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NATIONAL POWER CORPORATION

Diliman, Quezon City

Environmental Impact Statement

M G P P

Malbarara Geothermal Power Project

Sto. Tomas, Batangas

Environmental Management Department

Environmental Impact Assessment Division

(May 1992)

ENVIRONMENTAL MANAGEMENT BUREAU
6-3-92

Executive Summary

Maibarara Geothermal Power Project

Project Description

The Maibarara Geothermal Power Project (Maibarara GPP) is a 10 MW conventional power plant designed to utilize geothermal energy from wells drilled in Maibarara Geothermal Field. It will be located in Sitio Capus, Barangay San Rafael, Sto. Tomas, Batangas. The project will cost $ 22.754 million, $ 18.944 million of which will consist of foreign currency and ₱ 98.11 million local currency counterpart.

The power plant shall consist of powerhouse building, support building, cooling tower and switchyard. Equipment for the proposed power project includes: steam turbine and its auxiliaries, cooling tower system, generator and its auxiliaries. The cooling tower and substation will be situated at the southeastern and northeastern sides of the powerhouse, respectively. The proposed power station shall occupy an area of 1.2 ha. The power to be generated will be fed to the Luzon Grid via the 69 KV transmission line emanating from a radial breaker scheme at Maibarara switchyard. The 69 KV line, approximately 11 km will run in parallel to the existing 230 KV Biñan-MakBan A double circuit transmission line.

The proposed power plant will be designed to operate in accordance with DENR limits/standards. Its environmental features include:

1. Ducting the non-condensable gases to the cooling tower plenum to effect dilution of NCG with water vapor and air and increase effective height of release;

2. Materials/parts shall be selected with care or will be properly designed to limit corrosion to acceptable proportions;

3. Use of muffler for noise control;

4. Proper ventilation flow inside the buildings;

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5. Establishment of low population zone within the 1.0 km radius of the plant; and

6. Provision for the fire protection system in the power station.

Five (5) wells will be the source of steam to operate the proposed project. Freshwater supply will be taken from the Maibarara Well #2 of PGI which is approximately 100 m southwest of the project site. A back-up well should be drilled in case of failure of the existing well.

Solid wastes to be generated during construction will be hauled to appropriate dumping site. During operation, sludge will be immobilized in cement and stored in designated repository area in accordance with DENR guidelines. Resulting hydrogen sulfide (H_2S) ambient concentrations are projected to be within the DENR standard. Effluents which compose of cooling water blowdown will be reinjected into the geothermal reservoir. In case the reinjection system fails geothermal effluents will be impounded in a sump or pond and later reinjected in the cold reinjection well.

Project construction will start in January 1993 and plant operation in the early part of 1994.

Geology/Terrain/Soil

The proposed Maibarara Geothermal Power Project is centrally located between the southeastern and southwestern flanks of Mt. Makiling at elevation 200 masl. Four topographic reliefs aligned in an almost northward direction exist namely, Mt. Mabitog (with peak height of 295 m AMSL), Mt. Mapinggon (285 m), Mt. Maibarara (298 m), and Mt. Masaya (268 m).

Three types of soil are identified at the project site namely, the Macolod clay loam, the Macolod clay loam (steep phase), and Lipa loam. Rolling areas are covered with Macolod clay loam while steeper areas were identified with Macolod clay loam (steep phase). The Lipa loam occupies relatively flat areas.

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Three geologic fault structures are in the project site namely, the Makiling Arcuate Fault, Bijiang Fault, and Maibarara Fault. The core reservoir appears to be bounded by these faults on its NW, NE and SE sides.

Geothermal activities are not expected to effect a significant change in the Maibarara seismic regime considering that geothermal fluid extraction rate for a 1 x 10 MW plant is relatively small.
Monitoring of subsidence will be undertaken by setting baseline elevation levels which can be compared with the results of future surveys. Micro-Seismic monitoring will also be constructed during plant operation.

Meteorology/Air Quality

The Maibarara project area is located on the western slopes of Mt. Makiling some 50 km SSE of Manila. The proposed project is characterized by mountainous topography which plays a primary role in the movement of wind at Maibarara. The presence of Mt. Makiling and other surrounding mountains in the area complicates the surface wind at the project site from 10 m to 1000 m above ground and affects the stability condition of the local atmosphere.

The existing air quality at the Maibarara site can be described as clean, typical of an upland agricultural environment. There are no major anthropogenic sources of pollutants except for occasional backyard burning of dried leaves and other garbage of residents living within the vicinity of the project site.

The major air quality problem associated with geothermal power development has been the nuisance caused by the odor of H_2S gas. To effect better H_2S dispersion, the noncondensable gases will be ducted to the cooling tower plenum.

Predicted ambient H_2S values show that H_2S odor can be detected up to one km downwind of the proposed power plant during slightly unstable conditions. H_2S odor is expected to be discerned at an area close to the plant in Sitio Capus, Brgy. San Rafael, though the H_2S concentration will be well below the level that may cause physical respiratory irritation. Still households that may be exposed to H_2S over the 20 ppb DENR ambient limit will be relocated to other areas.

Normally, routine H_2S emission from the proposed power plant is not expected to be high enough to cause damage to plants and crops. The concentrations of H_2S that cause injury to vegetation are far in excess of the concentrations that are readily obnoxious or injurious to human beings.

Periodic air quality monitoring will be undertaken during the operational phase of the Maibarara Geothermal Power Project to document and assess any air quality changes within the project area.

Hydrology/Water Quality

The project site is influenced by several gullies originating from Mt. Makiling. Siam-siam River, some 60 to 90 m of the site, is usually dry during the summer but is expected to be flashy during the rainy season due to its high relief. There are no household artesian wells or deepwells in the area; the residents depend on a developed spring originating from one of the headwaters of Siam-siam River for all their domestic water needs. Based on the physical and chemical analyses performed on samples taken from this spring, domestic water supply within the Maibarara project site complied with the DENR Class GA water.

At the Maibarara field, spoils which may be produced during site levelling and excavation will be backfilled in lower lying areas away from drainage routes. Similarly, sewage and domestic wastes which will be generated by construction workers will be properly disposed of to prevent pollution/silting and increase in turbidity in Siam-siam River and streams/creeks near the project site.

Vegetative stabilization measures, terracing of cut-and fill slopes, and replanting will be implemented as soon as practicable in open areas and slopes exposed during civil works. Grounds in the immediate vicinity of the plant site not affected by plant construction will be likewise stabilized to protect these areas from the direct impact of heavy rains, thus, minimizing soil erosion.

Cooling tower blowdown will be contained in a thermal pond and reinjected into the geothermal reservoir. However, during occasional overcapacity of thermal pond or breakdown of the reinjection system, controlled

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discharges of cooling tower blowdown to nearby Siam-Siam River water may be resorted to but in accordance to effluent limits prescribed by DENR. During normal operations, 100% reinjection of geothermal wastewater will be implemented.

The cooling tower sludge, machinery and pipeline scales, and laboratory wastes will be solidified in concrete to immobilize the wastes and prevent leaching out of metals. The solid wastes will be hauled and properly disposed at the designated and properly designed leak-free repository according to DENR regulations. Domestic refuse will be buried in a landfill.

Pre-operational and regular operational water quality monitoring of rain, ground, surface and wastewaters shall be implemented to ensure that the DENR standards are not violated.

Terrestrial Ecology

Vegetation at the Maibarara GPP proposed project site situated in the northern part of Sitio Puting Lupa, Brgy. San Rafael, Sto. Tomas, Batangas, comprise mainly of agricultural crops, grasslands, secondary forest and some primary growth forest.

Agricultural lands within 1 km radius of the plant site include lowland and upland kaingin farms planted with annual and perennial crop species. Corn (*Zea mays*), cassava (*Manihot esculenta*), banana (*Musa* sp.), ubi (*Dioscorea alata*), gabi (*Colocasia esculentum*), ginger (*Zingiber* sp.) and sweet potato (*Ipomoea batatas*) are the annual crops planted while perennial crop species found in the area include mango (*Mangifera indica*), coconut (*Cocos nucifera*), langka (*Artocarpus heterophylla*), guyabano (*Anona muricata*), dalanghita (*Citrus* sp.), atis (*Anona squamosa*), cacao (*Theobroma cacao*) and coffee (*Coffea* sp.). Multiple cropping is also widely practiced whereby a combination of cash crop species are alternately planted during different periods within a year.

Axonopus compressus (Carabao grass), *Mikania cordata* (mile-a-minute), *Urena lobata* (kulut kulutan) and *Mimosa pudica* (makahiya) are the grasses and vine species encountered along the established transect lines. *Pentacme contorta* (white lauan), *Diplodiscus*

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paniculatus (balobo) and Celtis philippinensis (malaikmo) represent the uppermost tree layer of the lowland rain forest. On the other hand Ficus nota (tibig), Ficus variegata (tangisang bayawak) and Ficus hauili (hauili) comprise the trees at the middle layer of forest. Bracken fern (Pteridium aquilinum), pakpak lawin (Drynaria quercifolia), true fern (Cyathea sp.), pako (Diplazium esculentum), and birds nest fern (Asplenium nidus) form a part of the undergrowth cover beneath the trees.

Loriculus philippinensis (Phil. Hanging Parakeet), Dendrocopus maculatus (Pygmy Woodpecker), Cypsiurus parvus pallidior (Palm Swift), and Megalurus palustris (Striated Canegrass Warbler) were the most common bird species around the proposed project site. Other wildlife species known to exist in the area include 5 mammalian, 1 amphibian and 4 reptilian species. Haliastus indus intermedius (Brahminy Kite) and Loriculus philippinensis (Phil. Hanging Parakeet) are classified as protected under the Convention of the International Trade of Endangered Species (CITES), Appendix II.

Among insect and other invertebrates, those belonging to Families Cicadellidae, Formicidae, Cixiidae and Araneidae recorded the highest variation in relative abundance both in wet and dry season surveys.

During the construction phase of the project activities like ground cover clearing and levelling will result to loss of vegetative cover along the proposed site. This impact is minimal since the affected area is a flat agricultural land characterized by very low species diversity of flora and fauna. After plant construction, landscaping of the project site and revegetation of its environs will be implemented.

Predicted H2S emissions as a result of plant operation are below levels that could cause acute or chronic effects on vegetation. Monitoring of important crop species will be implemented during operation phase of the project while special studies will be conducted to determine possible long term effects of H2S exposure to relevant crops.

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Aquatic Ecology

Biological sampling/surveys were conducted in September 1988 for the wet season and April 1989 for the dry season to determine the distribution and seasonal variations of aquatic biota along the six (6) sampling stations established in Siam-Siam River.

Of the phytoplankton, the diatomic group (Chrysophyta) dominate the wet and dry season samplings. Pinnularia sp. is the most dominant phytoplankton species during the wet season sampling while Synedra sp. predominates the dry season samplings. Other phytoplanktonic groups represented are the green algae (Chlorophyta), blue-green algae (Cyanophyta) and the euglenoid (Euglenophyta) for the wet season while for the dry season, the presence of blue-green algae is noted.

On the other hand, the arthropods (Arthropoda) are the most abundant zooplanktons in both sampling periods with nymphs and larvae of insects accounting for the majority of the population. The annelids (Annelida), chordates (Chordata) and nematodes (Nematoda) are likewise represented in the wet season sampling while for the dry season, only the annelids are represented.

Among the benthic samples, the arthropods predominate during the wet season sampling with insect nymphs and larvae being the most numerous zooplankton organisms. Annelids and molluscs (Mollusca) are also represented, Whereas, during the dry season, the molluscs dominate the benthic community with Thiara sp. accounting for more than half of the population. Other benthic groups represented are the arthropods and the annelids.

Of main concern during plant construction would be the impact caused by sediment loading resulting to siltation and increased turbidity of the water. These effects, however, will be temporary as conditions would stabilize once the plant construction activities are completed. Proper land management and erosion control measures will be implemented to minimize sedimentation.

Liquid and solid wastes like waste water, effluents and sludges are possible sources of contamination to the aquatic ecosystem during the plant operation. But with the reinjection of plant effluents and proper disposal of plant wastes, effects on river waters will be minimal and insignificant.

Socioeconomics and Land Use

The Regional Impact Zone (RIZ) is the region within 5-km radius of the proposed geothermal plant and it includes portions of the municipalities of Santo Tomas in Batangas and Calamba in Laguna. The Primary Impact Zone (PIZ), on the other hand, covers the area within

1-km radius of the project site. It encompasses part of Barangay San Rafael of Santo Tomas and a portion of Barangay Puting Lupa of Calamba, Laguna. Agricultural land use is predominant in both areas.

The combined population of the RIZ is 231,662; in the PIZ, where 78 households reside, it is 395. The plant site itself which is a cornfield with some coconuts is free of settlers. The population is relatively young and ethnically homogenous - 99 percent are Tagalogs. Literacy rate is high at 84 percent.

Majority of the houses in the PIZ are owner-occupied but only 36 percent of these houses stand on the occupant's own land. Electricity is used by most households for lighting, and firewood is widely utilized for cooking.

Unemployment and low income among PIZ residents has placed more than three-fifths (66%) of the households below the poverty line. Less than half of individuals in the labor force are gainfully employed.

Sixty-seven percent of the PIZ residents are aware of the project. Of this figure, only 8 percent expressed opposition. Those who are in favor cited employment opportunities, improvement of roads, and additional power supply as possible benefits from the project.

Because H_2S is a nuisance even at the ambient DENR standards, households downwind of the plant within a 1-km radius will be declared an exclusion zone. Some 16 households in the PIZ will have to be relocated outside of the exclusion zone.

Project construction will effect a considerable change in employment pattern and may induce a temporary increase of household income. Once the power plant becomes operational, employment will be greatly reduced due to the limited number of jobs available at the plant. Only those qualified for jobs associated with plant operation, therefore, will be absorbed by

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NAPOCOR.

Power generated from MGPP will be fed to the Luzon Grid to help meet the ever increasing domestic and industrial demand. This is expected to contribute significantly to national economic recovery efforts.

An intensive information dissemination campaign will be conducted by NAPOCOR in the RIZ to heighten public awareness and ensure public acceptability of the project.

NAPOCOR will, likewise, formulate and strictly enact the most appropriate resettlement program for the 16 households who will be affected by the project.

Public Health

The existing health conditions of the population living in the 5-km radius of the project site were assessed. Assessment was based on the results of NAPOCOR-

Socioeconomic survey and the secondary data gathered from the Rural Health Units of the municipalities comprising the study area.

Water supplies in the study area come from deep wells, shallow wells river/ dugwells, spring and community waterworks systems. At the project site i.e. Sitio Capus, residents depend on a developed spring wherein spring water is impounded and piped into concrete reservoirs near the center of the community. Water is then hand carried in open containers. Water is treated in the study area, however, in rural barangays, there is no treatment of water sources due to insufficient supply of chlorine.

Majority of the households in the study area have water sealed toilets. Only about 13% do not have toilet facility. Drainage system is either open canal or blind drainage. Solid waste disposal on the other hand is through burning or burying and garbage collection if there's any.

Outdoor air pollution at the project site or at the direct impact area are H_2S, SOx and NOx, air particulates and noise. These are perceived to increase susceptibility to upper respiratory disease such as common cold and to aggravate existing illness.

Indoor air pollution on the other hand are tobacco smoke and combustion products of fuels used for cooking indoor.

Morbidity in the study area are mostly caused by communicable and infectious diseases. These are bronchitis, pulmonary tuberculosis, pneumonia and influenza. Enteric disease such as diarrhea, parasitism and anemia are also common.

Mortality/deaths in the study area are caused by bronchopneumonia, cancer, heart diseases cerebrovascular accidents and PTB.

Government health facilities is located 1 km. from the project site. Private and government health units are also present within the study area. Residents in the study area go to private doctors (47%) or go to government health centers (13%), do self medication (31%) and to herbal doctors (7.69%) for treatment of their diseases.

The construction of the 10MW Maibarara Geothermal Project may temporarily increase the noise and dust levels in the study area. However, it is projected that the project will not create nuisance to the residents. Unpaved roads will be watered to minimize generation of dust. During operation air pollution such as H_2S, NO_2, SO_2, noise will be within the DENR standard.

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Summary of Impacts and Mitigating Measures

Maibarara GPP EIS: May 1992

IMPACTS	MITIGATING MEASURES
1. Geology/Terrain/Soil	
1.1 The extraction of geothermal fluids for Maibarara-GPP operation is not expected to cause groound subsidence.	1.1 Reinjection of geothermal fluids (brine and condensate blowdown) will minimize risk of ground subsidence.
1.2 Because of the small scale of the 10 MW MGPP, the reinjection of geothermal wastewater as a result of Maibarara-GPP operation is not expected to cause seismicity.	1.2 During power plant operation, monitoring of ground levels in the vicinity of Maibarara-GPP shall be undertaken
1.3 The site development (site clearing and earth moving works) will cause minimal soil erosion and sedimentation of Siam-Siam River and adjacent creeks.	1.3 Adequate controls (spoils to be disposed away from water courses, construction of sediment traps and dikes, revegetation of exposed surfaces) shall be implemented
1.4 During Maibarara-GPP operation, the effects of soil chemistry from possible airborne contaminants from cooling towers and vent releases from the steam gathering system are expected to be insignificant.	1.4 Regular soil sampling and analysis shall be undertaken during Maibarara-GPP operation.
2.0 Meteorology/air Quality	
2.1 Slight rise in relative humidity is expected due to the cooling tower vapor releases and cooling tower drift.	

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Summary of Impacts and Mitigating Measures

Maibarara GPP EIS: May 1992

IMPACTS	MITIGATING MEASURES
2.2 The operation of Maibarara-GPP will release H2S in the atmosphere through ducting to the cooling tower, at an emission rate of 7.29 kg/hr.	2.2.1 Non-condensable gases (NCG) shall be ducted to the cooling tower. Ducting of NCG will reduce H2S emission concentration to 146.82 mg/scm.
	2.2.2 Regular monitoring of H2S levels at downwind areas during Maibarara-GPP operation shall be undertaken.
	2.2.3 Residents who would be directly affected by maximum H2S concentration shall be relocated by NAPOCOR.
	2.2.4 Monitoring of contaminants in the form of solid particles on droplets of solution from discharged gas stream (or cooling tower drift) shall be undertaken.
2.5 Acid rain may be formed at the Maibarara-GPP vicinity depending on the H2S releases, meteorological conditions and other factors.	2.5 Rainwater collection and analysis shall be undertaken during MGPP from strategic locations within a 10 km radius from the plant.
3.0 Hydrology/Water Quality	
3.1 Site preparation, workers may cause siltation/runoff erosion on the quality of Siam-Siam River.	3.1 During construction of MGPP excavated materials will be transported to areas away from drainage routes. Plant site drainage system will be constructed and shall be provided with sediment traps.

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Summary of Impacts and Mitigating Measures

Maibarara GPP EIS: May 1992

IMPACTS	MITIGATING MEASURES
3.2 No significant adverse surface water quality is expected because geothermal waste will be reinjected.	3.2.1 Effluents from steam separators are reinjected back into the reservoir through reinjection wells.
	3.2.2 Cooling tower blowdown will be contained in a holding pond before reinjection or discharged to river. Discharging to river will be made only when DENR effluent standards are met and during overcapacity of sump during reinjection system failure.
	3.2.3 Monitoring program on water quality shall be implemented during MGPP operation. Rain, ground and surface waters shall be collected and analyzed.
3.3 Minimal heavy metal-contaminated wastes will be generated by the small MGPP and will not pose any significant risk of soil, ground or surface water contamination.	3.3.1 Cooling tower sludge, machinery and pipeline scales, and heavy metal contaminated laboratory wastes shall be placed in drums/containers and mixed with cement. These are stored in toxic waste repository located in the Bulalo field.
	3.3.2 Domestic wastes are disposed in septic tanks with fluid drains.
3.4 No hot wastewaters will be discharge by the MGPP.	3.4 An induced draft cooling tower will be provided for the MGPP to prevent thermal pollution of surface waters.

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IMPACTS	MITIGATING MEASURES
4.0 Terrestrial Ecology	
4.1 During construction, vegetation loss within the 1.2 ha proposed plant site will occur due to site clearing and ground levelling activities.	4.1 After construction, revegetation activities like landscaping, afforestation and reforestation of the project site and its environs will be implemented.
4.2 Disturbance of wildlife particularly birds due to increased levels of noise brought about by the introduction of heavy equipment and increased vehicular traffic	4.2 Revegetated areas will provide habitat and refuge for displaced wildlife species.
4.3 Hydrogen sulfide (H2S), a major pollutant from geothermal power plants could affect biological processes of vegetation found around the proposed power plant.	4.3.1 Maximum short term ambient H2S concentration will be decreased below levels which could cause acute effects on vegetation. 4.3.2 Periodic evaluation of important crop species through monitoring and special studies to determine any effects due to long term exposure of low levels of pollutants. 4.3.3 Rehabilitation and management scheme will be implemented along Mount Makiling Reservation in coordination with University of the Philippines at Los Baños.

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IMPACTS	MITIGATING MEASURES
5.0 Aquatic Ecology	
5.1 Open areas and civil works activities may give rise to soil erosion especially during heavy precipitation. Increase in silt levels and turbidity of the Siam-Siam River would affect aquatic organisms. This effect will, however, be temporary and last only a few months.	5.1 Proper spoils management and strict erosion control measures such as use of sediment traps during construction activities will be implemented to lessen if not precluded the occurrence of significant impacts.
5.2 Possible surface water contamination effects from heavy metals (mercury, zinc, cadmium and lead) contained in wastewater brine to Siam-Siam River aquatic organisms will be insignificant.	5.2.1 Reinjection of all geothermal brine and cooling tower blowdown will be implemented in order to prevent contamination of Siam-siam River.
	5.2.2 Disposal of cooling tower blowdown within DENR effluents limits to the river system will only b done during emergency conditions.
	5.2.3 Construction/use of adequately-sized and leak free sumps will be made to impound geothermal effluents and prevent overflows.
	5.2.4 Maintaining effluent levels to the standards set by the DENR.
	5.2.5 A bi-annual monitoring program will be undertaken to be able to assess the long term effects and levels of bioaccumulable heavy metals.
	5.2.5 A bi-annual monitoring program will be undertaken to be able to assess the long term effects and levels of bioaccumulable heavy metals.

IMPACTS	MITIGATING MEASURES
6.0 Socioeconomics and Land Use	
6.1 Sixteen households will be directly affected the by H2S above ambient limits and will be resettled.	6.1.1 Information dissemination campaign will be conducted to promote awareness of the project among DIA residents and surrounding barangays. 6.1.2 Affected DIA residents will be compensated, be provided assistance, financial or otherwise, and transferred to NAPOCOR-developed resettlement site or to other sites of their choice.
6.2 Agricultural land in the DIA will be converted to industrial use.	6.2.1 Affected agricultural land and improvements will be compensated based on fair market value. 6.2.2 NAPOCOR in consultation with affected residents establish a resettlement site with potential opportunities and suitable for physical development.
6.3 During construction phase, temporary migration of workers into the DIA is expected. The number, however, will be greatly reduced once project is finished.	

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Summary of Impacts and Mitigating Measures

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IMPACTS	MITIGATING MEASURES
6.4 An increase in employment opportunities will be experienced during project construction. Local able-bodied residents will be given priority in hiring.	
6.5 A multiplier effect wil be subsequently induced in the wholesale/retail trade and construction products manufacturing sectors.	
6.6 Migration of workers during construction will cause increase in housing demand.	6.6.1 Project contractors will provide necessary housing, sanitary, and medical facilities for migrant workers.
6.7 Operation of MGPP will reduce consumption of imported, expensive fuel oil resulting to considerable savings in foreign exchange.	
6.8 Power generated by the project will augment existing supply in Luzon Grid.	

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Summary of Impacts and Mitigating Measures

Maibarara GPP EIS: May 1992

IMPACTS	MITIGATING MEASURES
7.0 PUBLIC HEALTH	
7.1 During construction, risk of exposure of residents to diseases of construction workers will be minimal.	7.1 The contractors will be required to screen out workers with communicable diseases and to provide construction camps with adequate sanitary quarters and waste disposal facilities.
7.2 No significant health effects are expected from exposure of residents to road dust during dry season from passing heavy equipment vehicles during construction.	7.2 Dirt roads infront of the residences shall be watered whenever necessary. During operation, access roads shall be asphalted or concreted.
7.3 Occasional and low level hydrogen sulfide (H2S) and noise exposure of the nearby public households from plant operation will have no significant public health impact.	7.3 To reduce H2S concentration, NCG from the gas extraction system shall be ducted to the cooling tower to dilute the out-going gas stream and and increase the effective height of release. To minimize the noise level at the source silencers shall be installed in the plant. An annual health survey shall be conducted in the study area to compare public health indices before and after plant operation.

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Recommended Environmental Monitoring Program for
Maibarara Geothermal Power Plant Project

Maibarara GPP EIS: May 1992

Parameter	Method	Frequency	Stations
AIR QUALITY			
H2S	Jerome Analyzer or gas bubbling for 30 min and 24 hr. sampling	Quarterly	Project Site Well Pad No. 9 & 11 Well Pad No. 5 & 6 Sitio Capus, Brgy. San Rafael Brgy. Pulang Lupa Reinjection well
	Lead Acetate tabs	Weekly	100 to 200 m downwind of the cooling tower of MGPP Maibarara plant site Sitio Capus, Brgy. San Rafael
SO2	Gas bubbling for (1 hour sample)	Quarterly	Same stations as H2S
Air Particulates	High Volume Sampler (1 hour sample)	Quarterly	Same stations as H2S
Noise	Noise meter	Quarterly and at different plant operations such as start-up, shutdown, low load operation and full load operation	plant site and at 100, 200, 500 and 800 m from the plant site with residences
SOIL QUALITY			
Heavy metals (Hg, As, Cr, etc.)	AAS	Semi-annual	Downwind of cooling tower
TERRESTRIAL ECOLOGY			
Vegetation	In-situ and laboratory analysis	Quarterly	500 to 1000 m downwind of the plant site

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Recommended Environmental Monitoring Program for
Maibarara Geothermal Power Plant Project

Maibarara GPP EIS: May 1992

Parameter	Method	Frequency	Stations
WATER QUALITY			
River Water			
pH, temp., turbidity, conductivity, DO, (TDS, TSS nitrates, PO4, alkalinity, Cl, sulfates, Trace Elements Trace Elements (As, Hg, Pb, Cr, Cd, B, Cu, Ca, Zn, Fe, K, Na)	In-situ and laboratory analysis	Quarterly	Siam-Siam River Talon Falls
Groundwater			
pH, temp., turbidity, conductivity, DO, Chemical Analysis (TDS, TSS, nitrates, PO4, alkalinity, Cl, sulfates) Trace Elements (As, Hg, Pb, Cr, Cd, B, Cu, Ca, Zn, Fe, K, Na)	In-situ and laboratory analysis	Semi-Annual	Spring water (source of drinking water of Sitio Capus residents)
Rainfall			
pH, SO4, and trace elements	In-situ and laboratory analysis	Monthly	Plant Site Pulang Lupa Sto. Tomas, Batangas (access road to plant site, near highway)
AQUATIC ECOLOGY			
River Water	In-situ and Laboratory Measurement	Monthly	Siam-Siam River Talon Falls
PUBLIC HEALTH			
Morbidity Mortality	Secondary data gathering	Annual	Study Area

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Chapter I

Introduction

CHAPTER I

INTRODUCTION

This Environmental Impact Statement (EIS) is made in accordance with the rules and regulations implementing Presidential Decree No. 1586 in relation to Section 4 of Presidential Decree No. 1151 as set forth by the Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR).

I.1 Project Proponent

The project proponent is the National Power Corporation (NAPOCOR) with address at Agham Road corner Quezon Boulevard, Diliman, Quezon City, Metro Manila.

I.2 Name, Location and Type of Project

I.2.1 Project Name

The project is the Maibarara Geothermal Power Project (Maibarara GPP).

I.2.2 Project Location

The project is to be located in Sitio Capus, Barangay San Rafael, Sto. Tomas, Batangas, about 65 km south of Manila. The site is accessible from the Sto. Tomas - Calamba road thru a 5 km feeder road. Figures I.1 and I.2 show the location and vicinity maps of the proposed plant site.

The proposed generating plant is to be constructed in a 1.2 ha agricultural land characterized by gently rolling terrain planted to coconuts and bananas.

I.2.3 Project Type Selection

The Maibarara resource has five productive steam wells. These wells are known to have high temperature but of limited size, underpressured, and of limited permeability and unknown storage.

The 20 MW modular unit was previously selected for this particular project due to its standard design that is adaptable to changing presssure, flows and gas content of steam. However, further investigation of the reserve capacity of the field showed that the field is ideally suited for a small power plant with rated capacity of

13.6 MW. Since the capacity of the modular unit is too big for the geothermal energy, NAPOCOR on advice of Philippine Geothermal Inc. (PGI) elected to install a 10 MW geothermal generating unit suited to the field.

I.2.3.1 Project Type

The project will compose of a single unit (10 MW) of conventional condensing steam turbine geothermal power plant designed to utilize geothermal energy from wells drilled in the Maibarara Geothermal Field.

I.3 Project Goals, Objectives and Purposes

The power capability of Luzon Grid has been significantly reduced by derated condition and frequent shutdown of ageing power plants, low generation capacity of hydro-electric plants caused by low reservoir level because of droughts, and late implementation of new power projects. The power cut down resulted to frequent power failure in most parts of Luzon including Metro Manila.

Though the power generation capability of this project is small compared with other geothermal power plants of NAPOCOR, development of this project will add to the aggregate capacity of existing generating power stations, utilize a cheaper indigenous energy and increase employment opportunities to local population. Since electricity consumption relates directly with growing economy, the greater availability of cheap and reliable electricity will help sustain the growth of industries and commercial establishments and our economy to a positive direction.

I.3.1 The Need for Power

The average energy sales growth rate in Luzon Grid over the period 1986-1990 was calculated at 6.79% and is predicted to increase to 7.16 % over the period 1991-1995. The 7.16 % growth rate reflects a relatively developed market base, particularly the Metro Manila area which accounts for 75 % of NAPOCOR sales in Luzon.

Table I.1 presents the annual energy sales, energy generation and peak megawatt demand of the Luzon Grid over the period 1986-2005 including the historical and forecasted load factors and system losses. Table I.2 shows the power expansion program for Luzon up to year 2005. Eight (8) geothermal generating units are

projected to add 175 MW by 1993, 120 MW by 1995 and 100 MW by 1996 to the system. The program will also include the construction of coal-fired power units, gas turbines, and the full development of the Tongonan geothermal field whose generated capacity is expected to be interconnected to the Grid starting 1996.

Generation facilities in Luzon are well developed and diversified. As of 1991, the system has a total installed capacity of 4,681 MW which consists of 2,495 MW oil-based, 1,226 MW hydro, 660 MW geothermal and 300 MW coal-fired power plants. Out of these units, 16 MW (0.38%) of hydro and 200 MW (4.36%) of oil-based are due for retirement by 1992 and 1995, respectively. The estimated cumulative dependable capacity of the Grid in 1991 is 3,779 MW, while the net peak demand during the same period was estimated at 3,013 MW.

I.3.2 Project Cost

Total project cost amounts to $ 22.754 million, consisting of $18.944 million in foreign currency and ₱98.111 million in local currency.

I.3.3 Site Selection

Unlike the fuels of other types of generating plants, geothermal steam cannot be delivered far from the source as there are limits to be maintained on temperatures, pressure and quality. The farther the power station from the steam source, the higher the cost of the steam gathering system. Thus, selection of sites for geothermal power plants are always confined to the vicinities where steam resources are located.

Four sites which are located in Barangay San Rafael in Sto. Tomas, Batangas, were identified and are designated as Mai-1, Mai-2, Mai-3 and Mai-4 (Figure I.3).

I.3.3.1 Mai-1

The proposed site is located within the perimeter of well pad for production wells No. 3D and No. 5. The area is approximately 750 square meters and is well developed. However, the area would not be sufficient to accommodate a condensing-type, portable generating unit.

Domestic and potable water supply for the plant can be available from deepwell or from the existing Maibarara water well No. 2 of PGI. The latter is approximately 530 m west of the proposed site and has a discharge rate of approximately 91 gallons per minute.

This site is accessible through a narrow barangay road that branched out from the Calamba-Sto. Tomas National Highway.

I.3.3.2 Mai-2

The site is located within the perimeter of well pad for production wells No. 6, 9 and 11. The area is well developed with an approximate area of 1,400 m^2. This area is at a higher in elevation than Mai-1. Sources of potable and domestic water supply for the plant at this site would be the existing Maibarara water well No. 2 of PGI located about 650 m west of the proposed site.

This site can be reached via the same small barangay road access to Mai-1.

I.3.3.3 Mai-3

The site is located approximately 200 m southwest of Maibarara Well No. 3D and 350 m northwest of Maibarara Well No. 9. The site topography is characterized by gently rolling terrain and at a lower elevation than sites Mai-1 and Mai-2. The 1.8 ha area is planted to coconuts and bananas. The domestic and potable water requirements of the plant will be sourced from Maibarara water well No. 2, about 100 m away.

I.3.3.4 Mai-4

This site is located approximately 420 m southwest of Maibarara No. 3D and approximately 500 m southwest of Maibarara No. 9. The 1.5 ha site is characterized by very flat topography planted to coconuts and bananas with intercropping of corn underneath. Pumping cost for the water requirement of the plant will be much less than that of the other three sites since Maibarara water well No. 2 is just 50 meters away. However, flash floods occur in this site during rainy season.

I.3.3.5 Site Evaluation

Evaluation of the candidate sites were made according to the following criteria:

a.	Proximity to Steam Source	25 %
b.	Topography/Earthworks	20 %
c.	Geologic Condition	20 %
d.	Fresh Water Supply Availability	25 %
e.	Effects on Field Developer's Facilities (Existing and Future)	5 %
f.	Flood Risk	5 %

Rating of the land sites was evaluated and rated based on the above criteria. Mai-3 was chosen because of its excellent geologic condition, topography and water supply availability.

Table I.1

LUZON GRID
SYSTEM LOAD FORECAST

Maibarara EIS: May 1992

	YEAR	ENERGY SALES (GWH)	NET GENERATION 1/ ENERGY (GWH)	NET GENERATION 1/ DEMAND MW	ASSUMPTIONS (%) LOAD FACTOR	ASSUMPTIONS (%) T/L LOSS
ACTUAL (NPC)	1986	13535	14010	2311	69.20	3.39
	1987	14980	15345	2457	71.30	2.38
	1988	16319	16742	2651	72.10	2.53
	1989	17142	17538	2792	71.70	3.26
	1990	17601	18064	2888	71.40	2.56
% GROWTH RATE (1987-1990)		6.97	6.56	5.73		
FORECAST 2/	1991	18402	18874	3013	71.50	2.50
	1992	19653	20157	3213	71.50	2.50
	1993	21257	21802	3481	71.50	2.50
	1994	22993	23583	3765	71.50	2.50
	1995	24868	25506	4072	71.50	2.50
% GROWTH RATE (1991-1995)		7.16	7.14	7.11		
	1996	26898	27588	4405	71.50	2.50
	1997	29094	29840	4764	71.50	2.50
	1998	31468	32275	5153	71.50	2.50
	1999	34037	34910	5574	71.50	2.50
	2000	36815	37759	6029	71.50	2.50
% GROWTH RATE (1996-2000)		8.16	8.16	8.17		
	2001	39569	40584	6480	71.50	2.50
	2002	42531	43622	6965	71.50	2.50
	2003	45712	46884	7485	71.50	2.50
	2004	49132	50392	8045	71.50	2.50
	2005	52807	54161	8647	71.50	2.50
% GROWTH RATE						
(2000-2005)		7.48	7.48	7.48		
(1991-2000)		7.66	7.65	7.64		
(1991-2005)		7.60	7.59	7.58		

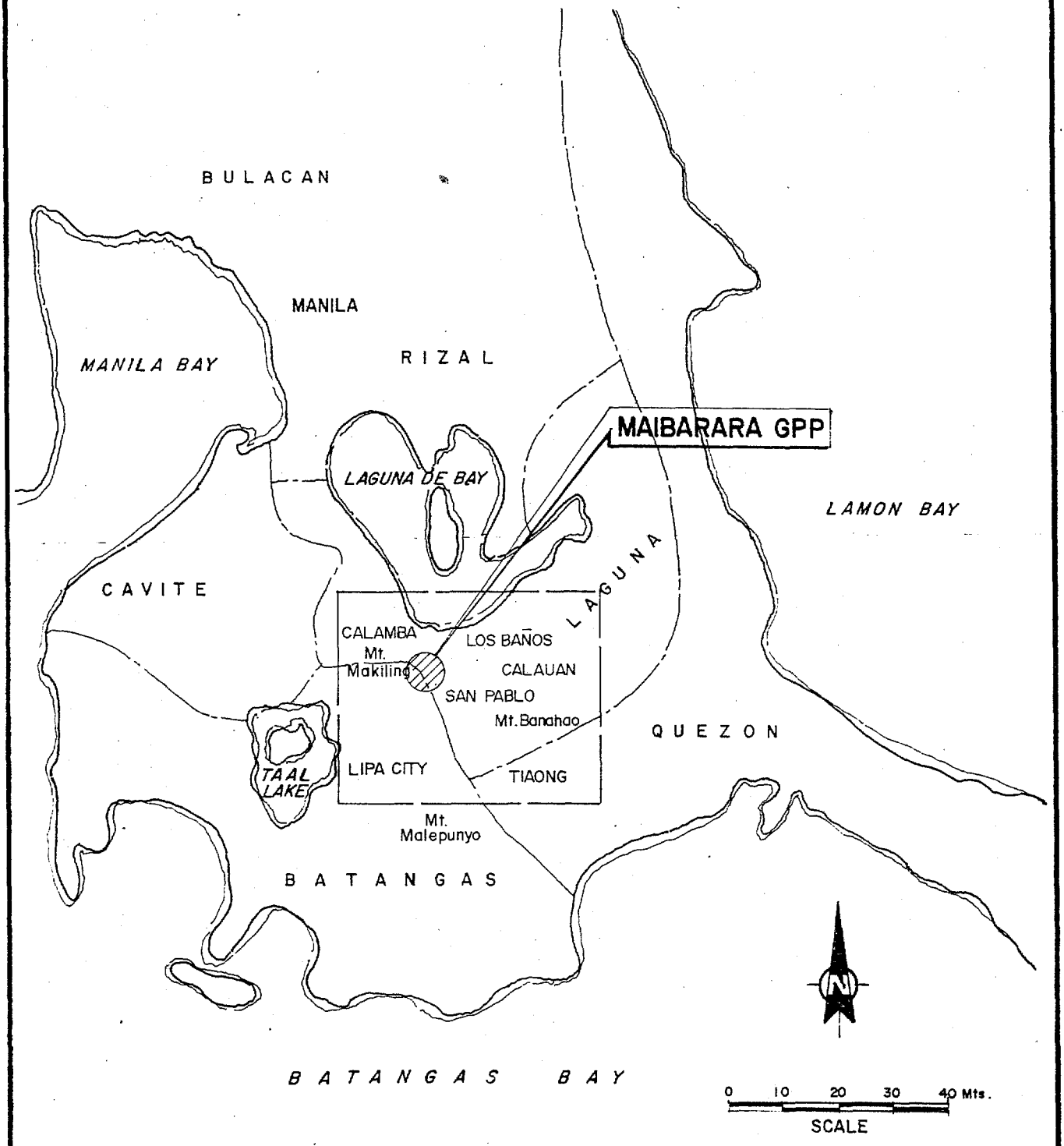
1/ Excludes station use.

Table I.2
Power Expansion Program For Luzon Grid
Maibarara GPP EIS: May 1992

YEAR	PLANT ADDITIONS	CAPACITY (MW) INST	CAPACITY (MW) DEP	CUMULATIVE INSTALLED CAPACITY (MW) HYDRO	GEO	COAL	NATURAL GAS	OIL THRML	OIL CC	OIL GT	TOTAL	CUM DEP CAPACITY (MW)	NET PEAK DEMAND (MW)	RESERVE MARGIN (%)	RELIABILITY LOLP (DAYS/YEAR)	UNSERVED ENERGY (GWH)	UNSERVED ENERGY (%)
1990	EXISTING			1226	660	300	0	1925	0	280	4391	3549	2888				
	HYDRO	1126	744														
	GEO	660	540														
	COAL	300	285														
	THERMAL	1925	1705														
	GT	280	275														
	PB#2																
1991	HOPEWELL GT #2	70	65	1226	660	300	0	1925	0	570	4681	3779 1/	3013	25	0.58	0.90	0.00
	PBGT - JB#1	30	30														
	PBGT - JB#2	30	30														
	HOPEWELL GT #3	70	65														
	PBGT - JB#3	30	30														
	PBGT - JB#4&5	60	60														
1992	LBGT - SUCAT	30	30	1226	660	300	0	1925	200	600	4911	4049	3218	26	1.62	2.70	0.01
	BATAAN CC - STAGE 1	200	190														
1993	MAKBAN BINARY	12	12	1226	835	300	0	1925	300	600	5186	4355	3481	25	2.00	3.90	0.02
	MAIBARARA BINARY	13	13														
	SUCAT 3		50														
	BACMAN I Unit 1	55	50														
	BATAAN CC-STAGE 2	100	95														
	BACMAN II Unit 1	20	10														
	BACMAN I Unit 2	55	50														
	BACMAN II Unit 2	20	10														
1994	SAN ANTONIO	42	42	1226	835	900	42	1925	300	600	5828	4997	3765	33	0.64	1.00	0.00
	SUCAT 2		30														
	CALACA II	300	285														
	MASINLOC I	300	285														
1995	MASINLOC II	300	285	1226	955	1200	42	1925	300	600	6248	5390	4072	32	0.20	0.10	0.00
	MODULAR GEO	120	100														
1996	MODULAR GEO	100	90	1226	1495	1200	42	1925	300	600	6788	5830 2/	4405	32	0.14	0.10	0.00
	TONGONAN A	440	440														
1997	TONGONAN B1	220	200	1226	1715	1200	42	1925	300	600	7008	6030	4764	27	0.49	0.80	0.00
1998	TONGONAN B2	220	200	1226	1935	1500	42	1925	300	600	7528	6515	5153	26	0.52	0.80	0.00
	COAL A	300	285														
1999	COAL B	600	570	1226	1935	2100	42	1925	300	600	8128	7085	5574	27	0.66	1.10	0.00
2000	COAL C	300	285	1494	1935	2400	42	1925	300	600	8696	7588 2/	6029	26	0.87	1.50	0.00
	CABECNAN	88	868														
2001	COAL D	600	570	1494	1935	3000	42	1925	300	600	9296	8158	6480	26	1.04	1.80	0.00
2002	COAL E	600	570	1644	1935	3600	42	1925	300	600	10046	8878	6965	27	0.78	1.40	0.00
	KALAYAAN	150	150														
2003	COAL F	600	570	1794	1935	4200	42	1925	300	600	10796	9598	7485	28	0.28	0.70	0.00
	KALAYAAN	150	150														
2004	COAL G	900	855	1794	1935	5100	42	1925	300	600	11696	10453	8045	30	0.58	1.30	0.00
2005	COAL H	900	855	1794	1935	6000	42	1925	300	600	12596	11308	8647	31	0.58	1.30	0.00

1/ Hydro dependable reduced by 50 MW due to whole outage of Ambuklao Plant.

2/ Tiwi Geothermal steam depletion - January 1996, 50 MW; January 2000, 50 MW.



NATIONAL POWER CORPORATION

Figure I.1

LOCATION MAP

MAIBARARA GPP EIS: MAY 1992

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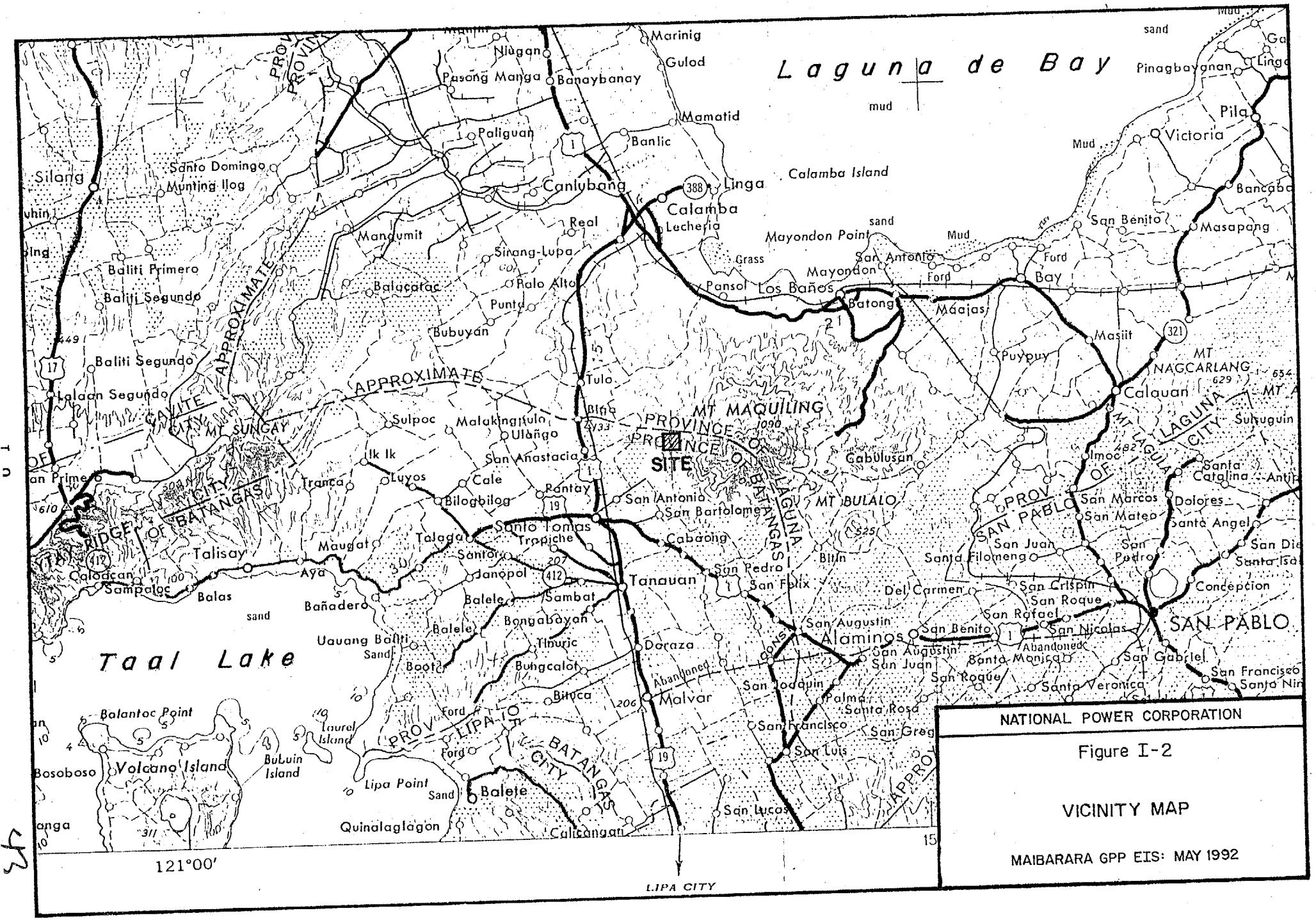
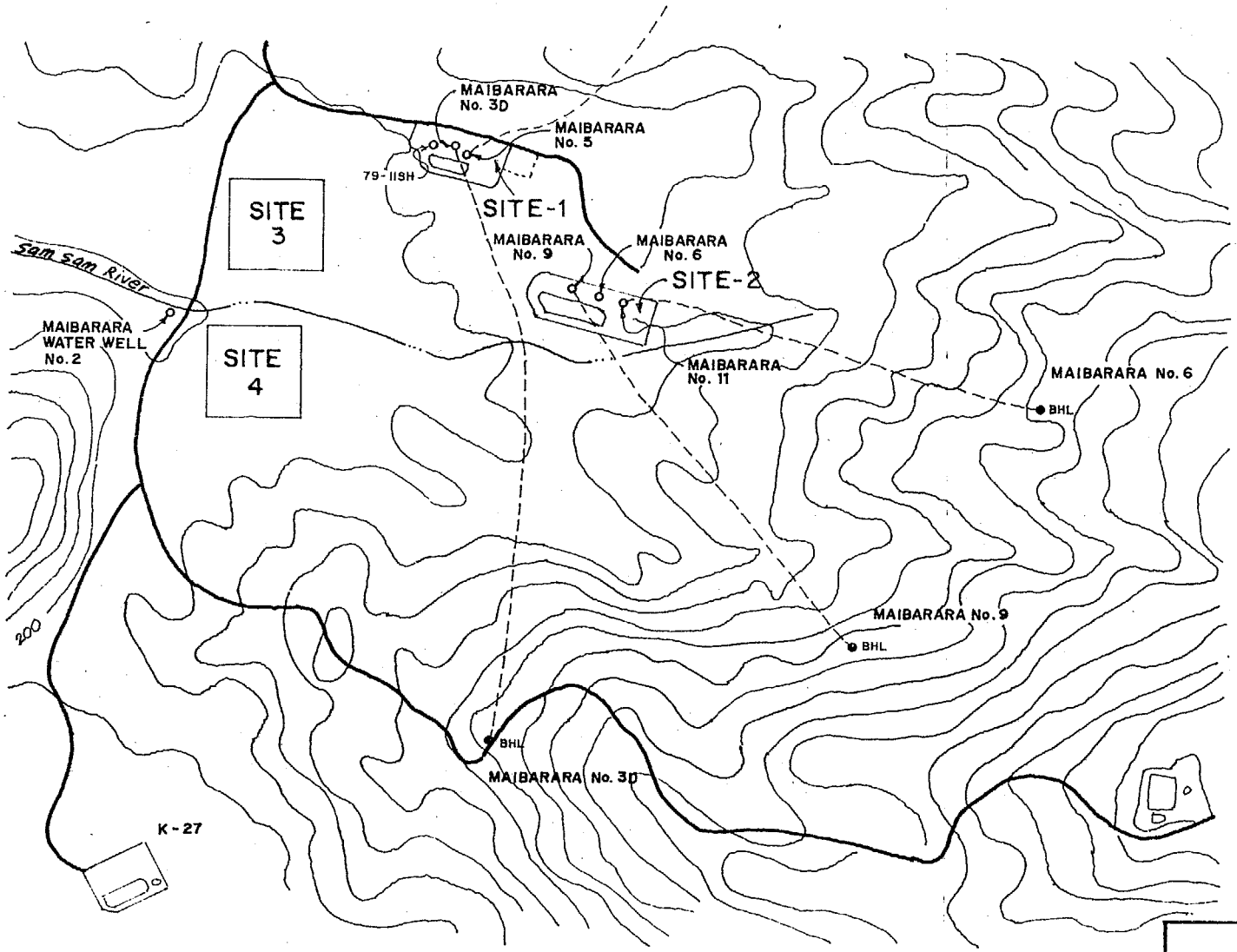


NATIONAL POWER CORPORATION

Figure I-2

VICINITY MAP

MAIBARARA GPP EIS: MAY 1992



NATIONAL POWER CORPORATION

Figure I-3

PROPOSED SITE
(MAIBARARA GEOTHERMAL POWER PROJECT)

MAIBARARA GPP EIS: MAY 1992

Chapter II

Project Description

CHAPTER II

PROJECT DESCRIPTION

II.1 Maibarara Geothermal Resource

The development of Maibarara field started in the mid-seventies as part of the development of the Mak-Ban potential. However, due to the failure to define a field large enough to support a bigger capacity plant, the existing productive wells remained untapped and idle.

