the scoping meeting in January 1995. The original stations monitored are now permanently established as the sampling areas.

<u>The Approach</u>

An additional feature in the planned monitoring program will be the establishment of permanent quadrats at specific stations, especially at the intake and outfall areas. This would comprise of the following:

- setting up square meter areas on the substrate where the parameters will be monitored throughout the year's sampling regime; and

- collating and subjecting the data to trend and correlational analysis (if feasible) to detect significant changes or fluxes in the parameters.

The overall result is an integrated picture of changes in benthic dynamics and recruitment of benthic population and data on indicator organisms or numerical responses of populations or communities.

It is envisioned that the data gathered will be useful to guide management in its future actions that deal with the coastal and marine environments. Among others, they may help in the local government's effort to delineate areas for possible protection such as sanctuaries or reserves, areas for rehabilitation or restoration, and areas for recreation.

Monitoring of the biotic components of the coastal and marine environments at the proposed project site will be considered at three levels: population, community and ecosystem. With one year of statistically adequate sample sizes will allow for the study to allow for spatial and temporal heterogeneity, prediction, and reliability, and serious consideration of the sources of uncertainty.

Parameters Under Study

- At the population level, *Sargassum* sp., the epiphytes on other larger seaweeds, *Gracilaria* ("gulaman"), the fish chaetodontids, and the seagrass *Thalassia* should be the object of intensive study.

  The parameters that will be considered are temporal and spatial abundance measures (e.g., density, frequency, or cover, depending on the morphology of the target organisms), levels of heavy metal contamination (in relation to background levels in water and sediments), stress-response curves (e.g., effects of industrial and domestic effluent), pattern of use by the coastal inhabitants, and socio-economic aspects of the populations.

- At the community level, temporal and spatial changes in the numerical relationships (e.g., diversity, dominance, similarity/dissimilarity) among the populations, community metabolism (if feasible), and heterotrophic-autotrophic shifts should be the focus of the effort. Extensive observational data on stress factors both natural and man-induced should be gathered and their effects on the community parameters (above) established. How the responses of the communities affect the patterns of their use by the inhabitants will be studied.

Related Concerns in Monitoring

It is to be expected that shifts in the structure of benthic and to a limited extent, pelagic communities along the coast of Mauban would change with time--with or without the project. While physical changes in the environment may be the major observable and operative factor, other factors may be as important. Therefore, it is recommended that at this time, no monitoring beyond the initial study year is recommended.

From the data and observations, there are indications that four biotic factors influence the observed variability in the structure of the community: (a) the life span of individuals; (b) competition for space; (c) predation; and (d) settlement of larvae. These are parameters which will be monitored.

6.0 SOCIO-ECONOMICS AND PUBLIC HEALTH

The following should be monitored in order to evaluate the socio-economic and public health impacts of the project:

- **Labor Force and Employment**

Project management should monitor the composition of its workforce annually to ensure that a considerable percentage of the local population is given employment opportunities. Otherwise, livelihood training programs may be initiated to encourage the provision of alternative sources of income. Adequate notice will be given to employees that will be terminated to prepare them for displacement.

- **Public Health**

Data on health parameters, particularly on morbidity and mortality rates, as gathered by the local health unit, i.e., historical data (preferably ten years back) prior to the construction of the plant and data during the operation of the plant should be used by the local health unit to serve as inputs to the establishment of trends that will describe the public health situation in relation to the operation of the power plant.