The Maibarara resource was initially suspected to contain substantial reserve because of the presence of surface manifestations similar to those that had characterized well-known geothermal fields. These include fumaroles, hydrothermally altered ground emitting odor of H_2S gas and low resistivity anomalies within the area. The first deepwell drilled, Maibarara 1, was initially completed at 591 m where a two-phased rig test suggested that the well flowed about 7.5 kg/sec of high steam fraction at 8.78 kg/cm^2 well head pressure. However, when the well was developed, an extreme temperature reversal occurred that resulted in the damaging of the shallow production zone. The well was found to be no longer commercial eventually.

Maibarara No. 2 on the northern side of the hydrothermally-altered ground was also a failure. Similar temperature reversal was encountered.

The third well however was successful. It is believed currently to tap the heart of the Maibarara geothermal field. While Maibarara No. 79-11SH was drilled as a slim hole and as such is not commercially productive, the 315 °C resource encountered extended from -716 m to the bottom of -1,402 m elevation.

Subsequent drilling of Maibarara Nos. 3D, 5, 6, 9 and 11 has expanded the known productive area only slightly. Significant area expansion outside of the general Maibarara No. 79-11SH area has been unsuccessful in every direction so far.

In the southern part, two wells (Maibarara 4 and 8) were drilled but intercepted hot formation only below -1,067 m elevation with extensive cool rock above said depth. The inability of these two wells to flow had discouraged additional exploration towards the south.

Further exploration was undertaken to determine the boundary of the reservoir, with a total of twelve wells drilled for a period of six years. Finally, it was concluded that Maibarara reserve is limited in size, underpressured, and of limited capacity. It has also been characterized as a high temperature resource with five wells currently capable of supplying 63 kg/sec at 10.9 kg/cm^2 well-head pressure and at most 11 MW in output.

II.2 Pre-Construction and Construction Details

II.2.1 Pre-Construction Activities

Pre-construction activities normally include the following:

a. construction of access roads and temporary site roads
b. bore hole drilling
c. cutting of trees and shrubs
d. burning of combustible debris from the preceding activity
e. survey cleared area
f. removal of overburden, and ground leveling
g. construction of temporary site buildings
h. construction of temporary site storage areas; and
i. ground filling

II.2.1.1 Pre-Construction Schedule

Pre-construction activity at Maibarara is no longer necessary because barangay roads leading to the project site are already in place.

Civil works and some electro-mechanical equipment shall be bidded out to several reputable local construction firms and manufacturers/suppliers, respectively.

Preparation of tender documents for the electro-mechanical equipment was done last April 1991 with the assistance of Ente per L' Energia Electrica (ENEL) as consultant. Issuance of bids was scheduled last September 1991. Evaluation of bids was originally scheduled to start last November 1991 but was postponed due to some changes in Plans and Specifications of the proposed project. Bidding was re-scheduled for April 1992 and evaluation of bids is expected to be finished in two months time. Equipment design, manufacturing, shipping and delivery shall commence in November 1992,

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immediately after awarding of contracts.

II.2.2 Construction Details

II.2.2.1 General Layout

II.2.2.1 Plant Layout

The power plant shall consist principally of powerhouse building, containerized control/support building, cooling towers and switchyard. The proposed power station will occupy an area of approximately 1.2 ha. The cooling tower and the high voltage substation will be situated at the southern and northern sides of the powerhouse, respectively.

Figures II.1 and II.2 present the general arrangement and site development plan of the proposed geothermal power project, respectively.

Intrasite roads shall be 10 m and 6 m wide. The existing barangay road (leading to the proposed power station) approximately 5.0 km long shall be developed to a permanent, all-weather road.

II.2.2.2 Construction Activities

Once the pre-construction activities have been completed, construction activities will commence.

Equipment design, manufacturing and delivery will commence in November 1992. Civil works are assumed to start in Jan 1993 and is expected to be completed by February 1994. Details of the construction/erection activities are shown in Table II.1.

II.2.2.3 Workforce and Construction Camps

During construction, workforce number and composition will vary as the activities progress. The number of skilled workers will increase while unskilled workers involved in pre-construction activities will decrease as plant erection progresses. About 100 persons will be hired during the construction period.

A number of specialized technical and engineering personnel will be needed during plant's testing and commissioning. Some of them may find temporary accommodation in construction camps while others will be accommodated in hotels and lodging houses in nearby

municipalities.

II.2.2.4 Safety Measures

Strict implementation of safety rules and regulations shall be enforced during the construction stage. All working personnel shall be provided with appropriate safety gadgets such as hard hats, safety shoes and belts, gas masks, gloves, ear plugs, and other protective devices. They shall be given safety instructions regarding occupational safety and health precautions/procedures as part of their orientation or seminar.

Sanitary facilities, potable drinking water and garbage facilities shall be provided at temporary camping facilities. Medical staff and facilities according to DOLE standards shall be stationed within the compound to ensure adequate medical care to injured workers.

Proper security shall be imposed and the whole project area shall be provided with firefighting equipment and alarms.

II.2.2.5 Special Design Features

To reduce or minimize adverse plant effects, the proposed plant shall have the following special design features:

a. ducting the non-condensable gases to the cooling tower plenum to increase dilution of NCG with water vapor and air and increase effective height of release

b. materials/parts will be selected with care and properly designed to limit corrosion to acceptable proportions

c. use of muffler for noise control

d. proper ventilation flow inside the buildings

e. above ground vents

f. establishment of low population zone within the 1-km radius of the plant

II.3 Operation and Maintenance

II.3.1 Raw Materials and Their Sources

II.3.1.1 Steam

Five drilled wells found to be commercially productive will provide the steam needed to operate the 1 x 10 MW geothermal power plant (Figure II.3). These production steam wells have wellhead pressure ranging from 0.93 MPA to 1.25 MPA and temperature from 247 °C to 324 °C.

Tables II.2 and II.3 show the geothermal steam well data and non-condensable gas analysis of each productive well drilled while Table II.4 present the composition of separated brine and steam.

II.3.1.2 Cooling Water

Plant fresh water supply will be taken from the Maibarara water well No. 2 of PGI, approximately 100 meters southwest of the proposed site. It is expected to produce 91 gallons of water per minute. It is recommended however, to drill an additional deep well for back-up in case of failure of the first well.

II.3.2 Process Flow

Two-phase geothermal fluid from the production wells enter the separator from where the steam is separated from water phase fluid. The segregated steam is filtered by the strainers attached to each pipeline. The steam enters the turbine which is directly coupled to an air-cooled generator, then to the condenser.

In the condenser, the exhaust steam from the turbine mixes directly with streams of cooling water, thus condensing the steam. A set of steam gas ejectors with their own condenser remove gases from the condenser maintaining a vacuum of 101.6 mm Hg absolute.

The cooling water (together with the condensed steam) collected in the condenser is pumped to the cooling tower. About 80 to 90 % of water added to the cycle by condensation of steam is released by evaporation from the cooling tower. The remainder is a waste (blowdown) to be disposed off into a reinjection well. The cooling water which is heated by condensing steam in the condenser is cooled by air flowing through the cooling tower.

The main flow diagram is shown in Figure II.4.

II.3.3 Equipment Requirements

II.3.3.1 Turbine and Auxiliaries

II.3.3.1.1 Steam Turbine

The turbine shall be single cylinder, single flow, impulse, and/or reaction-type, condensing turbine arranged to operate with saturated and superheated geothermal steam containing 1.75 % by weight of non-condensable gases. It shall be capable of driving the generator, exciters and auxiliary equipment mechanically coupled to the turbine.

The turbine shall be designed for the following operating conditions:

Continuous maximum rating (at generator terminal)	10,000 kw
Rated continuous rating at 10 % overload	11,000 kw
Speed	3,600 rpm
Steam Condition	
Maximum design pressure	12 kg/sq cm abs
Maximum design temperature	200 °C
Turbine exhaust pressure (abs)	0.138 Kg/cm^2

II.3.3.1.2 Casing

The turbine casing shall be of carbon steel (ASTM A6-72) plate with welded structure. The bottom half of the outer casing must be solid where the front bearing stands. The inner casing shall be key-guided to permit free thermal expansion. An atmospheric relief valve and a manhole must be provided at the upper half of the casing.

II.3.3.1.3 Turbine Rotor

The rotor shall be made of solid alloy steel forging machine to form solid rotor and shall compose of shaft, bearing journals and coupling flanges. Before

machining, an ultrasonic test, a magnetic particle test, and other tests shall be conducted to assure that the foregoing materials/parts meet the required physical and chemical properties.

II.3.3.1.4 Governor

A combination of electronic and electro-hydraulic speed/load governor and control systems shall be incorporated as part of the turbine to control the speed/output of the turbo-generator unit. The governing system shall operate the throttle valves to control steam to the turbine in accordance with the output demand from the load to full load and to maintain the steam flow. The oil to be used for the governor system shall be non-toxic and it shall have to be handled without particular protection.

II.3.3.1.5 Throttle Valve

The throttle valve of the load governing system shall be hydraulically operated to regulate the steam flow to the inlets of the turbine. It shall be designed to meet the speed/load control requirements specified for the governor and shall be arranged to open with increasing hydraulic pressure against the spring to ensure instantaneous closing on loss of hydraulic pressure during emergency.

II.3.3.1.6 Main Stop Valve

A manual/motor open-close (dual operated) stop valve shall be supplied and installed for each turbine. Each valve will be supplied with a geared handwheel operator mounted on the valve with a floor pedestal, shafting and bevel gears for remote, exposed operation.

II.3.3.1.7 Protective Device

a. Vacuum Trip Device

Vacuum trip devices shall be provided to protect the turbine against operation with excessive exhaust pressure. This is a pressure sensing mechanism which consists of a sensing rod mechanically installed in accordance with condenser vacuum, so that failure in the condenser to maintain proper vacuum will be indicated accurately by the vacuum trip device.

b. Overspeed Trip Device

Two overspeed trip devices will be provided to close down the turbine set in the event the speed exceeds the safe margin above the maximum speed permitted by the speed/load governor under the most adverse conditions.

c. Shaft Axial Displacement Indicator, Alarm and Trip Device

This device indicates and monitors the shaft position of the turbine and its relationship to the normal running position.

This device shall contain one set of contacts to actuate an alarm when displacement of the shaft becomes abnormal. The second set of contacts shall be arranged to close down the turbine and generator when the shaft displacement becomes excessive so as not to damage the turbine.

d. Vibration Detectors

Vibration detectors shall be installed on each of the bearing pedestal of the turbine with a multipoint indicator mounted on the turbine control panel to detect vibration of the unit.

e. Emergency Trip Device

This device is used to open the trip oil circuit with speed and reliability in case the turbine continues its operation during emergency situations.

f. Steam Strainer

The basket-type steam strainers shall be provided in all steam inlets to the turbine gas extractors and any other steam consuming auxiliary equipment that may become clogged or damaged by pipe scale or other debris that may be carried by the steam into the equipment.

g. Turbine Drains

All steam strainers shall be provided with blowdown valves to remove debris with suitable thermodynamic traps to drain condensate continuously.

The valves shall be of the best quality, half turn from closed to open type, without packed glands or any other type of seals which may leak.

h. Rupture Disc

A rupture disc shall be provided to protect the condenser, turbine casing and other appurtenances from excessive pressure in the event of failure of cooling devices.

The rupture disc shall be located so as to permit discharge of the steam outside the power station building.

i. Turning Gear

This device shall be provided with hand turning facility to allow turbine rotor turning at about two (2) RPM during start-up. This is being performed to heat the rotor and reduce the possibility of distortion.

This device shall also be provided with complete parts such as movable pinion used in disengaging gears without shock when the steam is admitted to the turbine. A pressure switch shall be provided to prevent operation of turning gear without oil supply to the turbine generator bearings.

II.3.3.2 Cooling Water System

II.3.3.2.1 Condenser

A low-level, direct contact, spray-type condenser shall be installed and flexibly coupled to the exhaust flange of the turbine and located outside the powerhouse. It shall be capable of condensing all the steam from the turbine.

Condenser pressure varies depending on the plant location. The condenser shall be designed at the maximum pressure of 1.5 Kg/sq cm g.

Supply of cooling water to the condenser will be by recirculation of water and condensate through an induced draft cooling tower.

Water will be delivered to the condenser by the pressure difference between the water at the cooling tower and the vapor in the condenser created by condensation of the turbine exhaust steam.

Design Conditions:

Condenser pressure	0.138 kg/cm^2 abs
Steam flow	77,766 kg/hr
Turbine exhaust flow	77,136 kg/hr
Type of water distribution system	spray type
Cooling water inlet design temperature	35 °C
Cooling water flow requirements	3,000 Tons/hr

II.3.3.2.2 Hotwell Pump

A set of vertical shaft pump with drive motor is required to pump mixed condensate and cooling water from the direct contact, spray type condenser attached to every geothermal steam turbine. The unit will pump the water from the turbine hotwell to the top of its associated cooling tower.

The pump shall at all times be capable of continuously pumping over 60 % to 130 % of its maximum rate flow at pumping head conditions and over the temperature range of 25 °C to 50 °C. Each pump shall be rated at 130 % flow capacity.

The pump shall be electric motor driven of three-phase type with squirrel cage rotor, single polarity, to be started-up directly at full voltage and continuous service with stator insulation conforming to the Vacuum Pressure Impregnation technique.

II.3.3.2.3 Cooling Tower

The cooling tower shall be of mechanical induced-draft, cross flow type. Its structure shall be made of timber and shall be treated with epoxy-based compound to provide resistance to any micro-fungi and other biological decay organism, and protection against

sulfate attack. All exterior surfaces of the tower including the fan deck, inlet louvers, and wall sheating shall be of non-combustible materials.

The cooling tower of the proposed project requires a single unit since the plant has only one turbine. This unit shall be divided into four cells, each of which shall have a cooling fan. Each cell shall be able to be taken out of service without affecting the operation of the other cells.

The fan shall be installed inside the shaped fan cylinder. Both fan cylinder and fan blades shall be made of glass-reinforced plastic which is metallic corrosion resistant. The fan drive shall consist of a motor drive shaft, flexible type coupling and gear box mounted on a frame to resist fan thrust and motor gear box torque.

The fan motor shall have 6 poles with voltage rating of 480 volts. The motor shall be started directly on line.

Design Conditions:

Type	Mechanical induced draft, cross flow
Circulating water flow rate	3,000 Tons/hr
Cooling water inlet temp.	48.9 °C
Cooling water outlet temp.	35 °C
Wet bulb temperature	26.7 °C
Dry bulb temperature	35 °C
Evaporation loss	2.3%
Number of fans	Four (4)
Power rating	105.6 kw

II.3.3.2.4 Auxiliary Cooling Water Booster Pump

Two centrifugal pumps are required to pump cooling water from the basin of the cooling tower to the condensers of the gas extraction system associated with the main condenser of the 10 MW geothermal turbine.

Each circuit shall be provided with two identical pumps, each capable of delivering 100 % of the maximum cooling water flow under the most unfavorable conditions. The pumps shall be electric motor-driven and shall either be the horizontal split casing centrifugal pumps or single suction centrifugal pumps.

II.3.3.2.5 Gas Extraction System

The non-condensable gas extraction system shall consist of hybrid gas extractor and 100 % back-up steam ejector.

The hybrid gas extractor will be used during start-up and normal operation of the plant. It shall compose of steam ejector connected in series to a direct contact spray intercondenser and to a vacuum pump and seal water separator. The saturated steam from the main steam line will be used to drive the steam ejector of the hybrid unit and shall be designed to optimize the usage of motive steam in conjunction with the vacuum pump. The vacuum pump shall be driven by an electric motor via v-belt drive arrangement or gear reducer. The operating speed of the vacuum pump shall not exceed 500 rpm. Water from the cooling tower will be used to seal the vacuum pump and recycled back to the cooling tower. The non-condensable gases will be compressed by the vacuum pump by means of the centrifugal rotation of the liquid seal in the compressor and discharged to a separator into the atmosphere at the cooling tower fan stack.

The 100% back-up steam ejector gas removal system will be operated only as a stand-by unit during periodic or emergency maintenance of the hybrid unit.

The two gas removal systems shall be designed as completely independent units capable of extracting all the non-condensable gases carried in the steam and condenser cooling water.

II.3.3.3 Generator and Auxiliaries

II.3.3.3.1 Generator

The generator shall be air-cooled, 3-phase, synchronous, 2-pole, horizontal-type machine to be directly coupled to the turbine shaft. It shall have the following normal operating characteristics:

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Maximum continuous rating	10 MW
Voltage at generator terminals	13,800 V
Power factor	0.8 lagging
Speed	3,600 RPM
Frequency	60 Hz

The generator cooling system shall be of closed circuit type. Each cooler shall be provided with stop valves and drainage system.

The casing shall be of fabricated construction with bearings preferably mounted on the front shield. Stator core shall be made of high permeability, low losses, non-aging stampings and tightly clamped.

The rotor shall be made of solid forging with high mechanical strength characteristics. It shall be designed with wide margins between the critical and running speed (both normal and overspeed). Conductors of rotor windings in contact with air shall be protected against hydrogen sulfide (H_2S).

II.3.3.3.2 Excitation System

The excitation system shall be of brushless type. It shall consist of an AC exciter, a rotating rectifier, a permanent magnet generator, an automatic voltage regulator, a manual generator with automatic follower, and other accessory equipment of the excitation cubicle. The generator excitation is controlled by means of the exciter field control which receives power from the permanent magnet generator and a bulb-and-boost signal from the voltage regulator.

The exciter shall be sized to cope with any load at the generator and shall be stable at all operating conditions.

II.3.3.3.3 Transformer

II.3.3.3.3.1 Main Power Transformer

The main power transformer shall be 13.8 KV/69 KV, 15 MVA, OA Class, 3-phase with no-load tap changers. Its design shall take into consideration the potential heavy presence of H_2S in the atmosphere.

It shall be suitable for continuous operation at full rated capacity at an ambient temperature of 45 °C.

Main features of this transformer are:

Voltage Ratio, KV	13.8/69
Rated Continuous Output	15,000 KVA
No. of Phases	Three (3)
Frequency, Hz	60
Connection	Delta/Star
Neutral (HV)	Solidly Grounded
Max. Temperature Rise (Coil)	55 °C

II.3.3.3.3.2 Unit Auxiliary Transformer

The unit auxiliary transformer shall be 13.8 KV/4.16 KV, OA Class, 3-phase with on-load tap changers. Its design shall take into consideration the heavy presence of hydrogen sulfide in the atmosphere. It shall be suitable for continuous operation at full rated capacity at an ambient temperature of 45 °C.

The main specifications shall be:

Voltage Ratio	13.8 KV/4.16 KV
Number of Phases	Three (3)
Frequency	60 Hz
Connection	Delta/Star
Neutral (Low Voltage)	Grounded through a transformer

II.3.3.3.3.3 Station Service Transformer

This project shall be provided with a single unit power transformer to be used as a construction power transformer during construction and start-up/commissioning and, later on, to serve as the station service transformer of the project. It shall be oil-immersed, self-cooled and outdoor type with three windings, the third winding being a delta connected

tertiary to suppress harmonics. Its rated capacity is not indicated in the main single line diagram because this must be determined with due consideration to the contractor's requirements and for start-up/commissioning purposes. The transformer capacity shall include provision for the power requirements of the unit auxiliary loads of the plant in the event the lone unit auxiliary transformer is out of order. The design of the station service transformer shall take into consideration the potential heavy presence of hydrogen sulfide in the environment.

Other specifications of this transformer shall be:

Voltage	4.16 KV/480 V
Number of Phases	Three (3)
Frequency	60 Hz
Connection	Star/star with delta connected tertiary
Neutral (LV)	Grounded through the transformer

II.3.3.3.3.4 Transformer Insulating Oil

The insulating oil for the transformer shall be free from moisture, acid, alkali and sulfur compunds and shall not form a deposit at normal operating temperatures. The oil shall have the following properties:

- power factor, measured at 100 °C, with 60 cycles AC, not more than 0.30%.
- Vicosity, not over 57 seconds Saybolt Universal at 40 °C.
- Freezing point, not higher than -40 °C.
- Flash point, not less than 130 °C; (open up)
- Burning point, not less than 145 °C; (open up)
- Color, very pale amber to water white, clear ASTM maximum no.3.

II.3.3.3.4 Switchgears (4.16 KV and 460 V)

The 4.16 KV and 460 V switchgears shall be metal-clad, of enclosed, ventilated, substantially dust proof type, with readily removable door at the rear for easy maintenance and repair. It shall be suitable for bottom access for convenient installation of cable interconnection.

II.3.3.3.5 Control Switchboard

The necessary control switches and lights to indicate the positions of the breakers, indicating and recording instruments, and relays shall be mounted on the unit control board. The panel shall be designed so that:

1. The grouping of the apparatus is such that the chances of reading the wrong instruments or manipulating the wrong device, for both normal and emergency operation, are minimized.

2. Panels for like purposes are wired alike.

3. Only meters, instruments and devices of recognized merit, design, construction and operation are to be used.

4. Control/supply buses are properly protected against accidental grounds or short circuits.

5. Wiring and connections to instruments, control switches and panel devices are neatly done in such a manner as to facilitate maintenance. Connection to studs are made positive and secure using solderless terminal lugs.

6. Test switches, test links, or similar devices are provided for instruments and relays in cases where the primary circuits cannot be de-energized.

7. Terminal strips or blocks are provided at bottom, top or sides of panels as required, for convenient connection of control cables.

8. Fuses of carefully selected capacities protect the various parts of the lateral wiring system.

II.3.3.3.6 Station Battery

Two sets of high grade, lead acid type storage batteries shall be provided for the unit to supply direct current for control service, emergency station lighting, and essential equipment that must function during loss of AC power. Each battery set shall have a nominal voltage of 125 V.

II.3.3.3.7 Battery Charger

Two (2) solid state, silicon, rectifier-type battery chargers suitable for 460 volts, 3-phase, 60 Hz supply shall be provided for the unit. Normally, the battery charger will feed the DC load as well as keep the battery under trickle charge. On failure of the rectifier charger or AC input to the rectifier charger, the battery will take over the DC load without any interruption in the supply. Only one charger and one set of batteries shall be connected to the system at anytime. Provision for automatic change-over the moment the charger in service fails shall be made. The battery charger shall be fully automatic and self-regulating.

II.3.3.3.8 Protective Relays

To protect equipment against abnormal system conditions, adequate protective devices shall be installed in the respective switchgears and/or control and relay panels. The relay settings and characteristics shall be selected to provide satisfactory protection on the particular equipment offered, that is, to isolate the faulted equipment only and to provide fault clearing discrimination throughout the complete electrical scheme. Relays shall be insensitive to vibrations and variations in temperature, and their operation shall not be affected by the following:

1. any kind of external faults beyond the protected section,

2. transient system disturbance or instability,

3. current surges due to sudden changes of line charging capacity,

4. normal operation of arresters on protected sections,

5. DC components of short circuit currents,

6. magnetic fields from other relays,

7. magnetizing inrush currents,

8. different current transformer characteristics, and

9. current transformer saturation.

II.3.3.3.9 Grounding System

A stable grounding system shall be provided for the grounding of equipment and structures in and around the powerhouse and the HV switchyard which is essential for the safety of personnel as well as the safeguarding of equipment under adverse conditions during fault.

A grounding grid of stranded bare copper conductor cable at ground potential shall be installed in the form of a grounding mat buried at least 0.60 meter below grade with driven copper-clad steel ground rods at suitable points to produce earth resistivity conforming to NAPOCOR standards. All electrical equipment, switchgears, transformers, panels, cable trays, equipment enclosures, motor control centers, equipment frames, bases and supporting steel shall have cable connection to this grounding system.

II.3.3.3.10 Lightning Arrester

Lightning arresters shall be provided to protect the associated transmission lines. It shall be metal oxide, gapless type designed for outdoors.

II.3.3.3.11 PLC Relay and Communication Equipment

The overhead associated transmission line shall be utilized as the medium of transmission for the combined protection, data and speech channels of the transmitted intelligence of the power line carrier (PLC) equipment. The PLC equipment shall perform the following services:

1. provide line carrier high speed protection for the 230 KV transmission circuit by means of a set of protection and signaling equipment, distance relays and other associated auxiliary relays; and

2. provide automatic telephone communications for simultaneous transmission and reception (duplex) among substation or power plants.

The corresponding line traps, coupling capacitor potential devices, carrier accessories, line tuning units, telephone equipment and other accessories shall also be provided.

II.3.3.4 Associated Transmission Lines

The generation from the proposed Maibarara Geothermal Power Project will be fed to the Luzon Power Grid via 69 KV transmission line emanating from a radial breaker scheme at Maibarara conventional switchyard. The 69 KV line, approximately 11 km long, will run parallel to the existing 230 KV Biñan-Mak-Ban "A" double circuit transmission line. The system one-line diagram is shown in Figure II.5.

The main specifications of the line to be constructed will be as follows:

Voltage	69 KV
Electric Supply System	3-phase, 3 wire, 60 Hz
No. of Circuits	One (1)
Conductor	336.4 MCM
Overhead Ground Wire	3/8" high grade galvanized steel
Support	steel tower
Approximate Length	11 km

A single 69 KV circuit with one 336.4 MCM ACSR conductor per phase would be adequate to carry the full output of the plant. However, to satisfy NAPOCOR's transmission planning criteria of single-outage circuit contingency, a 69 KV line approximately 5 km will be constructed from the Maibarara switchyard up to existing 69 KV Calamba substation. This line once constructed will also be utilized as a source of construction power for the project.

The existing 69 KV radial bus of Mak-Ban "A" will be extended to accommodate the Maibarara 69 KV line. The line will be protected basically by a 69 KV power circuit breaker and lightning arresters. The line will be maintained by disconnect switches and will be controlled and supervised by metering and protective relays in a control board located in the control room of Mak-Ban Plant "A".

II.3.3.5 Miscellaneous Equipment

II.3.3.5.1 Compressed Air System

The compressed air system shall be provided to supply dry, oil-free, purified air for the regulating devices and instruments, as well as for cleaning of plant auxiliary equipment and accessories during preventive maintenance periods. These compressors shall be provided with inter- and after-coolers, air receiver with safety valve, and a silica air dryer mounted on the discharge header to ensure right supply of dry air.

II.3.3.5.2 Control and Utility Air Compressor

The control and utility air compressor shall be provided to supply air requirement of regulating devices and instruments of the plant. It shall be oil-less, single-stage, air-cooled, double acting, reciprocating v-belt driven type compressor with a discharge pressure of 7.0 Kg/cm^2 gauge.

II.3.3.5.3 Air Dryer

Air dryer shall be installed at the discharge line of the air receiver to remove moisture in the air that has been carried into the system. The dryness of the compressed air shall be maintained in order not to damage the different plant instruments.

II.3.3.5.4 After Cooler

An after cooler shall be installed at the discharge line of the compressor to cool the air going into the air receiver. The cooler shall be of the shell and tube, horizontal type.

II.3.3.5.5 Air Receiver Tank

The air receiver tank will serve as storage of the compressed air requirements of the system. The tank will be vertical, cylindrical type complete with pressure gauge, gauge valve, safety valve, pressure switch, drain valve and trap.

II.3.3.5.6 Chemical Dosing System

The chemical dosing system shall consist of the motor drive and horizontal plunger pump that will enable the injection of sodium hydroxide (NaOH) at the suction side of the condensate pumps to remove any dissolved oxygen in the condensate water. The system includes a NaOH tank complete with mixing device of adequate capacity to handle the required injection into the system.

The NaOH injection system shall be designed for the following conditions:

NaOH Injection Pump

Two sets of chemical dosing pumps shall be provided for the turbine-generator; one set for normal and one set for stand-by operations. The pump shall be capable of delivering 10 li/min with sufficient discharge pressure as required by the system

NaOH Dilution Tank

One lot of 12 cu m NaOH dilution tank made of stainless steel shall be provided for each unit.

The tank shall be vertical cylinder type, complete with accessories such as level gauge, switches, valves, pipes and others.

NaOH Agitator

A motor driven agitator shall be provided for each solution tank suitable for mixing caustic soda to 20 % concentration.

Concentrated NaOH Tank

One set of concentrated NaOH storage tank complete with accessories shall be provided for each unit. The tank shall be vertical, cylindrical type made of stainless steel.

NaOH Transfer Pump

One lot of pumps, each of 100 % capacity, shall be provided for normal and standby operations of the system. The pump shall be capable of transferring concentrated hydroxide from the storage tank to dilution tanks. The pump shall be of centrifugal type and shall be capable of obtaining the desired capacity and head.

II.3.3.5.7 Lubrication Oil System

A common lubricating system shall be provided for the turbine bearing, auxiliary drive, generator bearing and exciter bearing. This system shall be composed of main oil tank, main oil pump, oil purifiers, oil coolers, oil transfer pump, auxiliary oil pump and vapor extractor.

II.3.3.5.7.1 Oil Tank

An oil tank of sufficient capacity shall be provided to store lube oil required by the system. The tank shall be equipped with high and low level indicator.

II.3.3.5.7.2 Main Oil Pump

The system shall be provided with main oil pump to be driven by the turbine shaft and capable of providing both the hydraulic and bearing oil requirement of the system. The pump will also provide the turbo set with the oil requirement for cooling the shaft journals.

II.3.3.5.7.3 Oil Purifier

The lube oil purifier shall be vertical shaft, canned pump either of the centrifugal or mixed flow type.

II.3.3.5.7.4 Oil Cooler

Oil cooler shall be provided to cool the lubricating oil at the required design operating conditions. Oil filters shall be provided at the main oil tank to

separate debris and other foreign materials that have been carried in the oil.

The oil cooler shall be cooled by the recirculating water pumped through heat exchangers immersed in the water outlet of the cooling water.

II.3.3.5.7.5 Oil Transfer Pump

Oil transfer pump shall be provided to deliver the lube oil from the clean oil tank to the main oil tank.

II.3.3.5.7.6 Auxiliary Oil Pump

An auxiliary oil pump shall be provided to deliver oil into the suction pipe of the main oil pump for priming purposes. It will also provide the necessary oil supply in case the main oil pump fails or when the turbine is not running.

II.3.3.5.7.7 Vapor Extractor

A motor driven extractor shall be installed on the top of the main oil tank to remove air and the moisture accumulation from the lubricating system.

II.3.3.5.8 Overhead Traveling Crane

An overhead traveling crane will be provided for the installation and maintenance of the generating unit. The crane must have a motor, main and auxiliary hoisting, and trolley traversing with two motors for each bridge.

The rated capacity of the crane should be sufficient to handle the heaviest piece of the unit. The capacity will be specified by the manufacturer of the turbo-generator.

II.3.3.5.9 Fire Protection System

A fire protection system shall be installed to safeguard against combustible elements of the power station .

Water hydrant fire protection system shall be provided for the power house, cooling towers and the entire area of the plant compound. The flow capacity of hydrants will be about 190 li/min for the indoor hydrants and 380 li/min for the outdoor hydrants.

The electrical rooms in the powerhouse as well as the control room and indoor and outdoor lubricating tanks shall be provided with carbon dioxide fire protection system. The fire protection system for electrical rooms as well as indoor and outdoor oil tanks in the powerhouse shall be operated automatically. A motor-driven siren warns persons before start of gas emission. The system for the plant main control board in the control room shall be operated manually. Portable type, dry chemical extinguisher shall be provided in the control room, chemical laboratory, staff's room, and other necessary rooms.

The step-up transformer area shall be provided with air foam hydrant protection system. It consists of hydrant valve, air foam proportioner, air foam liquid, and air foam nozzle. The flow capacity of air foam hydrant is 400 li/min.

An automatic water sprinkler system shall be provided for the cooling tower, lube oil reservoir and purifier, seal oil tank and the main transformer. A manual spray wetting system shall be installed in the cooling tower for operation during shutdown period/s to reduce flammability of wooden parts.

II.3.3.5.10 Standby Pump

A standby pump (diesel-driven) shall be provided and started automatically at times of power failure to the main pump.

A fire alarm and detection system shall also be installed within the powerhouse building and the entire plant area. The system shall consist of push button, pilot lamp and bell. The push button of the fire alarm devices shall be mounted on the wall at several locations in the powerhouse, control building and other strategic points within the plant site.

The detection system shall bear permanent identification to indicate circuit number, temperature range, etc. All essential parts of the installation which are not specified or specifically excluded shall be supplied and installed.

The systems and equipment shall comply with the Philippine Fire Code (PFC) and National Fire Code (NFC).

II.3.3.5.11 Air Conditioning and Ventilation System

Air conditioning and ventilation system shall be provided in order to maintain an atmosphere suitable for the electro-mechanical equipment and conducive to personnel comfort, safety and efficiency. The air conditioning system for the proposed power station shall be of packaged type, water-cooled units.

Cable ways and the powerhouse area shall be ventilated with the use of centrifugal blowers for the supply of air and roof ventilators for the exhaust. Air from the battery room, rest rooms and machine shop shall be exhausted by using propeller fans with gravity shutter. All exhaust fans shall be of corrosion-resistant type.

The outside air shall be taken in through a prefilter and H_2S absorption filters to provide dry, oil-free and purified air of suffient quantity.

III.3.3.5.12 Sewage and Drainage System

Materials for sewage pipes shall be PVC pipes for above ground applications, with proper anchorage and joint scaling. Embedded piping shall be cast iron material. The sewage shall be discharged to a septic tank below the ground with fluid drains and located such that it will not contaminate ground water.

Materials for drainage shall be reinforced concrete pipe that conform to ASTM requirements. Joints shall be collared and sand bedding shall be provided.

II.3.3.6 Expected Project Size and Scale

Maibarara Geothermal Power Plant when operated is expected to add 10 MW to the Luzon Grid. The power to be generated will be tapped to the grid via the 69 KV system emanating from the radial breaker scheme at Maibarara Gas Insulated Switchyard (GIS).

During normal operation, the steam requirement of the proposed plant is estimated to be about 77,776 Kg/hr.

Total construction cost for the project is $22.754 million. The project is expected to operate by April 1994 and will have an economic lifetime of 20 years.

II.4 Noise, Wastes, Emissions and Effluents

II.4.1 Noise

Present background noise level in the proposed site is that of a typical remote area. The sources of noise are the birds and insects, a few number of jeepneys plying the area at few, long intervals and domestic noise.

Noise during construction phase will be expected to increase because of increase vehicular traffic and due to operation of construction equipment.

During normal operation period, noise will be coming mainly from the cooling tower fans, falling water, pumps and motors.

The noise levels within the building or structure containing the works shall not exceed the ISO NRN 85-90 levels over the octave band mid-frequency range between 62.5 and 8000 Hz, for full habitual exposure of both maintenance and construction staff in working areas where ear protection devices are not used.

The noise levels in control rooms shall not exceed the ISO NRN 50-60 levels over the octave band mid-frequency range between 250 and 2000 Hz.

II.4.2 Solid Wastes

During site clearing, solid wastes will compose mainly of coconut tree parts, shrubs and grasses. Solid wastes generated during construction and operation stage will compose of garbage and waste brought about by the influx of construction workers and from regular maintenance activities. Wastes shall be disposed in-situ by burial or hauled to appropriate dumping sites. Sludge generated will be contained in a container and later on mixed with cement and then disposed in designated repository area according to DENR regulations.

II.4.3 Emissions

During start-up and normal operation, gaseous emissions will be ducted to the cooling tower fan stacks.

II.4.4 Effluents

Liquid effluents from the operation of the proposed plant will compose of the cooling water blowdown, rainfall run-off, and domestic effluent. Rain water will be discharged to the drainage canals, while domestic wastes will be directed to the septic tanks.

The cooling water blowdown is condensed steam like freshwater, pre-treated with NaOH to adjust the pH to minimize corrosion in the cooling tower. This will also carry solids and some gases contained in the incoming steam plus some dust naturally scrubbed from the air passing through the cooling tower. Cooling tower blowdown will be reinjected to reinjection wells. In case the reinjection system will fail or during maintenance, geothermal effluents will be impounded in an adequately-sized, leak-free sump or pond.

II.5 Employment Possibilities

The local residents shall be given top priority in employment. A few job opportunities will be available to unskilled and semi-skilled workers. Local recruits shall be given on-the-job training at the project site or in any of the existing geothermal power plant for upgrading of their capabilities.

II.6 Maintenance

Planned maintenance during normal operation will be carried out regularly. Regular inspection and maintenance of the steam generators will be undertaken in accordance with the manufacturer's recommendations.

II.7 Contingency Plan

The plant will be designed to withstand natural calamities such as typhoons, rainwater flooding, landslide and earthquakes. In addition, the plant is provided with safety devices which will shut it down when upsets or faults occur.

II.8 Abandonment

The predicted useful life of the proposed power generating unit is about 20 years. After this period, operation of the plant may become uneconomical and abandoned, or the plant may be rehabilitated if the steam supply is available.

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In case of abandonment, usable plant structures will be utilized in the rehabilitation of other NAPOCOR plants/projects. Components that are in good condition will be utilized as spare parts of other generating units. Buildings and roads at the site will be left and turned over for other purposes by the local government or residents.

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Table II.1

CONSTRUCTION SCHEDULE

MAIBARARA GPP EIS: MAY 1992

10 MW MAIBARARA GEOTHERMAL POWER PROJECT SCHEDULE

SHORT LISTING

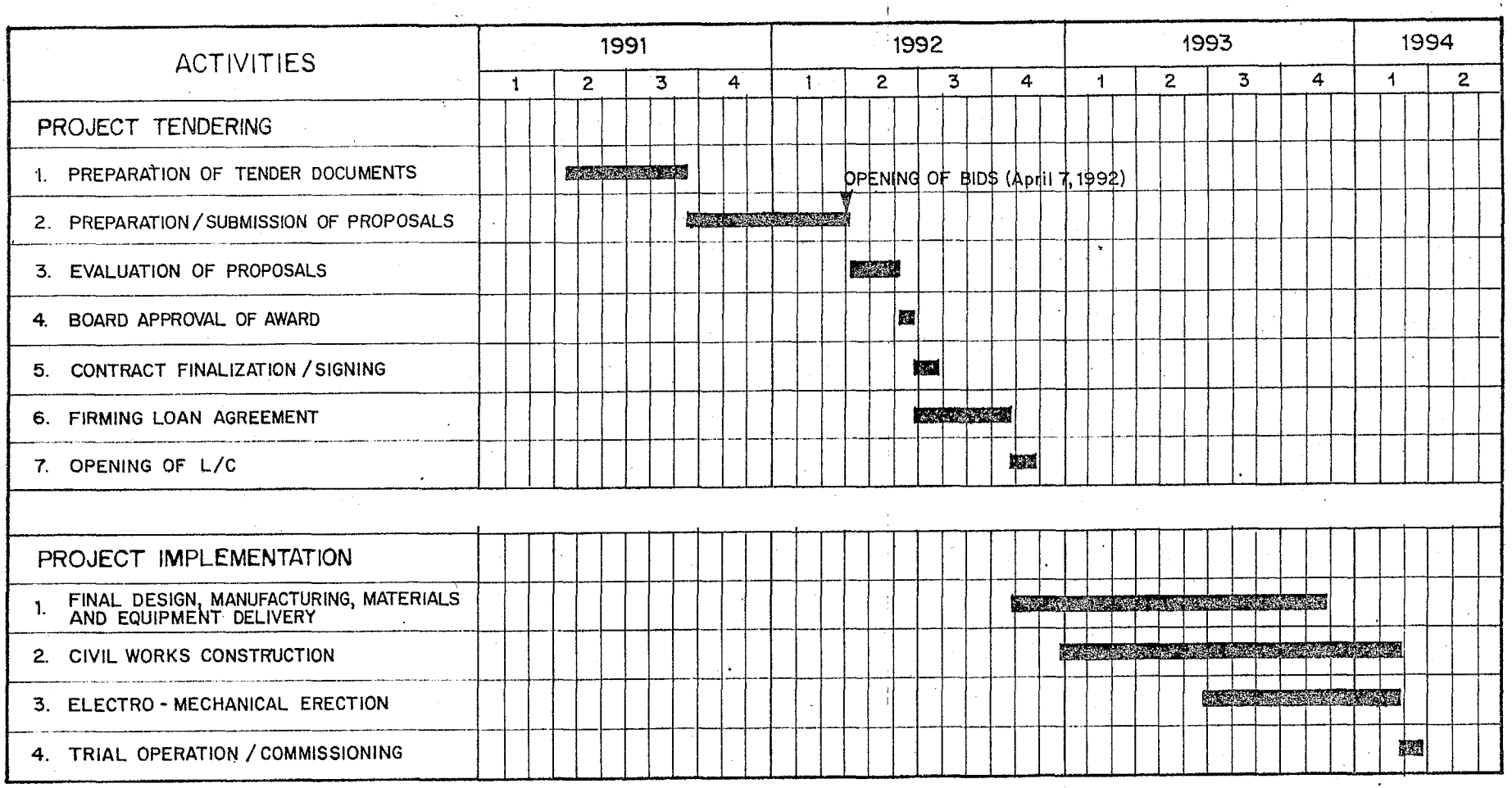

Table II.2

Geothermal Steam Well Data

Maibarara GPP EIS: May 1992

Well Name		3D	5	6	9	11
Well Data						
a. Total Depth (meters)		2,979	2,564	1,982	1,680	2,856
b. CHF Coordinates	mE	517,632.92	517,650.91	517,808.77	517,781.32	517,752.65
	mN	1,563,898.89	1,563,884.21	1,563,662.17	1,563,675.65	1,563,686.15
Discharge Data						
a. Wellhead Pressure	(Mpag)	1.18	1.03	1.25	1.18	0.93
b. Total Mass Flow	(kg/s)	34	21	32	55	20
c. Enthalpy	(kj/kg)	1,519	1,693	2,249	1,251	1,389
d. Steam Flow	(kg/s)	12	10	23	12	6
Others						
a. Max. Measured Temp.	(°C)	310	322	324	247	318

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Table II.3

Average Non-condensable Gas Analysis

Maibarara GPP EIS: May 1992

Well Number	Composition, Mole Percent in Dry Gas				
	CO_2	H_2	CH_4	N_2	O_2
3D	96.68	0.30	0.06	0.96	0.02
5	97.30	0.70	0.01	0.64	0.01
6	96.25	1.25	0.01	0.30	0.01
9	97.70	0.53	0.04	0.92	0.01
11	97.32	0.18	0.02	0.87	0.06

One Analysis of Maibarara Well #11 steam condensate showed:

H_2S	445 ppm
NH_3	4.0 ppm

Table II.4

Composition of Separated Brine and Steam

Maibarara GPP EIS: May 1992

Separated Brine Composition	MAI-3D	MAI-5	MAI-6
Ph 25 °C	6.0	6.1	5.8
SiO, mg/l	1030	860	870
B, mg/l	51	110	100
Cl, mg/l	8700	11330	7710
SO_4, mg/l	10	16	7
HCO_3, mg/l	34	39	37
Na, mg/l	4760	6090	4120
K, mg/l	1260	1700	1190
Ca, mg/l	90	300	78
Mg, mg/l	0.21	0.14	0.07
Steam Composition			
Ph 25 °C	4.0	4.0	4.1
SiO, mg/l	300	10	60
B, mg/l	19	3.4	7.5
Cl, mg/l	2500	200	560
SO_4, mg/l	<4.0	<4.0	<4.0
HCO_3, mg/l	15	15	13
Na, mg/l	1310	99	280
K, mg/l	360	55	100
Ca, mg/l	26	4.5	5.6
Mg, mg/l	0.075	0.022	0.017

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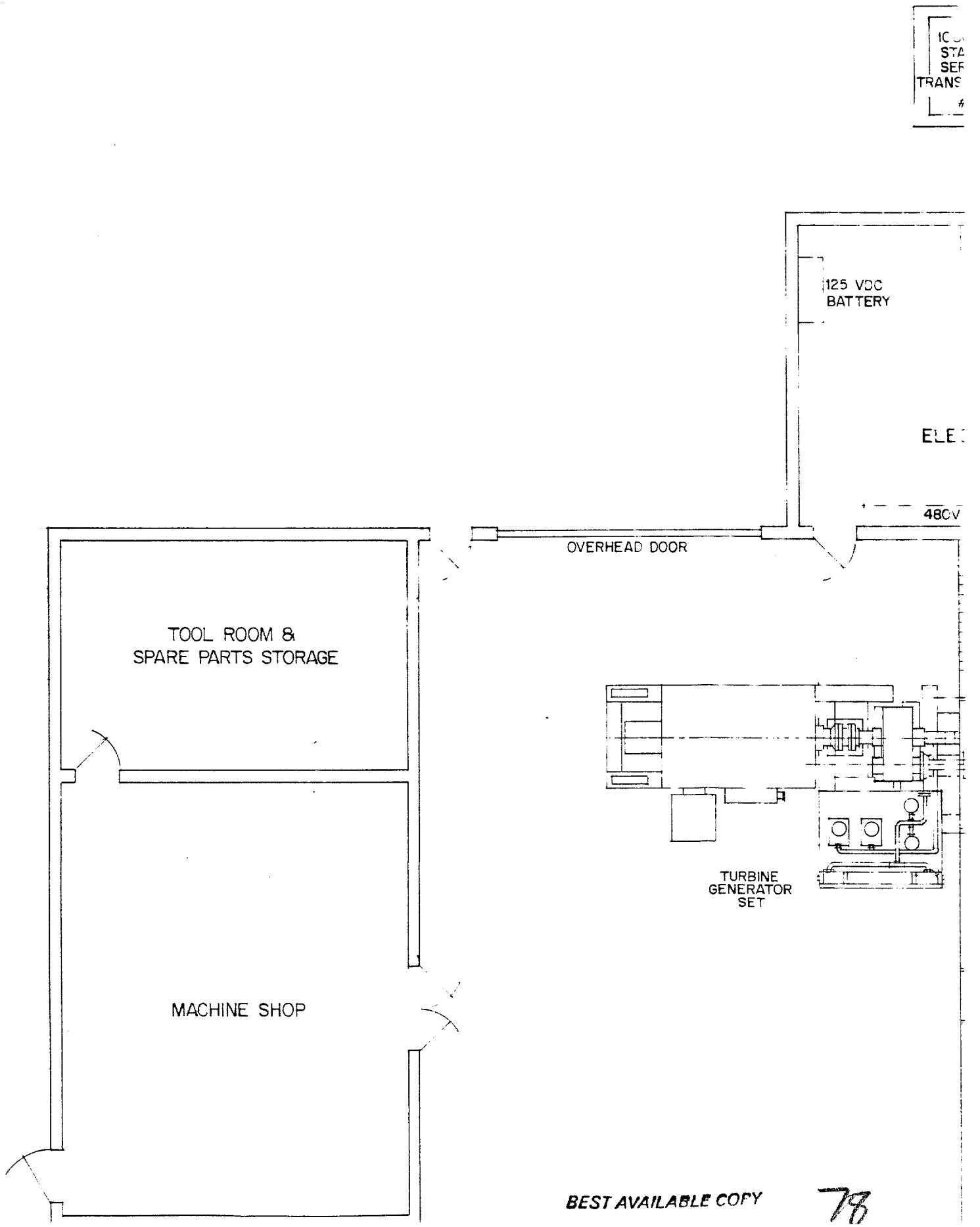

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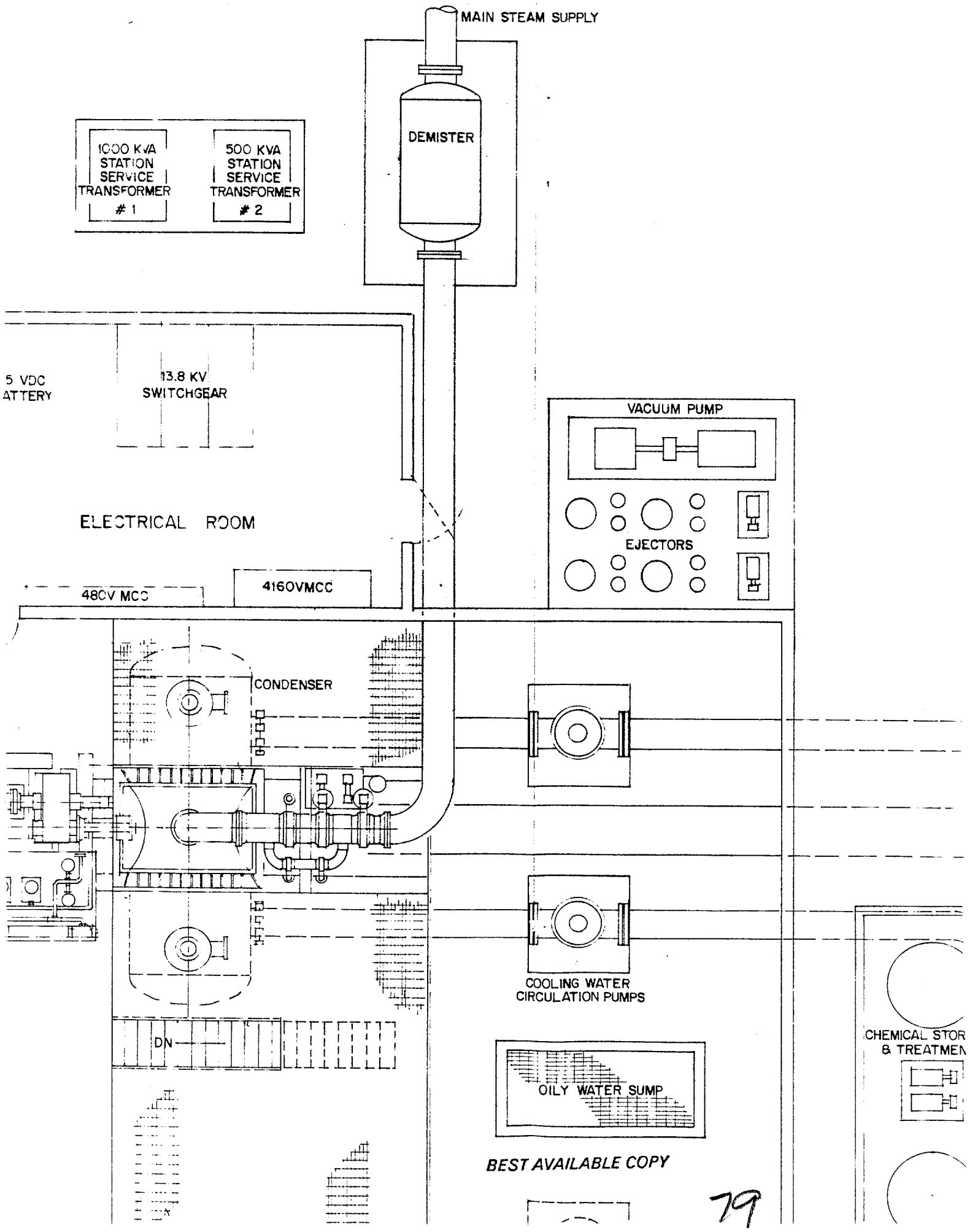

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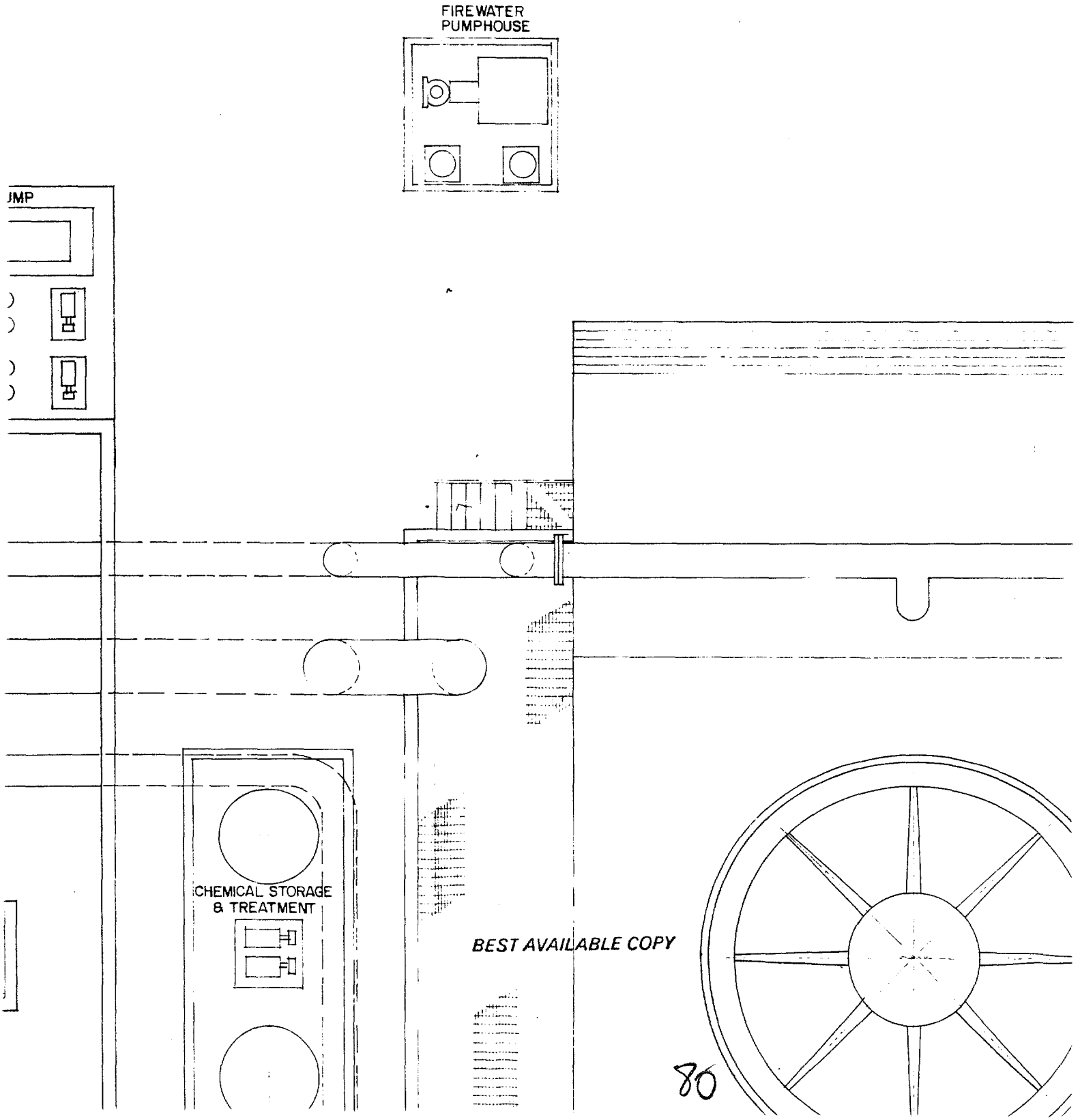

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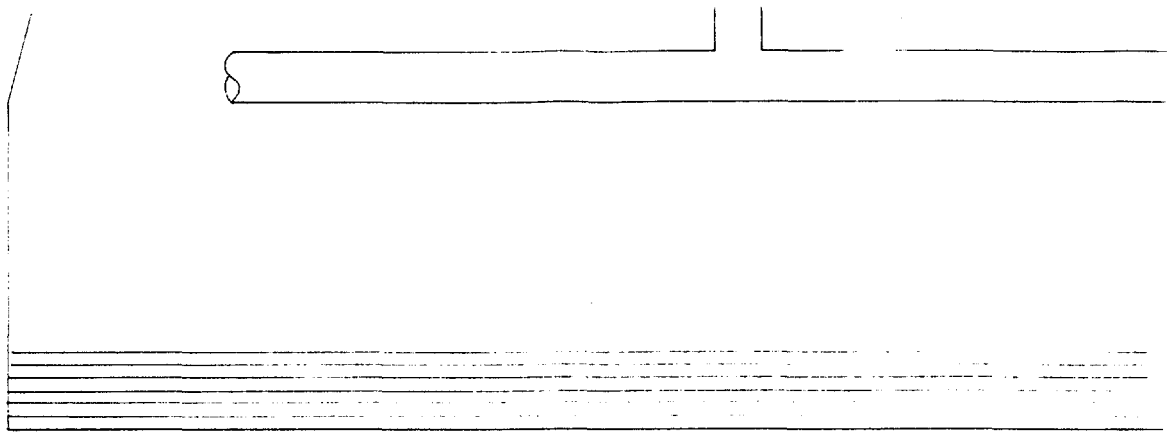

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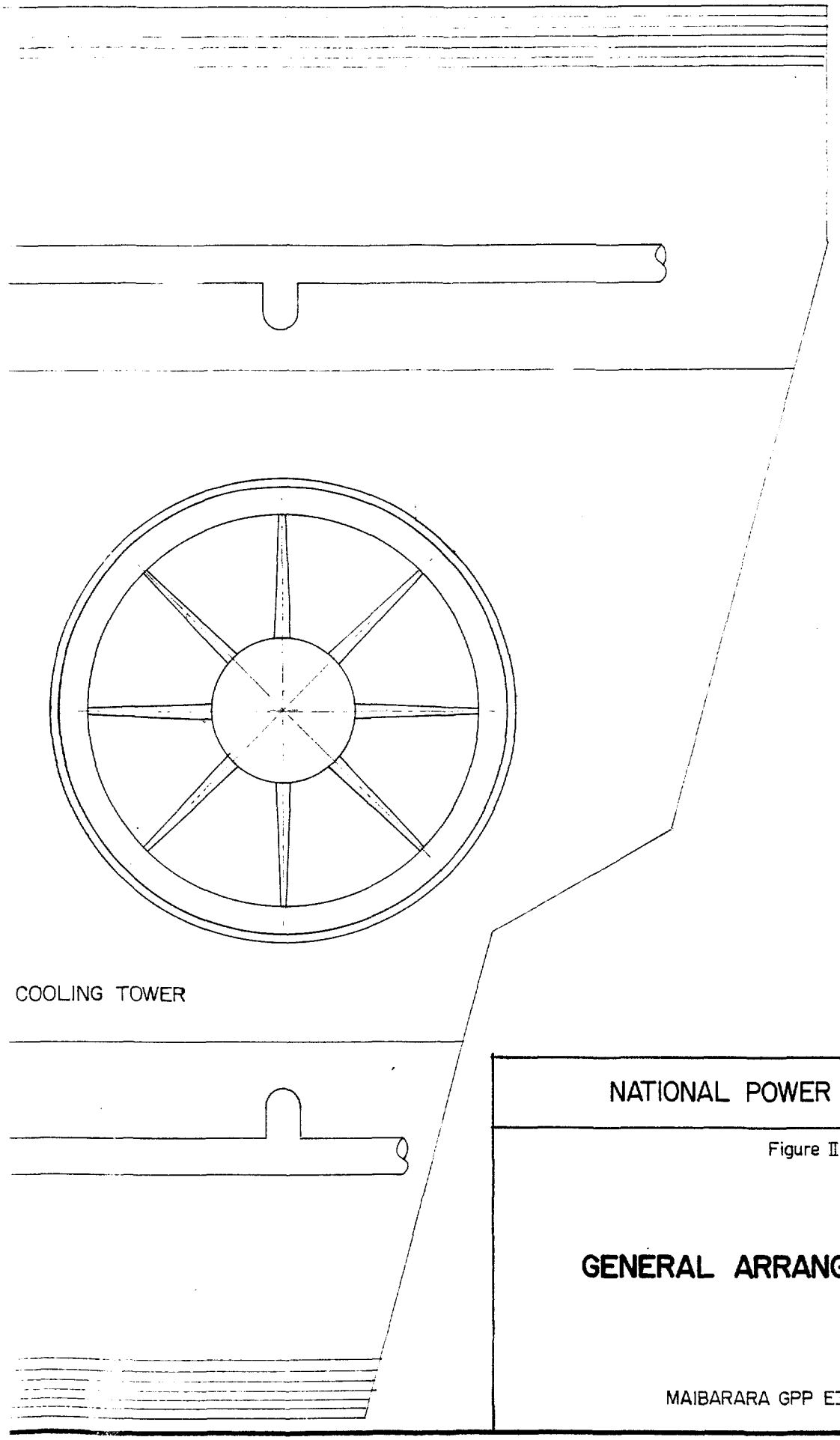
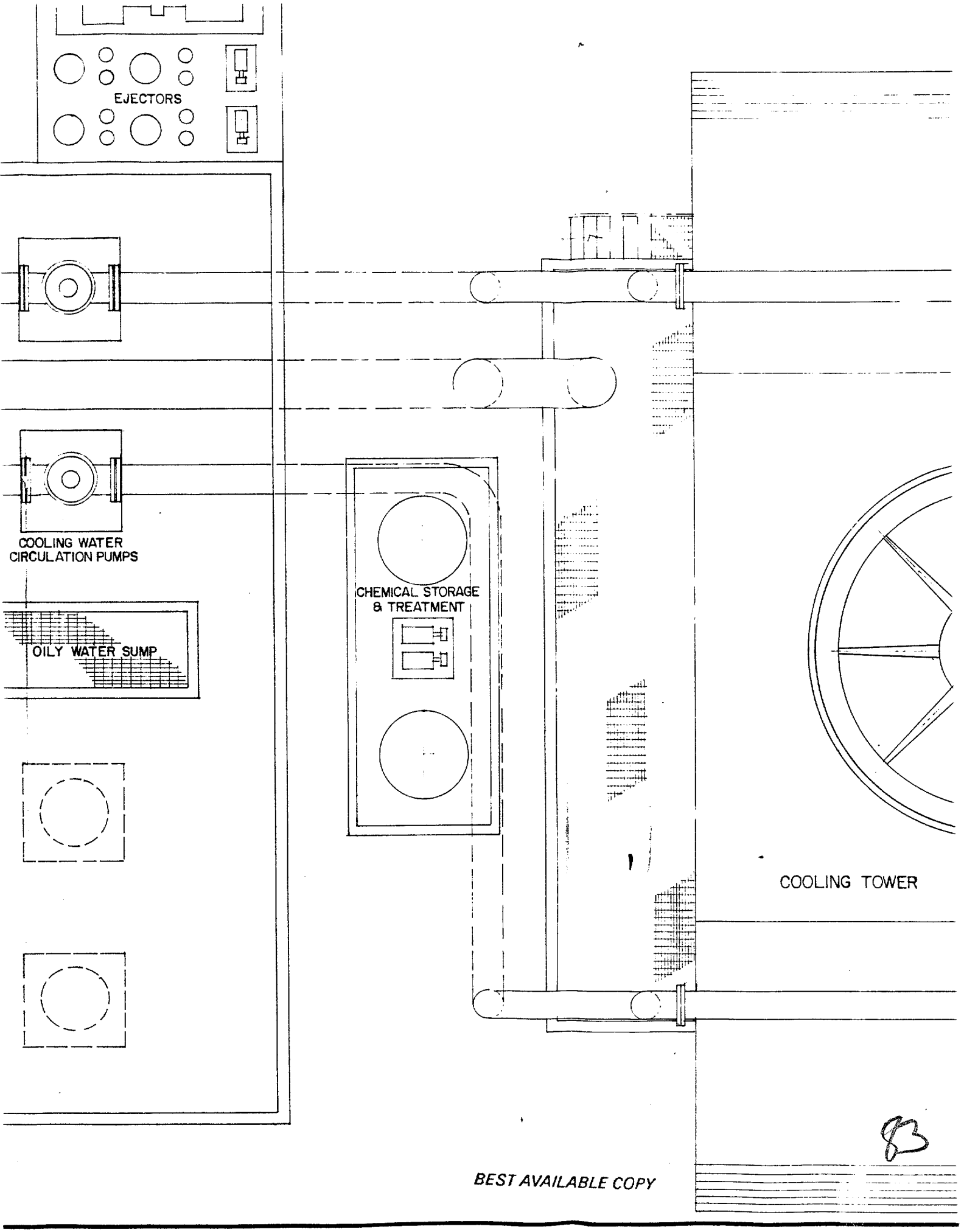


NATIONAL POWER CORPORATION

Figure II-1

GENERAL ARRANGEMENT PLAN

MAIBARARA GPP EIS: MAY 1992



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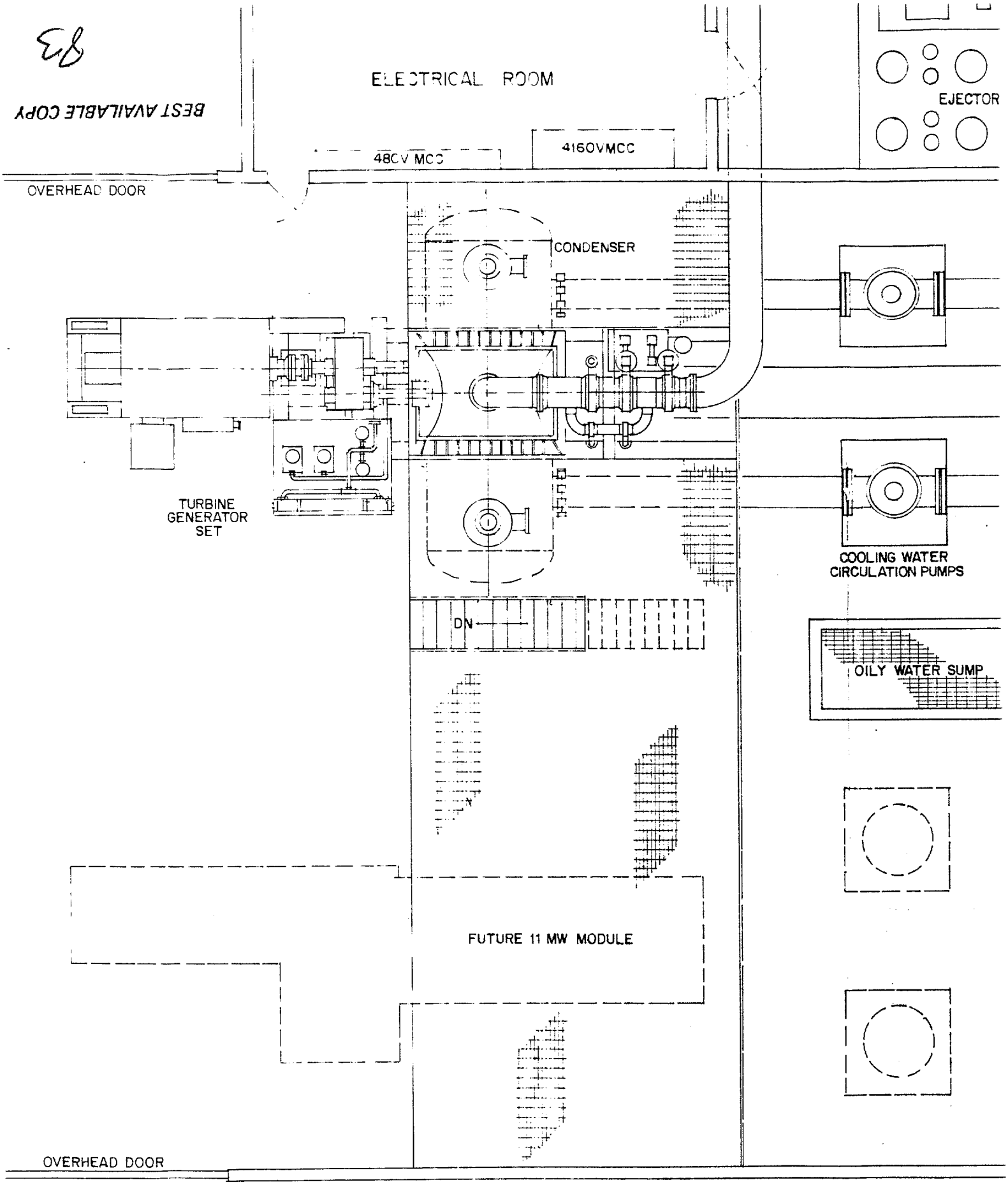

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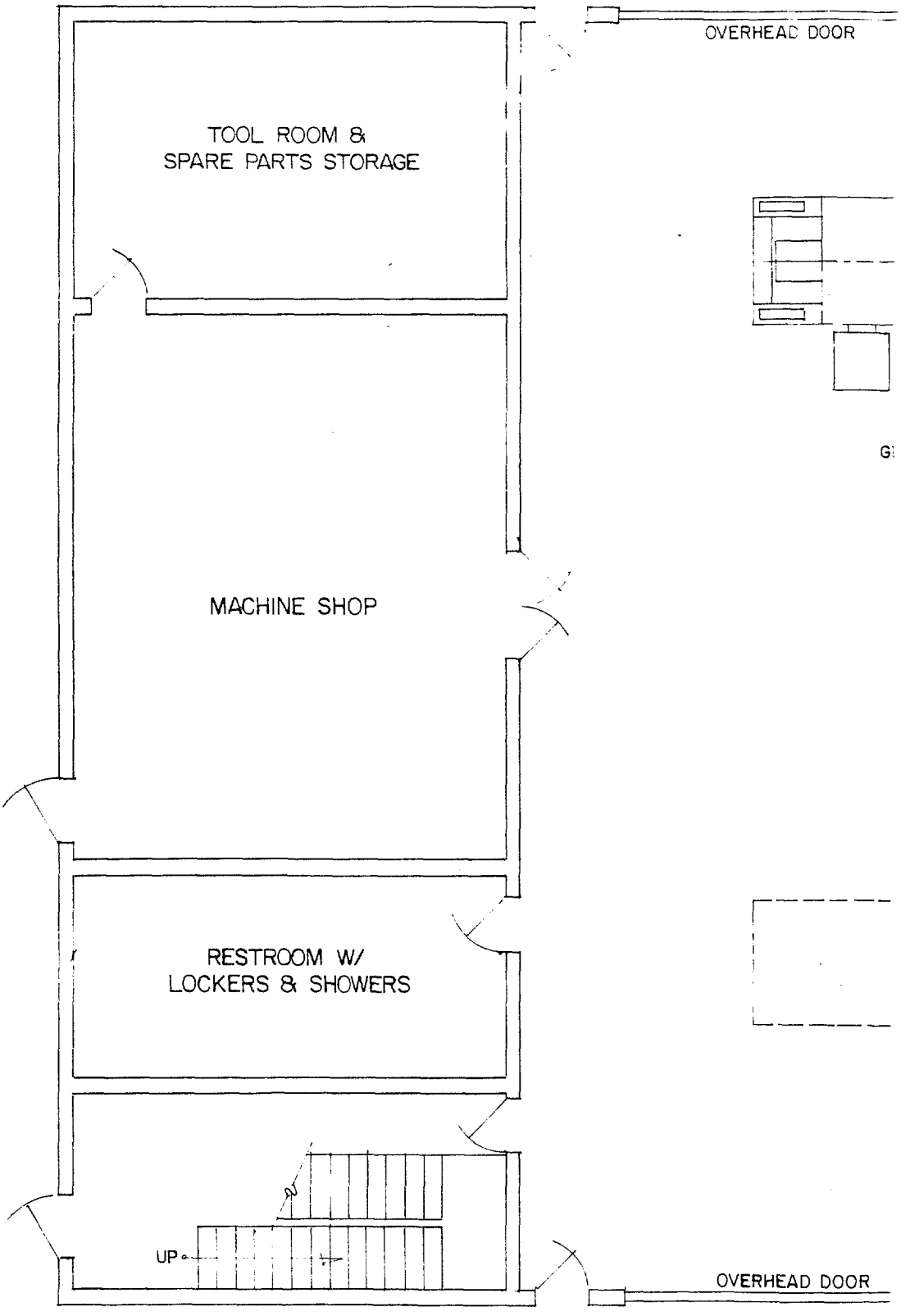

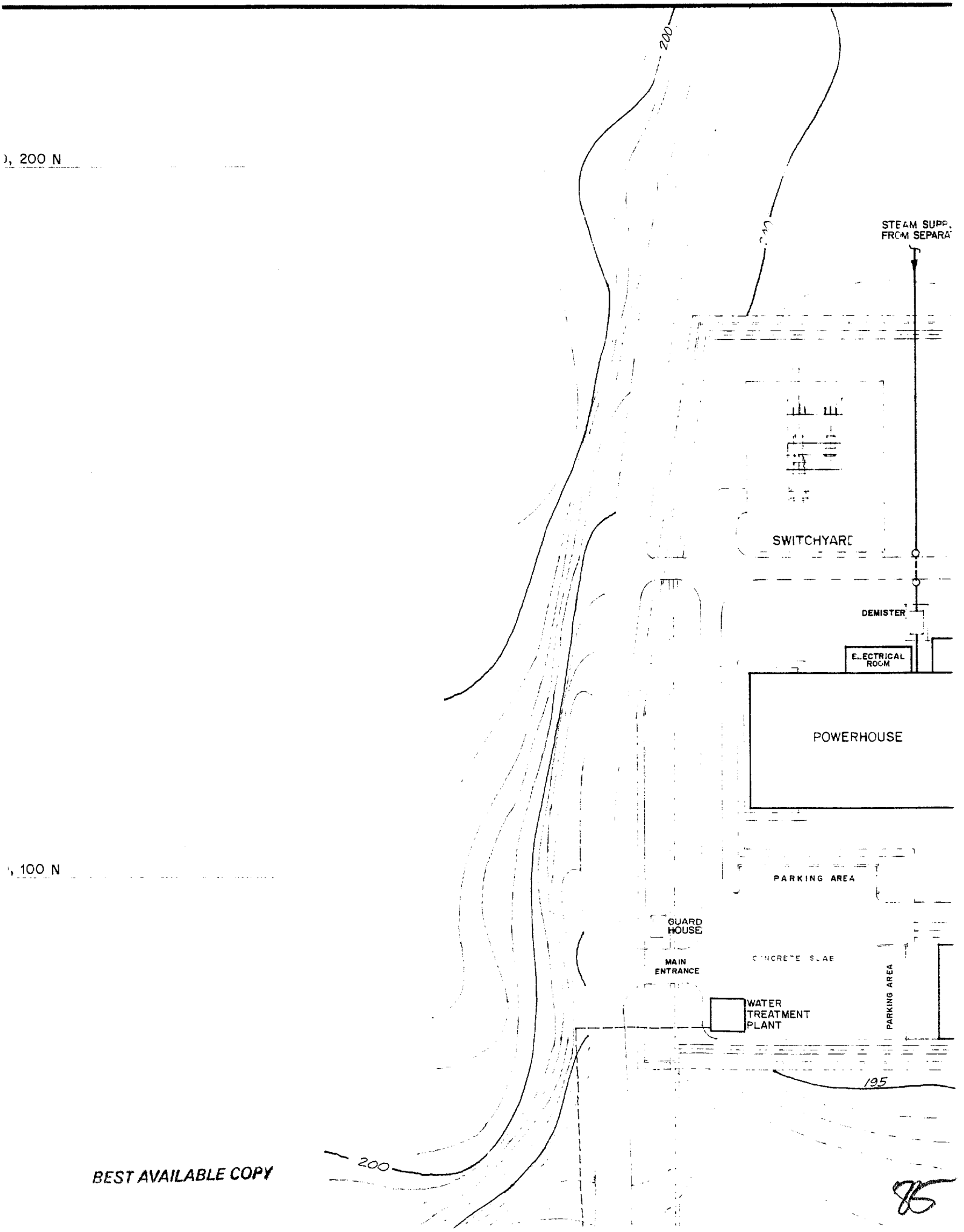

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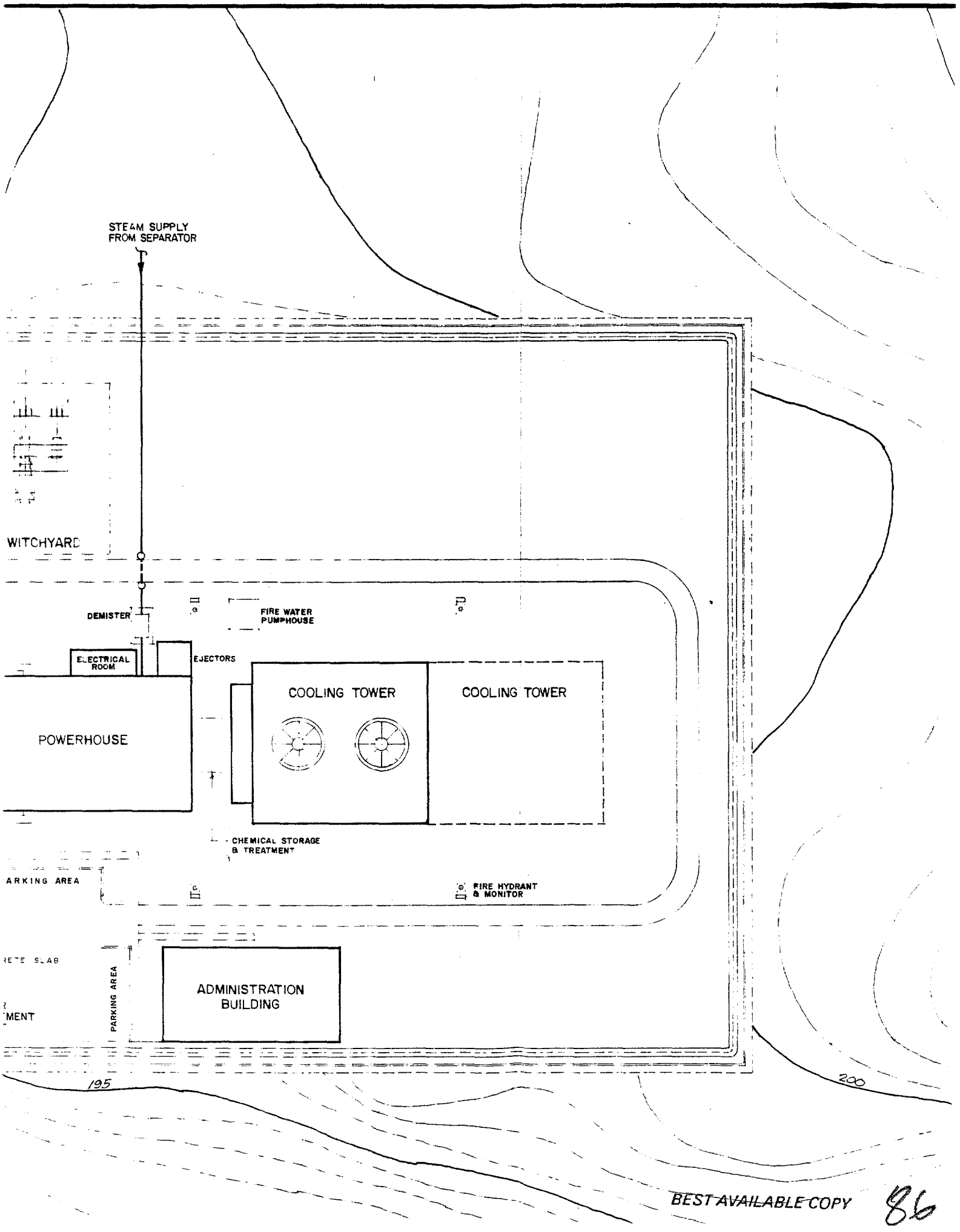

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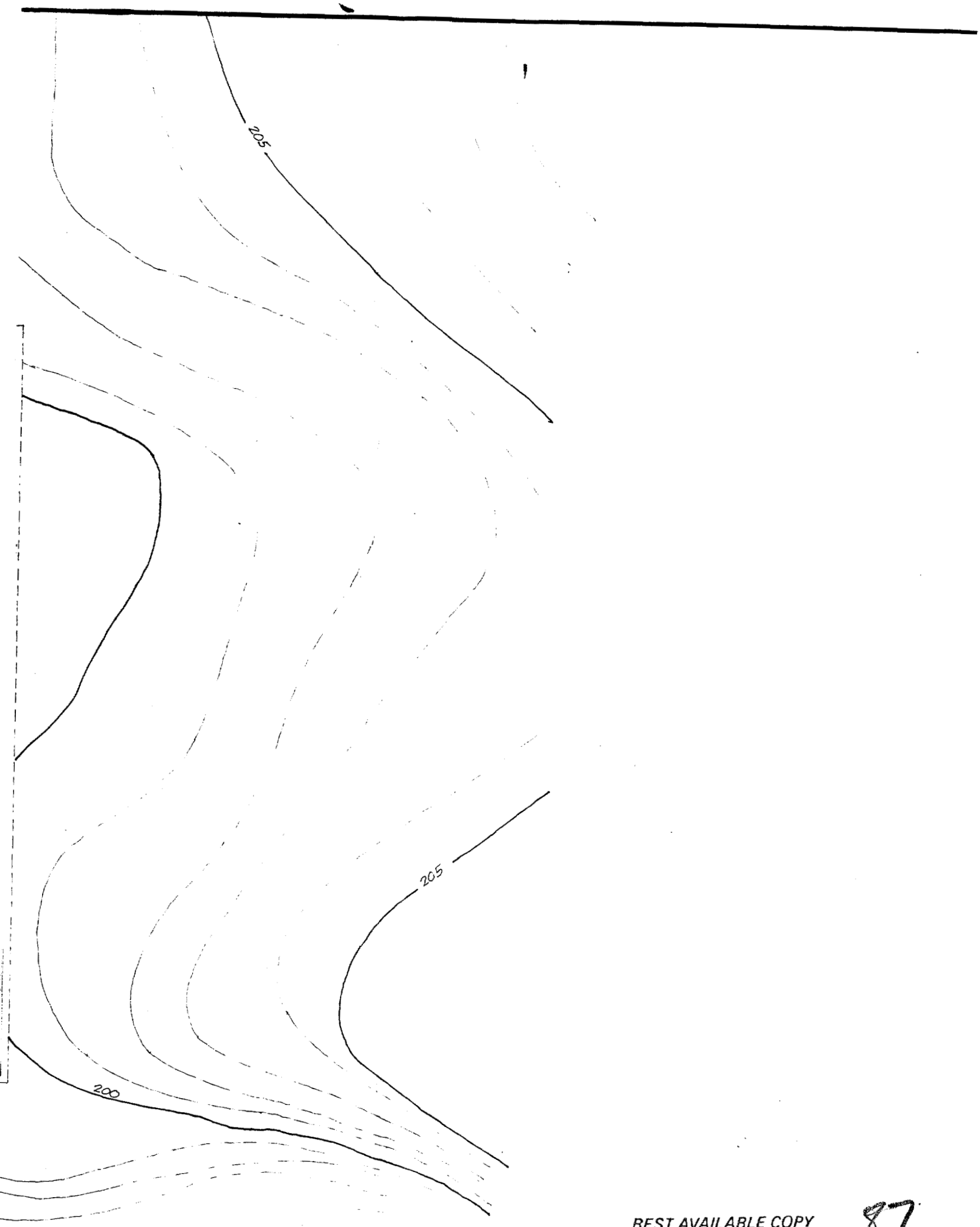

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Figure II-2

SITE DEVELOPMENT PLAN

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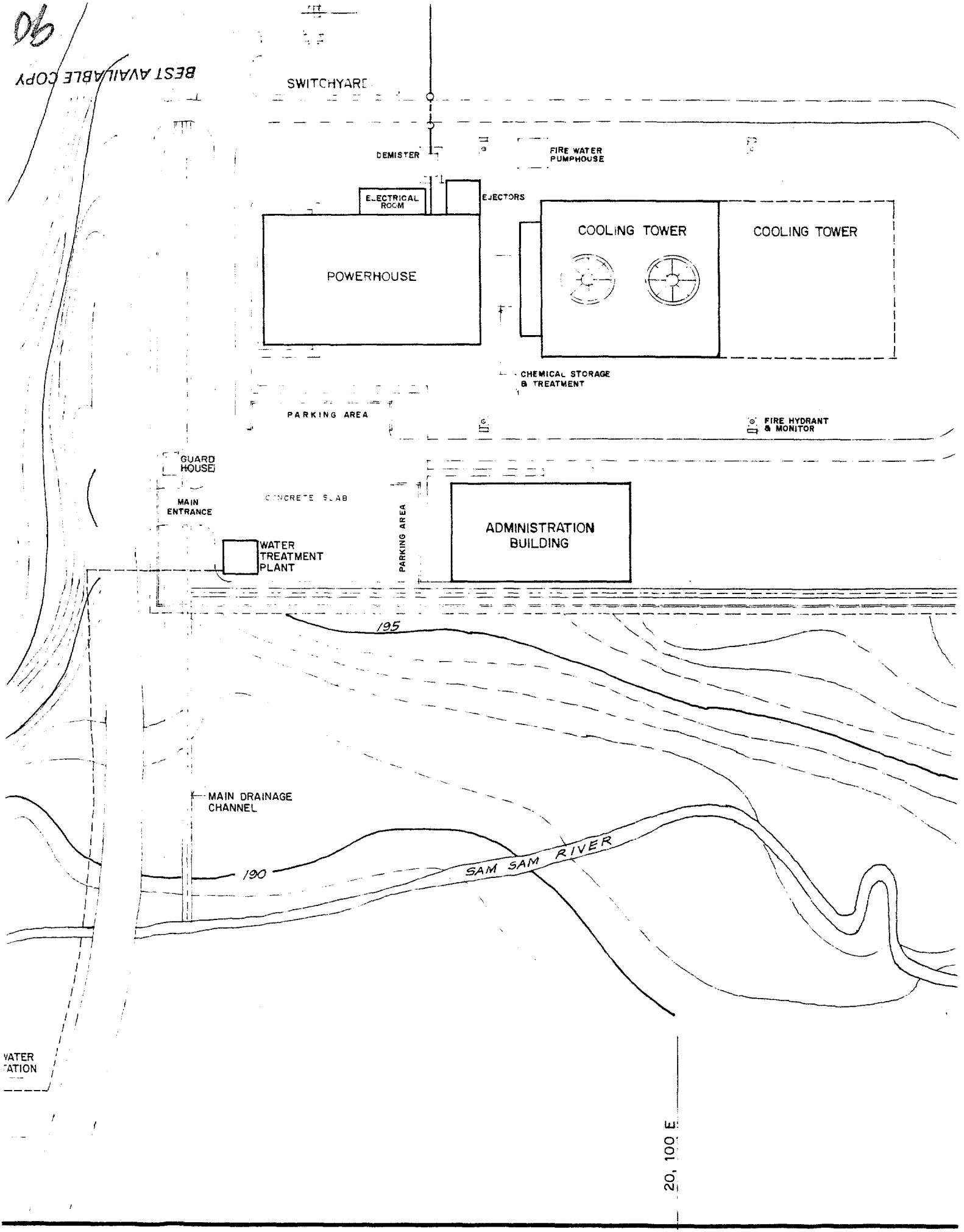

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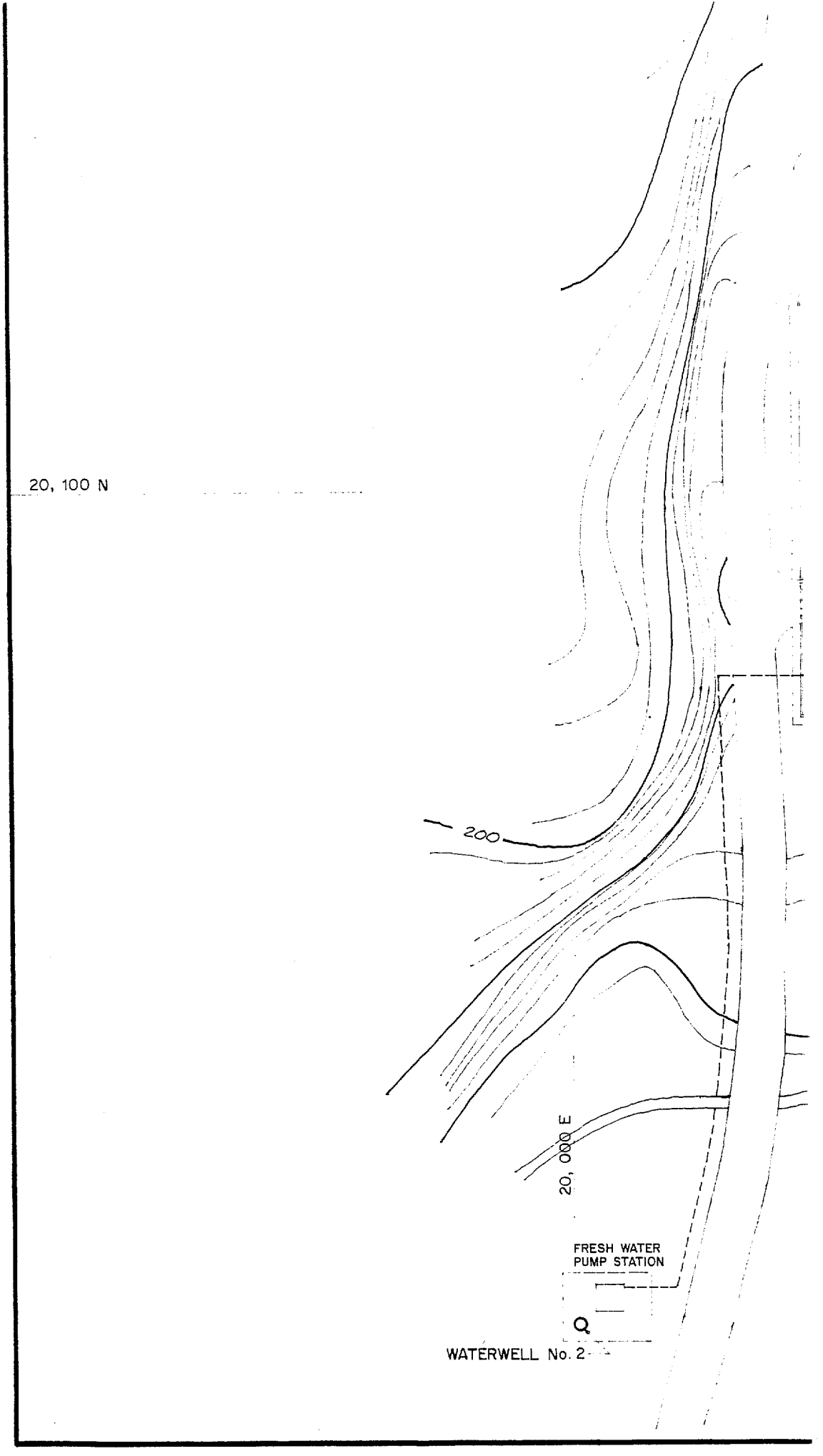

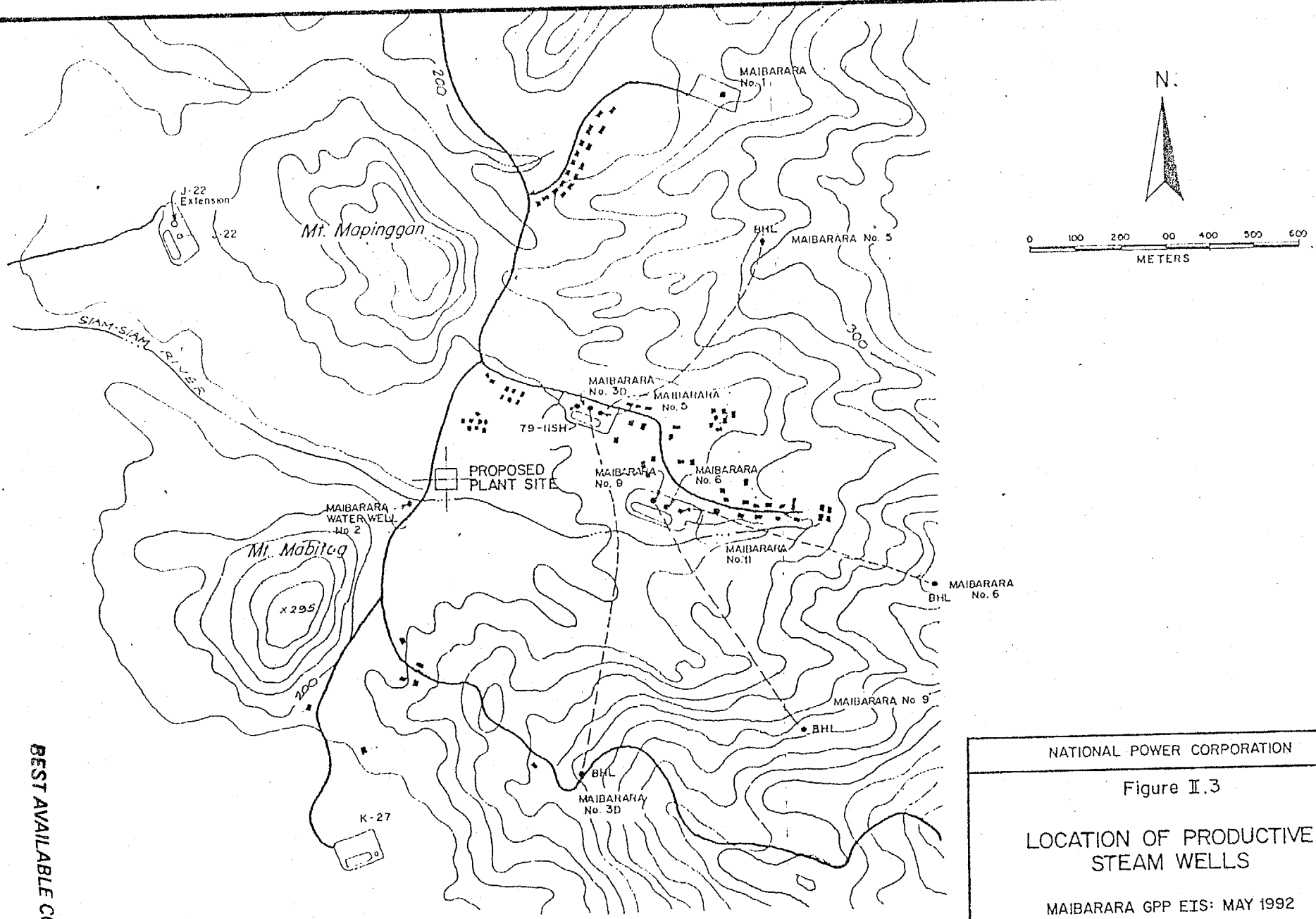

NATIONAL POWER CORPORATION

Figure II.3

LOCATION OF PRODUCTIVE STEAM WELLS

MAIBARARA GPP EIS: MAY 1992

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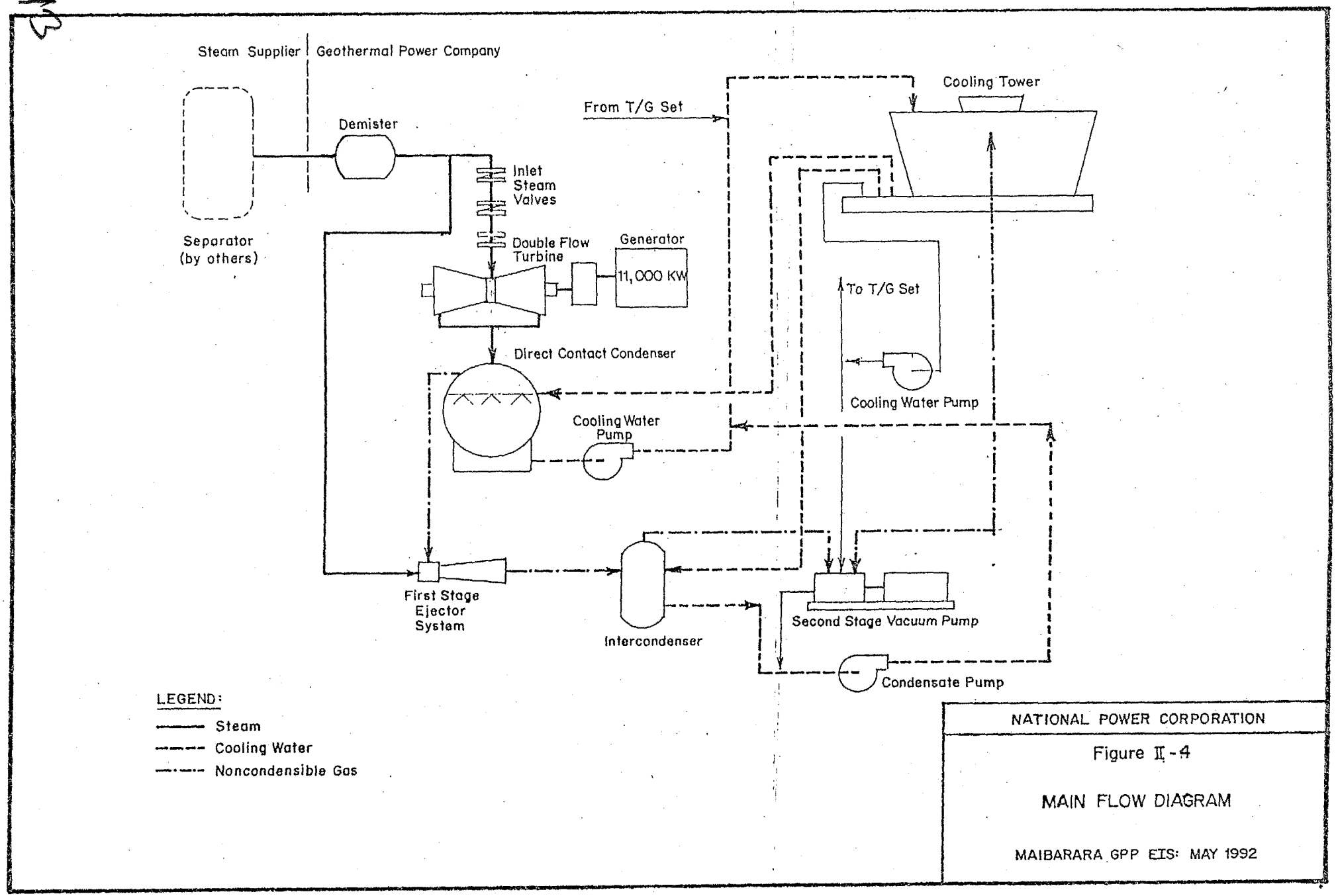

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Figure II-4

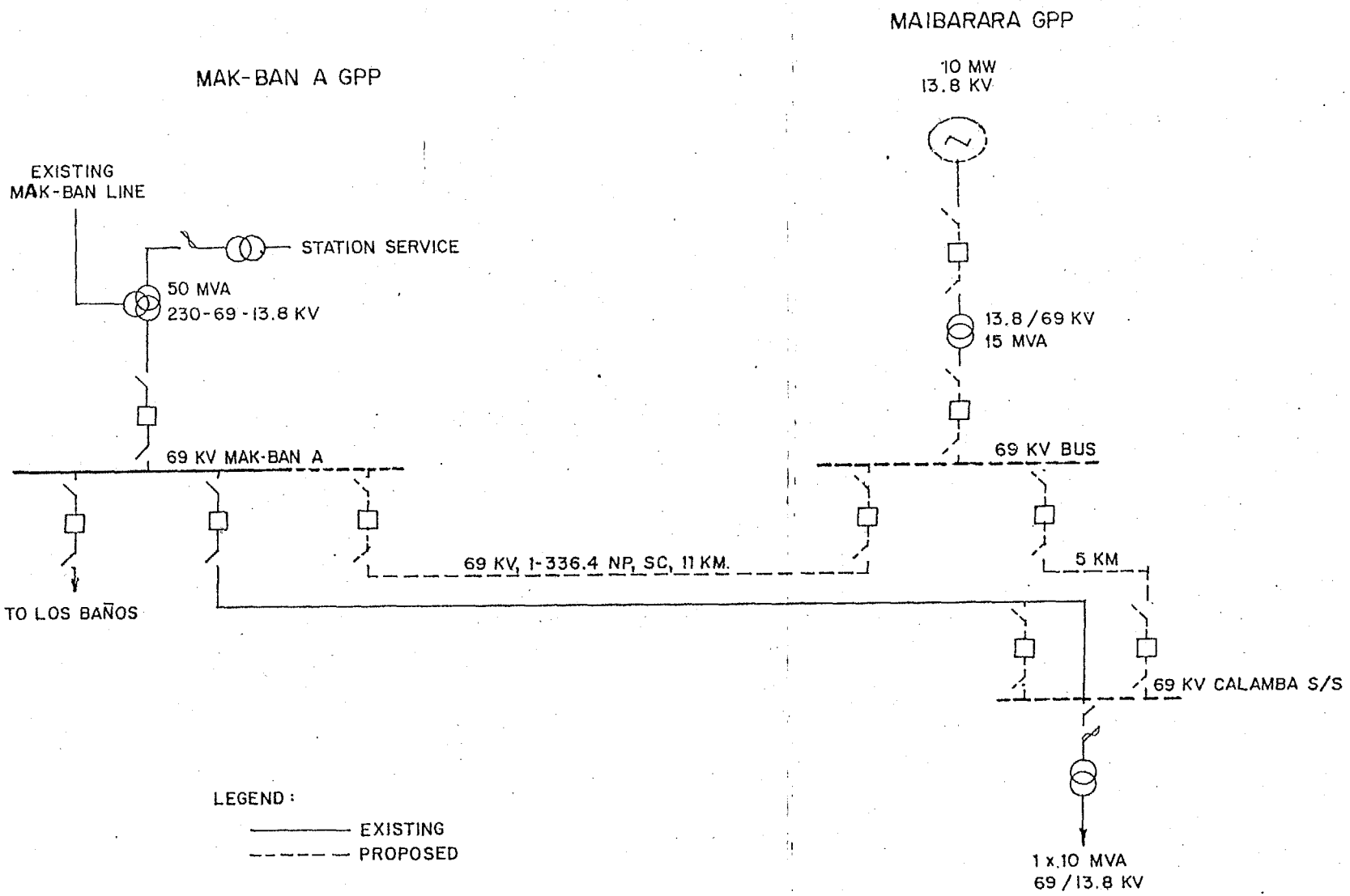
MAIN FLOW DIAGRAM

MAIBARARA GPP EIS: MAY 1992

Figure II.5

SYSTEM ONE LINE DIAGRAM

MAIBARARA GPP EIS: MAY 1992



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Chapter III

Existing Environment

MAIBARARA GEOTHERMAL POWER PLANT

III Existing Environment

III.1 Geology/Terrain/Soils

III.1.1 Geology

The site is centrally located between the southeastern and southwestern flanks of Mt. Makiling at elevation 220 masl. Four (4) topographic reliefs aligned in an almost northward direction exist, namely Mt. Mabitog (with peak height of 295 m AMSL), Mt. Mapinggon (285 m), Mt. Maibarara (298 m), and Mt. Masaya (268 m) believed to be of andesitic rock formation (see Figure III.1-1). The area seems to have undergone intense weathering owing to the existence of thick overburden. The rock units underlying the proposed site could not be determined since no subsurface exploration was conducted. However, geologic mapping reveals four types of rocks in the area namely tuff, lapilli, breccia and andesite flow.

Ocular inspection of outcrops shows no near surface indication of vertical movement or other structural features such as folds or joints. Probable fracturing or faulting which provided the ingress of hydrothermal fluid to the geothermal wells exists at considerable depths.

Some 750 m NW of the site on Mt. Mapinggon is a rock quarry operated by Supreme Aggregates Inc., with a plant and bunkhouse located nearby.

III.1.2 Regional Geology

The period of active volcanism resulted to the deposition of sub-volcanics consisting of intercalated andesite flows, agglomerates, tuffs and breccia interbedded with marine sediments of late miocene to middle pliocene. Volcanism continued on into late Tertiary which gave rise to Mt. Makiling. Eastward migration of volcanic activity resulted in the formation of a post Makiling volcanic belt comprised of Mt. Banahaw.

Related to these is a second group of maars and cinder cones which lie to the southwest. The maars have crater rims still largely preserved. Mt. Banahaw is the largest preserved and it is the largest volcanic

structure in the district. Farther to the south is Taal Volcano, representing the latest volcanic activity.

III.1.1.2 Site Geology

The proposed site is located at the foot of the western flank of Mt. Makiling. Four (4) prominent topographic reliefs lie in a North to South direction namely, Mt. Masaya, Mt. Mapinggon, Mt. Maibarara and Mt. Mabitog, and are quite visible in this area ranging in height from 290-300 masl (Fig. III.1-1). The proposed site is NNE of Mt. Mabitog and SSE of Mt. Mapinggon.

The topography of the project site is 200 masl and drops to 140 masl towards the national road. The highest topographical structure adjacent to the proposed site is Mt. Makiling which towers to a height of 1,100 masl.

The rock units exposed in the area consist of pyroclastic rock and volcanic flow with andesitic composition. The pyroclastic rock is made up of lapilli, tuff and breccia.

Resistivity survey (PGI) reveals the existence of dacite, hornblende andesite, and tuff (Fig. III.1-2).

III.1.2 Terrain

There are four hills aligned in the northward direction existing in the area, namely: Mt. Maibarara with peak height of 288 meters; Mt. Masala, with peak height of 268 meters; Mt. Mapinggon with peak height of 285 meters, and Mt. Mabitog, with peak height of 295 meters.

The watershed has a total area of 440.33 has. with generally steep to very steep topography. More than 95% of the area belong to 18% and above slope gradient while only over 4.44% of the total area belong to the lower slope categories. Half of the site has slope ranging from 25 - 35 percent. A third portion belongs to slope ranges above 35% hence reflecting the vulnerability of the area to runoff erosion.

The highest elevation in the area is 920 masl while the lowest is 190 masl. Three major sub-catchments are distinguished: the first includes portions of Sitio Puting Lupa, Calamba, Laguna, the outlet draining in

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between Mt. Maibarara and Mt. Mapinggon; the second and third catchments include portions of Sitio Capus, Brgy. San Rafael, Sto. Tomas, Batangas, the intermittent creek outlet draining in between Mt. Mapinggon, and Mt. Mabitog. These sub-cathcments lie within the 1 km radius of the project site.

III.1.3 Soil

Three (3) types of soil are identified at project site, namely, the Macolod clay loam, the Macolod clay loam (steep phase), and Lipa loam. Rolling areas are covered with Macolod clay loam while steeper areas were identified with Macolod clay loam (steep phase). The Lipa loam occupies relatively flat areas.

III.1.3.1 Physical Characteristics of Rocks/Soil

The rocks found in the area are of volcanic origin. The pyroclastic rocks consist of tuff, lapilli and breccia with sizes ranging from less than a millimeter to boulder size. The tuffs are cemented in a common groundmass while the lapilli and breccia consist of phenocryst cemented in a finer ground matrix.

The andesite has a gray color, very hard when fresh. It is a mixture of Na, Al, Ca, silicate, CaO with small amount of ferromagnesiun minerals.

The Macolod clay loam has a dark grayish brown to brown color and generally possesses fine rounded gravels, black andesite rocks exposed on steep slopes, and diffused inter-horizontal boundary.

The Lipa series consist of soils representing the residual product of the tuff deposit. The underlying strata of rocks are uniform and deeply weathered. The soil of this type is dark brown, very friable with gravel and tuffaceous concretions in the lower subsoils, and can be easily cultivated. These gravels and concretions are exposed in highly eroded sloping and hilly portions. While this type of soil shows evidence of lasting fertility, the present system of cultivation has led to the depletion of the soil because of pronounced effects of erosion.

Extensive soil physico-chemical studies have been conducted by the UPLB Hydroecology Program in 1979 on different slope ranges. Sub-surface soils are generally clayey in texture except for kaingins which

were observed to be fine textured, i.e. clay loam to sandy clay loam. This reflects a high degree of soil erosion taking place in the area. On the other hand, grasslands, secondary and plantation forests which are characteristically undisturbed ecosystems still possess clay contents greater than 35%.

The soils in the area are generally loose, friable and exhibit a light degree of soil compaction regardless of land use type. Undisturbed grassland and secondary forest were, however, observed to have lower values of bulk density and porosity attributed to their relatively higher organic matter content.

III.1.4 Geologic Structures/Seismicity

Three (3) geologic fault structures were identified in the project site (Fig. III.1-3), namely, the Makiling Arcuate Fault, Bijiang Fault and Maibarara Fault. The core reservoir appears to be bounded by these faults on its NW, NE, and SE sides. It is believed that the existence of geothermal fluids is intimately associated with these faults. According to the National Oceanographic and Atmospheric Administration (NOAA), USA, the Maibarara area is aseismic relative to other areas of the Philippines.

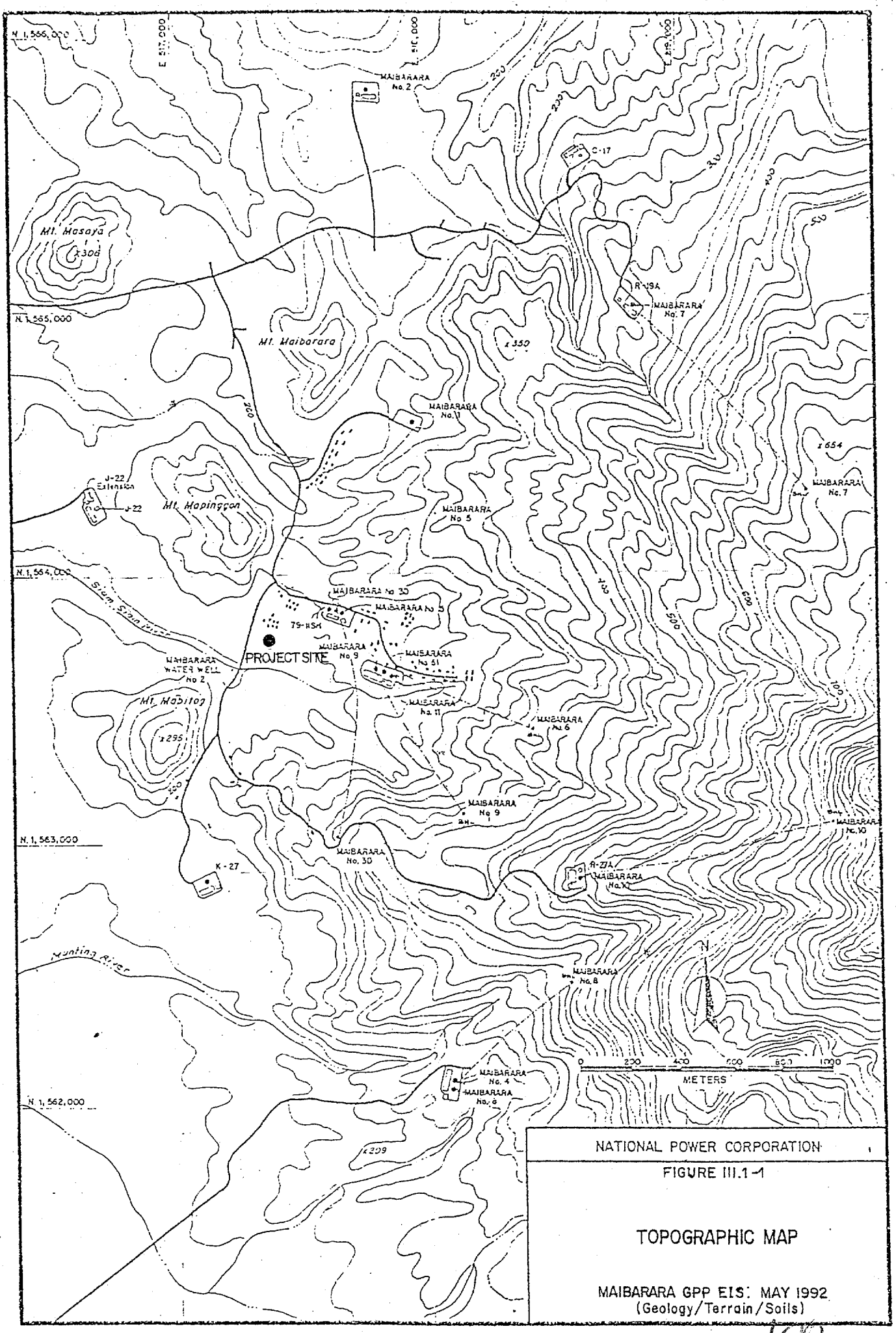

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FIGURE III.1-1

TOPOGRAPHIC MAP

MAIBARARA GPP EIS: MAY 1992
(Geology/Terrain/Soils)

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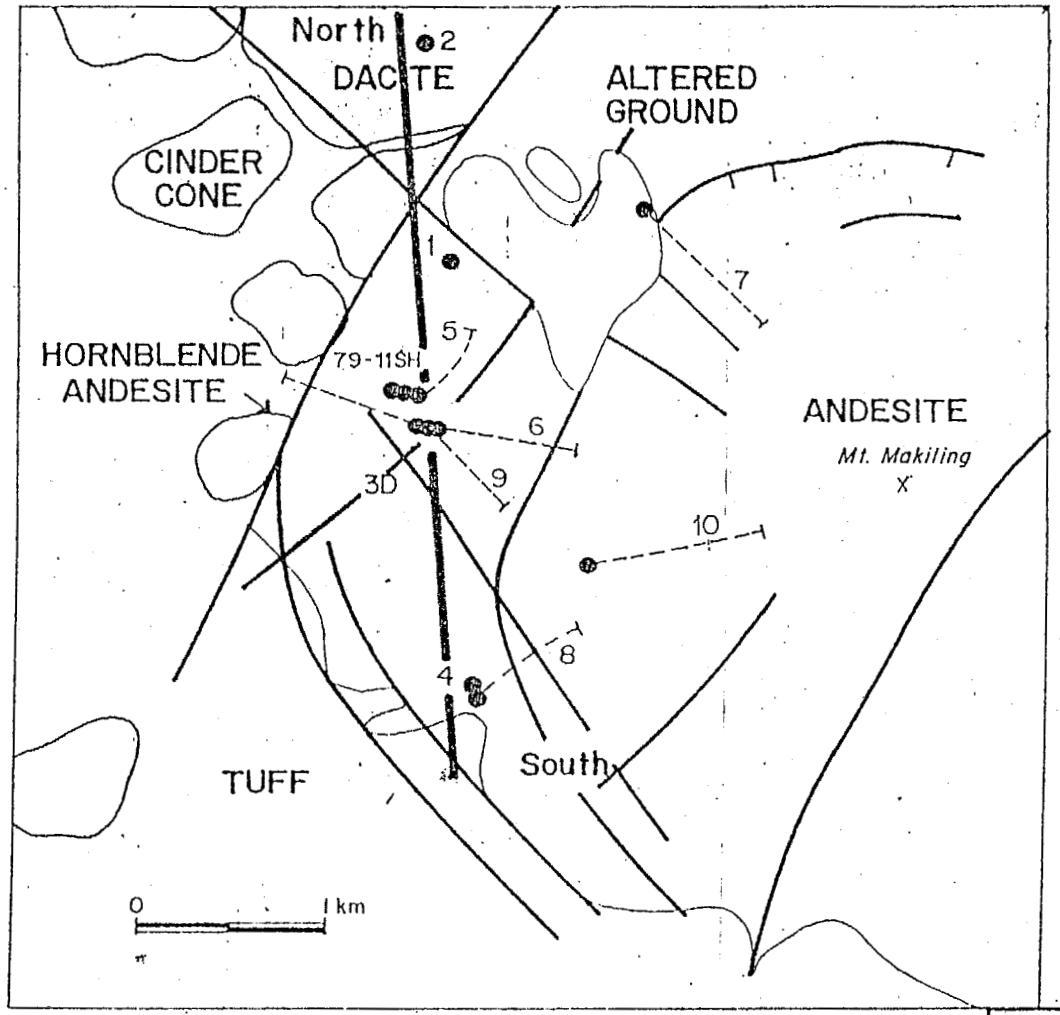

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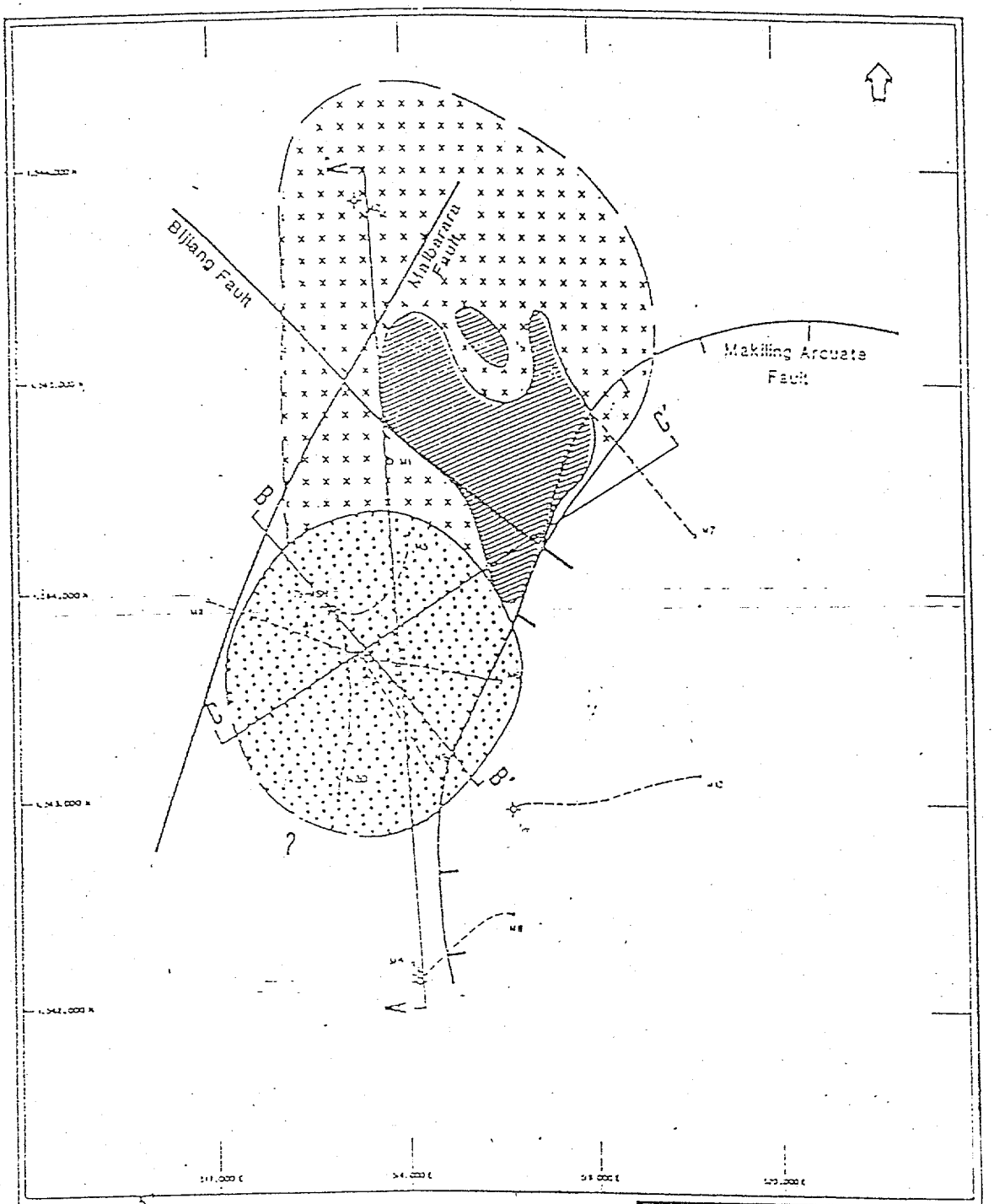
Figure III.1-2

MAIBARARA FIELD GEOLOGIC MAP

MAIBARARA GPP EIS: MAY 1992
(Geology/Terrain/Soils)



Cross-section

Proven productive area ~450acres

Shallow outflow

Surface alteration

LEGEND:

PRODUCER

INJECTOR (INCAPABLE OF COMM. PROD)

NON-COMMERCIAL

0.5 0 0.5 1.0 M

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FIGURE III.1-3

GEOLOGIC FAULT STRUCTURES

MAIBARARA GPP: EIS: MAY 1992
(Geology/Terrain/Soil)

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III.2 Meteorology and Air Quality

III.2.1 Meteorology

III.2.1.1 Regional Meteorology

The Maibarara project area is located on the western slopes of Mt. Makiling some 50 km SSE of Manila. Historical meteorological records from Ambulong weather station were used for the climatic characterization of the project area. This station is the closest climatological weather station to the project site and is almost 10 km SW of the project site. Fig. III.2-1 shows the location of the weather station relative to the project site.

Rainfall. The mean rainfall values are presented in Table III.2-1 and illustrated in Fig. III.2-2. From the table, it can be seen that August is the rainiest month at the project site, while the driest is February. The rainy season starts in May and continues until about November. The period from December to April is the dry season. The mean annual rainfall value is 1790.1 mm.

Temperature. The warmest month is May registering an average dry bulb temperature of 28.8 deg. C while the coldest is January with 25.3 deg. C average temperature. The highest temperature recorded during the period 1919 to 1986 (Climatological Extremes at Ambulong) was 38.8 deg. C on May 15, 1921 and the lowest was 16.0 deg. C observed on January 9, 1985. The monthly temperature profile for the project area is presented in Fig. III.2-2.

Relative Humidity. Relative humidity is generally high in the region vicinity of the project site having an annual mean value of 78 %. March and April are humid with an average value of 69.0 %. The rainy months as expected register high relative humidity values. Mean monthly RH value are given in Table III.2-1.

Wind Speed and Direction. Summary of wind vectors for the period 1951 to 1985 is given in Table III.2-1. As depicted in Table III.2-1, the most frequent wind direction in the area is NE. This NE wind speed in the area is 2 mps. The southwesterly wind prevails between May to September.

Cloudiness. The mean annual cloudiness at the region is 5 octas. Cloudy months prevail between June to September with an average cloud amount of 6 octas. The presence of clouds over the region occasionally couples with lightning occurrences with 82 cases of thunderstorms.

III.2.1.2 Site Meteorology

The proposed project site is characterized by mountainous topography which plays a primary role in the movement of wind at Maibarara. Relative to the project site, the tallest mountain which dominates the eastern areas is the Mt. Makiling. The presence of this mountain and other surrounding mountains (Mt. Mapinggon, Mt. Maibarara, Mt. Mabitog and Mt. Masaya) complicates the surface wind at the project site from 10 m to 1000 m above ground and affects the stability condition of the local atmosphere.
The complex terrain around the site causes anomalous air currents as does the non-uniform heating of variably sloped terrain. Consequently, several resultant meteorological conditions may occur, depending on the temperature structure as well as the direction and speed of the wind.

Wind Speed and Direction. During the Northeast Monsoon season, most of the surface winds is channeled into two possible directions i.e., toward the northern (southerly flow) and southern (northerly flow) portions of Mt. Makiling. This channeling effect causes variabilities of surface wind vectors particularly at the project site. Wind components moving alongside of the Mt. Makiling (mostly northerly and southerly) generally appear to rejoin after splitting around the mountain (Mt. Makiling). Some flows ascend the mountain. Also, winds tend to be stronger above the layer of coconut trees particularly in the early afternoon as per observation performed in May 6, 1988 (between 12:00 PM - 2:00 PM). The wind speed during this observation varied from 3 mps to 4 mps. Short actual observation (one hour) performed at the project site last April 29, 1988 (1430H) and May 6, 1988 (1300H) indicated a North (N) to Northnortheasterly (NNE) wind with an average magnitude of 2 mps (ground surface). Simultaneous smoke plume tracking (from burning of firewood) observations showed that expansion of the smoke against the surrounding air displays dispersion in an unstable manner. The forcing of air around and over terrain increases turbulence. With the

presence of moderate to strong winds, the atmosphere becomes more turbulent enhancing atmospheric mixing. However, formation of vortices on the lee side of the ridges and funneling of winds may increase pollutant concentrations in particular areas.

III.2.2 Air Quality

Air quality at the Maibarara site can be described as clean, typical of an upland agricultural environment. There are no major anthropogenic sources of pollutants except for those areas around from decaying agricultural wastes, occasional backyard burning of dried leaves and other garbage of residents living within the vicinity of the project site.

At areas around wellpads and sumps, and volatile pollutants such as boric acid, mercury, radon, and possibly some arsenic compounds in air particulates are generally present in quantities considered too small to constitute significant problems. In the Maibarara geothermal field, the average noncondensable gas analysis from the well pads is given in Table III.2-2.

H_2S measurements were conducted at the project site using H_2S tabs, gas bubbling method (CdS Method) and Jerome Analyzer. Results of analysis (see Table III.2-3 and III.2-3a) show that H_2S concentration only exceeds the DENR standard of 30 ug/scm (0.02 ppm) for one-hr exposure, during the bleeding of Maibarara Well No. 3d, 5, 6, 9, 11, and #1. Gas bleeding is conducted after well testing to allow the release of its well pressure and for proper maintenance of the well.

Measurements of SO_2 level from the same sampling stations (None detected to 4.35 ug/m^3) showed that it is way below the DENR limit of 850 ug/scm for a one-hr exposure.

Noise levels near the Maibarara Geothermal well are typical of a residential area (see Table III.2-4). Maximum noise levels exceeded the daytime standard of 55 dB(A) for residential areas due to vehicular noise and other domestic activities.

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Table III.2-1

Climatological Normals at Ambulong, Batangas
Period of Record: 1961-1985

Malbarara CPP EIS: May 1992
(Meteorology/Air Quality)

MONTH	RAIN-FALL (mm)	RAINY DAYS	TEMPERATURE (°C) MAX-IMUM	MIN-IMUM	MEAN	DRY BULB	WET BULB	DEW PT.	RH (%)	MEAN SEA LEVEL PRE-SSURE (mbs)	PREVAILING WIND DIREC-TION	SPEED (mps)	CLOUD (octa)	DAYS WITH TSTM	LGHT
JAN	22.1	5	30.6	21.5	26.0	25.3	22.2	21	76	1013.1	NE	2	4	0	0
FEB	9.9	3	31.7	21.4	26.6	25.8	22.2	21	73	1012.9	NE	2	4	0	0
MAR	16.3	3	33.5	22.2	27.9	27.2	22.9	21	69	1010.4	NE	2	3	1	1
APR	37.4	5	34.8	23.4	29.2	28.6	24.2	23	69	1010.8	NE	2	3	4	6
MAY	105.3	10	34.3	23.9	29.2	28.8	25.0	24	73	1009.3	SW	2	4	12	18
JUN	237.5	16	31.6	24.0	27.8	27.9	25.2	24	80	1008.7	SW	2	6	14	16
JUL	289.9	19	31.4	23.6	27.5	27.2	24.9	24	83	1008.4	SW	2	6	16	16
AUG	323.7	19	30.8	23.8	27.3	27.1	24.5	24	83	1009.3	SW	2	6	9	9
SEP	259.7	18	31.3	23.4	27.3	26.9	24.6	24	84	1009.1	SW	2	6	14	16
OCT	234.1	16	31.5	23.0	27.3	26.7	24.4	24	83	1009.7	NE	2	5	8	12
NOV	156.6	13	31.1	22.3	27.0	26.5	23.8	23	80	1010.6	NE	2	5	3	5
DEC	97.6	10	30.0	22.2	26.2	25.6	23.0	22	79	1012.1	NE	2	5	1	2
ANNUAL	1790.1	137	31.9	22.9	27.5	27.0	23.9	23	78	1010.4	NE	2	5	82	102

Source: PAGASA

mm - millimeter
mb - millibars
mps - meters per second
TSTM - thunderstorm
LGHT - lightning
RH - relative humidity
°C -degrees Celsius

FN: III.2-1.WR1
PCZS-05/17/92

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Table III.2-2

AVERAGE NONCONDENSABLE GAS ANALYSIS FROM
MAIBARARA GEOTHERMAL FIELD

Maibarara GPP EIS: May 1992
(Meteorology/Air Quality)

Well No.	Composition, Mole Percent In Dry Gas					Measured Steam Flow, lb/hr
	CO_2	H_2S	CH_4	N_2	O_2	
3D	96.68	0.03	0.06	0.96	0.02	99,500
5	97.30	0.7	<0.01	0.64	0.01	80,800
6	96.25	1.25	<0.01	0.3	0.01	185,400
9	97.7	0.53	0.04	0.92	0.01	83,225
11	97.32	0.18	0.02	0.07	0.06	48,700

One analysis of Maibarara Well No. 11 steam condensate showed:

H_2S = 445 ppm
NH_3 = 4.0 ppm

Average weight % of NCG in steam : 1.75 %

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FN: III2-2
PCES-05/17/92

Table III.2-3

Results of Ambient H2S and SO2 Measurements

Maibarara GPP EIS: May 1992
(Meteorology/Air Quality)

STATION	DATE	TIME	Wind Direction	H2S Conc'n. ug/m3	SO2 Conc'n ug/m3
* Well No. 3D and 5	9-15-88	1314H-1414H	Calm	425 (0.306 ppm)	ND
	9-03-91	1000H-1100H		***	1.1
** Well No. 9, 6 and 11	9-15-88	1330H-1430H	Calm	34 (0.024 ppm)	3.93
	9-03-91	0930H-1030H		***	4.35
Maibarara Project Site	9-15-88	1424H-1525H	Calm	ND	ND
	9-03-91	1100H-1200H		1.39	4.1
* 200 SW of Maibarara Well #1	9-15-88	1550H-1650H	Calm	4.25(0.306 ppm)	ND
	9-03-91	1420H-1520H	NE	1.39	ND

Note:

DENR Standard: SO2 = 850 ug/scm
(1-hr exposure) H2S = 30 ug/scm

ND - none detected

* Well # 3D, 5 and 1 were being bled at the time of sampling
** Wells #9, 6 and 11 were partially leaking at the time of sampling
*** H2S Sampling for these stations were not performed due to heavy rain at the time of sampling

Minimum Detectable Limit (MDL): SO2 = 0.74 ug

FN: III2-3.WR1
PCEB-05/17/92

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Table III.2-3a

Results of Ambient H2S Measurements Using H2S Tabs

Maibarara GPP EIS: May 1992
(Meteorology/Air Quality)

STATION	DATE	TIME	Wind Direction	H2S Conc'n. ug/m3
Maibarara Well No. 3D and 5	9-16-17-88	1255H-1346H	NE/Variable	0.0374 ppm
Maibarara Well 9, 6 and 11	9-16-17-88	1235H-1340H	NE/Variable	<0.3 ppm
Maibarara Project Site	9-16-17-88	1300H-1335H	NE/Variable	<0.3 ppm
Maibarara Well #1	9-16-17-88	1320H-1400H	NE/Variable	<0.3 ppm

Note:

DENR Standard: H2S = 30 ug/scm or 0.02 ppm (20 ppb)
(1-hr exposure)

Minimum Detectable Limit (MDL): H2S = 12.4 ppb

FN: III2-3A.WR1
PCES-05/17/92

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Table III.2-4

Noise Level Measurements At the Proposed
Maibarara GPP Project Site , dB(A)
(September 3, 1991)

Maibarara GPP EIS: May 1992
(Meteorology/Air Quality)

STATION	TIME	SPL	MAX	MIN	LEQ
Maibarara Well # 9, 6 and 11	1030H	53.2	58.1	51.4	53.9
Maibarara Well # 3D and 5	1045H	48.1	83.7	46.2	68.3
Residences 100 m from Supreme Aggregates Inc.	1230H	56.1	50.2	60.7	57.7
	1245H	54.4	47	63.7	52.8

DENR Ambient Quality and Emission Standards for Noise (dBA):

	AA	A	B	C	D
Daytime (0700H-1700H)	50		65	70	75
Morning (0500H-0700H) and Evening (1700H-2100H)	45	50	60	65	70
Nighttime (2100H-0500H)	40	45	55	60	60

Class AA - Institutional, requires quietness e.g. school, hospital
Class A - Residential, used for residential purposes
Class C - Light industrial area
Class D - Heavy industrial area

FN: III2-4.WR1
PCES-05/17-92

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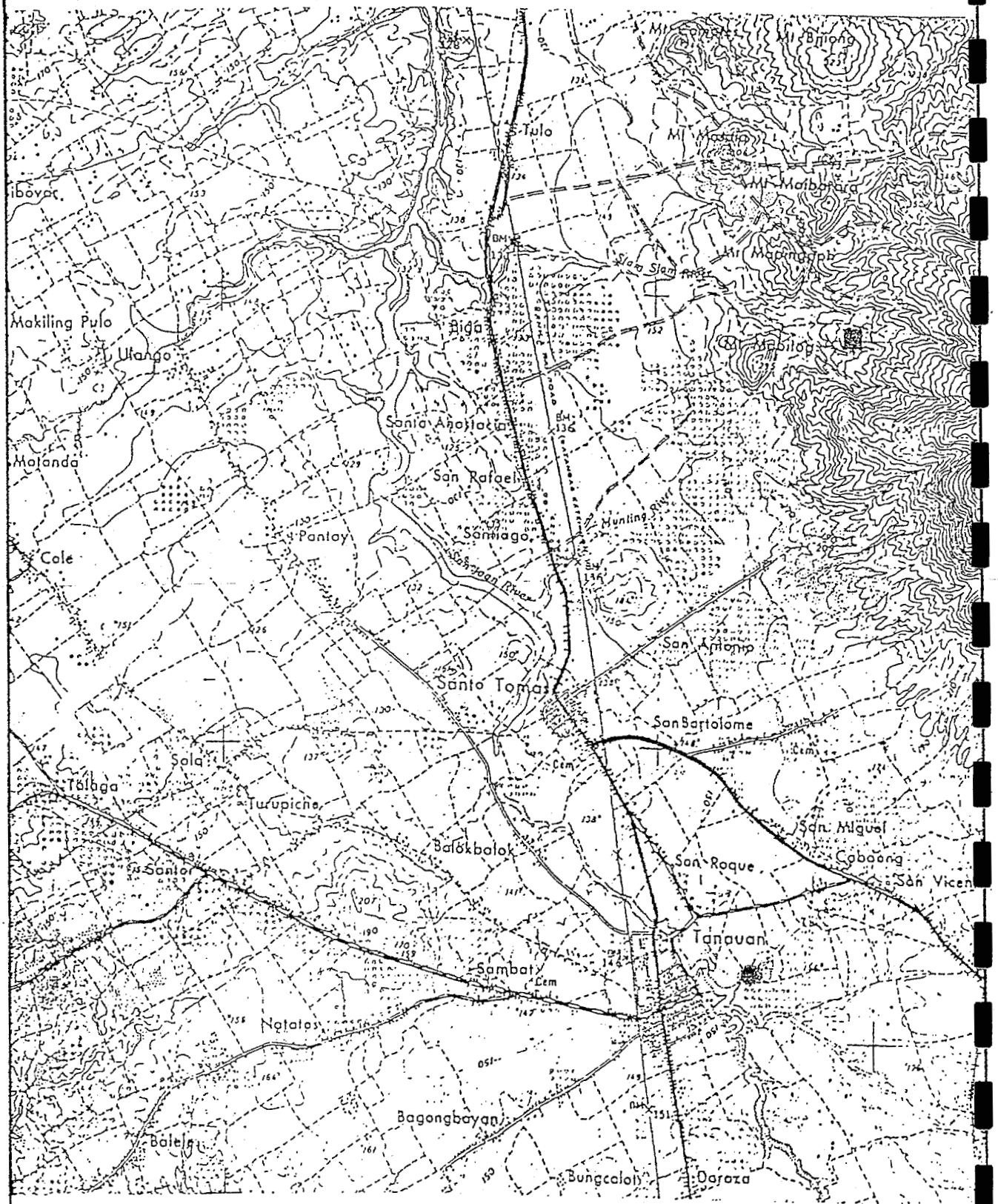

SCALE: ——— 1 : 50,000 m.

LEGEND:

- ■ Project Site
- ● Ambulong Wx Station

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FIGURE III.2-1

Location of Ambulong Wx Station relative to the project site

MAIBARARA GPP EIS: MAY 1992
(Meteorology/Air Quality)

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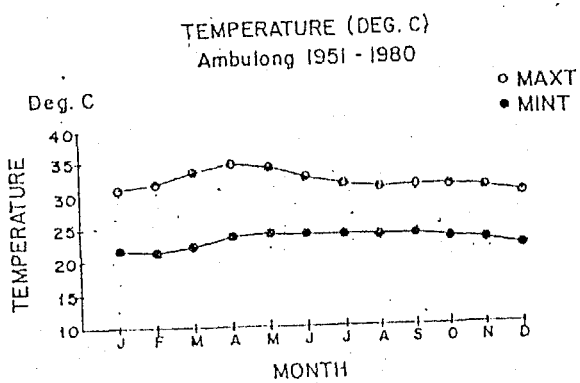

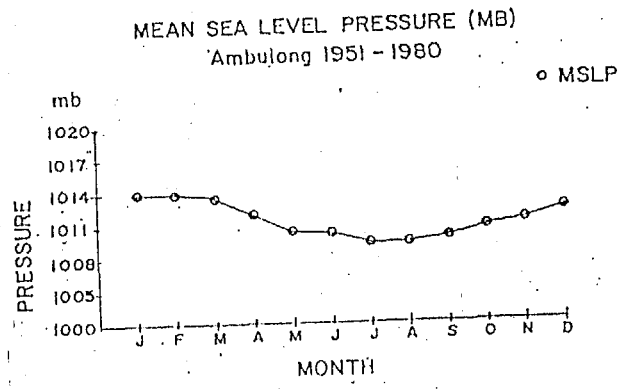

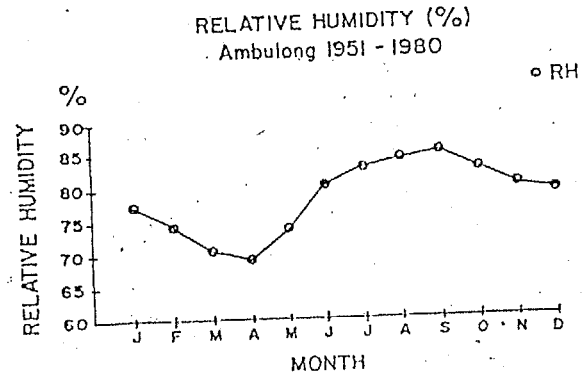

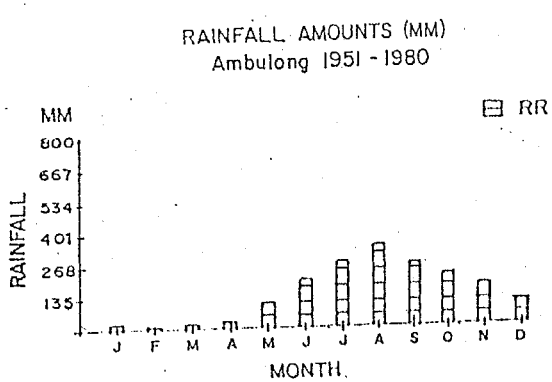

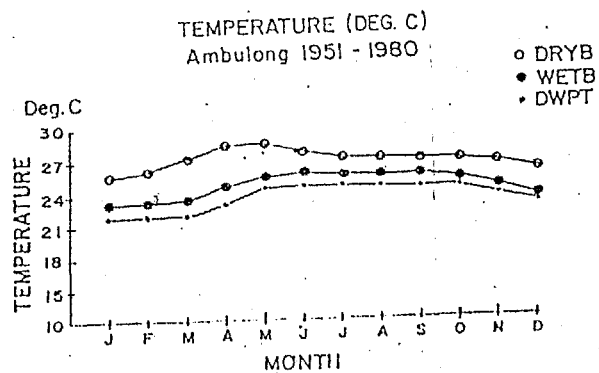

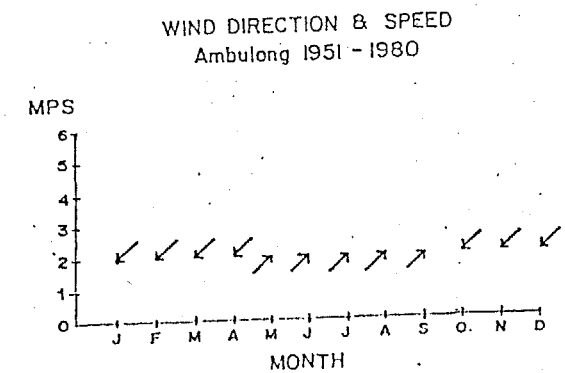

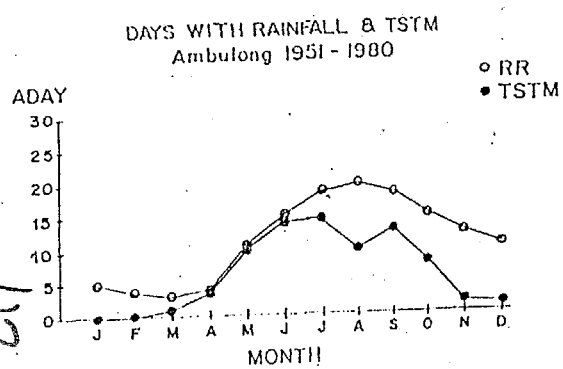

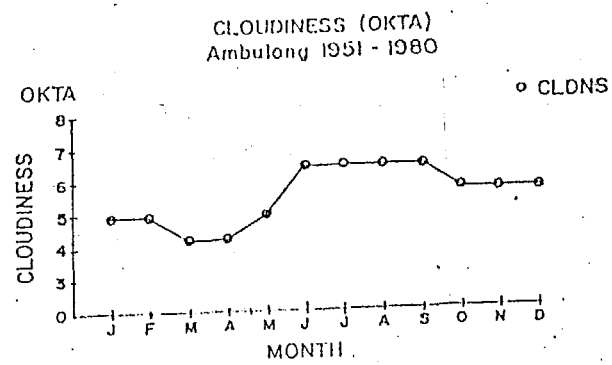

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FIGURE III. 2-2

Climatological Graphs at PAGASA Ambulong Station

MAIBARARA GPP EIS: MAY 1992
(Meteorology/Air Quality)

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III.3 Hydrology and Water Quality

III.3.1 Hydrology

III.3.1.1 Surface Hydrology

The proposed project site is influenced by several streams and gullies originating from Mt. Makiling, the most dominant of which is the Siam-Siam River about 60 m south of the proposed site. About 2 km further south is the Munting River. These rivers are characterized by deep ravines on both sides and are intermittent. Siam-Siam River is still in its youthful stage and runs without meandering (Figure III.3-1). The river path is blocked by big boulders during rainy days causing the river to shift direction. Fine sediments are usually absent in its channel. The outlet of this river is near Barrio Biga, Sto. Tomas, Batangas, where it joins the bigger San Juan River which flows into Laguna Bay. The river flow is expected to be flashy during the rainy season due to high relief. The river usually becomes dry during summer.

Talon Falls, one of the headwaters of Siam-Siam River flows through a small stream which contributes to a spring where local residents derive their water supply. A coffer dam was constructed below the spring to increase water availability. At present, this dam is no longer operational due to sediments accumulation.

III.3.1.2 Groundwater Hydrology

There are no artesian wells in the area except for the one drilled by PGI which was used during the exploration stage. It is fully covered with steel plate welded to the casing. The well is drilled at -284m with static water level estimated at 149m. No data was gathered as to the ground water level prevailing in the area. The area is overlain with thick overburden consisting of pyroclastic materials showing poor to moderate porosity.

The spring originating from Talon Falls is impounded and distributed by gravity through GI pipes into concrete reservoirs located at the center of the populace of Sitio Capus. The water discharge from the spring yields insufficient quantity of water for the residents during the dry season. Water is available during nighttime.

III.3.2 Water Quality

III.3.2.1 Water Quality Environmental Regulations

The country's existing ambient standards for various types and classes of water (or water quality criteria) are promulgated under Department of Environment and Natural Resources (DENR) Administrative Order No. 34, Series of 1990 (Revised National Pollution Control Commission (NPCC) Rules and Regulations) and are reproduced in Tables III.3-1 to III.3-2.

The Effluent Regulations of 1990 (reproduced in Table III.3-3) require that all discharges into inland or coastal waters shall not contain metals and other pollutants in levels greater than those indicated in the said effluent regulation. Wastewater discharges from the proposed geothermal power plants will have to comply with the above cited Effluent Regulations. Geothermal offluents will be reinjected into the geothermal reservoir.

III.3.2.2 Groundwater Quality Analyses

To establish groundwater quality, field measurements on several springs and tap water were conducted and water samples were collected for physico-chemical analysis. Field measurements of groundwater were conducted on September 1988 and September 1991.

Results of laboratory analyses of groundwater are shown in Tables III.3-4 to III.3-4b. For the September 1988 sampling, levels of arsenic (0.00008 - 0.001 mg/l), cadmium (ND), mercury (ND - 0.0009 mg/l), boron (ND), magnesium (3.18 - 14 mg/l), chloride (3.55 - 11.3 mg/l), calcium (1.69 - 21.7 mg/l) and sulfate (2.95 - 19.7 mg/l) satisfy the DENR standards for Class "GA" water. Similarly, for the September 1991 sampling, results of analysis reveal that the levels of arsenic (0.0007 mg/l), cadmium (ND), mercury (<0.0002 - 0.0002 mg/l), boron (ND), chloride (3.5 - 4.5 mg/l), calcium (ND - 0.17 mg/l) and sulfate (4.46 - 7.61 mg/l) comply with the DENR standards for Class "GA" water. However, magnesium level (69 - 71 mg/l) exceeded the DENR Class "GA" water (50 mg/l). Locations of water sampling stations are shown in Figure III.3-2.

III.3.3 Geothermal Fluid

The Maibarara geothermal reservoir produces pressurized hot brine rather than dry steam. Steam is produced by depressurizing the brine and separating the steam from residual brine.

The Maibarara geothermal resource is characterized by high temperature ranging from 247 to 324°C and a well head pressure ranging from 0.93 MPa_g to 1.25 MPa_g. The enthalpy of the geothermal fluid ranges from 1,257 kJ/kg to 2,249 kJ/kg.

Preliminary data on the composition of the produced fluid from the Maibarara geothermal reservoir based on a two-day flow test on June 10 and 11, 1991 for three wells (Ma-3D, Mai-5 and Mai-6) reveal an average silica content of 920 mg/l, boron concentration of 87 mg/l, chloride level of 9,247 mg/l, and a pH of 6.0. Table III.3-5 shows the data from the three wells.

Based on the 1988 data, the Maibarara geothermal fluid has an average chloride concentration of 3,900 ppm, silica content of 600 ppm, and a boron level of 37 ppm. Measured temperature ranged from 204 to 329°C and a pH of 7.2 Comparative analysis of characteristics of geothermal fluid from Bulalo Field and Tiwi Geothermal Field indicate that although Maibarara Field is relatively adjacent to the Bulalo field, its geothermal fluid composition has a strong resemblance to that of Tiwi Field. Table III.3-6 presents the comparative characteristics of geothermal fluids.

Table III.3-1

DENR WATER QUALITY CRITERIA (1990)

Naibarara GPP EIS: May 1992
(Hydrology/Water Quality)

Quality Parameter	Unit	Fresh Surface Water					Ground Water		Marine and Estuarine Waters			
		Class AA	Class A	Class B	Class C	Class D	Class GA	Class GB	Class SA	Class SB	Class SC	Class SD
Color	PCU	15	50	C	C	C	-	50	C	C	C	C
Temperature	°C rise	-	3	3	3	3	-	-	3	3	3	3
pH (range)		6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5	6.0 - 9.0	(A)	6.0 - 8.5	6.5 - 8.5	6.0 - 8.5	6.0 - 8.5	6.0 - 9.0
Dissolved Oxygen	mg/l	5	5	5	5	3	-	-	5	5	5	2
5-Day BOD, 20 °C	mg/l	1	5	5	7	10	-	-	3	5	7	-
Total Suspended Solids	mg/l	25	50	D	E	F	(A)	-	D	E	E	F
Total Dissolved Solids	mg/l	500	1000	-	-	1000	-	1000	-	-	-	-
Surfactants (MBAS)	mg/l	nil	0.2	0.3	0.5	-	-	-	0.2	0.3	0.5	-
Oil/Grease	mg/l	nil	1	1	2	5	nil	-	1	2	3	5
Nitrate as Nitrogen	mg/l	1.0	10	NR	10	-	-	(A)	-	-	-	-
Phosphate as Phosporus	mg/l	nil	0.1	0.2	0.4	-	-	-	-	-	-	-
Total Coliforas	MPN/100ml	50	1000	1000	5000	-	50	-	70	1000	1000	-
or Fecal Coliforas	MPN/100ml	20	100	200	-		-	-	nil	200	-	-
Phenolic Substances as Phenols	mg/l	nil	0.002	0.005	0.02	-	(A)	-	nil	0.01	6	-
Chloride as Cl	mg/l	250	250	-	350	-	(A)	-	-	-	-	-
Copper	mg/l	1.0	1.0	-	0.05	-	-	(A)	-	0.02	0.05	-
Toxic and Other Deleterious Substances												
Arsenic	mg/l	0.05	0.05	0.05	0.05	0.10	0.05	0.10	0.05	0.05	0.05	-
Barium	mg/l	(A)	(A)	-	0.05	-	(A)	-	-	0.05	0.05	-
Cadmium	mg/l	0.01	0.01	0.01	0.01	0.05	(A)	0.01	0.01	0.01	0.01	-
Chromium	mg/l	0.05	0.05	0.05	0.05	0.10	(A)	0.10	0.05	0.10	0.10	-
Cobalt	mg/l	-	-	-	-	0.05	-	0.05	-	-	-	-
Cyanide	mg/l	0.05	0.05	0.05	0.05	-	0.05	-	0.05	0.05	0.05	-

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Table III.3-1

DENR WATER QUALITY CRITERIA (1990)

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

Quality Parameter	Unit	Fresh Surfaces Water					Ground Water		Marine and Estuarine Waters			
		Class AA	Class A	Class B	Class C	Class D	Class GA	Class GB	Class SA	Class SB	Class SC	Class SD
Toxic and Other Deleterious Substances												
Flouride	mg/l	(A)	(A)	-	-	1	(A)	-	-	-	-	-
Iron	mg/l	(A)	(A)	-	-	5	(A)	5	-	-	-	-
Lead	mg/l	0.05	0.05	0.05	0.05	0.5	0.05	5	0.05	0.05	0.05	-
Lithium	mg/l	-	-	-	-	2.5 (D)	-	2.5 (D)	-	-	-	-
Manganese	mg/l	(A)	(A)	-	-	0.20	(A)	0.20	-	-	-	-
Total Mercury	mg/l	0.002	0.002	0.002	0.002	0.002	0.002	-	0.002	0.002	0.002	-
Nickel	mg/l	-	-	-	-	0.20	-	0.20	-	-	-	-
Selenium	mg/l	0.05	0.05	0.05	0.05	0.02	0.05	0.02	0.05	0.05	0.05	-
Silver	mg/l	0.05	0.05	0.05	0.05	-	0.05	-	0.05	0.05	0.05	-
Vanadium	mg/l	-	-	-	-	0.10	-	0.10	-	-	-	-
Organophosphate	mg/l	nil	nil	nil	nil	nil	-	-	nil	nil	nil	-
Aldrin	mg/l	0.001	0.001	-	-	-	0.001	-	0.001	-	-	-
DDT	mg/l	0.05	0.05	-	-	-	0.05	-	0.05	-	-	-
Dieldrin	mg/l	0.001	0.001	-	-	-	0.001	-	0.001	-	-	-
Heptachlor	mg/l	nil	nil	-	-	-	0.0001	-	nil	-	-	-
Lindane	mg/l	0.004	0.004	-	-	-	0.004	-	0.004	-	-	-
Toxaphane	mg/l	0.005	0.005	-	-	-	0.005	-	0.005	-	-	-
Methoxychlor	mg/l	0.10	0.10	-	-	-	0.10	-	0.10	-	-	-
Chlordane	mg/l	0.003	0.003	-	-	-	0.003	-	0.003	-	-	-
Endrin	mg/l	nil	nil	-	-	-	0.0002	-	nil	-	-	-
PCB	mg/l	0.001	0.001	-	-	-	nil	-	0.001	-	-	-

*Remarks:

1. (A) National Standards for Drinking Water (NSDW) in the Philippines.
   (B) Recommended maximum concentration for irrigating citrus is 0.075 mg/l.
   (C) No abnormal discoloration from unnatural causes
   (D) Not more than 30% increase
   (E) Not more than 30 mg/l increase
   (F) Not more than 60 mg/l increase
   (G) Not present in concentrations to affect fish flavor/taste
2. All values are maximum permissible except for dissolved oxygen which is minimum permissible.
3. Sources: Department of Environment and Natural Resources (DENR) Administrative Order No. 34, Series of 1990.
   NPCC Rules and Regulations (1978), Official Gazette, Volume 74, No. 23, June 5, 1978.

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Table III.3-2

DENR WATER CLASSIFICATION AND USAGE

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

CLASSIFICATION	BENEFICIAL USE
A. Fresh Surface Waters (rivers, lakes, reservoirs, etc.)	
Class AA	- Public Water Supply Class I. This class is intended primarily for waters having watersheds which are uninhabited and otherwise protected and which require only approved disinfection in order to meet the National Standards for Drinking Water (NSDW) of the Philippines.
Class A	- Public Water Supply Class II. For sources of water supply that will require complete treatment (coagulation, sedimentation, filtration, and disinfection) in order to meet the NSDW.
Class B	- Recreational Water Class I. For primarily contact recreational such as bathing, swimming, skin diving etc. (particularly those designated for tourism purposes).
Class C	1) Fishery Water for the propagation and growth of fish and other aquatic resource; 2) Recreational Water Class II (Boating, etc.); 3) Industrial Water Supply Class I (For manufacturing processes after treatment).
Class D	1) For agricultural, irrigation, livestock watering, etc.; 2) Industrial Water Supply Class II (e.g. cooling, etc.); 3) Coral reef parks and reserves designated by law and concerned authorities.

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Table III.3-2

DENR WATER CLASSIFICATION AND USAGE

MGPP EIS: May 1992
(Hydrology/Water Quality)

CLASSIFICATION	BENEFICIAL USE
B. Coastal and Marine Waters	
Class SA	1) Water suitable for the propagation, survival and harvesting of shellfish for commercial purposes; 2) Tourist zones and national marine parks and reserves established under Presidential Proclamation No. 1801; existing laws and/or declared as such by appropriate government agency; 3) Coral reef parks and reserves designated by law and concerned authorities.
Class SB	1) Recreational Water Class I (Areas regularly used by the public for bathing, swimming, skin diving, etc.); 2) Fishery Water Class I. (Spawning areas for Chanos chanos or "Bangus" and similar species);
Class SC	1) Recreational Water Class II (e.g. boating, etc.); 2) Fishery Water Class II (Commercial and sustenance fishing); 3) Marshy and/or mangrove areas declared as fish and wildlife sanctuaries.
Class SD	1) Industrial Water Supply Class II (e.g. cooling, etc.); 2) Other coastal and marine waters, by their quality, belong to this classification.

Source: DENR Administrative Order No. 34, Series of 1990

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Table III.[illegible]

DENR EFFLUENT REGULATIONS OF 1990*
(Revised NPCC Effluent Regulations of 1982)

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

Classification		PROTECTED WATERS				INLAND WATERS				COASTAL/MARINE WATERS			
		Category I Class AA & SA		Category II Class A, B & SB		Class C		Class D		Class SC		Class SD & Other	
Parameters													
Physical and Chemical Substances	Unit	OEI	NPI	OEI	NPI	OEI	NPI	OEI	NPI	OEI	NPI	OEI	NPI
Color	PCU	(B)	(B)	150	100	200	150	-	-	(C)	(C)	(C)	(C)
Temperature	°C rise	(B)	(B)	3	3	3	3	3	3	3	3	3	3
pH (range)		(B)	(B)	6.0-9.0	6.0-9.0	6.0-9.0	6.5-9.0	5.0-9.0	6.0-9.0	6.0-9.0	6.0-9.0	5.0-9.0	5.0-9.0
COD	mg/l	(B)	(B)	100	60	150	100	250	200	250	200	300	200
Settleable Solids (1-hour)	mg/l	(B)	(B)	0.3	0.3	0.5	0.5	-	-	-	-	-	-
BOD, 5-Day 20 oC	mg/l	(B)	(B)	50	30	80	50	150	120	120	100	150	120
Total Suspended Solids	mg/l	(B)	(B)	70	50	90	70	200	150	200	150	(E)	(D)
Total Dissolved Solids	mg/l	(B)	(B)	1200	1000	1500	1000	2000	1500	-	-	-	-
Surfactants (MBAS)	mg/l	(B)	(B)	5.0	2.0	7.0	5.0	-	-	15	10	-	-
Oil/Grease	mg/l	(B)	(B)	5.0	5.0	10.0	5.0	-	-	15	10	15	15
Phenolic Substances	mg/l	(B)	(B)	0.1	0.05	0.5	0.1	-	-	1.0	0.5	5.0	1.0
Total Coliform	MPN/100ml	(B)	(B)	5000	3000	15000	10000	(F)	(F)	-	-	-	-
Toxic and Other Deleterious Substances													
Arsenic		(B)	(B)	0.2	0.1	0.50	0.20	-	-	0.50	0.20	1.00	0.50
Cadmium		(B)	(B)	0.05	0.02	0.10	0.05	-	-	0.10	0.05	0.20	0.10
Chromium (hexavalent)		(B)	(B)	0.10	0.05	0.20	0.10	-	-	0.20	0.10	0.50	0.20
Cyanide		(B)	(B)	0.20	0.10	0.30	0.20	-	-	0.30	0.20	0.50	0.20
Lead		(B)	(B)	0.20	0.10	0.50	0.30	-	-	0.50	0.30	1.00	0.50
Total Mercury		(B)	(B)	0.005	0.005	0.005	0.005	-	-	0.005	0.005	0.005	0.005
PCB		(B)	(B)	0.003	0.003	0.003	0.003	-	-	0.003	0.003	0.003	0.003
Formaldehyde		(B)	(B)	2.0	1.0	0.20	1.0	-	-	0.20	1.0	2.0	1.0

* (A) Except as otherwise indicated, all limiting values are maximum values that shall not be exceeded.
(B) Discharge of sewage and/or trade effluents are prohibited or not allowed.
(C) Discharge shall not cause abnormal discoloration in the receiving waters outside of the mixing zone.
(D) Not more than 30 mg/l increase (dry season).
(E) Not more than 50 mg/l increase (dry season).
(F) If effluent is used to irrigate vegetable and fruit crops which may be eaten raw, fecal coliforms should be less than 500 MPN/100ml.

Source: Department of Environment and Natural Resources (DENR) Administrative Order NO. 34, Series of 1990.

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Table III.3-4

Results of Groundwater Quality Analyses

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

Date of Sampling: September 15-16, 1988

Sampling Stations	Units	GW1	GW2	GW3	GW4	GW5	GW6	GW7	DENR Standard Class "GA"
Temperature	°C	25.8	26.5	26.6	25	28.5	27.9	27.2	-
pH		7.27	6.7	6.74	6.67	6.66	6.86	6.99	6.5 - 8.5
Salinity	ppt	0	0	0	0	0	0	0	-
Conductivity	umho/cm	100	110	90.5	100.5	350	100	33.2	-
Turbidity	NTU	26	12	4.5	4.1	0.2	6.5	30	5
Total Suspended Solids	mg/l	30.1	31.1	5.4	2.8	ND	2.8	6.8	-
Total Dissolved Solids	mg/l	194	191	104	111	380	202	231	-
Alkalinity, as CaCO3, Total	mg/l	34	35	34	27	114	52	150	-
Chloride	mg/l	5.92	5.8	3.55	3.55	8.36	7.43	11.3	200
Silica	mg/l	9.4	9	7.8	8.3	10	9.5	10	-
Phosphate (-PO4)	mg/l	0.188	0.132	ND	ND	0.97	0.187	ND	-
Ammonium (-N)	mg/l	ND	ND	ND	ND	ND	ND	ND	-
Nitrate (NO3)	mg/l	0.117	ND	ND	ND	15.72	6.45	2.5	30
Nitrite (NO2)	mg/l	ND	ND	ND	ND	0.134	ND	ND	-
Sulfate	mg/l	3.17	2.95	4.42	4.95	19.7	10.2	8.02	200
Boron	mg/l	ND	ND	ND	ND	ND	ND	ND	-
Trace Elements									
Arsenic	mg/l	0.0003	0.0007	0.0005	(0.00006)	0.0019	0.001	(0.00008)	0.05
Cadmium	mg/l	ND	ND	ND	ND	ND	ND	ND	0.01
Chromium	mg/l	ND	ND	0.11	0.12	ND	ND	0.11	0.05
Calcium	mg/l	1.74	ND	6.44	3.06	21.7	10.6	21.4	75
Copper	mg/l	ND	1.69	ND	ND	ND	ND	ND	1
Iron	mg/l	1.88	3.94	0.33	1.26	ND	0.64	4.72	1
Lead	mg/l	(0.12)	(0.11)	(0.02)	(0.19)	(0.04)	(0.19)	(0.08)	0.05
Lithium	mg/l	(0.002)	(0.004)	0.02	(0.008)	0.02	ND	0.02	-
Magnesium	mg/l	3.18	3.19	3.3	3.03	14	4.25	10.2	50
Mercury	mg/l	0.0004	0.0008	0.0006	0.0008	0.0009	ND	0.0003	0.0002
Nickel	mg/l	ND	ND	ND	ND	ND	ND	ND	-
Potassium	mg/l	3.8	4.2	3.6	3.5	7.6	4.7	7.3	-
Sodium	mg/l	6.6	7.4	7	7.9	19	10	24	-
Zinc	mg/l	0.03	0.03	0.48	0.02	0.15	0.17	0.29	5

Notes: Values in parenthesis are less than MDL

GW1 - Open Well
GW2 - Improved spring
GW3 - Water tank (Sitio Bitin)
GW4 - Spring (along river bed)
GW5 - Motorized pump
GW6 - LWUA
GW7 - Hand pump (Santiago family)

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Table III.3-4a

Results of Groundwater Quality Analyses

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

Date of Sampling: September 3, 1991

Sampling Stations		GW1	GW2	DENR Standard Class "GA"
P A R A M E T E R S	UNIT			
Temperature	°C	25.3	25.5	-
pH		6.73	7.1	6.5-8.5
Turbidity	NTU	35	60	-
Conductivity	umho/cm	115	45	-
Dissolved O2 Conc´n.	mg/l	5.3	5.0	-
Alkalinity	ppm CaCO3			
a) Total		23	76	-
b) Phenolpthalein	-			
c) Bicarbonate		22.93	75.90	-
d) Carbonate		0.05	0.09	-
Total Suspended Solids		16.6	53.0	-
Total Dissolved Solids		103	147	-
Chloride		4.5	3.5	200
Nitrate/Nitrite		0.21	0.10	30
Phosphate		0.053	0.093	-
Sulfate		7.61	4.46	200
Silica		45.2	74.7	-
Ammonium		0.018	0.030	-
Trace Elements				
Arsenic		0.0007	0.0007	0.05
Barium		<1.0	1.10	-
Boron		ND	ND	-
Cadmium		ND	ND	0.01
Chromium +6		ND	ND	0.05
Calcium		ND	0.17	75
Iron		1.40	7.40	1
Lead		ND	ND	0.05
Magnesium		69.0	71.0	50
Manganese		ND	0.02	-
Mercury		0.0002	<0.0002	0.0002
Strontium		0.20	0.51	-
Zinc		0.03	2.46	5

Sampling Stations:

GW1 - Maibarara Spring Water
GW2 - Pulang Lupa

FN: III3-4A.WR1
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Table III.3-5

Preliminary Characteristic Data
Maibarara Geothermal Fluid

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

Date of Flow Test: June 10-11, 1991

PARAMETERS	UNIT	Geothermal Well #		
		MAI-3D	MAI-5	MAI-6
pH @ 25°C		6.0	6.1	5.8
SiO2	mg/l	1030	860	870
Boron	mg/l	51	110	100
Chloride	mg/l	8700	11330	7710
Sulfate	mg/l	10	16	7
Bicarbonate	mg/l	34	39	37
Sodium	mg/l	4760	6190	4120
Potassium	mg/l	1260	1700	1190
Calcium	mg/l	90	300	78
Magnesium	mg/l	0.21	0.14	0.02

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Table III.3-6

COMPARATIVE CHARACTERISTICS OF GEOTHERMAL FLUIDS

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

Brine Composition, ppm	Maibarara	Bulalo	Tiwi
Sodium	2200	1400	2900
Potassium	650	350	550
Calcium	65	15	70
Magnesium	1	1	2
Bicarbonate	170	15	110
Silica	600	700	450
Chloride	3900	2500	4800
Sulfate	90	15	120
Boron	37	55	56
Non-condensable Gas, % Weight in Steam	1.75	0.85	3.00
pH	7.20	6.90	5.70
Temperature Range, °F	400 - 625	520 - 660	500 - 575
Average Well, lb/hr			
Brine	100,000	150,000	100,000
Steam	100,000	160,000	130,000

FN: III3-6
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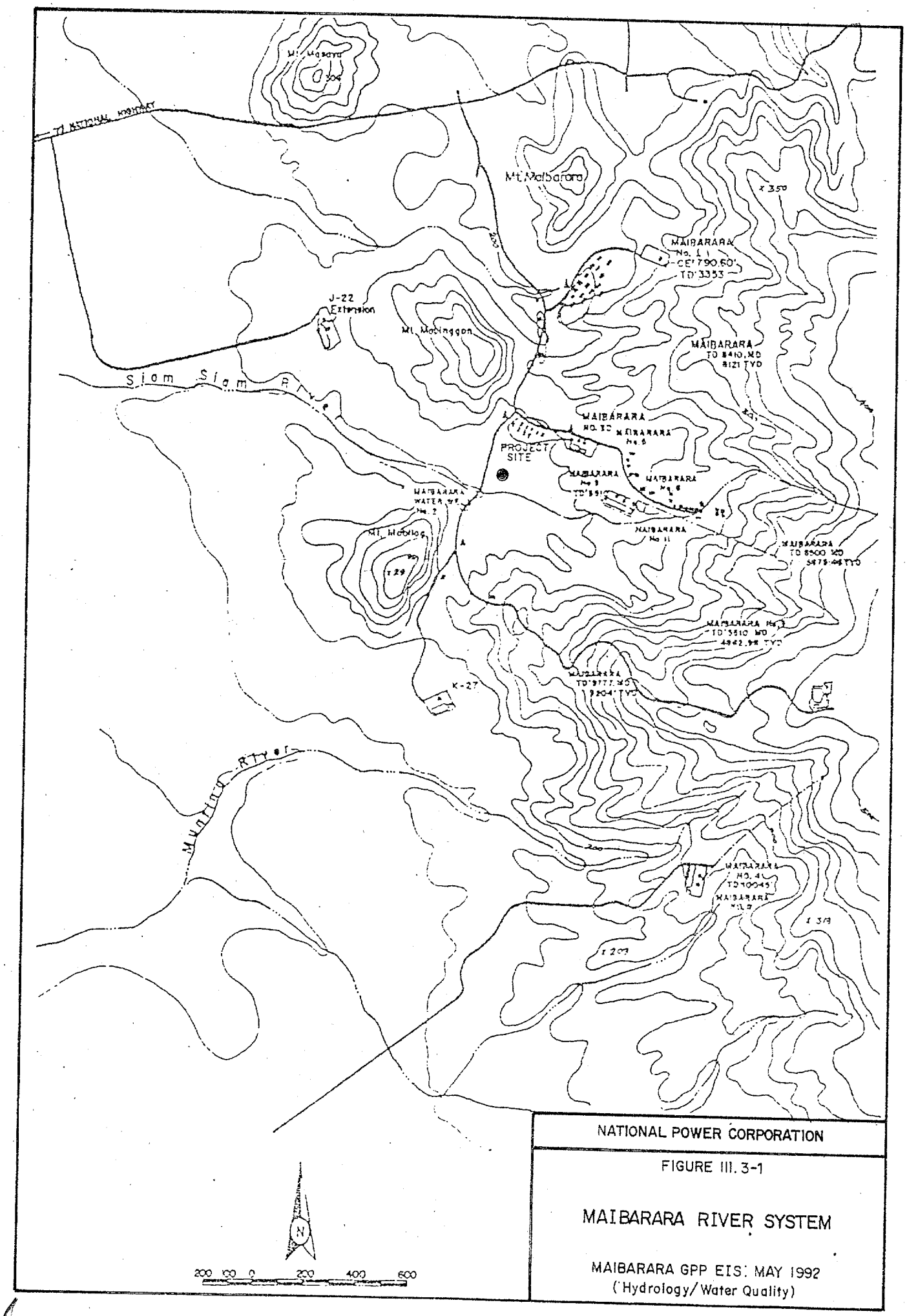

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FIGURE III. 3-1

MAIBARARA RIVER SYSTEM

MAIBARARA GPP EIS: MAY 1992
(Hydrology/Water Quality)

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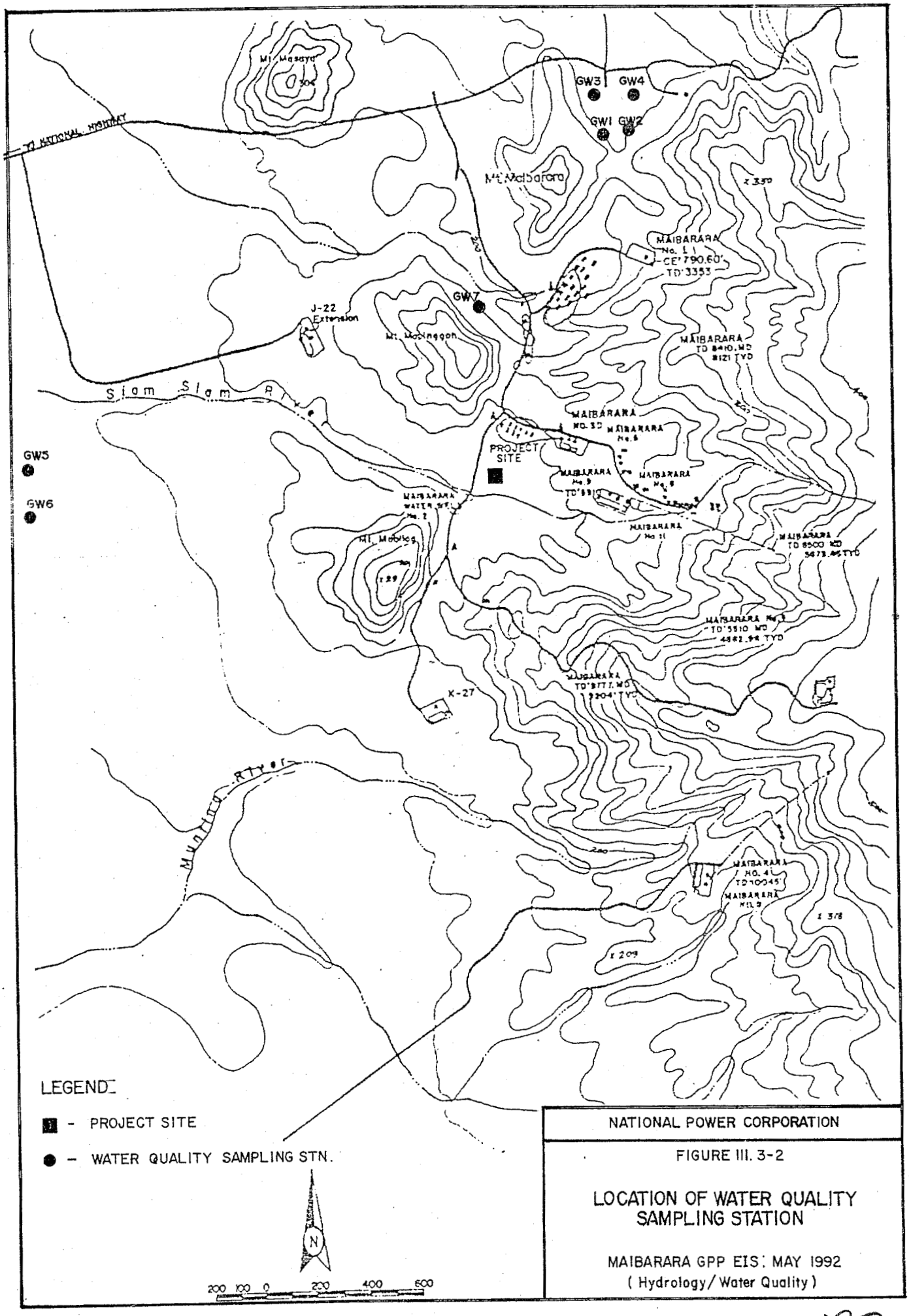

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FIGURE III. 3-2

LOCATION OF WATER QUALITY SAMPLING STATION

MAIBARARA GPP EIS: MAY 1992
(Hydrology/ Water Quality)

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III.4 TERRESTRIAL ECOLOGY

Terrestrial ecosystem surveys around the proposed Maibarara Geothermal Power Plant (MGPP) site at Sitio Capus, San Rafael, San Tomas, Batangas were conducted on September 1988 (wet season) and April 1989 (dry season). Three (3) transect lines were established where baseline studies were made on vegetation, insects, and wildlife (birds, mammals, reptiles and amphibians). Shown in Figure III.4-1 are the locations of the transect lines. Descriptions of the transect line are as follows:

	Starting Point/ Location	Direction
Transect Line 1 (TL 1)	100 m west of the project site	SSW
Transect Line 2 (TL 2)	1000 m NE of the project site	ESE
Transect Line 3 (TL 3)	600 m ESE of the project site	SE

III.4.1 METHODOLOGY

III.4.1.1 VEGETATION

Vegetation were sampled along each transect line with the establishment of 1 sq.m. plots (1 m x 1 m) with intervals of 10 m. or more between each plot. In-situ identification was applied in most species encountered along each transect line while unidentified species were brought to the laboratory for further identification.

All plants species observed at established transect lines were classified as herb/grass, shrub, fern, tree, palm or vine. These plant components observed at the corresponding stratum of the study plots along each transect line were identified as to scientific, common and local names, as well as their usages and roles in the community. The total number of individuals, cover value and frequency of different plant species were likewise evaluated/computed.

The absolute frequency of a species refers simply to the number of plots where it occurs or the frequency of encountering it along the transect line. The percent cover value of each species per sample plot was estimated and transformed to the following modified percent cover values:

% cover per plot	Modified Percent Cover Value
76-100	87.5
51-75	62.5
26-50	37.5
5-25	15.0
below 5	2.5

The coverage values of the individuals belonging to one species per sample plot was approximated in terms of the mean values of the range of percent cover per plot, i.e. 87.5 for the 76-100 range. The average per cent cover per plot of each species was computed by dividing the cover values of one species by the absolute frequency. The relative frequency expressed as a percentage for each species may be computed by dividing its absolute frequency by the total number of plots.

III.4.1.2 WILDLIFE

Wildlife inventory survey of birds, reptiles, amphibians and mammals within the vicinity of the proposed power project were accomplished through visual/ocular surveys and through inquiries/interviews with the residents in the area. The latter was resorted to because difficulties were encountered in the study of some reptiles, amphibians and mammals which are generally nocturnal. Using the vegetation transect line as a route, traps were baited with coconut meat, set overnight and retrieved at dawn. Captured specimens were identified on the spot and recorded. Inventory of birds was conducted through visual observations. A pair of binoculars was used to identify different species of birds. Birds which were not seen but heard along the way were also noted. Results of survey were presented with a taxa list together with corresponding common names, census count and relative abundance indices.

III.4.1.3 INSECTS AND OTHER INVERTEBRATES

Daytime sampling and collection of insects and invertebrates were undertaken on each established vegetation transect lines using a sturdy net in the collection of active flying specimens such as dipterans, hemipterans, coleopterans, homopterans, hymenopterans, lepidopterans, orthopterans and odonatans. Using the transect line as a route, the net was employed through each station. The captured specimens were transferred into a plastic container with 10% ethyl alcohol where they were preserved. Collected samples were brought to the laboratory for analysis and identification.

Other insects and invertebrates not captured by conventional methods were surveyed by random sampling. This type of sampling includes collection by the use of forceps and fingers for specimens that are non-fliers such as coleopterans, arachnids, and some homopteran and millipedes. Other soil inhabiting insects were searched underneath rotten tree barks, stems and rocks. Captured specimens were preserved in jars with ethyl alcohol.

III.4.2 RESULTS AN DISCUSSION

III.4.2.1 VEGETATION

Vegetative cover at the proposed MGPP project site and its vicinities comprises mainly of agricultural crops, grasslands, secondary forests and some primary growth forests.

Grasses, shrubs and vines generally occupy uncultivated areas, abandoned upland and "kaingin" farms, roadsides, junction between cultivated areas and gulleys while forest trees are located along the upper slopes of Mount Makiling some 1.5 km east of the proposed project site.

Agricultural lands in the area include lowland and upland/"kaingin" farms planted with annual and perennial crop species. Annual crop species include corn (Zea mays), cassava (Manihot esculenta), banana (Musa sp.), ubi (Dioscorea alata), gabi (Colocasia esculentum), ginger (Zingiber sp.), and sweet potato (Ipomoea batatas). Perennial crops found in the area are mango (Mangifera indica), coconut (Cocos nucifera) langka (Artocarpus heterophylla), guyabano (Anona

muricata), dalanghita (Citrus sp.), atis (Anona squamosa), cacao (Theobroma cacao),) and coffee (Coffea sp.). Intercropping is widely practiced wherein a combination of two or three annual cash crop species are alternately planted during different periods within a year. Multiple cropping or multi-story agroforestry is also widespread in application with taller perennial crops like coconuts and mangoes forming the upper layer vegetation with the second layer occupied by shorter perennials like coffee, cacao, and guayabano. A third lowermost layer comprising of annual crops like ginger, cassava, corn and gabi are found in some areas.

Presented below are the average production of major agricultural crops (Department of Agriculture, 1989):

Crop	Production (metric ton/hectare)
Mango	19.8
Coffee/Cacao	1.5
Coconut	15.0
Banana	120.0
Ginger	1.0
Corn	3.5
Cassava	8.0
"Ubi"	8.0
"Gabi"	8.0

The proposed 1.2 ha plant site is an agricultural land intercropped with different annual crops during different periods of the year (Figure III.4-2).

Presented in Tables III.4-1 to III.4-6 are the species frequency of vegetation at the established three transect lines during the September 1988 and April 1989 surveys while the economic and ecological importance of these vegetation species are listed in Table III.4-7. A total of 91 floral species belonging to 46 families were recorded during field surveys along the transect lines established.

TL 1 is a grass and vine dominated ecosystem although some mango orchards and coconut groves traversed along the established transect line (Tables III.4-1 and Table III.4-4 and Figure III.4-3). Carabao grass (Axonopus compressus) was the most dominant species during the September 1988 survey. This mat-forming grass with long stalks accounted for 15.3 percent of

the total cover values obtained. The second most abundant species was the fast growing, scandent vine mile-a-minute (Mikania cordata) which had a percentage value of 9.7 percent. Other dominant species were kulut-kulutan (Urena lobata), mango (Mangifera indica), makahiya (Mimosa pudica), and coconut (Cocos nucifera) see Figure III.4-4. During the April 1989 survey (Table III.4-4), mile-a-minute (Mikania cordata) came out as the most abundant species obtaining 14.5 percent of the total cover values obtained. The dominant species during the dry season, Axonopus compressus, obtained a percentage value of only 9.1 percent. The higher tolerance and adaptability of Mikania cordata to lower soil moisture levels during dry months could account for its predominance during said survey.

Remnants of a lowland rain forest comprising of three layers of trees exist at TL 2 (Tables III.4-2 and III.4-5 and Figure III.4-5). However forest cover is not continuous since some patches of this forest have been cleared and now planted with agricultural crops like coffee, cacao and banana while other places are predominated by various shrub and herb species. White lauan (Pentacme contorta), a tall dipterocarp tree with a cylindrical bole and cracked gray bark, was the most predominant species during the 1988 (9.7 %) and 1989 (24.6%) surveys (Figure III.4-6). This species together with other tree species like balobo (Diplodiscus paniculatus), and malaikmo (Celtis philippinensis) represent the uppermost tree layer of the lowland rain forest at the study area. These tree species reach a height of about 30 to 40 meters. On the other hand, "tibig" (Ficus nota), "tangisang bayawak" (Ficus variegata) and "hauili" (Ficus hauili) comprise the trees at the middle layer of the forest wherein tree heights measure between 15 to 20 meters. "Kaliantan" (Leea manillensis) comprise the third and lowermost tree layer at the study site. "Bracken fern" (Pteridium aquilinum), "pakpak lawin" (Drynaria quercifolia), "true fern" (Cyathea sp.), "pako" (Diplazium esculentum) and "birds nest fern" (Asplenium nidus) of Order Filicales form a part of the undergrowth cover beneath the trees.
TL 3 passes through continuous upland plantations of mango, and coconuts (Tables III.4-3 and III.4-6 and Figure III.4-7). Planted underneath these plantations are coffee, jackfruit, papaya and guayabano. During the 1988 survey "biga" (Alocasia macrorrhiza) was the most predominant species with 10.7 percent of cover values obtained (Figure III.4-8). This species,

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however, was not present during the 1989 survey. Instead mile-a-minute (Mikania cordata) emerged as the predominant species during the dry season. Aside from lower moisture levels, another reason for change in dominant plant species is the cutting and clearing undergrowth vegetation beneath the coffee, mango and coconut plantations. This has resulted to clearing of ground cover and predominance of fast growing species like Mikania cordata which was able to predominate at the cleared areas through their faster growth rates and minimal soil moisture requirements.

III.4.2.2. FOREST CONVERSION TO UPLAND FARMS

Increasing growth of population and non-availability of land to till in lowland areas have led to conversion of forested upland areas east of the project site into upland/"kaingin" farms. Thus trees have been cut down, piled together and burned. A clearing is thus formed where crops are grown in soil enriched by ashes from the fire. Since a deep humus layer is seldom found in forest soil, the soil easily loses its fertility after some time unless proper soil management techniques are utilized to maintain soil fertility and structure. But more often than not, proper soil management techniques are not applied thus leading to erosion of the shallow topsoil when exposed to the elements. A new area thus has to be cleared and the whole process is repeated. In place of primary forest species, a secondary forest develops comprising of fast growing species with deep roots that can reach down to the lowered water table into which have leached nutrients necessary for plant growth. Cutting of the trees for timber and firewood, however hampers the development of forest species. Grasses together with various shrubs and herbs predominate thus transforming the forest ecosystem into a grassland/savannah type of community which is susceptible to erosion and maintains a lesser number of floral and faunal species.

Maintenance of lush and dense tree growth greatly dampens soil erosion. This is due to :

1. Reduction in impact of falling raindrops as a result of rainfall interception.

2. Increased resistance to air and water flow through greater roughness.

3. Decreased sedimentation brought about by reduction in flow velocity.

4. Increased infiltration capacity resulting from root growth opening up voids in the soil.

5. Additional structural stability following an increase in organic content of the soil.

6. Reduced run-off as a result of increased interception, infiltration and evapotranspiration from vegetated areas compared with bare surfaces.

Along upland areas near the project site, consequences of loss of forest cover due to upland farm conversion is very evident. The small dam built at the foot of Talon Falls and another one downstream near a spring are already filled with sediments. Moreover during the height of a typhoon on September 1989, the stretch of Siam-siam river from Talon Falls up to the dam downstream has been drastically altered due to heavy flow of water. During the April 1989 visit, it was noted that the banks of that stretch of Siam-siam river was densely covered with vegetation (Figure III.4-9). However, during the last visit on February 1990, that same area was found to be almost completely cleared of vegetative cover up to within a 5 m radius of the river bank with lots of boulders, rocks and sediments deposited downstream. Only the big trees were able to withstand the flood.

III.4.2.3 BIRDS

Taxonomic listing of birds species surveyed during the 1988 and 1989 surveys with their corresponding scientific and common names, census count and relative abundance indices were presented in Table III.4-8 while their feeding habits and habitat were tabulated in Table III.4-9.

During the 1988 bird survey, 23 species belonging to 20 families were noted while 10 species belonging to 9 families were accounted for during the 1989 survey. Dominant bird species during the 1988 survey were Cyornis rufigaster - Mangrove Blue Flycatcher (14.3%), Lanius validirostris - Strong-Billed Shrike (12.8%), Cypsiurus parvus - Asian Palm Swift (12.8%), Hypsipetes philippinus - Phil. Bulbul (12.0%) and Anthus novaeseelandiae - Richard's Pipit (6.8%). During the 1989 survey Cypsiurus parvus (29.4%), Pycnonotus q.

goiavier - Yellow-Vented Bulbul (29.4%), Orthotomus cucullatus (11.9%) and Loriculus philippinensis - Phil. Hanging Parakeet were the most common species tabulated.

Among the species identified, 23 are resident, 2 are migrant while only 1 is introduced.

The resident bird species noted include:

1. Lanius validostris - Strong-Billed Shrike
2. Lanius schack nasutus - Shack Shrike
3. Cyornis rufigaster - Mangrove Blue Flycatcher
4. Rhipidura javanica - Malaysian Fantail
5. Cypsiurus parvus palliodor - Asian Palm Swift
6. Hypsipetes philippinus - Phil. Bulbul
7. Zosterops montana white-headi - Mountain White Eye
8. Centropus sinensis bubutus - Common Coucal
9. Saxicola caprata - Pied Bushchat
10. Loriculus philippinensis - Phil. Hanging Parakeet
11. Corvus macrorhynhos - Large-Billed Crow
12. Oriolus chinensis - Black-Naped Oriole
13. Porzana tabuensis - Sooty Rail
14. Megalurus palustris - Striated Canegrass Warbler
15. Pycnonotus g. goiavier - Yellow-Vented Bulbul
16. Orthotomus cucullatus philippinus - Mountain Tailor Bird
17. Dendrocopus maculatus - Pygmy Woodpecker
18. Streptopelia bitorquata - Phil. Turtle Dove
19. Anthus novaeseelandiae - Richard's Pipit
20. Haliastus indus intermedius - Brahminy Kite
21. Hirundo rustica - Barn Swallow
22. Eurostopodus macrotis - Phil. Eared Nightjar
23. Lalage nigra - Pied Thriller

Migrant Species

1. Alcedo atthis bengalensis - River Kingfisher
2. Lanius cristatus - Brown Shrike

Introduced species

1. Passer montanus - Tree Sparrow

The bird species common during both survey periods were Lanius validirostris, Cypsiurus parvus palliodor, Loriculus philippinensis, Cyornis rufigaster, Hirundo rustica and Streptopelis bitorquata.

One of the bird species surveyed, Strong-Billed Shrike (Lanius validirostris), is classified as rare species

(PAWB 1988) although it was noted to be present during both survey seasons. Loriculus philippinensis (Phil. Hanging Parakeet) and Haliastus indus (Brahminy Kite) are classififed as protected under the Convention of the Internation Trade of Endangered Species (CITES, Appendix II). Collection of birds at the slopes of Mount Makiling by residents in the area is rampant. Commonly caught to be sold as pets and for cage display is the Phil. Hanging Parakeet (Loriculus philippinensis). These are caught through the application of a sticky sap on wood branches where the bird perches on. Use of captured birds as bait ("pangati") to attract other birds to the branch usually result to greater chances of catching more birds. This practice could later result in population depletion of Phil. Hanging Parakeet in the area.

III.4.2.3 MAMMALS, AMPHIBIANS AND REPTILES

Presented in Table III.4-10 are the list of mammalian, amphibian and reptilian species surveyed around the proposed Maibarara GPP project site. Mammalian species tabulated were Phil. Common Field Rat (Rattus m. mindanensis), Small field rat (Rattus exulans), wild pig (Sus spp.), yellow brown bat (Scotophilus temminck) and Phil. Monkey (Macaca philippinensis) while reptilian species noted consist of house lizard (Hemidactylus frenatus), brown skink (Mabuya sp.), common rat snake (Elaphne sp.) and Phil. Tuk-ko (Gecko gekko). The lone amphibian species observed was giant toad (Bufo marinus).

During the survey period only 2 species of mammals were collected namely: Rattus m. mindanensis and Rattus exulans. Based on interviews and queries with local residents in the area Phil. monkey and wild pig are found at the upper slopes of Mount Makiling while the rest are common within the immediate vicinity of the proposed project area. No rare or endangered species were observed.

III.4.2.4 INSECTS AND OTHER INVERTEBRATES

Presented in Tables III.4-11 to III.4-16 are the insect and other invertebrate taxa list, census count and relative abundance indices at the three established transect lines during both sampling periods. A total of 98 families were recorded in all transect lines during wet and dry season surveys. Of these, 38 families were identified during the dry season while 60 families were

noted during the wet season sampling. Feeding habits and habitat of insects and other invertebrates were presented in Table III.4-17.

During the wet and dry season survey, the same number of families (26) were recorded in Transect 1. The dominant families identified during the wet season were Acrididae (21.9%), Cicadellidae (20.5%), Tenthridinidae (20.5%) and Araneidae (10.9%), while Culicidae (12.9%) were the most abundant families recorded during the dry season.

Along TL 2, 22 families were recorded during the wet season while 33 families were identified during the dry season. Families belonging to Formicidae (24.5%), Araneidae (12%), Corimelaenidae (9.6%) and Tenthridinidae (9.1%) were the most dominant taxa recorded during the wet season. However, during the dry season, Family Cicadellidae (20.5%), Formicidae (10.5%), Diastatidae (6.8%) and Dolichopodidae (5.7%) were the most abundant families noted.

At TL 3 recorded was a total of 22 families during the dry season while 34 families were observed during the wet season. The dominant families identified during the wet season were Araneidae (29.6%) and Cixiidae (13.5%). During the dry season , Cicadellidae (22.9%), Araneidae (10.4%) and Miridae (7.5%) were the most abundant families collected.

Families belonging to Cicadellidae (TL 1), Formicidae and Cicadellidae (TL 2) and Cixiidae, Araneidae and Cicadellidae (TL 3) recorded the highest variation in relative abundance in both wet and dry season. It was noted that Cicadellidae, Araneidae and Chrysomelidae were the most common families observed in Transect lines 1 - 3.

The difference in species composition and abundance of insects and other invertebrates between the two (2) sampling periods are possibly due to the changes in vegetation structure, inherrent behavior of organisms and seasonal changes. Different insect families, feed, breed and take refuge in certain plants species such that their alteration of vegetative cover might have led to their decline in number. Likewise predation, migration, competition and human activity also affects survival and dominance of insect species within the environment.

Table III.4-1

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 1 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 2

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
HERB/GRASS				
Axonopus compressus	11	73.3	307.5	27.9
Mimosa pudica	11	73.3	172.5	15.7
Achyranthes aspera	2	13.3	5.0	2.5
Alocasia macrorrhiza	2	13.3	30.0	1.5
Echinocloa colonum	1	6.7	2.5	2.5
Bambusa spp.	3	20.0	92.5	30.8
Musa spp.	1	6.7	2.5	2.5
Stachytarpheta jamaicensis	7	46.7	55.0	7.9
Digitaria ciliaris	3	20.0	55.0	18.3
Eleusine indica	5	33.3	12.5	2.5
Curcuma zedoaria	1	6.7	15.0	15.0
Cyperus brevifolius	1	6.7	2.5	2.5
Dactyloctenium aegyptium	1	6.7	2.5	2.5
Amaranthus viridis	3	20.0	55.0	18.3
Cyperus compressus	2	13.3	5.0	2.5
Hyptis suaveolens	4	26.7	47.5	11.9
Eragrostis tenella	1	6.7	2.5	2.5
Euphorbia hirta	1	6.7	2.5	2.5
Aeschynomene americana	1	6.7	2.5	2.5
Bidens pilosa	1	6.7	2.5	2.5
Elephanthus scaber	2	13.3	5.0	2.5
Cleome viscosa	1	6.7	2.5	2.5
Panicum maximum	1	6.7	2.5	2.5
Amorphophallus campanulatus	2	13.3	5.0	2.5
SHRUB				
Ficus sp.	1	6.7	2.5	2.5
Urena lobata	8	53.3	177.5	22.2
VINE				
Mikania cordata	8	53.3	195.0	24.3
Centrosema pubescens	3	20.0	67.5	22.5
Pueraria phaseoloides	5	33.3	107.5	21.5

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Table III.4-1

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 1 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
TREE				
Theobroma cacao	2	13.33	30.0	15.0
Endospermum peltatum	1	6.67	37.5	37.5
Premna odonata	1	6.67	15.0	15.0
Callicarpa candicans	2	13.33	102.5	51.2
Leucaena leucocephala	1	6.67	17.5	17.5
Macaranga grandiflora	1	6.67	37.5	37.5
Mangifera indica	2	13.33	175.0	87.5
Macaranga tanarius	1	6.67	2.5	2.5
Trema orientalis	1	6.67	15.0	15.0
PALM				
Cocos nucifera	4	26.67	150.0	37.5

SOURCE: NAPOCOR EMD SURVEY SEPTEMBER 1988

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Table III.4-2

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 2 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 2

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
HERB/GRASS				
Achyranthes aspera	5	26.3	37.5	7.5
Commelina benghalensis	1	5.3	2.5	2.5
Elephantopus scaber	2	10.5	17.5	8.8
Piper sp.	2	10.5	5.0	2.5
Stachytarpheta jamaicensis	1	5.3	2.5	2.5
Alocasia macrorrhiza	1	5.3	15.0	15.0
Donax cannaeformis	3	15.8	20.0	6.7
Amorphophallus campanulatus	5	26.3	12.5	2.5
Musa sp.	5	36.3	50.0	10.0
Schizostachyum diffusum	2	10.5	5.0	2.5
Phyllanthus sp.	2	10.5	5.0	2.5
Axonopus compressus	1	5.3	2.5	2.5
SHRUB				
Urena lobata	1	5.3	2.5	2.5
Cleodendron sp.	2	10.5	17.5	8.8
Codiaeum variegatum	1	5.3	15.0	15.0
Tabernaemontana sp.	1	5.3	37.5	37.5
VINE				
Mikania cordata	1	5.3	15.0	15.0
Flagellaria indica	1	5.3	2.5	2.5
FERN				
Pteridium aquilinum	6	31.6	40.0	6.7
Drynaria quercifolia	3	15.8	20.0	6.7
Cyathea sp.	2	10.5	30.0	15.0
Diplazium esculentum	1	5.3	2.5	2.5

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Table III.4-2

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 2 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
TREE				
Coffea sp.	4	21.0	47.5	11.9
Leucaena leucocephala	1	5.3	2.5	2.5
Kleinhofia hospita	1	5.3	87.5	87.5
Ficus nota	1	5.3	87.5	87.5
Ixora sp.	1	5.3	2.5	2.5
Ficus variegata	1	5.3	37.5	37.5
Leea manilensis	4	21.0	22.5	5.6
Callicarpa candicans	4	21.0	10.0	2.5
Pentacme contorta	3	15.8	115.0	38.3
Theobroma cacao	3	15.8	32.5	10.8
Ficus sp.	1	5.3	62.5	62.5
Lunasia amara	1	5.3	15.0	15.0
Celtis philippensis	2	10.5	65.0	32.5
Pterocymbium tinctorium	1	5.3	2.5	2.5
Voacanga globolosa	1	5.3	62.5	62.5
Diplodiscus paniculatus	1	5.3	87.5	87.5
Dillenia sp.	1	5.3	15.0	15.0
Ficus hauili	1	5.3	2.5	2.5
Koordersiodendron pinnatum	1	5.3	15.0	15.0
Caryota cumingii	5	26.3	50.0	10.0

SOURCE: NAPOCOR EMD SURVEY SEPTEMBER 1988

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Table III.4-3

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 3 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
HERB/GRASS				
Musa sp.	6	40.0	87.5	14.6
Peperomia pellucida	1	6.7	2.5	2.5
Alocasia macrorrhiza	10	66.7	185.0	18.5
Paspalum conjugatum	3	20.0	20.0	6.7
Emelia sonchifolia	2	13.3	5.0	2.5
Achyranthes aspera	3	20.0	20.0	6.7
Ageratum conyzoides	7	46.7	102.5	14.6
Crassocephalum crepidioides	7	46.7	115.0	16.4
Axonopus compressus	10	66.7	50.0	5.0
Triumfetta bartramia	2	13.3	40.0	20.0
Amorphophallus campanulatus	1	6.7	2.5	2.5
Capsicum frutescens	1	6.7	2.5	2.5
Blechum pyramidatum	4	26.7	22.5	5.6
Biophytum sensitivum	1	6.7	2.5	2.5
Elephantopus scaber	1	6.7	2.5	2.5
Asystasia gangetica	1	6.7	2.5	2.5
Cyperus brevifolius	2	13.3	5.0	2.5
Capsicum lycopersicum	1	6.7	15.0	15.0
Commelina benghalensis	1	6.7	2.5	2.5
Digitaria ciliaris	1	6.7	15.0	15.0
Tridax procumbens	1	6.7	2.5	2.5
Carica papaya	5	33.3	25.0	5.0
FERN				
Pteridium aquilinum	4	26.7	47.5	11.9
VINE				
Acangelisia flava	1	6.7	2.5	2.5
Mikania cordata	8	53.3	165.0	20.6
Abrus precatorius	1	6.7	15.0	15.0
Dioscorea alata	1	6.7	2.5	2.5
Tinospora reticulata	2	13.3	5.0	2.5
Pachyrrhizus erosus	4	26.7	35.0	8.8

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Table III.4-3

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 3 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 2 of 2

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
SHRUB				
Tabernaemontana subglobosa	4	26.7	22.5	5.6
Urena lobata	2	13.3	5.0	2.5
Gliricidia sepium	6	40.0	40.0	6.7
TREE				
Mangifera indica	3	20.0	115.0	38.3
Coffea sp.	6	40.0	157.5	26.2
Anona muricata	3	20.0	32.5	10.8
Artocarpus heterophylla	2	13.3	17.5	8.8
Endospermum peltatum	1	6.7	2.5	2.5
Theobroma cacao	1	6.7	2.5	2.5
Callicarpa candicans	8	53.3	82.5	10.3
Celtis philippensis	1	6.7	2.5	2.5
Ceiba pentandra	1	6.7	2.5	2.5
Dillenia philippinensis	1	6.7	15.0	15.0
Leucaena leucocephala	3	20.0	15.0	5.0
PALM				
Arenga saccharifera	2	13.3	75.0	37.5
Cocos nucifera	4	26.7	127.5	31.9

SOURCE: NAPOCOR EMD SURVEY SEPTEMBER 1988

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Table III.4-4

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 1 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 2

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
HERB/GRASS				
Mimosa pudica	11	73.3	172.5	15.7
Axonopus compressus	11	73.3	170.0	15.4
Bambusa sp.	3	20.0	92.5	30.8
Digitaria ciliaris	3	20.0	55.0	18.3
Stachytarpheta jamaicensis	7	46.6	55.0	7.8
Amaranthus viridis	3	20.0	55.0	18.3
Hyptis suaveolens	4	26.6	47.5	11.9
Colocasia esculenta	2	13.3	30.0	15.0
Eleusine indica	5	33.3	12.5	2.5
Amorphophallus campanulatus	2	13.3	5.0	2.5
Elephantopus scaber	2	13.3	5.0	2.5
Cyperus compressus	2	13.3	5.0	2.5
Euphorbia hirta	2	13.3	5.0	2.5
Achyranthes aspera	2	13.3	5.0	2.5
Cyperus brevifolius	1	6.6	2.5	2.5
Echinocloa colonum	1	6.6	2.5	2.5
Musa sp.	1	6.6	2.5	2.5
Dactyloctenium aegyptium	1	6.6	2.5	2.5
Aeschynomene americana	1	6.6	2.5	2.5
Eragrostis tenella	1	6.6	2.5	2.5
Bidens pilosa	1	6.6	2.5	2.5
Cleome viscosa	1	6.6	2.5	2.5
Panicum maximum	1	6.6	2.5	2.5
Curcuma zedoaria	1	6.6	15.0	15.0
SHRUB				
Urena lobata	8	53.3	152.5	19.0
Ficus ulmifolia	1	6.6	2.5	2.5
VINE				
Mikania cordata	9	60.0	272.5	30.3
Pueraria phaseoloides	4	26.6	92.5	23.1
Centrosema pubescens	2	13.3	5.0	2.5

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Table III.4-4

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 1 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
TREES				
Mangifera indica	2	13.3	175.0	87.5
Callicarpa formosana	2	13.3	102.5	51.3
Macaranga grandiflora	1	6.6	37.5	37.5
Endospermum peltatum	1	6.6	37.5	37.5
Theobroma cacao	2	13.3	30.0	15.0
Premna odorata	2	13.3	30.0	15.0
Leucaena leucocephala	2	13.3	17.5	8.8
Trema orientalis	1	6.6	15.0	15.0
Macaranga tanarius	1	6.6	2.5	2.5
PALM				
Cocos nucifera	4	26.6	150.0	37.5

SOURCE: NAPOCOR EMD SURVEY APRIL 1989

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Table III.4-5

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 2 (DRY SEASON)

MAIBARARA G PP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 2

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
HERBS/GRASS				
Cyathula sp.	5	26.3	50.0	10.0
Cyathula prostata	1	5.3	2.5	2.5
Musa sp.	2	10.5	5.0	2.5
Elephantopus scaber	1	5.3	15.0	15.0
Commelina benghalensis	1	5.3	2.5	2.5
Paspalum conjugatum	1	5.3	15.0	15.0
Stachytarpheta jamaicensis	1	5.3	2.5	2.5
Colocasia esculenta	2	10.5	5.0	2.5
Piper sp.	1	5.3	2.5	2.5
Donax cannaeformis	2	10.5	5.0	2.5
SHRUB				
Clerodendron minnahasse	1	5.3	15.0	15.0
Ixora sp.	1	5.3	15.0	15.0
Codiaeum variegatum	2	5.3	30.0	15.0
FERN				
Diplazium esculentum	1	5.3	15.0	15.0
Asplenium nidus	3	15.8	10.0	3.3
TREES				
Pentacme contorta	6	31.6	190.0	31.7
Celtis philippensis	8	42.1	152.5	19.1
Ficus nota	2	10.5	125.0	62.5
Diplodiscus paniculatus	2	10.5	90.0	45.0
Ficus variegata	1	5.3	60.5	60.5
Coffea sp.	6	31.6	52.5	8.8
Theobroma cacao	4	21.1	47.5	11.9
Leea manillensis	5	26.3	32.5	6.5
Leucaena leucocephala	5	26.3	12.5	2.5
Ficus sp.	2	10.5	17.5	8.8

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Table III.4-5

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 2 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
TREES				
Endospermum peltatum	2	10.5	5.0	2.5
Laportea sp.	1	5.3	2.5	2.5
Kleinhofia hospita	5	15.7	12.5	2.5
Voacanga globosa	1	5.3	62.5	62.5
Callicarpa candicans	5	26.3	37.5	7.5
Koordersiodendron pinnatum	2	5.3	5.0	2.5

SOURCE: NAPOCOR EMD SURVEY APRIL 1989

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Table III.4-6

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 3 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 2

SPECIES	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
HERB/GRASS				
Cyathula prostrata	3	20.0	67.5	22.5
Musa sp.	3	20.0	32.5	10.8
Paspalum conjugatum	2	13.3	30.0	15.0
Blechum pyramidatum	3	20.0	20.0	6.7
Cyperus brevifolius	1	6.7	15.0	15.0
Colocasia esculenta	4	26.7	10.0	2.5
Commelina benghalensis	2	13.3	5.0	2.5
Crassocephalum crepidioides	1	6.7	2.5	2.5
Sporobolus sp.	1	6.7	2.5	2.5
Cyathula sp.	1	6.7	2.5	15.0
Gomphrena sp.	1	6.7	2.5	2.5
SHRUB				
Urena lobata	3	20.0	20.0	6.7
Tabernaemontana subglobosa	1	6.7	2.5	2.5
Clerodendron minnahase	1	6.7	2.5	2.5
Gliricidia sepium	1	6.7	2.5	2.5
Ervatamia sp.	1	6.7	2.5	2.5
VINE				
Mikania cordata	8	53.3	130.0	16.2
Arcangelisia flava	1	6.7	2.5	2.5
Calopogonium mucunoides	1	6.7	2.5	2.5
Ipomoea batatas	1	6.7	2.5	2.5
FERN				
Cyathea sp.	1	6.7	37.5	37.5

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Table III.4-6

SPECIES FREQUENCY CHARACTERISTICS AND ABUNDANCE
OF VEGETATION AT TL 3 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

S P E C I E S	ABSOLUTE FREQUENCY	RELATIVE FREQUENCY	TOTAL COVER VALUE	PERCENT COVER/PLOT
TREES				
Mangifera indica	1	6.7	87.5	87.5
Coffea sp.	6	40.0	112.5	18.8
Artocarpus heterophylla	2	13.3	17.5	8.8
Trema orientalis	1	6.7	2.5	2.5
Annona muricata	1	6.7	2.5	2.5
Ficus nota	1	6.7	2.5	2.5
Leucaena leucocephala	1	6.7	2.5	2.5
Callicarpa candicans	1	6.7	2.5	2.5
PALM				
Arenga saccharifera	6	40.0	112.5	18.75
Cocos nucifera	3	20.0	32.5	10.83

SOURCE: NAPOCOR EMD SURVEY APRIL 1989

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Table III.4-7

Economic and Ecological Importance of Vegetation
Species Encountered at Maibarara, Sto.Tomas, Batangas

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

FAMILY/SPECIES	COMMON NAME	ECONOMIC/ECOLOGICAL IMPORTANCE
ACANTHACEAE		
Asystasia gangetica	zamboangenita	leaves antidote for snake bite; sp. diversity
Blechum pyramidatum	sapin-sapin	leaves- vulnerary; species diversity
AMARANTHACEAE		
Amaranthus viridis	kolitis	forage/therapeutic; sp. diversity
Gomphrena celosioides	botonsilyo	ornamental; species diversity
Achyranthes aspera	hangod	medicinal; species diveristy
ANACARDIACEAE		
Mangifera indica	mangga	fruit edible; species diversity
Koordersiodendron pinnatum	amugis	wood for general construction; sp. diversity
ANNONACEAE		
Annona muricata	guayabano	fruit edible; species diversity
APOCYNACEAE		
Voacanga globosa	bayag usa	firewood; species diversity
Tabernaemontana subglobosa	pandakaqui	firewood; species diversity
ARACEAE		
Alocasia macrorrhiza	biga	ornamental; species diversity
Colocasia esculenta	gabi	stem & leaves edible; sp. diversity
Amorphophallus campanulatus	pongapong	stem edible; species diversity
ASTERACEAE		
Elephantopus scaber	dila-dila	species diversity
Bidens pilosa	beggar ticks	medicinal; species diversity
Mikania cordata	bikas	medicinal; specis diversity
Crassocephalum crepedioides	-	species diversity
ATHYRIACEAE		
Diplazium esculenta	pako	young portion edible; species diversity
BOMBACACEAE		
Bombax ceiba	buboy-gubat	textile raw material; species diversity

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Table III.4-7

Economic and Ecological Importance of Vegetation
Species Encountered at Maibarara, Sto.Tomas, Batangas

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

FAMILY/SPECIES	COMMON NAME	ECONOMIC/ECOLOGICAL IMPORTANCE
CORDIACEAE		
Cordia dichotoma	anonang	medicinal; species diveristy
CARICACEAE		
Carica papaya	papaya	fruit edible; species diversity
CONVOLVULACEAE		
Ipomea babatas	kamote	roots edible; species diversity
COMMELINACEAE		
Commelina benghalensis	alikbangon	leaves edible; species diversity
CYATHEACEAE		
Cyathea sp.	tree fern	ornamental; species diversity
CYPERACEAE		
Cyperus compressus	tuhog-dalag	livestock feed; species diversity
Cyperus brevifolius	pugo-pugo	livestock feed; species diversity
CLEOMACEAE		
Cleome viscosa	apoy-apoyan	species diversity
CAESALPINACEAE		
Leucaena leucocephala	ipil-ipil	animal feed; firewood; species diversity
Abrus precatorius	saga	fibers as cordage; species diversity
DENNSTAEDTIACEAE		
Pteridium aquilimum	pako	livestock feed; species diversity
DIPTEROCARPACEAE		
Pentacme contorta	lauan	construction material; species diversity
DIOSCOREACEAE		
Dioscorea alata	kalut	root edible; species diversity

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Table III.4-7

Economic and Ecological Importance of Vegetation
Species Encountered at Maibarara, Sto.Tomas, Batangas

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

FAMILY/SPECIES	COMMON NAME	ECONOMIC/ECOLOGICAL IMPORTANCE
EUPHORBIACEAE		
Codiaeum variegatum	san francisco	ornamental; species diversity
Euphorbia hirta	botobotones	decoction for skin disease; species diversity
Endospermum peltatum	gubas	wood for match sticks manufacture;sp. diversity
Macaranga tanarius	binonga	sap as glue; species diversity
Macaranga grandiflora	binonga	resin as astringent; species diversity
LAMACEAE		
Hyptis suaveolens	soob- kabayo	leaf infusion cure for headache; sp. diversity
LEGUMINOSAE		
Gliricidia sepium	madre de cacao	firewood; species diversity
Pachirrhizus erosus	singkamas	root edible; species diversity
Phanera integrifolia	agpoy	tying purpose; species diversity
MALVACEAE		
Urena lobata	kulot-kulotan	root decoction; species diversity
MARANTHACEAE		
Donax cannaeformis	banban	antidote for snake bite; species diversity
MENISPERMACEAE		
Arcangelisia flava	ligtang	cure for woods/stomach pain; sp. diversity
Tinospora reticulata	makabuhay	cure for indigestion; species diversity
MIMOSACEAE		
Mimosa pudica	makahiya	root decoction for UTI; species diversity
MORACEAE		
Artocarpus heterophylla	langka	fruit edible; species diversity
Ficus nota	tibig	for light construction material; sp. diversity
Ficus variegata	tangisang bayawak	fruit edible; species diversity
Ficus ulmifolia	isis	leaves used as sandpaper; species diversity
MUSACEAE		
Musa sp.	saging	edible; good source of vit. A; sp. diversity

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Table III.4-7

Economic and Ecological Importance of Vegetation
Species Encountered at Maibarara, Sto.Tomas, Batangas

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

FAMILY/SPECIES	COMMON NAME	ECONOMIC/ECOLOGICAL IMPORTANCE
OXALIDACEAE		
Biophytum sensitivum	makahiya	species diversity
PALMAE		
Caryota cumingii	tapikan	leaves for thatching; species diversity
Arenga saccharifera	kaong	food/sap for vinegar making; sp. diversity
Cocos nucifera	niog	construction material/source of oil/fibers species diversity
PAPILIONACEAE		
Aeschynomene americana	makahiyang lalake	animal feed; species diversity
Pueraria phaseoloides	-	cover crop in orchard/plantation; sp. diversity
POACEAE		
Sporobolus sp.	-	animal feed; species diversity
Axonopus compressus	carpet grass	animal feed; species diversity
Bambusa sp.	bamboo	furniture/construction material; sp. diversity
Digitaria ciliaris	crab grass	animal feeds; species diversity
Eleusine indica	bakis-bakisan	decoction for dysentery; species diversity
Echinocloa colonum	bulang	species diversity
Dactyloctenium aegyptium	damong balang	animal feeds; species diversity
Eragrostis tenella	kalirauau	animal feeds; species diversity
Panicum maximum	guinea grass	animal feeds; species diversity
Digitaria ciliaris	-	animal feeds; species diversity
POLYPODIACEAE		
Asplenium nidus	birds nest fern	ornamental; species diversity
PIPERACEAE		
Piper sp.	litlit	substitute for betel leaf; sp. diveristy
Peperomia pellucida	ikmong-batang	for boils/pimples & abcesses; sp. diversity
RUBIACEAE		
Ixora sp.	-	species diversity

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Table III.4-7

Economic and Ecological Importance of Vegetation
Species Encountered at Maibarara, Sto.Tomas, Batangas

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

FAMILY/SPECIES	COMMON NAME	ECONOMIC/ECOLOGICAL IMPORTANCE
RUTACEAE		
Coffea sp.	kape	stimulant/diuretic; species diversity
Lunasia amara	lunas	medicinal; species diversity
SAPINDACEAE		
Cadiospermum halicacabum	balloon vine	rubifacient & emetic; species diversity
SOLANACEAE		
Capsicum frutescens	siling-labuyo	stimulant; species diversity
STERCULACEAE		
Kleinhofia hospita	tanag	wood for light construction; sp. diversity
Pterocymbium tinctorium	taluto	species diversity
Theobroma cacao	kakaw	source of chocolate; species diversity
TILIACEAE		
Diplodiscus paniculatus	balobo	for construction material; species diversity
Triumfetta bartramia	kulot-kulotan	species diversity
ULMACEAE		
Trema orientalis	anabiong	wood for light construction; species diversity
Celtis philippinensis	mala-ikmo	construction material; species diversity
URTICACEAE		
Laportea sp.	lipa	species diversity
VERBENACEAE		
Clerodendron minnahasse	bagauac	medicinal; species diversity
Stachytarpheta jamaicensis	kandi-kandilaan	medicinal; species diversity
Callicarpa candicans	tambalasi	boils/wounds; species diversity
Premna odorata	alagao	medicinal; for bathing infant; sp. diversity
VITACEAE		
Leea manillensis	caliantan	firewood; species diversity
ZINGIBERACEAE		
Cucurma zeodoasia	luya-luyahan	for stomach pain; species diversity
Zingiber sp.	ginger	medicinal; species diversity

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Table III.4-8

BIRD ABUNDANCE AND TAXA LIST SURVEYED AT THE PROJECT SITE

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

sheet 1 of 2

TAXA	COMMON NAME	CENSUS COUNT 1988	CENSUS COUNT 1989	RAI 1988	RAI 1989
FAMILY ACCIPITRIDAE					
Haliastus indus	Brahminy Kite	3		4.4	
FAMILY ALCEDINIDAE					
Alcedo atthis bengalensis	River Kingfisher	1		1.5	
FAMILY APODIDAE					
Cypsiurus parvus	Palm Swift	15	10	22.1	23.8
FAMILY CAMPEPHAGIDAE					
Lalage nigra	Pied Triller	1		1.5	
FAMILY CAPRIMULGIDAE					
Eurostopodus macrotis	Phil. Eared Nightjar	2		2.9	
FAMILY COLUMBIDAE					
Streptopelia bitorquata	Phil. Turtle Dove		1		2.9
FAMILY CORVIDAE					
Corvus macrorhynchus	Large Billed Crow	1		1.5	
FAMILY CUCULIDAE					
Centropus sinensis	Common Coucal	2		2.9	
FAMILY HIRUNDINIDAE					
Hirundo tahitica	Barn Swallow	3	1	4.4	2.4
FAMILY LANIIDAE					
Lanius cristatus	Brown Shrike	5		7.4	
Lanius schach nasutus	Schach Shrike	8	2	11.8	4.8
Lanius validisrostis	Strong Billed Shrike		1		2.4
FAMILY MOTACILLIDAE					
Anthus novaeseelandiae	Richard's Pipit	5		7.4	

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Table III.4-8

BIRD ABUNDANCE AND TAXA LIST SURVEYED AT THE PROJECT SITE

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

sheet 2 of 2

TAXA	COMMON NAME	CENSUS 1988	COUNT 1989	RAI 1988	RAI 1989
FAMILY MUSCICAPIDAE					
Cyornis rufigaster *	Mangrove-Blue Flycatcher	1	1	1.5	2.4
Rhipidura javanica	Malaysian Fantail	1		1.5	
FAMILY ORIOLIDAE					
Oriolus chinensis	Black-Naped Oriole	1		1.5	
FAMILY PICIDAE					
Dendrocopos maculatus	Pygmy Woodpecker		1		2.4
FAMILY PLOCIEDAE					
Passer montanus	Tree Sparrow	2	5	2.9	11.9
FAMILY PSITTACIDAE					
Loriculus philippinensis	Phil. Hanging Parakeet	4	4	5.9	9.5
FAMILY PYCNONOTIDAE					
Hypsipetes philippinus	Phil. Bulbul	3		4.4	
Pycnonotus g. goiavier *	Yellow-Vented Bulbul		2		4.8
FAMILY RALIIDAE					
Porzana tabuensis	Sooty Rail	1	1.5	0.7	
FAMILY SYLVIIDAE					
Megalurus palustris	Striated Canegrass Warbler	4	10	5.9	23.8
Orthotomus cucullatus	Mountain Tailor Bird		1		2.4
FAMILY TURBIDAE					
Saxicola caprata	Pied Bushchat	2		2.9	
FAMILY ZOSTEROPIDQE					
Zosterops montana	Mountain White Eye	3	1	4.4	2.4

Source: NAPOCOR EMD SURVEY SEPTEMBER 1988 & APRIL 1989

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Table III.4-9

FEEDING HABITS AND HABITAT OF BIRD SPECIES
ENCOUNTERED AT THE PROJECT SITE

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

TAXA	COMMON NAME	DIET	HABITAT
FAMILY LANIIDAE			
Lanius validirostris	Strong-Billed Shrike	insects	bushes & tall weeds
Lanius cristatus	Brown Shrike	insects	open country, fields & meadows, cultivated farms and city streets
Lanius schach nasutus	Schach Shrike	insects	grasslands
FAMILY MUSCICAPIDAE			
Cyornis rufigaster	Mangrove-Blue Flycatcher	insects	mangrove forest, bamboo groves, dense-second growth patches, mixed tree & bush growth along streams and edges of dense original dipterocarp forest
Rhipidura javanica	Malaysian Fantail	insects	mangrove/nipa swamps/ bamboo groves/gardens & orchards/farm hedges/ second-growth patches
FAMILY APODIDAE			
Cypsiurus parvus	Asian Palm Swift	insects	city street & gardens
FAMILY PYCNONOTIDAE			
Hysipetes philippinus	Phil. Bulbul	weeds/foliage/ insect	mangrove & bush-type forest/dipterocarp forest/mid-mountain forest & pine forest
Pycnonotus g. goiavier	Yellow Vented Bulbul	insects	
FAMILY MOTACILLIDAE			
Anthus novaeseelandiae	Richard's Pipit	insects	grassland/open meadow/ fallow & newly plowed field & grassy hillsides

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Table III.4-9

FEEDING HABITS AND HABITAT OF BIRD SPECIES
ENCOUNTERED AT THE PROJECT SITE

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 2 of 3

TAXA	COMMON NAME	DIET	HABITAT
FAMILY ZOSTEROPIDAE Zosterops montana	Mountain White-Eye	fruits/berries/ insects	villages/fields/bamboo thickets & second growth
FAMILY CUCULIDAE Centropus sinensis	Common Coucal	insects	open bush & forest edge
FAMILY ACCIPITRIDAE Haliastus indus	Brahminy Kite	scavenger	seacoast/lowland river & in coastal clearings
FAMILY HIRUNDUNIDAE Hirundo rustica	Barn Swallow	insectivore	city streets/gardens/ farm areas
FAMILY TURBIDAE Saxicola caprata	Pied Bushchat	insectivore	grasslands/parang region
FAMILY CAPRIMULGIDAE Eurostopodus macrotis	Phil. Eared Nightjar	insectivore	mountain forest/ second growth
FAMILY PLOCEIDAE Passer montanus	Tree Sparrow	seeds/grains	city streets/gardens
FAMILY PSITTACIDAE Loriculus philippinensis	Phil. Hanging Parakeet	fruits/berries/ coconut juice	villages/fields/ bamboo thickets/growth
FAMILY CAMPEPHAGIDAE Lalage nigra	Pied Triller	fruits/insect	villages/fields/bamboo thickets/second growth
FAMILY COLUMBIDAE Streptopelia bitorquata	Phil. Turtle Dove	rice/mongo/ fruit/weeds	city streets/gardens/ newly-harvested fields parang-type of veg.

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Table III.4-9

FEEDING HABITS AND HABITAT OF BIRD SPECIES
ENCOUNTERED AT THE PROJECT SITE

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

TAXA	COMMON NAME	DIET	HABITAT
FAMILY CORVIDAE Corvus macrorrhynchus	Large Billed Crow	carrion/fruit/cor mice/rats	city streets/gardens/ coconut grove/ mangrove forest/farms/seashores/ secondary-growth patches
FAMILY ORIOLIDAE Oriolus chinensis	Black-Naped Oriole	fruits/insects	coconut grove/orchard/ mangrove forest/secondary growth forest/patches/ trees around the farm & parang type of veg.
FAMILY RALLIDAE Porzana tabuensis	Sooty Rail	snails/insect/ seeds/weeds	swamps/rivers/creeks
FAMILY SYLVIIDAE Megalurus palustris	Striated Canegrass Warbler	insects	grasslands
FAMILY ALCEDINIDAE Alcedo atthis bengalensis	River Kingfisher	fish/crustaceans water insects	seashores/tidal streams in mangrove & nipa swamps open freshwater streams & creeks

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Table III.4-10

ABUNDANCE COUNT AND TAXA LIST OF
MAMMALS, AMPHIBIANS AND REPTILES

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

T A X A	COMMON NAME	1988 CENSUS COUNT	1989 CENSUS COUNT
CLASS MAMMALIA			
Scotophilus Temminck	Yellow Brown Bat		
Rattus mindanensis	Phil. Field Rat	2	*
Rattus exulans	Small Field Rat	1	*
Sus spp.	Wild Pig	*	*
Macaca philippinensis	Monkey	*	*
CLASS AMPHIBIA			
Bufo marinus	Giant Toad	*	*
CLASS REPTILIA			
Hemidactylus frenatus	House lizard	1	*
Mabuya sp.	Brown Skink	*	*
Elaphne spp.	Common Rat Snake	*	*
Gecko-gekko	Phil. Tuk-ko	*	*

SOURCE: NAPOCOR EMD SURVEY SEPTEMBER 1988 & APRIL 1989
* PRESENCE VERIFIED THROUGH
INTERVIEW/QUERIES

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Table III.4-11

INSECTS AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 1 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

ORDER/FAMILY	COMMON NAME	CENSUS COUNT	RAI
COLEOPTERA			
Coccinellidae	Ladybird Beetles	7	2.0
Chrysomelidae	Leaf Beetles	11	3.2
Crytophagidae	Silken Fungus Gnat	1	.3
DIPTERA			
Muscidae	Common Houseflies	18	5.2
Syrphidae	Syrphid Flies	2	.6
Sciomyzidae	Marsh Fly	1	.3
HEMIPTERA			
Lygaeidae	Seed Bugs	3	0.9
Corimelaenidae	Negro Bug	1	.3
HOMOPTERA			
Cicadellidae	Leafhoppers	71	20.5
Aphididae	Aphids	4	1.2
Cercopidae	Spittle Bugs	2	.6
Dictyopharidae	Dictyopharid Planthopper	1	.3
HYMENOPTERA			
Tenthredinidae	Common Sawflies	71	20.5
Formicidae	Ants	7	2.0
LEPIDOPTERA			
Lycaenidae	Gossamer-winged Butterflies	3	.9
Hesperiidae	Common Skipper	1	.3
Arctiidae	Tiger Moth	1	.3
ODONATA			
Coenagrionidae	Narrow-winged Damselflies	7	2.0
Libellulidae	Dragonflies	5	1.4

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Table III.4-11

INSECTS AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 1 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 2 of 2

ORDER/FAMILY	COMMON NAME	CENSUS COUNT	RAI
ORTHOPTERA			
Acrididae	Grasshoppers	76	21.9
Tettigoniidae	Meadow Grasshoppers	6	1.7
Tridactylidae	Pygmy Mole Crickets	3	.9
Mantidae	Mantids	2	.6
Blattidae	Cockroaches	2	.6
Gryllidae	Cricket	1	.3
ARACHNIDA			
Araneidae	Ground Spiders	38	10.9

SOURCE: NAPOCOR EMD SURVEY SEPTEMBER 1988

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Table III.4-12

INSECTS AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST AT TL 2 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

ORDER/FAMILY	COMMON NAME	CENSUS COUNT	RAI
COLEOPTERA			
Chrysomelidae	Leaf Beetles	8	3.8
DIPTERA			
Sciomyzidae	Marsh Flies	8	3.8
Chironomidae	Midges	1	.5
Tabaniidae	Deer fly	1	.5
HEMIPTERA			
Corimelaenidae	Negro Bugs	20	9.6
Lygaeidae	Seed Bugs	8	3.8
HOMOPTERA			
Cixiidae	Cixiid Planthoppers	14	6.7
Issidae	Issid Planthoppers	7	3.4
Cicadellidae	Leafhoppers	6	2.9
Cercopidae	Froghopper	1	.5
HYMENOPTERA			
Formicidae	Ants	51	24.5
Tenthredinidae	Common Sawflies	19	9.1
Ichneumonidae	Ichneumons	1	.5
LEPIDOPTERA			
Hesperiidae	Common Skipper	1	.5
Satyridae	Wood nymph	1	.5
ODONATA			
Libellulidae	Dragonfly	1	.5
OTHROPTERA			
Acrididae	Grasshoppers	14	6.7
Tettigoniidae	Meadow Grasshoppers	12	5.8
Gryllidae	Ground Crickets	4	1.9
Tridactylidae	Pygmy Mole Cricket	2	.9
Mantidae	Mantid	2	.9
ARACHNIDA			
Araneidae	Ground Spiders	25	12.0

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Table III.4-13

INSECTS AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 3 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 2

ORDER/FAMILY	COMMON NAME	CENSUS COUNT	RAI
COLEOPTERA			
Chrysomelidae	Leaf Beetles	9	5.3
Crytophagidae	Silken Fungus Gnats	2	1.2
Coccinellidae	Ladybird Beetle	1	.6
DIPTERA			
Muscidae	House Flies	10	5.9
Culicidae	Mosquitoes	3	1.8
Heleomyzidae	Heleomyzid Flies	1	.6
HEMIPTERA			
Lygaeidae	Seed Bugs	9	5.3
HOMOPTERA			
Cixiidae	Cixiid Planthoppers	23	13.5
Cicadellidae	Leafhoppers	5	2.9
Dictyopharidae	Dictyopharid Planthoppers	4	2.4
Cicadidae	Cicads	3	1.8
Aphididae	Aphid	1	.6
HYMENOPTERA			
Formicidae	Ants	14	8.2
Trigonalidae	Trigonalids	6	3.5
Pompilidae	Spider Wasps	8	4.7
Pteromalidae	Pteromalid	1	.6
ODONATA			
Libellulidae	Dragonflies	13	7.6

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Table III.4-13

INSECTS AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 3 (WET SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 2 of 2

ORDER/FAMILY	COMMON NAME	CENSUS COUNT	RAI
ORTHOPTERA			
Tettigoniidae	Meadow Grasshoppers	5	2.9
Acrididae	Grasshoppers	4	2.4
Mantidae	Mantid	1	.6
ARACHNIDA			
Araneidae	Ground spiders	47	27.6

SOURCE: NAPOCOR EMD SURVEY SEPTEMBER 1988

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Table III.4-14

INSECT AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL I (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

ORDER/FAMILY	COMMON NAME	CENSUS COUNT	RAI
COLEOPTERA			
Chrysomelidae	Leaf Beetles	4	2.6
Mordellidae	Tumbling Flower Beetle	1	.6
DIPTERA			
Culicidae	Mosquitoes	20	12.9
Sciaridae	Dark Winged Fungus Gnats	7	4.5
Otitidae	Picture Winged Flies	2	1.3
Diastatidae	Diastatid Flies	2	1.3
Scatopsidae	Minute Black Scavenger Fly	1	.6
Pipunculidae	Big Head Fly	1	.6
Chamaemyiidae	Chamaemyiid fly	1	.6
HEMIPTERA			
Pyrrhocoridae	Red Bugs	42	27.1
Pentatomidae	Stink Bugs	3	1.9
	unidentified nymph bugs	11	7.1
HOMOPTERA			
Cixiidae	Cixiid Planthoppers	2	1.3
Cicadellidae	Leafhoppers	4	2.6
Membracidae	Treehopper	1	.6
HYMENOPTERA			
Formicidae	Ants	12	7.8
Braconidae	Braconids	4	2.6
Scelionidae	Scelioinid	1	.6
Apidae	Carpenter Bee	1	.6
Platygasteridae	Platygasterid	1	.6
LEPIDOPTERA			
Tortricidae	Tortricid Moths	8	5.2
Pterphroridae	Plume Moths	6	3.9
Pyralidae	Pyralid Moths	6	3.9
Cosmopterygidae	Cosmopterygid Moths	4	2.6
Hesperiidae	Common Skipper	1	.6

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Table III.4-14

INSECT AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 1 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

ORDER/FAMILY	COMMON NAME	CENSUS COUNT	RAI
TYHSANOPTERA Aeolothripidae	Banded Thrips	4	2.6
ARACHNIDA Araneidae	Ground Spiders	5	3.2

SOURCE: NAPOCOR EMD SURVEY APRIL 1989

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Table III.4-15

INSECT AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 2 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 2

ORDER/FAMILY	COMMON NAME	CENSUS COUNT	RAI
COLEOPTERA			
Chrysomelidae	Leaf Beetles	3	1.7
Cryptophagidae	Silken Fungus Beetles	4	2.3
Anthicidae	Antlike Flower Beetles	6	3.4
DIPTERA			
Diastatidae	Diastatid Flies	12	6.8
Chloropidae	Frit Flies	5	2.8
Calliphoridae	Blow Fly	1	0.6
Sciomyzidae	Marsh Flies	2	1.1
Phoridae	Humpbacked Flies	6	3.4
Culicidae	Mosquitoes	6	3.4
Sciaridae	Dark-winged Fungus Gnats	5	3.4
Scatopsidae	Minute Black Scavenger Flies	6	3.4
Mycetophilidae	Fungus Gnats	5	2.8
Dolichopodidae	Long-legged Flies	10	5.7
HEMIPTERA			
Miridae	Leaf Bug	1	0.6
HOMOPTERA			
Cicadellidae	Leafhoppers	36	20.5
Aphididae	Aphid	1	0.6
HYMENOPTERA			
Formicidae	Ants	9	5.1
Perilampidae	Perilampids	2	1.1
Mymaridae	Fairyflies	2	1.1
Pteromalidae	Pteromalid	1	0.6
Eulophidae	Eulophid	1	0.6
Platygasteridae	Platygasterids	2	1.1
Bethylidae	Bethylids	2	1.1
Ichneumonidae	Ichneumons	1	0.6
LEPIDOPTERA			
Pyralidae	Pyralid Moth	4	2.3
Satyridae	Wood Nymph	2	1.1
Pieridae	Yellow/Sulfur/Orange Tips	2	1.1
Citheroniidae	Royal Moth	1	0.6

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Table III.4-15

INSECT AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 2 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

ORDER/FAMILY	COMMON NAME	CENSUS	RAI
ORTHOPTERA			
Gryllidae	Crickets	6	3.4
Blattidae	Wood Cockroach	1	0.6
Tetrigidae	Pygmy Grasshoppers	2	1.1
THYSANOPTERA			
Aeolothripidae	Banded Thrip	1	0.6
ARACHNIDA			
Araneidae	Ground Spiders	13	7.4

SOURCE: NAPOCOR EMD SURVEY APRIL 1989

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Table III.4-16

INSECT AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 3 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 2

ORDER/FAMILY	COMMON NAME	CENSUS	RAI
COLEOPTERA			
Chrysomelidae	Leaf Beetles	14	
Cryptophagidae	Silken Fungus Beetles	4	2.0
Mordellidae	Tumbling Flower Beetle	1	0.1
Coccinellidae	Ladybird Beetles	5	2.4
DIPTERA			
Scatopsidae	Minute Black Scavenger Flies	7	3.5
Sciaridae	Dark-winged Fungus Gnats	5	2.4
Pipunculidae	Big-headed Fly	1	0.5
Muscidae	House Flies	2	1.0
Phoridae	Humpbacked Flies	5	2.4
Otitidae	Picture-winged Fly	1	0.5
Sphaeroceridae	Small Dung Flies	7	3.5
HEMIPTERA			
Miridae	Leaf Bugs	15	7.5
Pyrrhocoridae	Red Bugs	3	1.5
Pentatomidae	Stink Bugs	8	3.9
Lygaeidae	Seed Bugs	6	2.9
HOMOPTERA			
Cicadellidae	Leafhoppers	46	22.9
Cixiidae	Cixiid Planthopper	1	0.5
Aphididae	Aphids	2	1.0
Cercopidae	Froghoppers	3	1.5
HYMENOPTERA			
Eulophidae	Eulophids	8	3.9
Mymaridae	Fairyflies	2	1.0
Torymidae	Torymids	7	3.5
Cynipidae	Gall Wasp	1	0.5
Chrysididae	Cuckoo Wasps	2	1.0
Apidae	Bumble Bee	1	0.5

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Table III.4-16

INSECT AND OTHER INVERTEBRATES ABUNDANCE
AND TAXA LIST ALONG TL 3 (DRY SEASON)

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 2 of 2

ORDER/FAMILY	COMMON NAME	CENSUS	RAI
LEPIDOPTERA			
Cosmopterygidae	Cosmopterygid moth	1	0.5
Pyralidae	Pyralid moths	3	1.5
Lycaenidae	Gossamer-winged Butterflies	2	1.5
ORTHOPTERA			
Acrididae	Short-horned Grasshoppers	4	2.0
Tetrigidae	Pygmy Grasshoppers	3	1.5
Tettigoniidae	Long-horned Grasshoppers	2	1.0
Gryllidae	Crickets	2	1.0
THYSANOPTERA			
Aeolothripidae	Banded Thrips	3	1.5
ARACHNIDA			
Araneidae	Ground Spiders	21	10.4
	Daddy Long Legs	3	1.5

SOURCE: NAPOCOR EMD SURVEY APRIL 1989

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Table III.4-17

FEEDING HABITS AND HABITAT OF INSECT AND OTHER INVERTEBRATES
SURVEYED ALONG THE PROJECT SITE

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

sheet 1 of 3

ORDER/FAMILY	COMMON NAME	FEEDING HABIT	ROLE
COLEOPTERA			
Coccinellidae	Ladybird Beetles	feeds on foliage/roots	Ecological/Agr'l pest
Chrysomelidae	Leaf Beetles	feeds on foliage/roots	Ecological
Crytophagidae	Silken Fungus Gnats	feeds on foliage/sap	Ecological
Mordellidae	Tumbling Flower Beetles	larvae feed on rotten veg	Ecological
DIPTERA			
Muscidae	Houseflies	feeds on decaying matter	Ecological/Agr'l pest
Syrphidae	Syrphid Flies	feeds on decaying matter	Ecological
Sciomyzidae	Marsh Flies	feeds on aquatic snail	Ecological
Chironomidae	Midges	feeds on organic matter	Ecological
Tabanidae	Horsefly	feeds on decaying matter	Ecological
Culicidae	Mosquitoes	feeds on algae/blood sucker	Ecological/Disease vector
Heleomyzidae	Heleomyzid Flies	feeds on fungi	Ecological
Sciaridae	Dark Winged Flies	feeds on roots/plant	Ecological
Otitidae	Picture Winged Flies	feeds on decaying matter	Ecological
Diastatidae	Diastatid Flies	feeds on decaying matter	Ecological
Pipunculidae	Big Head Flies	feeds on decaying matter	Ecological
Chamaemyiidae	Chamaemyiida Flies	scavengers	Ecological
Chloropidae	Frit Flies	scavengers	Ecological
Calliphoridae	Blow Flies	feeds on nectar/sweet liquid	Ecological/Agr'l pest
Phoridae	Humpbacked Flies	scavengers	Ecological
Scatopcidae	Minute Black Scavenger Flies	scavengers	Ecological
Mycetophilidae	Fungus Gnats	feeds on decaying matter	Ecological
Dolichopodidae	Long-legged Flies	feeds on decaying matter	Ecological
Sphaeroceridae	Small Dung Flies	feeds on decaying matter	Ecological
HEMIPTERA			
Lygaeidae	Seed Bugs	plant/insect feeders	Ecological/Agr'l. pest
Corimelaenidae	Negro Bugs	plant feeders	Ecological
Pyrrhocoridae	Red Bugs	plant feeders	Ecological
Pentatomidae	Stink Bugs	plant feeders	Ecological
Miridae	Leaf Bugs	plant feeders	Ecological

Table III.4-17

FEEDING HABITS AND HABITAT OF INSECT AND OTHER INVERTEBRATES
SURVEYED ALONG THE PROJECT SITE

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

ORDER/FAMILY	COMMON NAME	FEEDING HABIT	ROLE
HOMOPTERA			
Cicadellidae	Leafhoppers	plant feeders	Disease vector/Agr'l pest
Aphididae	Aphids	plant feeders	Ecological/Agr'l pest
Cercopidae	Froghoppers	plant feeders	Ecological
Cixiidae	Cixiid Planthopper	plant feeders	Ecological
Membracidae	Treehoppers	feeds on trees/shrubs	Ecological
Dictyopharidae	Dictyopharid Planthopper	plant feeders	Ecological
Cicadidae	Cicad	feeds on trees	Ecological
Issidae	Issid	plant feeders	Ecological
HYMENOPTERA			
Myrmaridae	Fairy Flies	plant feeders	Disease vector/Agr'l pest
Pteromalidae	Pteromalid	feeds on other insects	Ecological/Agr'l pest
Eulophidae	Eulophid	feeds on other insects	Ecological
Platygasteridae	Platygasterid	plant feeders	Ecological
Betyllidae	Betyllid	feeds on other insects	Ecological
Ichneumonidae	Ichneumons	feeds on other insects	Ecological
Formicidae	Ants	plant feeders/scavenger	Ecological
Perilampidae	Perilampid	plant feeders	Ecological
Braconidae	Braconid	plant feeders	Ecological
Trigonalidae	Trigonalid	plant feeders	Ecological
Pompilidae	Spider Wasps	plant feeders	Ecological
Tenthredinidae	Common Sawlies	plant feeders	Ecological
Eulophidae	Eulophids	plant feeders	Ecological
Cynipidae	Gall Wasps	plant feeders	Ecological
LEPIDOPTERA			
Tortricidae	Tortricid Moths	leaf feeders	Ecological/Agr'l pest
Pterophoridae	Plume Moth	leaf/stem feeders	Ecological/Agr'l pest
Pyralidae	Pyralid Moth	feeds on foliage	Ecological
Cosmopterygidae	Cosmopterygid Moths	leaf feeders	Ecological
Hesperiidae	Common Skipper	leaf feeders	Ecological
Satyridae	Wood Nymph	feeds on grass	Ecological
Pieridae	Sulfur	feeds on cabbage	Ecological
Citheroniidae	Royal Moth	feeds on trees	Ecological
Lygaenidae	Gossamer-winged Butterfly	feeds on nectar/sap	Ecological
Arctiidae	Tiger Moth		

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Table III.4-17

FEEDING HABITS AND HABITAT OF INSECT AND OTHER INVERTEBRATES
SURVEYED ALONG THE PROJECT SITE

MAIBARARA GPP EIS: MAY 1992
(TERRESTRIAL ECOLOGY)

ORDER/FAMILY	COMMON NAME	FEEDING HABIT	ROLE
ODONATA			
Libellulidae	Dragonflies	feeds on nectar/sap	Ecological
Coenagrionidae	Narrow-winged Damselflies	feeds on flower/veg.	Ecological
ORTHOPTERA			
Gryllidae	Crickets	plant feeders	Ecological/Agr'l pest
Blattidae	Wood Cockroaches	decaying matter	Pest/disease vector
Tetrigidae	Pygmy Grasshopper	plant feeders	Ecological
Acrididae	Short-Horned Grasshopper	plant feeders	Ecological
Tettigonidae	Long-Horned Grasshopper	feeds on rotten wood	Ecological
Tridactyllidae	Pygmy Mole Cricket	plant feeders	Ecological/Agr'l pest
Mantidae	Mantid	feeds on other insects	Ecological
THYSANOPTERA			
Aeolothripidae	Banded Thrips	plant feeders	Ecological
ARACHNIDA			
Araneidae	Ground Spiders	feeds on other insects	Ecological
Phalangidae	Daddy Long Legs	feeds on other insects	Ecological

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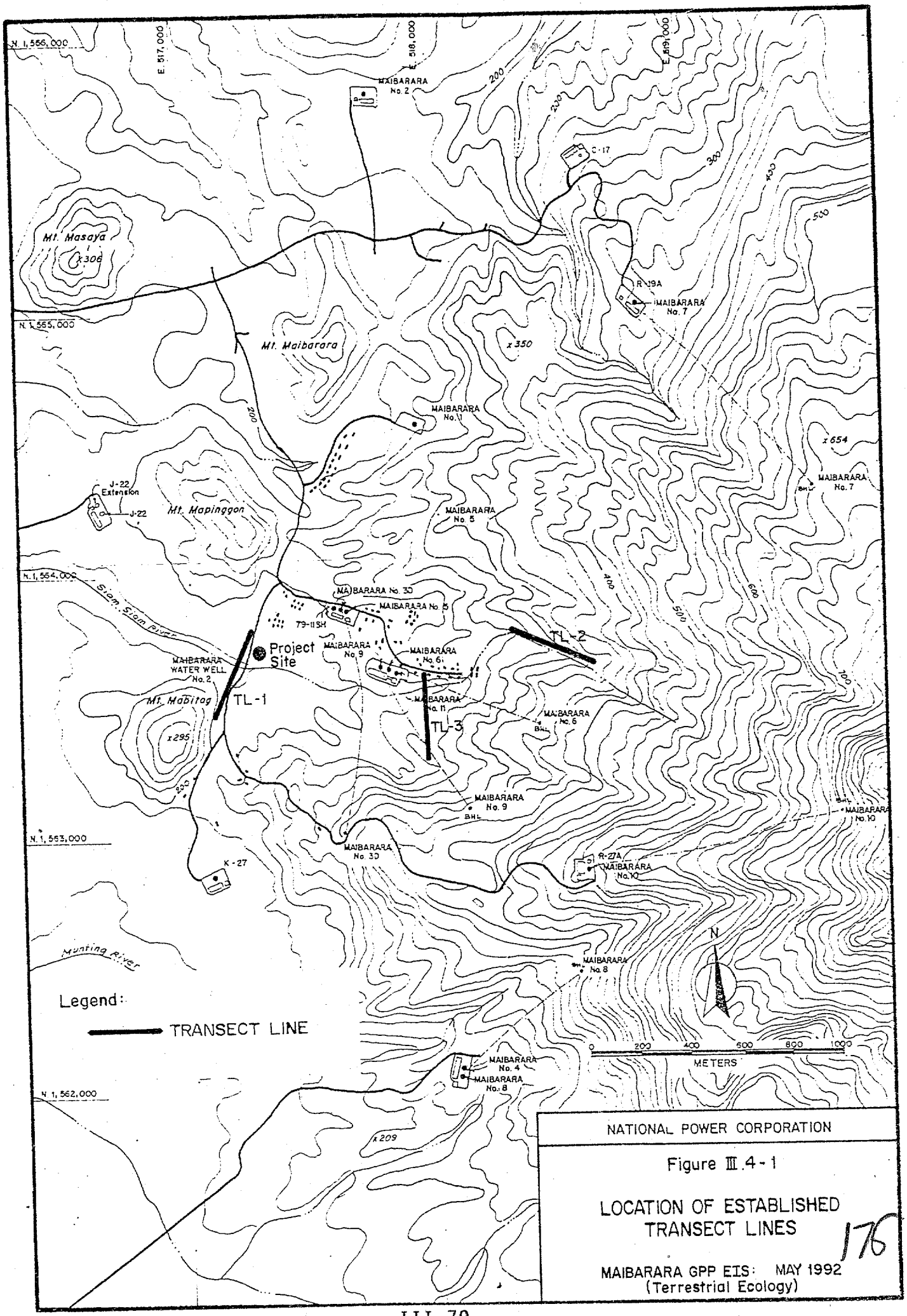

NATIONAL POWER CORPORATION

Figure III.4-1

LOCATION OF ESTABLISHED TRANSECT LINES

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

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Agricultural land along the proposed Maibarara Geothermal Power Plant

NATIONAL POWER CORPORATION

Figure III.4-2

TERRESTRIAL ECOLOGY PHOTO

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

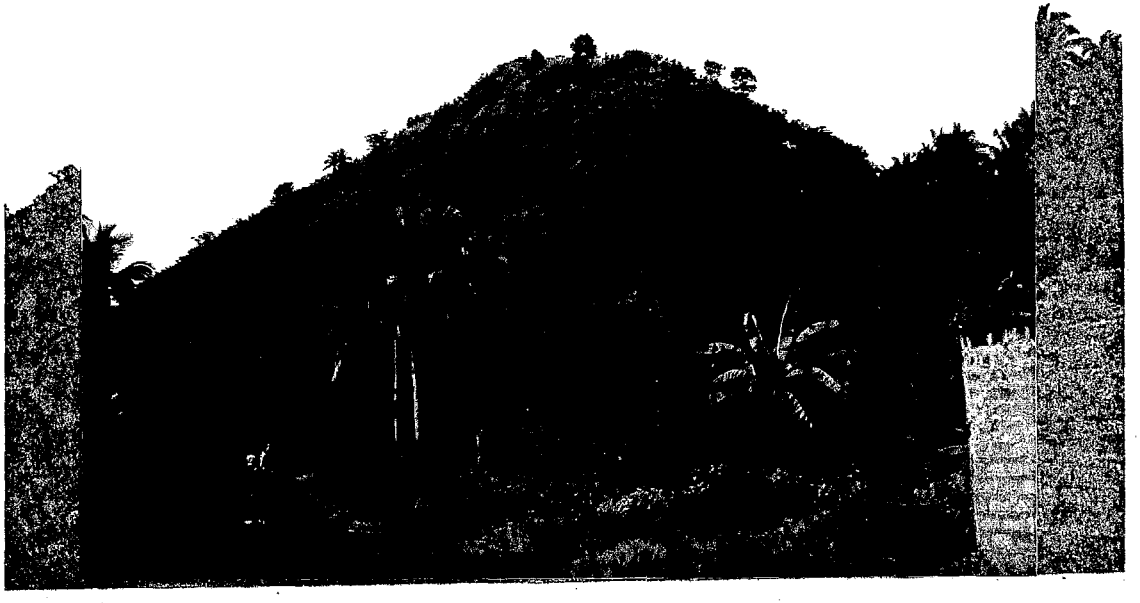

Photo showing Transect Line 1

NATIONAL POWER CORPORATION

Figure III.4-3

TERRESTRIAL ECOLOGY PHOTO

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

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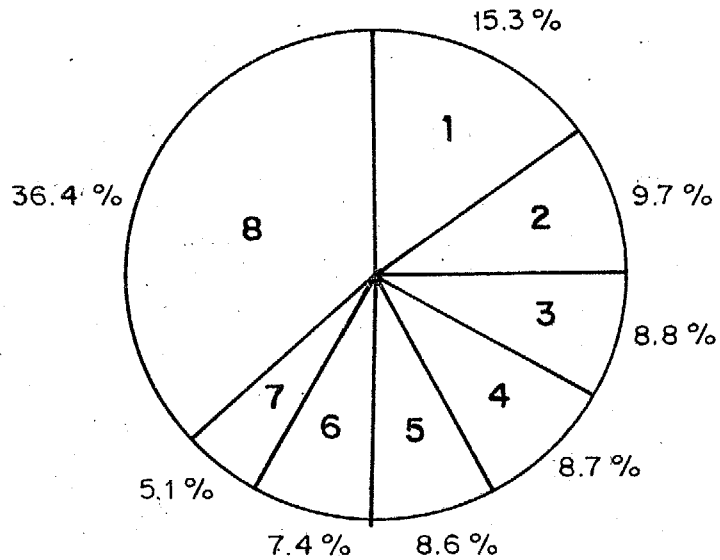
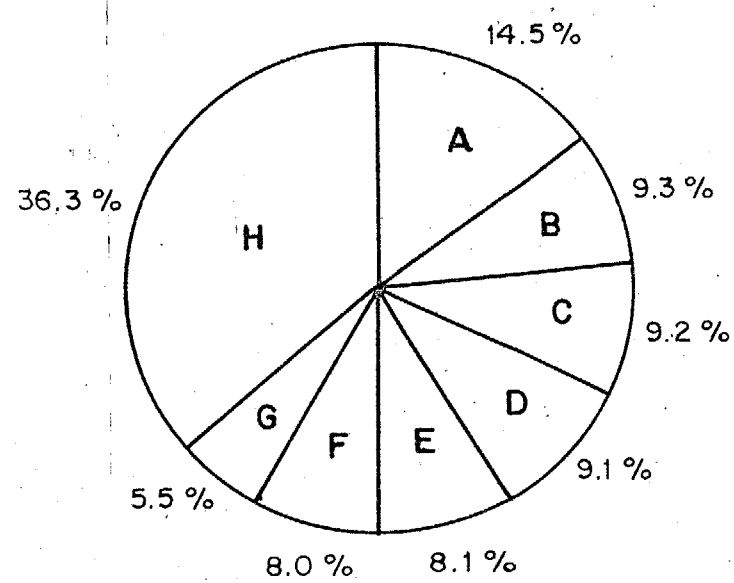
SEPTEMBER 1988 (WET)



LEGEND:

1 - Axonopus compressus
2 - Mikania cordata
3 - Urena lobata
4 - Mangifera indica
5 - Mimosa pudica
6 - Cocos nucifera
7 - Callicarpa formosana
8 - Others, 32 species

APRIL 1989 (DRY)



LEGEND:

A - Mikania cordata
B - Mangifera indica
C - Mimosa pudica
D - Axonopus compressus
E - Urena lobata
F - Cocos nucifera
G - Callicarpa formosana
H - Others, 32 species

NATIONAL POWER CORPORATION

Figure III.4-4

DOMINANT VEGETATION SPECIES ENCOUNTERED ALONG TL-1 (Wet / Dry Season)

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

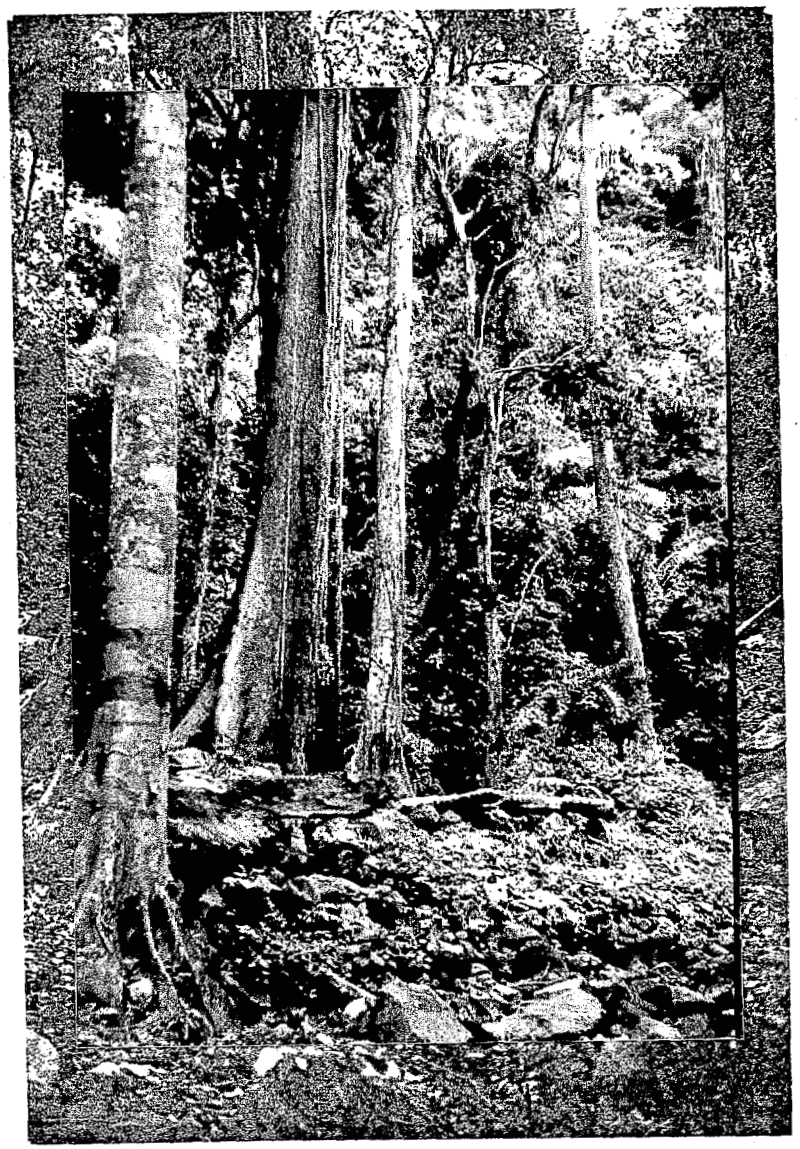


Photo showing Transect Line 2

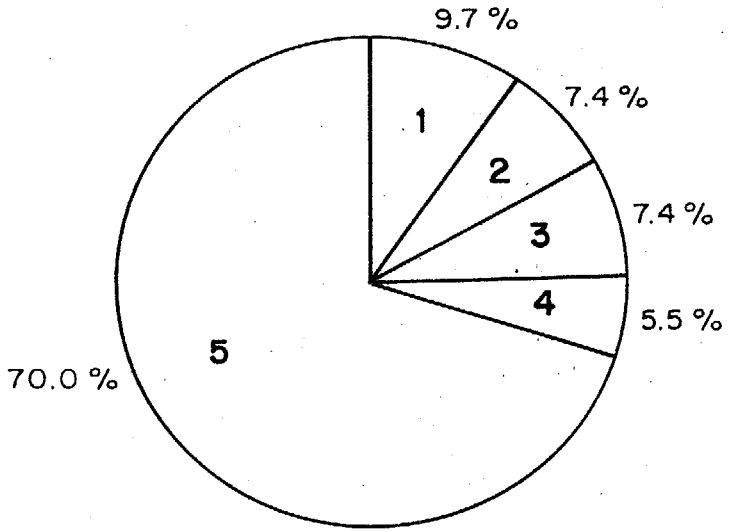
NATIONAL POWER CORPORATION

Figure III.4-5

TERRESTRIAL ECOLOGY PHOTO

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

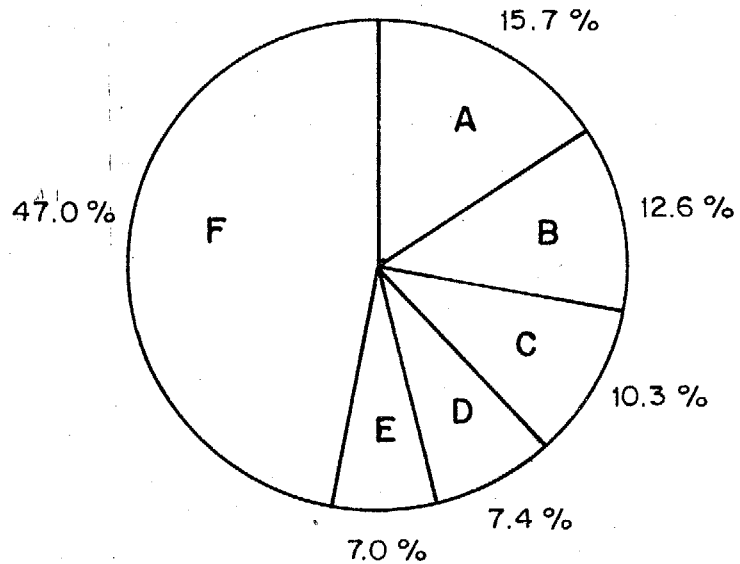
SEPTEMBER 1988 (WET)



LEGEND:

1 - Shorea contorta
2 - Diplodiscus paniculatus
3 - Kleinhovia hospita
4 - Celtis philippinensis
5 - Others

APRIL 1989 (DRY)



LEGEND:

A - Shorea contorta
B - Diplodiscus paniculatus
C - Kleinhovia hospita
D - Celtis philippinensis
E - Arenga saccharifera
F - Others

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Figure III.4-6

DOMINANT VEGETATION SPECIES ENCOUNTERED ALONG TL-2 (Wet / Dry Season)

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

Photo showing Transect Line 3

NATIONAL POWER CORPORATION

Figure III.4-7

TERRESTRIAL ECOLOGY PHOTO

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

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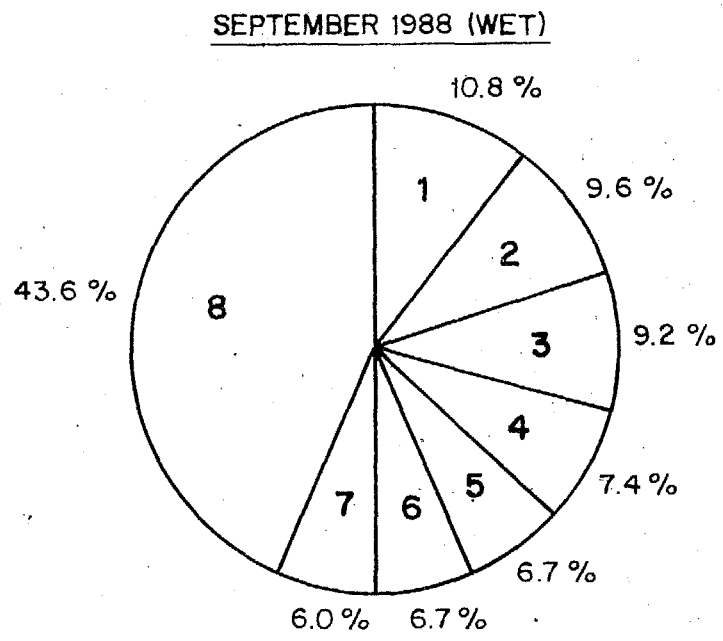

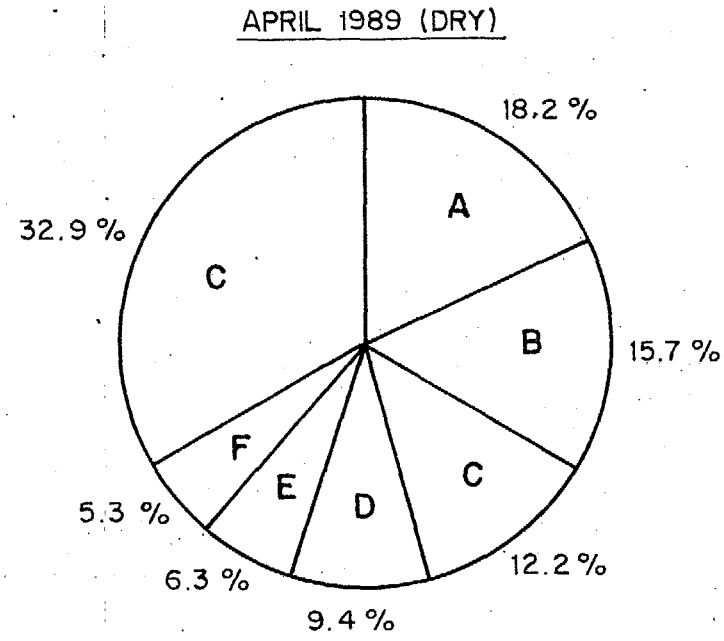

LEGEND:

1 - Alocasia macrorrhiza
2 - Mikania cordata
3 - Coffea sp.
4 - Cocos nucifera
5 - Mangifera indica
6 - Crassocephalum crepideides
7 - Ageratum conyzoides
8 - Others

LEGEND:

A - Mikania cordata
B - Coffea sp.
C - Mangifera indica
D - Cyathula prostata
E - Cocos nucifera
F - Cyathea sp.
G - Others

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Figure III.4-8

DOMINANT VEGETATION SPECIES ENCOUNTERED ALONG TL-3 (Wet / Dry Season)

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

Left : A portion of Siam-Siam River near the Talon Falls (Photo taken Sept. 1988)

Right : Due to the effect of heavy rains after the typhoon, (this same area was cleared of all vegetative) cover except for a few trees. (Photo taken Feb. 1990)

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Figure III.4-9

TERRESTRIAL ECOLOGY PHOTO

MAIBARARA GPP EIS: MAY 1992
(Terrestrial Ecology)

III.5 Aquatic Ecology

Freshwater ecology sampling/surveys were carried out in September 1988 for the wet season and April 1989 for the dry season in six (6) the sampling geotherna; field, located along Siam-Siam River in the Maibarara (located within of the Mak-Ban (Bulalo) geothermal reservation) in Sitio Capus, Brgy. San Rafael, Sto. Tomas, Batangas (Figure III.5-1). During the dry season, however, samples were obtained from only three (3) stations because stretches of the river along STNs MAI-3, MAI-5 and MAI-6 were dry.

In the discussion of the biotic compositions within the environs of the proposed Maibarara Geothermal Power Plant Project, only phytoplankton, zooplankton and benthic organisms were sampled since no freshwater fishes were sampled during the surveys/collection.

The description of the sampling stations are as follows:

Station	Location/Description
MAI-1	1500 m E of the project site, with 0.3-0.6 m water depth, rocky substrate, within the vicinity of Talon Falls.
MAI-2	1400 m E of the project site, with 0.3-0.6 m water depth, rocky substrate, slow-flowing water.
MAI-3	1250 m E of the project site, with 0.3 m water depth, sandy-rocky substrate, slow-flowing water and dry during the dry season.
MAI-4	1150 m E of the project site, 0.3-0.5 m water depth and within the vicinity of Capus Dam.
MAI-5	350 m E of the project site, with 0.2-0.3 m water depth, sandy-muddy substrate and dry during the dry season.

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MAI-6	100 m E of the Maibarara water well, within the vicinity of the project site, with 0.2-0.3 m water depth, sandy-muddy substrate and dry during the dry season.

III.5.1 Methodology

III.5.1.1 Phytoplankton

One-half (1/2) gallon of surface-water phytoplankton samples were collected from the sampling stations. Samples were preserved with 4% formalin. Lugol's solution was also added to the samples to retain the color of the collected phytoplankton. In the laboratory, samples were allowed to settle in their original container and after 4-7 days, the supernatant was siphoned off and the samples were transferred to a shallow container. They were again allowed to settle for 3-7 days and the final concentrate of 100 ml was obtained. The final concentrate was mixed well and a 1 ml aliquot sample was examined using the Sedgewick-Rafter (S-R) counting cell under a compound microscope (10x magnification, 10 field). The phytoplankton samples were identified to the lowest practicable taxonomic level, counted and their density (D) and relative abundance index (RAI) were calculated using the following formula:

$$D = \frac{N \times 1000 \times Vc}{L \times d \times W \times S \times Vs} \text{ cells/ml}$$

where:

D	=	Density, cells per ml
N	=	Number of cells counted
L	=	Length of each strip (S-R cell length), mm
d	=	Depth of a strip (S-R cell width), mm
W	=	Width of a strip (Whipple grid range width), mm
S	=	Number of strips counted
Vc	=	Volume of concentrate, ml
Vs	=	Volume of original sample, ml

and

$$RAI = \frac{S}{T} \times 100$$

where:

RAI = Relative Abundance Index (%)
S = Total number of organisms per species
T = Total number of organisms of all species

III.5.1.2 Zooplankton

Using a fine mesh 0.33 mm plankton net with a 0.5 meter mouth opening, zooplankton samples were collected from the established sampling stations. Zooplankton collection was done through setting of net for at least five (5) minutes against the direction of water current. The plankton net was thoroughly washed and rinsed with water to remove all attached organisms in the net into a plastic container. The zooplankton samples were preserved in 4% formalin. Rose bengal solution was added to stain specimens to facilitate sorting and identification.

In the laboratory, total zooplankton biovolume was measured by displacement method. A Folsom plankton splitter was used to obtain two (2) ml aliquot samples. One set of fraction was sorted through 125, 250, 500 and 1000 micron mesh sieves.

Identification and counting of various taxa were made using a dissecting stereozoom microscope and a zooplankton counting wheel, respectively. The relative abundance index (RAI) of zooplankton samples was calculated using the standard formula.

III.5.1.3 Benthos

Benthic fauna were collected by means of a Surber Square Foot sampler with attached nylon bag net from the sampling stations on October 1988 and April 1989. Samples taken at each station were placed in properly labelled plastic containers and preserved with 4% formalin. In the laboratory, samples were sieved through a 500 micron mesh screen. Rose Bengal solution was added to stain the specimens to facilitate sorting and identification.

Taxonomic identification was done to the lowest practicable taxonomic level with the use of a dissecting stereozoom microscope. The Relative Abundance Index (RAI) was calculated using the standard formula. Density (D) of benthic organisms was calculated using the formula:

$$D = \frac{\text{number of organisms}}{0.093} \quad \text{organisms/sq m}$$

III.5.2 Results and Discussion

III.5.2.1 Phytoplankton

A total of 211 organisms belonging to 22 species/taxa and 4 phyla were collected during the wet season (September 1988) sampling. Of this, 19.9% were Pinnularia sp., 15.2% Chlorococcum sp., 13.3% Navicula sp., 12.8% Achnanthes sp., 12.3% Synedra sp., and 6.2% Fragilaria sp.. The remaining 20.3% of the total phytoplankton samples belongs to 16 other species/taxa (Table III.5-1).

During the dry season (April 1989), a total of 217 organisms belonging to 9 taxa and 2 phyla were collected. Almost two-thirds (63.6%) of the total phytoplankton were Synedra sp. while other major phytoplankton genera include Navicula sp. (17.5%), Diatoma sp. (5.5%), and Nitzschia sp. (5.5%). The remaining 7.9% of the total samples were composed of 5 other species/taxa (Table III.5-2).

Differences between the dry and wet season sampling were noted in the number of species and phyla present rather than the organism count. In the wet season samples, there were 22 taxa belonging to 4 phyla as against 17 species/taxa belonging to 2 phyla in the dry season. Furthermore, of the 24 taxa identified, there were 7 species/taxa common to both seasons giving a similarity index of 0.45. The genus common in both seasons were Achnanthes sp., Fragilaria sp., Synedra sp., Navicula sp., Pinnularia sp., Nitzschia sp., and Spirulina sp. In addition, there were 4 indicator species of clean water (Cocconeis sp., Navicula sp., Pinnularia sp. and Surirella sp.) and 2 indicator species that also survive in polluted water (Chlorococcum sp. and Nitzschia sp.) that were identified.

The variation in the phytoplakton population between the two (2) seasons may be attributed to the speed of water current, temperature and amount of dissolved salts in the water. The speed of the current is the most important not only directly, but indirectly since it influences the type of river bed and the amount of silt deposition (Hynes, 1974).

With regards to station distribution of phytoplankton samples, STN MAI-5 registered the highest (86) organism count during the wet season while STNs MAI-1 and MAI-3 registered the least with 9 organisms each. In the dry season, STN MAI-2 registered the highest (97) organism count while the least count was obtained from STN MAI-4 with 24 organisms. No samples were obtained from STNs MAI-3, MAI-5 and MAI-6 during the dry season because these areas of the river were dry.

Moreover, Navicula sp. (a clean water indicator species) registered higher densities during the wet season in STNs MAI-4, MAI-5 and MAI-6 as compared to STNs MAI-2 and MAI-3. On the other hand, Chlorococcum sp. (an indicator species of polluted waters) showed higher densities in STNs MAI-1 and MAI-2 as compared to other stations.

III.5.2.2 Zooplankton

During the wet season (September 1988), a total of 272 organisms belonging to 4 phyla were identified (Table III.5-3). Species belonging to Phylum Arthropoda were the most dominant with 239 organisms (87.9%) while Phylum Annelida, Phylum Chordata and Phylum Nematoda were the minor phyla with relative abundances of 5.9%, 4.0% and 2.2%, respectively.

In addition, more than half (58.8%) of the total zooplankton species belong to Order Diptera (midges) followed by Order Trichoptera (caddisfly) with 5.9%, Phylum Annelida (segmented worms) with 5.9%, and Order Ephemeroptera (mayfly) with 5.5%. Other taxa (14 species/taxa) accounted for 23.9% of the samples.

On the other hand, during the dry season more than one-fourth (27.7%) of the zooplankton samples belong to Order Ephemeroptera followed by Order Diptera (23.1%), Order Calanoida (13.8%), and Order Hemiptera (10.8%). Other taxa (7 species/taxa) accounted for 24.6% of the samples (Table III.5-4).

It was noted that wet season survey registered higher organism count (272) than the dry season sampling with 65 organisms. In addition, there were 4 phyla represented in the wet season while only 2 phyla were present during the dry season.

Moreover, it was noted that Order Diptera was the major taxa during the wet season with a relative abundance of 58.8%. In the dry season, species belonging to Orders Ephemeroptera and Diptera accounted for 27.7% and 24.6% of the total zooplankton population, respectively. Pentaneura sp. (a dirty water indicator species) and Hydropsyche sp. (a clean water indicator species) were noted in the dry season (Table III.5-4).

With regards to station distribution, during the wet season, STN MAI-5 registered the highest (67) organism count (24.8% of the total samples) while the lowest organism count was obtained from STN MAI-4 with 30 organisms (11.1%). In the dry season, STN MAI-2 had the highest organism count with 28 or 43.1% of the total samples while the least number of organism was obtained from STN MAI-4 with 17 organisms (26.15%). Similarly, no samples were collected from STNs MAI-3, MAI-5, and MAI-6 during the dry season since these were dry.

III.5.2.3 Benthos

Around one-fourth (25.7%) of the 74 benthic organisms collected during the wet season (September 1988) were Baetis sp. followed by polychaete larvae (21.6%), Thiara sp. (14.9%), Pila sp. (8.1%), Palaemonetes sp. (5.4%) and mosquito larvae (Family Culicidae) with 5.4%. The remaining 18.9% of the total samples include 11 other species/taxa (Table III.5-5).
On the other hand, more than half (59.3%) of the total benthic samples (216 organisms) during the dry season were Thiara sp. followed by Palaemonetes sp. with 24.1%. The remaining 16.6% of the samples consisted of 14 other taxa (Table III.5-6).

The predominance of insect species in the benthos samples may be attributed to the fact that insects are aquatic during their immature/larval stages except for Hemipterans and Coleopterans whose adults normally inhabit freshwater environments (Elsinga, 1981).

Seasonal differences of samples showed that in the wet season there were 17 taxa belonging to 4 phyla that were recorded as against 15 species/taxa belonging to 3 phyla in the dry season. However, there were more (216) organisms that were obtained during the dry season as compared to the wet season with 74 organisms.

The higher abundance of benthic organisms in the dry season may be influenced by the concentration of food supply in the sediments due to reduced water currents. Detritus materials such as dried leaves and grass stems and the products of their breakdown and decay are the major food of these animal communities (Hynes, 1974).

Baetis sp. (a clean water indicator species) was recorded only during the wet season while organisms belonging to Family Hirundinidae (polluted water indicator species) were present in the dry season. In addition, of the 25 species/taxa identified, 6 species/taxa were common to both seasons giving a similarity index of 0.38. The common species in both seasons were Palaemonetes sp., Varuna sp., Thiara sp., Viviparus sp., Radix sp., and Gyraulus sp.

During the wet season sampling, STN MAI-2 registered the highest with 24 organisms or 32.4% of the total benthic organisms while STNs MAI-4 and MAI-5 registered the lowest with 5 organisms (6.8%) each. During the dry season, STN MAI-1 registered the highest (125) organism count which is 57.9 % of the total samples and STN MAI-2 with the least (26 organisms or 12%). No samples were collected from STNs MAI-3, MAI-5, and MAI-6 because these were dry.

Baetis sp. and polychaete larvae were present in all the stations during the wet season while mosquito larvae (Family Culicidae) were recorded in the upstream stations (MAI-1, MAI-2, MAI-3, and MAI-4).

Table III.5-1

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER PHYTOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (WET SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (cells/ml)						
	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL
PHYLUM CHLOROPHYTA																					
Class Chlorophyceae																					
Order Chlorococcales																					
Family Chlorococcaceae																					
Chlorococcum sp.	5	16	4	3		4	32	55.56	45.71	44.44	15.00		7.69	15.17	0.024	0.077	0.019	0.014		0.019	0.153
Family Hydrodictyaceae																					
Pediastrum sp.		1				1	2		2.86				1.92	0.95		0.005				0.005	0.010
Family Oocystaceae																					
Quadrigula sp.					5	4	9					5.81	7.69	4.27					0.024	0.019	0.043
Trochiscia sp.		1	1		1		3		2.86	11.11		1.16		1.42		0.005	0.005		0.005		0.014
Family Scenedesmaceae																					
Scenedesmus sp.			1				1			11.11				0.47			0.005				0.005
Order Zygnematales																					
Family Desmidiaceae																					
Closterium sp.	2	1					3	22.22	2.86					1.42	0.010	0.005					0.014
PHYLUM CHRYSOPHYTA																					
Class Bacillariophyceae																					
Order Centrales																					
SubOrder Coscinodiscineae																					
Family Coscinodiscaceae																					
Coscinodiscus sp.						1	1						1.92	0.47						0.005	0.005
Melosira sp.		2			1		3		5.71			1.16		1.42		0.010			0.005		0.014
Eucampia sp.					2	1	3					2.33	1.92	1.42					0.010	0.005	0.014

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Table III.5-1

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER PHYTOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (WET SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (cells/ml)						
	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL
Order Pennales																					
Suborder Achnanthineae																					
Family Achnanthaceae																					
Achnanthes sp.					16	11	27					18.61	21.16	12.80					0.077	0.053	0.129
Cocconeis sp.						1	1						1.92	0.47						0.005	0.005
SubOrder Fragilarineae																					
Family Fragilariaceae																					
Fragilaria sp.	1	2			8	2	13	11.11	5.71			9.30	3.85	6.16	0.005	0.010			0.038	0.010	0.062
Synedra sp.		5		10	10	1	26		14.28		50.00	11.63	1.92	12.32		0.024		0.048	0.048	0.005	0.125
SubOrder Naviculineae																					
Family Cymbellaceae																					
Rhopalodia sp.		1					1		2.86					0.47		0.005					0.005
Family Naviculaceae																					
Navicula sp.		2	2	6	13	5	28		5.71	22.22	30.00	15.12	9.62	13.27		0.010	0.010	0.029	0.062	0.024	0.134
Pinnularia sp.		1			25	16	42		2.86			29.07	30.77	19.91		0.005			0.120	0.077	0.201
Pleurosigma sp.	1					1	2	11.11					1.92	0.95	0.005					0.005	0.010
SubOrder Surirelineae																					
Family Nitzschiaceae																					
Nitzschia sp.					4	2	6					4.65	3.85	2.85					0.019	0.010	0.029
Family Surirellaceae																					
Surirella sp.		1			1		2		2.86			1.16		0.95		0.005			0.005		0.010

Table III.5-1

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER PHYTOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (WET SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (cells/ml)						
	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL
PHYLUM CYANOPHYTA																					
Class Cyanophyceae																					
Order Chroococcales																					
Family Chroococcaceae																					
Gloeothece sp.		1	1				2		2.86	11.11				0.95		0.005	0.005				0.010
Order Oscillatoriales																					
SubOrder Oscillatorineae																					
Family Oscillatoriaceae																					
Spirulina sp.				1		2	3				5.00		3.85	1.42				0.005		0.010	0.014
PHYLUM EUGLENOPHYTA																					
Class Euglenophyceae																					
Order Euglenales																					
Family Euglenaceae																					
Trachelomonas sp.		1					1		2.86					0.47		0.005					0.005
Total No. of Organisms	9	35	9	20	86	52	211								0.043	0.171	0.043	0.096	0.412	0.252	1.011
Total No. of Species/Taxa	4	13	5	4	11	14	22														
Total No. of Phyla	2	4	3	3	2	3	4														

Source: MAPOCOR EMD SURVEY, SEPTEMBER 1988

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Table III.5-2

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER PHYTOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (DRY SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

sheet 1 of 2

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (cells/ml)						
	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL
PHYLUM CHRYSOPHYTA																					
Class Bacillariophyceae																					
Order Pennales																					
SubOrder Achnanthineae																					
Family Achnanthaceae																					
Achnanthes sp.		2					2		2.06					0.92		0.010					0.010
SubOrder Fragilarineae																					
Family Fragilariaceae																					
Fragilaria sp.	1	3		1			5	1.04	3.09		4.17			2.30	0.005	0.014		0.005			0.024
Synedra sp.	66	64		8			138	68.75	65.98		33.33			63.60	0.316	0.307		0.038			0.661
Family Diatomaceae																					
Diatoma sp.	7	3		2			12	7.29	3.09		8.33			5.53	0.034	0.014		0.010			0.057
SubOrder Naviculineae																					
Family Naviculaceae																					
Navicula sp.	8	18		12			38	8.33	18.56		50.00			17.51	0.038	0.086		0.057			0.182
Pinnularia sp.	1	5					6	1.04	5.16					2.77	0.005	0.024					0.029
SubOrder Surirellineae																					
Family Nitzschiaceae																					
Nitzschia sp.	11	1					12	11.46	1.03					5.53	0.053	0.005					0.057

Table III.5-2

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER PHYTOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (DRY SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (cells/ml)						
	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL
PHYLUM CYANOPHYTA																					
Class Cyanophyceae																					
Order Chroococcales																					
SubOrder Oscillatorineae																					
Family Oscillatoriaceae																					
Spirulina sp.				1			1				4.17			0.46				0.005			0.005
Family Chroococcaceae																					
Chroococcus sp.	2	1					3	2.09	1.03					1.38	0.010	0.005					0.014
Total No. of Organisms	96	97		24			217								0.460	0.465		0.115			1.040
Total No. of Species/Taxa	7	8		5			9														
Total No. of Phyla	2	2		2			2														

Note : * - No samples collected
Source: NAPOCOR EMD Survey, April 1989

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Table III.5-3

TAXONOMIC LISTING, DISTRIBUTION AND RELATIVE ABUNDANCE
OF FRESHWATER ZOOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (WET SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)						
	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL
PHYLUM ANNELIDA														
Annelida (segmented worm)	9	4		2		1	16	21.95	7.02		6.67		2.17	5.88
PHYLUM ARTHROPODA														
Class Arachnida														
Order Araneida				1	1		2				3.33	1.49		0.74
Class Arachnoidea														
Order Acarina	1						1	2.44						0.37
Class Crustacea														
SubClass Copepoda														
Order Calanoida														
Calanus sp.	1	8				1	10	2.44	14.04				2.17	3.68
SubClass Malacostraca														
Order Mysidacea														
SubOrder Mysidea														
Mysis		3					3		5.26					1.10
Class Insecta														
Order Coleoptera	1	1	1	2	1	1	7	2.44	1.75	3.23	6.67	1.49	2.17	2.57
Order Collembola			1				1			3.23				0.37
Order Diptera	23	27	16	21	48	25	160	56.10	47.37	51.61	70.00	71.64	54.35	58.82
Order Ephemeroptera		4	5	1	2	3	15		7.02	16.13	3.33	2.99	6.52	5.51
Order Hemiptera		1					1		1.75					0.37
Order Hymenoptera	2	1	2	1		2	8	4.88	1.75	6.45	3.33		4.35	2.94

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Table III.5-3

TAXONOMIC LISTING, DISTRIBUTION AND RELATIVE ABUNDANCE
OF FRESHWATER ZOOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (WET SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)						
	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL
Order Lepidoptera					2		2					2.99		0.74
Order Odonata	1						1	2.44						0.37
Order Orthoptera						1	1						2.17	0.37
Order Plecoptera			1	1	7	2	11			3.23	3.33	10.45	4.35	4.04
Order Trichoptera	3	5	3		2	3	16	7.32	8.77	9.68		2.99	6.52	5.88
PHYLUM CHORDATA														
SubPhylum Vertebrata														
Class Pisces (Eggs)		2	2	1	3	3	11		3.51	6.45	3.33	4.48	6.52	4.04
PHYLUM NEMATODA														
Nematodes		1			1	4	6		1.75			1.49	8.70	2.21
Total No. of Organisms	41	57	31	30	67	46	272							
Total No. of Species/Taxa	8	11	8	8	9	11	18							
Total No. of Phyla	2	4	2	3	3	4	4							

Source: NAPOCOR EMD Survey, September 1988

Table III.5-4

TAXONOMIC LISTING, DISTRIBUTION AND RELATIVE ABUNDANCE
OF FRESHWATER ZOOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (DRY SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)						
	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL
PHYLUM ANNELIDA														
Class Polychaeta														
Polychaete larvae				3			3				17.65			4.62
PHYLUM ARTHROPODA														
Class Crustacea														
SubClass Copepoda														
Order Calanoida														
Calanoid copepods		1		6			7		3.57		35.29			10.77
Mitis sp.				2			2				11.77			3.07
Class Insecta														
Order Coleoptera				1			1				5.88			1.54
Family Hydrophilidae														
Hydrophilis sp.		1					1		3.57					1.54
Order Diptera				1			1				5.88			1.54
SubOrder Nematocera														
Family Chironomidae														
SubFamily Tanyponidae														
Pentaneura sp.	9						9	45.00						13.85
Family Heleidae														
Dasyhelia sp.		2					2		7.14					3.07
Family Orthocladiinae														
Symbiocladius sp.		1					1		3.57					1.54
Family Tipulidae		3					3		10.72					4.62

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Table III.5-4

TAXONOMIC LISTING, DISTRIBUTION AND RELATIVE ABUNDANCE
OF FRESHWATER ZOOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (DRY SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)						
	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL
Order Ephemeroptera		15		3			18		53.57		17.65			27.69
Order Hemiptera														
Family Gerridae														
Gerris sp.	2						2	10.00						3.07
Family Notonectidae														
Notonecta sp.	2	2					4	10.00	7.14					6.15
Family Vellidae														
Rhagovelia sp.	1						1	5.00						1.54
Order Hymenoptera														
SubOrder Apocrita														
Family Formicidae		1					1		3.57					1.54
Order Odonata														
SubOrder Anisoptera														
Family Macromiidae														
Macromia sp.	1						1	5.00						1.54
SubOrder Zygoptera														
Family Coenagrionidae														
Coenagrion sp.	1						1	5.00						1.54
Enallagma sp.				1			1				5.88			1.54

Table III.5-4

TAXONOMIC LISTING, DISTRIBUTION AND RELATIVE ABUNDANCE
OF FRESHWATER ZOOPLANKTON AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (DRY SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

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TAXA	FREQUENCY (no.)							PERCENTAGE (%)						
	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL
Order Lepidoptera														
Family Pyralidae														
Paraponyx sp.	3						3	15.00						4.62
Order Trichoptera														
Family Hydropsychidae														
Hydropsyche sp.	1						1	5.00						1.54
Class Arachnida														
Order Acarina														
Hydracarina sp.		2					2		7.14					3.07
Total No. of Organism	20	28		17			65							
Total No. of Species/Taxa	8	9		7			21							
Total No. of Phyla	1	1		2			2							

Note : * - No samples collected
Source: NAPOCOR EMD Survey, April 1989

Table III.5-5

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER BENTHIC FAUNA AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (WET SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (organisms/sq m)						
	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL
PHYLUM ANNELIDA																					
Class Hirudinea																					
Order Rhynchobdellida																					
Family Glossiphoniidae																					
Glossiphonia complanata			1				1			7.69				1.35			10.75				10.75
Class Polychaeta																					
Order Sedentaria																					
Family Cirratulidae																					
Polychaete larvae	2	4	4	2	1	3	16	22.22	16.67	30.77	40.00	20.00	16.67	21.62	21.51	43.01	43.01	21.51	10.75	32.26	172.04
PHYLUM ARTHROPODA																					
Class Crustacea																					
SubClass Malacostraca																					
Order Decapoda																					
Family Palaemonidae																					
Palaemonetes sp.	1	1	2				4	11.11	4.17	15.39				5.41	10.75	10.75	21.51				43.01
Family Portunidae																					
Varuna litterata		1	1		1		3		4.17	7.69		20.00		4.05		10.75	10.75		10.75		32.26
Class Insecta																					
Order Diptera																					
Family Culicidae	1	1	1	1			4	11.11	4.17	7.69	20.00			5.41	10.75	10.75	10.75	10.75			43.01
Family Tipulidae																					
Epiphragma sp.		1					1		4.17					1.35		10.75					10.75

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Table III.5-5

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER BENTHIC FAUNA AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (WET SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (organisms/sq m)						
	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL
Order Ephemeroptera																					
Family Baetiscidae																					
Baetis sp.	3	5	4	1	3	3	19	33.33	20.83	30.77	20.00	60.00	16.67	25.68	32.26	53.76	43.01	10.75	32.26	32.26	204.30
Order Hemiptera																					
Family Gerridae																					
Gerris sp.						1	1						5.56	1.35						10.75	10.75
Order Odonata																					
Family Macroniidae																					
Macromia sp.	2						2	22.22						2.70	21.51						21.51
Order Plecoptera																					
Family Perlidae																					
Acroneuria sp.		1					1		4.17					1.35		10.75					10.75
PHYLUM CHORDATA																					
Class Pisces																					
Order Gobioidea																					
Family Gobiidae																					
Glossogobius sp.		1					1		4.17					1.35		10.75					10.75

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Table III.5-5

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER BENTHIC FAUNA AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (WET SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (organisms/sq m)						
	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL	MAI-1	MAI-2	MAI-3	MAI-4	MAI-5	MAI-6	TOTAL
PHYLUM MOLLUSCA																					
Class Gastropoda																					
SubClass Prosobranchia																					
Order Mesogastropoda																					
SubOrder Taenioglossa																					
Family Ampullariidae																					
Pila sp.		6					6		25.00					8.11		64.52					64.52
eggs (*Pila* sp.)				1			1				20.00			1.35				10.75			10.75
Family Thiariidae																					
Thiara sp.						11	11						61.11	14.87						118.28	118.28
Family Viviparidae																					
Viviparus subpurporeus		1					1		4.17					1.35		10.75					10.75
SubClass Pulmonata																					
Order Basommatophora																					
Family Lymnaeidae																					
Radix sp.		1					1		4.17					1.35		10.75					10.75
Family Planorbidae																					
Gyraulus sp.		1					1		4.17					1.35		10.75					10.75
Total No. of Organisms	9	24	13	5	5	18	74								96.77	258.06	139.76	53.76	53.76	193.55	795.68
Total No. of Species/Taxa	5	12	6	4	3	4	16														
Total No. of Family	5	12	6	4	3	4	16														
Total No. of Phyla	2	4	2	3	2	3	4														

Source: NAPOCOR EMD Survey, September 1988

Table III.5-6

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER BENTHIC FAUNA AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (DRY SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (organisms/sq m)						
	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL
PHYLUM ANNELIDA																					
Class Hirudinea (leech)	1						1	0.80						0.46	10.75						10.75
PHYLUM ARTHROPODA																					
Class Crustacea																					
SubClass Malacostraca																					
Order Decapoda																					
SubOrder Reptantia																					
SuperFamily Brachyrhyncha																					
Family Grapsidae																					
Varuna sp.	1						1	0.80						0.46	10.75						10.75
SubOrder Natantia																					
Family Palaemonidae																					
Palaemonetes sp.				52			52				80.00			24.07				559.14			559.14
Class Insecta																					
Order Coleoptera																					
SubOrder Polyphaga																					
SuperFamily Hydrophilicdea																					
Family Hydrophilidae																					
Hydra sp.	1						1		3.85					0.46		10.75					10.75
Order Diptera																					
SubOrder Nematocera																					
Family Tipulidae																					
Tipula sp.	1						1	0.80						0.46	10.75						10.75

Table III.5-6

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER BENTHIC FAUNA AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (DRY SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (organisms/sq m)						
	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL
Order Ephemeroptera																					
Ephemeropteran nymph	3	5					8	2.40	19.23					3.70	32.26	53.76					86.02
Order Hemiptera																					
SubOrder Cryptocerata																					
Family Notonectidae		2		1			3		7.69		1.54			1.39		21.51		10.75			32.26
SubOrder Gymnocerata																					
Family Gerridae		9					9		34.62					4.17		96.77					96.77
PHYLUM MOLLUSCA																					
Class Gastropoda																					
SubClass Prosobranchia																					
Order Mesogastropoda																					
SubOrder Taenioglossa																					
SuperFamily Cerithiacea																					
Family Thiaridae																					
Thiara sp.	119	9					128	95.20	34.62					59.26	1279.57	96.77					1376.34

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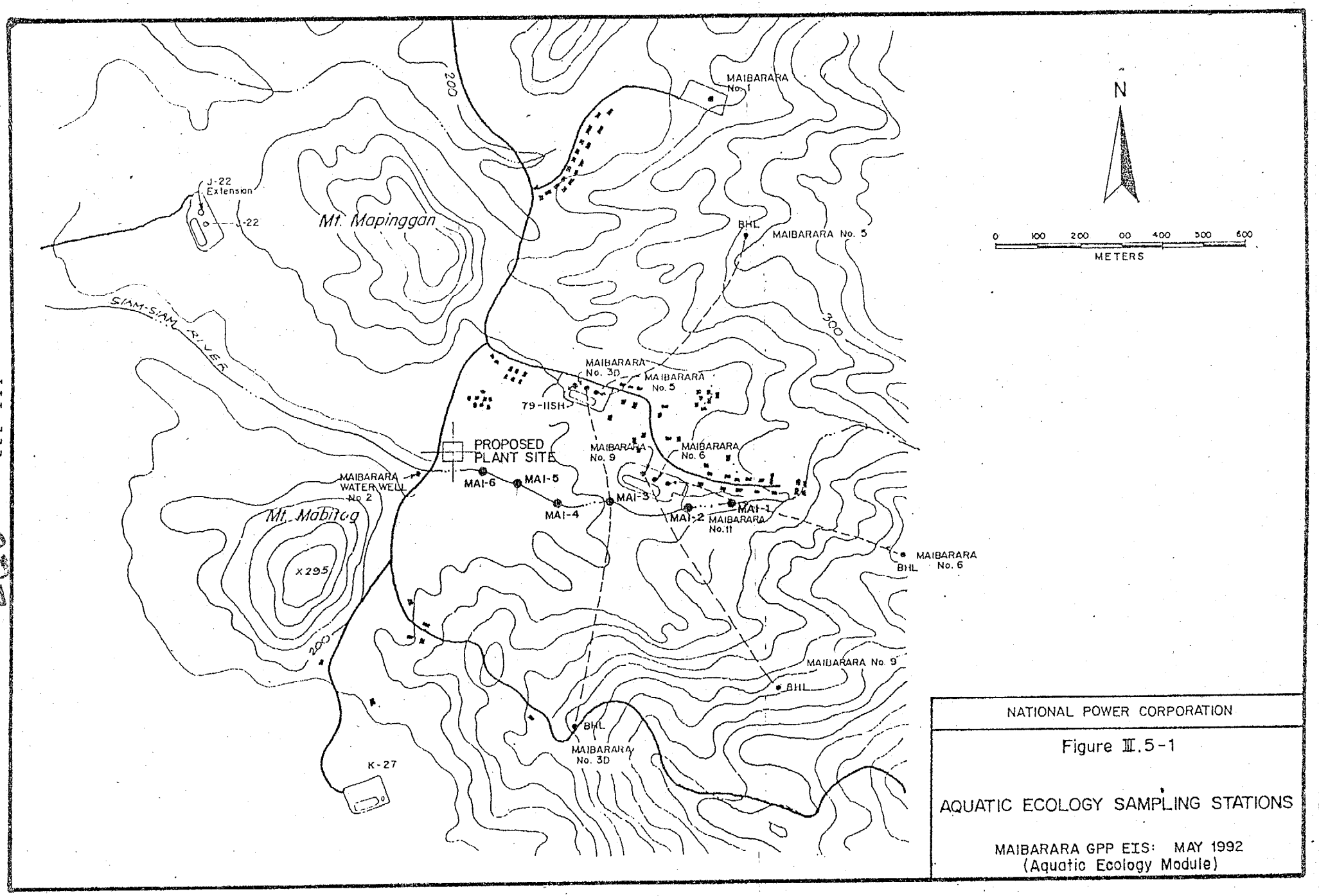
Table III.5-6

TAXONOMIC LISTING, DISTRIBUTION, RELATIVE ABUNDANCE AND DENSITY
OF FRESHWATER BENTHIC FAUNA AT SIAM-SIAM RIVER, STO. TOMAS, BATANGAS (DRY SEASON)

MAIBARARA GTPP EIS: MAY 1992
(Aquatic Ecology)

TAXA	FREQUENCY (no.)							PERCENTAGE (%)							DENSITY (organisms/sq m)						
	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL	MAI-1	MAI-2	MAI-3*	MAI-4	MAI-5*	MAI-6*	TOTAL
Family Pleuroceridae																					
Goniobasis sp.				1			1				1.54			0.46				10.75			10.75
Family Viviparidae																					
Viviparous sp.				2			2				3.08			0.93				21.51			21.51
SubClass Pulmonata																					
Order Basommatophora																					
Family Lymnaeidae																					
Lymnaea sp.				2			2							0.93				21.51			21.51
Family Planorbidae																					
Gyraulus spirillus				4			4				6.15			1.85				43.01			43.01
Family Bithyniidae																					
Bithynia sp.				2			2				3.08			0.93				21.51			21.51
Radix sp.				1			1				1.54			0.46				10.75			10.75
Total No. of Organisms	125	26		65			216								1344.08	279.56		698.93			2322.58
Total No. of Species/Taxa	5	5		8			15														
Total No. of Phyla	3	2		2			3														

Note : * - No samples collected
Source: NAPOCOR EMD Survey, April 1989



NATIONAL POWER CORPORATION

Figure Ⅲ.5-1

AQUATIC ECOLOGY SAMPLING STATIONS

MAIBARARA GPP EIS: MAY 1992
(Aquatic Ecology Module)

III.6 SOCIOECONOMICS AND LAND USE

This part of the EIS covers the demographic, housing, land use, and employment aspects of the human environment with the focus on two areas, namely, the Regional Impact Zone (RIZ) and the Primary Impact Zone (PIZ).

The area within 5-km radius of the project site, encompassing portions of Santo Tomas, Batangas and Calamba in Laguna, is designated the Regional Impact Zone or RIZ (Figure III.6-1). This delineation, however, applies only in the discussion of land use since socioeconomic data exclusive to the 5-km limit are not available. Municipal data for the whole of Santo Tomas and Calamba, which include statistics on barangays outside the 5-km limit, are instead used to expound on the demographic, housing, and employment aspects in the RIZ.

The PIZ, on the other hand, is the region within 1-km radius of the proposed geothermal plant (Figure III.6-2). Included in the PIZ are portions of Barangay San Rafael of Santo Tomas and Barangay Puting Lupa of Calamba. It is here where the effects of the proposed geothermal plant and the five steam production wells will be most felt. The discussion, therefore, includes the perceptions and attitudes of PIZ residents towards the project.

Information used in this discussion came from various sources. A socioeconomic and land use survey conducted by NAPOCOR-EMD in March 1989 provided selected primary data on the PIZ while information from the Municipal Planning and Development Offices (MPDO), the 1980 NCSO Census of Population and Housing Reports, and the 1990 NSO Census of Population Preliminary Report are used to describe the general socioeconomic condition in the Regional Impact Zone.

Since only partial 1990 NSO census data are available as of this writing , only population, population density, number of households, and household size, are updated to 1990 figures; the rest are based on 1980 NCSO data.

III.6.1 Regional Impact Zone

III.6.1.1 Demography of RIZ

The two municipalities comprising the RIZ had a combined population of 271,888 in 1990. This figure accounts for only 8 percent of the combined population of the provinces of Laguna and Batangas for the same year. Its aggregate land area is 235.90 sq km.

The RIZ has a relatively higher population density - 982 persons per sq km - compared to Laguna's 779 persons per sq km and Batangas' 466 persons per sq km. It has also 780 persons more than the national figure of 202 persons per sq km.

The difference in population density between the RIZ and the two provinces may be attributed to the high concentration of industries in the area specifically in Calamba, where the Canlubang Industrial Estate is located. Labor intensive industries in the area may have induced significant in-migration in the 70's and 80's.

Within the RIZ, Calamba (with 1,197 persons per sq km) has 557 individuals more per sq km than Santo Tomas (with 472 persons per sq km).

There are 43,409 households in the Regional Impact Zone in 1990 and the average household size is 5. Tagalogs make up 99 percent of the households in the area .

The RIZ's median age of 19 years is slightly higher than the national figure of 18 years. However, the country has a slightly higher percentage of persons who are less than 25 years old, 63 percent compared to the RIZ's 62 percent. The population pyramid of the RIZ exhibits the population's expansive age-sex profile (Figure III.6-21).

Majority (56%) of the RIZ's population belong to the economically productive age group (i.e., age group 15-64). There are about 78 persons in the dependent ages (viz., age groups 0-14, and 65 and over) for every 100 persons in the economically productive ages. Computing the economic dependency ratio, it was found out that there are about 223 persons who are not gainfully employed for every 100 employed individuals in the

area.* The large discrepancy between the age-dependency ratio and the economic dependency ratio imply that there are many not gainfully employed persons in the economically productive ages.

The RIZ has a higher literacy rate than the rest of the country in general. More than four-fifths (90%) of its population who are 10 years old and over are literate, 7 percentage points more than the national figure of 83 percent.

In terms of highest grade completed, almost half (48%) of the RIZ's population who are 7 years old and over have finished some elementary education while approximately 27 percent have either reached or finished high school. Some 10 percent have reached but have not finished college while about 9 percent are academic degree holders. Only 6 percent of the RIZ's concerned population have not gone to school, 4 percentage points less than the national figure.

Of the 138,625 persons in the RIZ who were 5 years old and over during the 1980 census, 93 percent reportedly remained in the same municipality where they had lived in 1975. The others are migrants from other cities/municipalities of Batangas and Laguna (2%) and from other provinces (4%).

Table III.6-1 summarizes selected demographic statistics in the RIZ.

III.6.1.2 Housing in RIZ

Majority (94%) of the households in the RIZ own their dwelling units. The rest are either leased or occupied free of rent. In terms of land ownership, 70 percent of the owner-occupied houses are built on the occupant's land (Figure III.6-4). Some 11 percent of the owner-occupants are agricultural tenants and as such the land is owned by the landlord.

Moreover, 86 percent of the households in the Regional Impact Zone occupy single-detached dwelling units. In terms of floor area, 46 percent of the houses measure below 30 sq m.

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* Data used in the computation of economic dependency ratio are actually provincial figures since municipal data are lacking. Further, due to data limitation, all persons below 15 years old were automatically considered not gainfully employed.

Electricity is used by more than three-fourths (78%) of the population to light their homes while one fifth (20%) use kerosene. In terms of cooking fuel, majority (52%) use wood and/or charcoal. Only 11 percent cook their food using electricity. The rest use LPG and kerosene.

III.6.1.3 Land Use in the RIZ

Agricultural land use, totalling 37.72 sq km, occupies a greater portion of the RIZ (48%) (Table III.6-5 and Figure III.6-22). Sugar and coconut plantations constitute most of this type of land use (Figure III.6-23).

The northeastern part of the Regional Impact Zone, that which rims the base of Mt. Makiling, exhibits stands of secondary growth forests covering approximately 32 percent of the total land area; grasslands and brushlands, which are scattered in the RIZ, account for 11 percent or a total of 8.72 sq km.

Built-up areas are composed primarily of residential land use; only about one-third are utilized for industrial uses. These residential and industrial areas are both concentrated along the national highway traversing the RIZ. Residential and industrial land use account for 4.80 sq km and 2.18 sq km, respectively, totalling to approximately 9 percent of the RIZ.

There are a total of 11 industrial companies in the RIZ. Their activities include dairy products processing, swine/poultry raising, earthen resource extraction and manufacture of car accessories, detergents and paint, among others (Table III.6-6 and Figures III.6-24 and III.6-25).

III.6.1.4 Employment in the RIZ*

Of the 1,267,372 persons who are 15 years old and over in Batangas and Laguna, majority (53%) are engaged in gainful occupations. Males compose the majority (65%) of those employed (Figure III.6-12). Of the 47 percent

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* For lack of employment data at the municipal level, Batangas and Laguna provincial data from the 1980 NCSO Census of Population and Housing Reports were used in the discussion. The 1990 NSO employment data are not yet available as of this writing.

who are not gainfully employed, 42 percent are housekeepers and 18 percent are students (Figure III.6-13).

Agricultural workers account for 31 percent of those gainfully employed (Table III.6-3 and Figure III.6-14). Production workers, transport equipment operators and laborers account for 42 percent while sales workers make up 10 percent.

In terms of industrial classification, the agriculture/fishery/forestry sector employ the largest proportion of workers in the area accounting for 36 percent of the gainfully employed population (Table III.6-4 and Figure III.6-15). This employment trend may be attributed to the dominance of agricultural production pursuits over other economic activities in Batangas and Laguna. The manufacturing sector on the other hand employs 30 percent of the working population. Another 13 percent are with the community/social/personal services sector while some 5 percent are with the wholesale and retail trade sector.

III.6.2 The Primary Impact Zone (PIZ)

III.6.2.1 Demography

All households within 1-km radius of the project site were included in the NAPOCOR-EMD socioeconomic survey of March 1989. A total of 78 households or 395 persons were counted in the PIZ survey. More than half (51%) of these households are located in Barangay San Rafael.

The 40 households surveyed in Barangay San Rafael account for 7 percent of the 574 total barangay households while the 38 households in Barangay Puting Lupa comprise 32 percent of the barangay's 120 households. Of the 395 persons in the PIZ, 210 are males and 185 are females (Table III.6-1). The PIZ population is generally younger than the Regional Impact Zone's population by 4 years. Its median age is only 15 years. Persons less than 25 years old comprise the majority (59%).

Less than three-fifths (59%) of the population belong to the so-called labor force or economically active age group (i.e., age group 15-64). For every 100 individuals in the labor force, there are about 70 young and old dependents (Table III.6-1).

As in the provincial figure, the PIZ's economic dependency ratio (or number of unemployed persons for every 100 employed individuals) is 223.* This figure is 16 persons less than the national economic dependency ratio of 239.

The PIZ has the same proportion of uneducated people as the Regional Impact Zone which is 6 percent of the population who are 7 years old and over. However, PIZ residents as a whole are less educated than the population of the Regional Impact Zone. There is a bigger proportion of people who have reached college in the Regional Impact Zone (9%) than in the PIZ (3%). Moreover, only 2 percent of the PIZ's concerned population are academic degree holders, 7 percentage points less than the Regional Impact Zone figure.

More than two-fifths (46%) of the household heads in the PIZ have been in the community for at least 25 years. Moreover, 24 percent reported they are original residents of their barangay. Of the 59 migrant household heads, 61 percent came from barangays of Santo Tomas and Calamba outside the PIZ. The rest are from other municipalities of Batangas and Laguna (25%) and from other provinces (14%) (Figure III.6-3).

III.6.2.2 Housing

More than three-fourths (78%) percent of the houses in the PIZ are owned by their occupants. The rest are either leased or occupied free of rent. Only 36 percent of the owner-occupied houses are built on the occupant's land (Figure III.6-4). Another 36 percent of the owner-occupants are tenants while 21 percent enjoy rent-free occupancy.

Shanties are the most common type of dwelling unit in the PIZ sheltering 54 percent of the households. Other types of houses include bungalows (24%), two-storey units (12%), houses-on-stilts (8%) and duplexes (3%).

Nearly one-third of the houses in the PIZ have floor areas below 30 sq m. Twenty-eight percent measure between 30-49 sq m while 27 percent have floor areas above 69 sq m.

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* Due to data limitation, all persons below 15 years old were automatically considered not gainfully employed.

Houses made of light (bamboo) materials are the most common dwelling structure in the PIZ. They constitute 37 percent of the total number of houses. Houses made of wood/plywood constitute another 28 percent. Galvanized iron sheets are used by more than three-fifths (68%) of the households for roof.

More than four-fifths (86%) of the households use electricity to light their homes. Only 5 percent use kerosene. Due to its proximity to the Makiling forest, firewood is widely available in the area. In fact, 99 percent of the PIZ families use it for cooking.

The two main sources of news and information in the PIZ are radio (41%) and television (34%). Other less popular, though not necessarily less effective, sources of information are neighbors (15%) and local newspapers (10%).

Recreation among households in the PIZ revolve around radio and television sets. More than two-fifths (44%) of the households reported that household members watch television shows during leisure hours while nearly one-third (32%) reportedly listen to radio programs. Typical of rural communities, a significant proportion (17%) prefer to chat with their neighbors during their free time.

When asked whether barangay problems exist in the area, only 44 percent answered in the affirmative. Problems cited include the absence/lack of community services/ facilities (76%), unemployment (12%), and alcoholism/ drug addiction (6%).

When asked to propose possible solutions to the problems, assistance from the local government was suggested by 75 percent of the respondents while cooperation among barangay residents and assistance from NAPOCOR were suggested by others.

III.6.2.3 Land Use

The PIZ is primarily dominated by agricultural lands (Table III.6-2 and Figure III.6-5). Of the total land area of 3.14 sq km, 72.61% or 2.28 sq km are planted with coconuts intercropped with banana, cassava and corn (Figure III.6-6 and Figure III.6-7). The proposed project site itself is planted with coconuts interspersed with bananas and an underbrush that is very dense (Figure III.6-8).

Forests, consisting mostly of secondary growth trees found on the eastern periphery of the PIZ, occupy 0.41 sq km or 13.06 percent (Figure III.6-9). This area is already on the slopes of Mt. Makiling.

Grasses and shrubs covering the slopes of Mts. Mabitog and Mapinggon, including a small portion on the northern part of the PIZ, account for 11.14 percent or 0.35 sq km.

Residential land use is composed mostly of small clusters of houses majority of which are found northeast of the project site and along the access roads. These houses occupy only 0.08 sq km of land or just 2.55 percent of the PIZ (Figure III.6-10). A total of 78 houses are found within the area.

The only industrial use in the PIZ is represented by a quarry which extracts sand and gravel from an area on the eastern base of Mt. Mapinggan. This accounts for a mere 0.64% of the total land area (Figure III.6-11).

III.6.2.4 Employment

Employment in the PIZ. Less than half (49%) of the PIZ's 247 individuals who are 15 years old and over are gainfully employed in March 1989. Males comprise 68 percent of the working population (Figure III.6-12). Among those not gainfully employed, 43 percent are housekeepers, 17 percent are students, and 38 percent are jobless (22 percent of whom are seeking employment) (Figure III.6-13).

Like the provincial employment pattern, majority (53%) of those gainfully employed in the PIZ are agricultural workers. Only twenty-nine percent are production workers. (Table III.6-3 and Figure III.6-14).

The agriculture/fishery/forestry sector employs 63 percent of the PIZ's working population. The manufacturing sector, on the other hand employs 22 percent; the community/social/personal services sector, 6 percent (Table III.6-4 and Figure III.6-15).

The preponderance of workers in the agricultural sector could be attributed to the fact that the PIZ is primarily an agricultural area. Needless to say, almost all (95%) of those in the agricultural sector are engaged in the cultivation of various crops such as coconut, corn, cassava and banana.

Workers in the manufacturing sector on the other hand, are generally employed in industries located near the PIZ. Fifteen percent are employed in textile, wearing apparel and leather industries while another 15 percent are with establishments engaged in the manufacture of fabricated metal products, machinery and equipment.

The exploration phase of the project which involved basically the drilling of the 5 existing wells took years from 1973 to 1981 to finish. This phase became extended because work activities were scheduled on a staggered basis, with one well drilled at a time. During this period, Philippine Geothermal, Inc. employed 25 laborers at each working season whose tasks included clearing of sites, hauling of tools and materials, and other auxiliary services. Adhering to the policy of local hiring, PGI enlisted only workers who were residents of the two barangays in the vicinity of the Maibarara Geothermal field.

III.6.2.5 Income

The incidence of poverty in the PIZ is quite high compared to regional and national figures. Using the 1986 poverty line* for Rural Southern Luzon Region which is ₱2,141.00** as reference figure in determining the incidence of poverty in the PIZ, it was found that more than three-fifths (66%) of the households are below the poverty line with 63 percent even earning less than half of it (Figure III.6-16). In contrast, Southern Tagalog Region and the whole nation for the same period registered 49.3 percent and 49.5 percent of their population, respectively, falling below the poverty line.

In terms of individual income, more than four-fifths (82%) of the employed individuals earn below the monthly equivalent of the 1989 minimum wage of ₱1,958.00 (Figure III.6-17). The proportion of workers

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* Poverty line is the monthly income required to satisfy 100 percent of nutritional requirements and other needs of a family of 6.

** 1986 Economic and Social Indicators, National Statistics Coordination Board of the Economic and Social Statistics Office as lifted from reports of the Interagency Working Group on poverty determination composed of NEDA, NCSO and FNRI.

earning below the minimum wage according to major occupation group are as follows: agricultural workers (92%), service workers (75%), production and related workers, transport equipment operators and laborers (69%), and sales workers (59%). Classifying workers by major industry group, the figures are as follows: agriculture/fishery/forestry sector (87%), wholesale and retail trade sector (80%), transportation/storage/communication sector (75%), community/social/personal services sector (71%) and manufacturing sector (67%).

Study findings also show that workers in all occupation groups earn on the average less than the 1989 minimum wage (Figure III.6-18). Agricultural workers earn the least with less than a thousand (₱850.00) monthly income. This is ₱1,108.00 lower than the minimum wage.*

Grouping workers by major industry, workers in the agriculture sector earn just an average monthly income of ₱933.00, ₱1,025.00 lower than the minimum wage. Only workers in the construction sector earn on the average more than the minimum wage, ₱4,000.00 a month (Figure III.6-18).

III.6.1.6 Perceptions and Attitude Towards the Project

Majority (67%) of the PIZ residents is aware of NAPOCOR's plan to construct the Maibarara GPP. Of this figure, 92 percent are in favor of it (Figure III.6-19).

Expected employment opportunities, the possible improvement of barangay infrastructures, and the expected additional supply of electricity from the Plant are the most common reasons for the favorable reaction while potential adverse health effects, fears of resettlement and its effect on crops were among the reasons for opposing the project (Figure III.6-20).

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* There is a slight underestimation of income of agricultural workers since crops harvested and consumed by their families are not included in the reported monthly income of these workers.

Table III.6-1

SUMMARY OF SELECTED DEMOGRAPHIC STATISTICS, MAIBARARA GPP RIZ AND PIZ

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

Sheet 1 of 2

VARIABLES	RIZ[1]	PIZ[2]
1. Population	231,662*	395
2. Land Area (sq km)	239.90	3.14
3. Population Density (persons per sq km)	982*	130
4. Number of Households	43,409*	78
5. Average Household Size	5*	5
6. Sex Ratio (number of males for every 100 females	100	113
Both Sexes	164,185	395
Male	82,199	210
Female	81,986	185
7. Median Age	19	15
8. Age Dependency Ratio (number of persons in the dependent ages for every 100 persons in the economically productive ages)	78	70
All Ages	231,662	395
Population, 0-14, 65 & over	129,731	232
Population, 15-64	101,931	163

Table III.6-1 (cont.)

SUMMARY OF SELECTED DEMOGRAPHIC STATISTICS, MAIBARARA GPP RIZ AND PIZ

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

Sheet 2 of 2

VARIABLES	RIZ[1]	PIZ[2]
Economic Dependency Ratio (Number of persons who are not employed for every 100 persons 15 years old and over who are employed)	89**	102
Number of persons who are not employed	595,665**	125
Number of persons who are employed	671,707**	122

Note: * Figure is based on the 1990 Census of Population and Housing Preliminary Report.

** Figure is based on Batangas and Laguna provincial data from 1980 NCSO Census of Population and Housing Report.

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Laguna and Batangas
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

Table III.6-2

DISTRIBUTION OF LAND USE IN THE MGPP PIZ: 1989

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

	LAND AREA (Sq km)	PERCENT
TOTAL	3.14	100.00
Residential	0.08	2.55
Industrial	0.02	0.64
Agricultural	2.28	72.61
Forest	0.41	13.06
Grassland/Shrubland	0.35	11.14

Source: 1989 NAPOCOR-EMD Socioeconomic Survey

Table III.6-3

GAINFUL WORKERS 15 YEARS OLD AND OVER BY MAJOR OCCUPATION GROUP,
RIZ AND MAIBARARA GPP PIZ

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

MAJOR OCCUPATION GROUP	FREQUENCY		PERCENT	
	STUDY AREA[1]	PIZ[2]	STUDY AREA	PIZ
TOTAL EMPLOYED INDIVIDUALS	787	122	100.00	100.00
Professional, Technical and Related Workers	19	-	2.41	-
Administrative, Executive and Managerial Workers	10	-	1.27	-
Clerical and Related Workers	38	-	4.83	-
Sales Workers	82	17	10.42	13.93
Service Workers	45	5	5.72	4.10
Agricultural, Animal Husbandry and Forestry Workers, Fishermen and Hunters	244	65	31.00	53.28
Production and Related Workers, Transport Equipment Operators and Laborers	332	35	42.18	28.69
Members of the Armed Forces	6	-	0.76	-
Workers Not Classifiable by Occupation	11	-	1.40	-

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Laguna and Batangas provinces
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

Table III.6-4

GAINFUL WORKERS 15 YEARS OLD AND OVER BY MAJOR INDUSTRY GROUP,
MAIBARARA GPP RIZ AND PIZ

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

MAJOR INDUSTRY GROUP	FREQUENCY		PERCENT	
	STUDY AREA[1]	PIZ[2]	STUDY AREA	PIZ
TOTAL EMPLOYED INDIVIDUALS	787	122	100.00	100.00
Agriculture, Fishery and Forestry	280	77	35.58	63.11
Mining and Quarrying	1	-	0.12	-
Manufacturing	234	27	29.73	22.13
Electricity, Gas and Water	3	1	0.38	0.82
Construction	33	1	4.19	0.82
Wholesale and Retail Trade	41	5	5.21	4.10
Transportation, Storage and Communication	68	4	8.64	3.28
Financing, Insurance, Real Estate and Business Services	9	-	1.14	-
Community, Social and Personal Services	103	7	13.08	5.74
Activities Not Adequately Defined	17	9	1.90	-

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Laguna and Batangas provinces
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

Table III.6-5

DISTRIBUTION OF EXISTING LAND USE IN THE MGPP RIZ: 1989

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

LAND USE	LAND AREA (Sq km)	PERCENT
TOTAL	78.50	100.00
Residential	4.80	6.11
Industrial	2.18	2.78
Agricultural	37.72	48.05
Forest	25.08	31.95
Grassland/Shrubland	8.72	11.11

Source: 1989 NAPOCOR-EMD Socioeconomic Survey

Table III.6-6

INDUSTRIES PRESENT IN THE MGPP RIZ: 1989

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

NAME OF COMPANY	TYPE OF INDUSTRY	PRODUCTS
Yazaki - Torres Mfg., Inc.	manufacturing	car accessories
Angmaya Coco Resources, Inc.	coconut oil processing	cooking oil
Laguna Rubber Co., Inc.	manufacturing	industrial and molded rubber
Unisol Industries and Mfg. Corp.	manufacturing	textile, garment thread
Yakult	food processing	milk, yoghurt
Diversey Co.	manufacturing	detergent
Wilframs Mfg. Corporation	manufacturing	paint
Paramount Vinyl Products, Inc.	manufacturing	leatherette
Kewalram	manufacturing	garment thread
Rock Mt. Enterprises	quarrying	sand and gravel
Robina Food Mfg., Inc.	poultry/hog raising	dressed livestock

Source: 1989 NAPOCOR-EMD Socioeconomic Survey

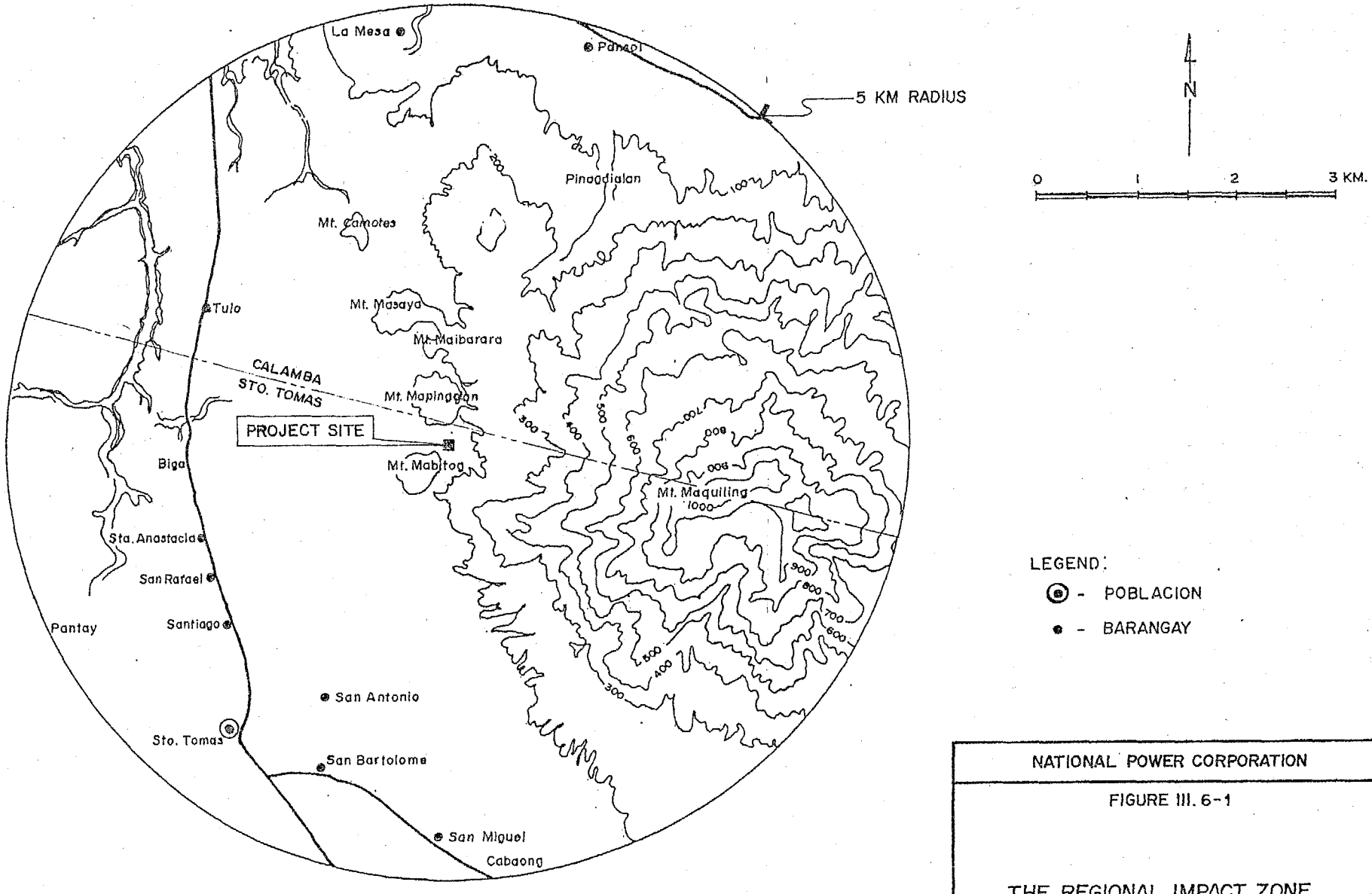

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FIGURE III. 6-1

THE REGIONAL IMPACT ZONE

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)

225

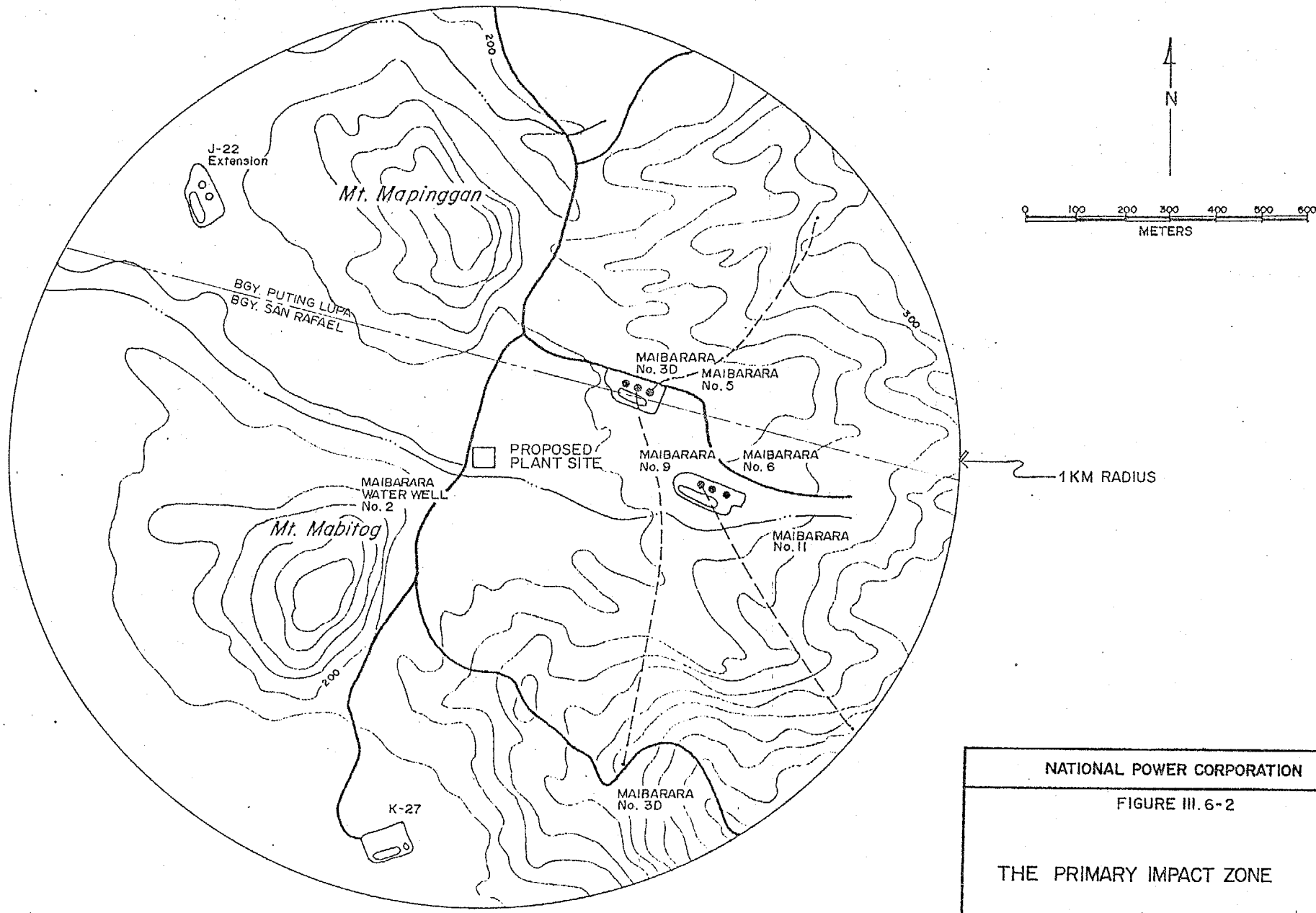

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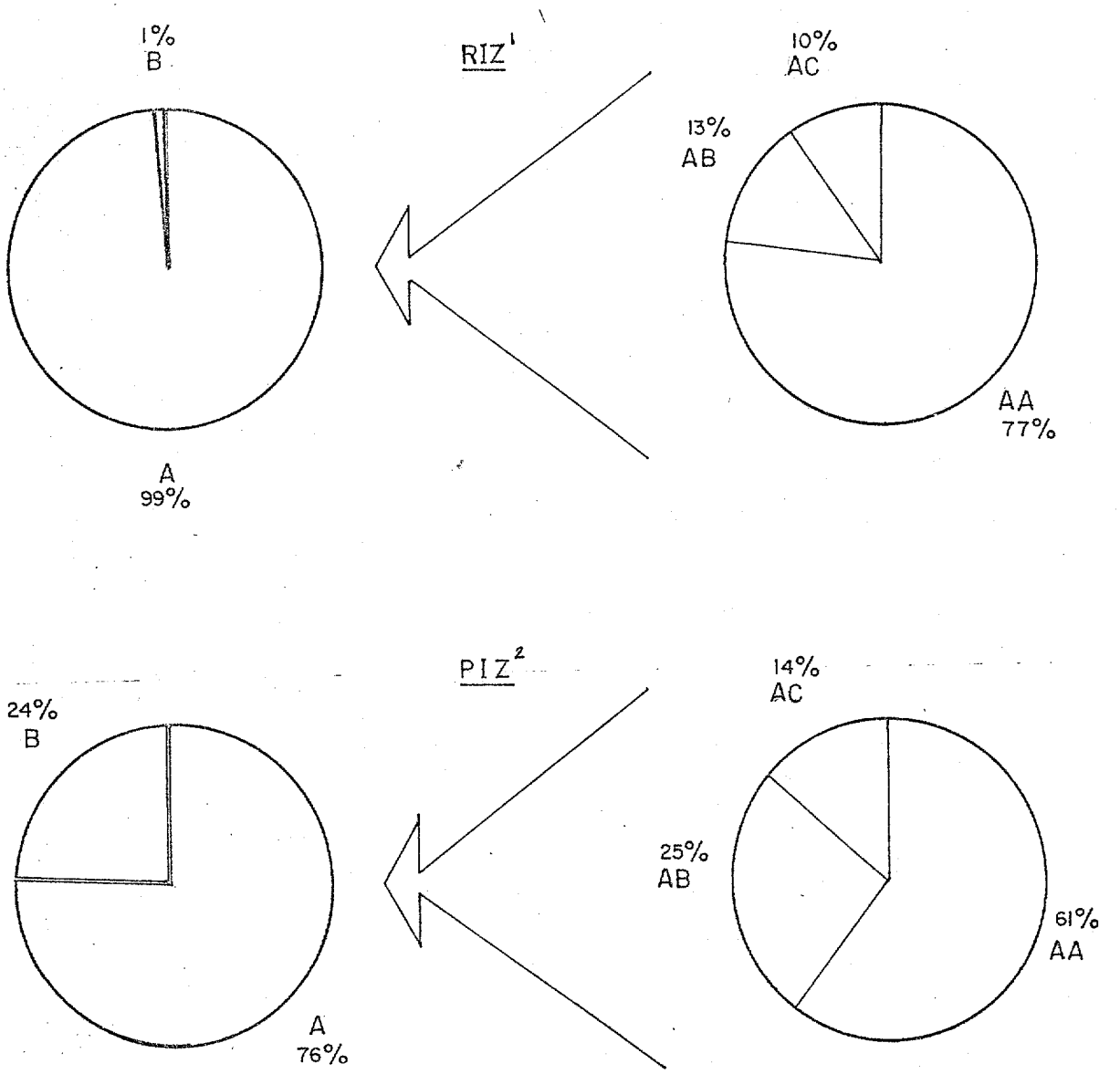
FIGURE III. 6-2

THE PRIMARY IMPACT ZONE

MAIBARARA GPP EIS: MAY 1992
(Socieconomics and Land Use)



A - Migrant Househol Heads
B - Original Residents

AA - From other barangays of Calamba and Sto. Tomas
AB - From other Municipalities of Batangas and Laguna
AC - From the Rest of the Philippines

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Batangas and Laguna Provinces
2 - 1989 NAPOCOR - EMD Socioeconomic Survey

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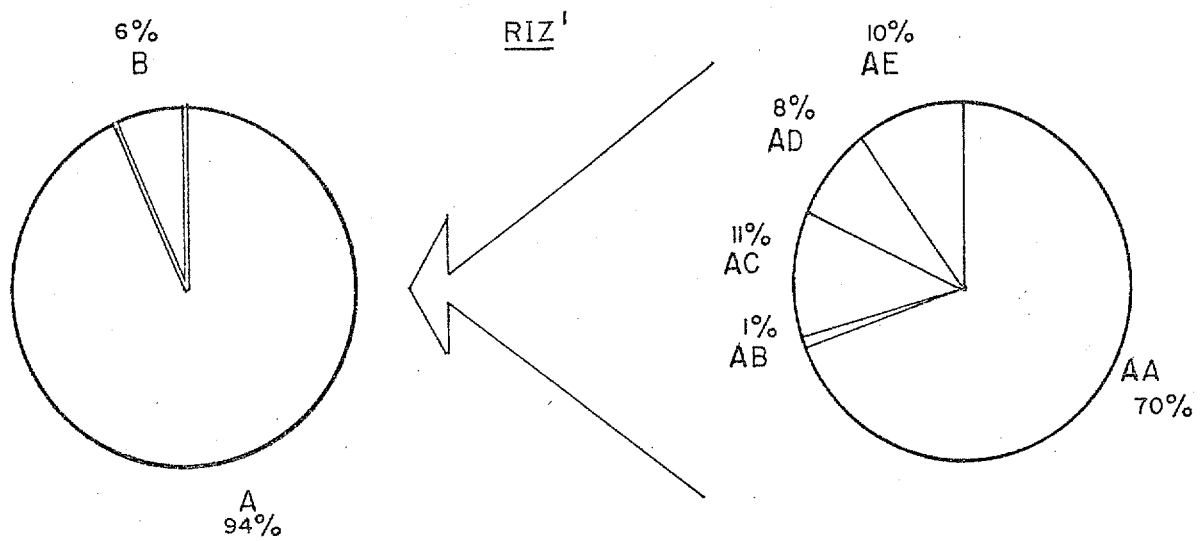
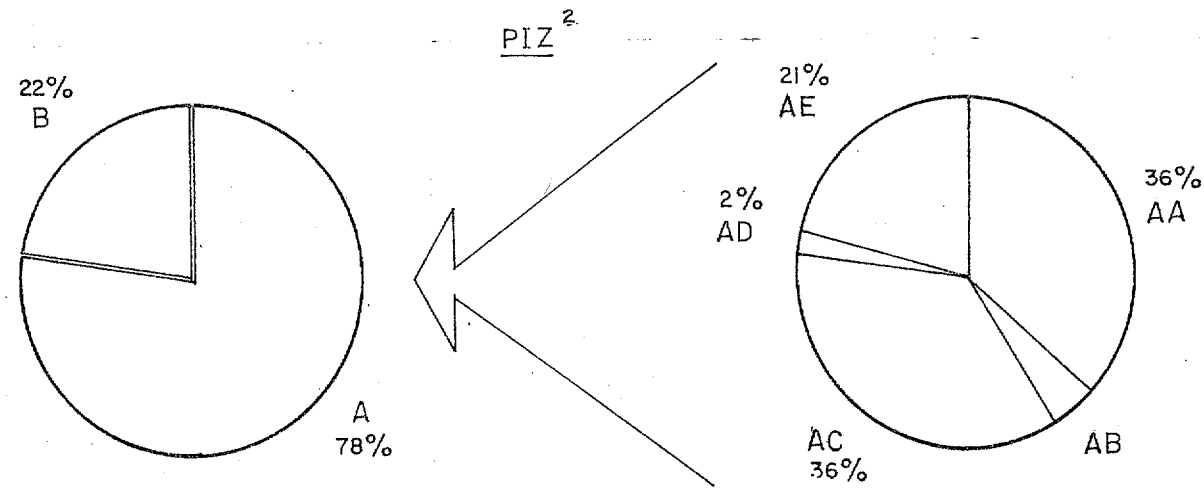
FIGURE III.6-3

MIGRANT HOUSEHOLD HEADS BY PREVIOUS PLACE OF RESIDENCE, RIZ MAIBARARA GPP PIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)





A - House is owned
B - House is not owned

AA - Owns land
AB - Lessee
AC - Agricultural Tenant
AD - Other Legal Tenure
AE - Squatter

Sources:

1 - 1980 NCSO Census of Population and Housing Report, Batangas and Laguna Provinces
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

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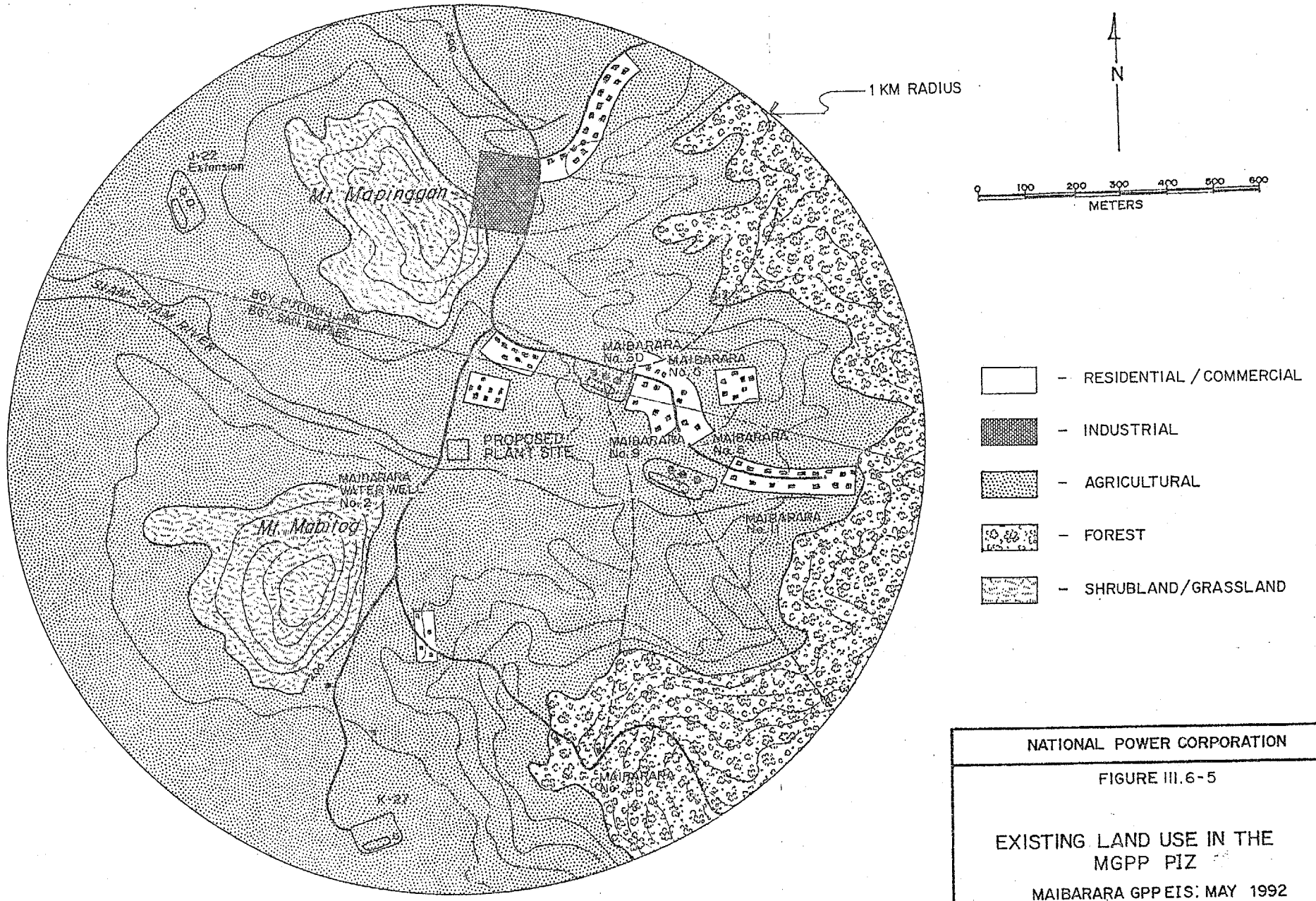
FIGURE III.6-4

HOUSEHOLDS IN OWNER-OCCUPIED DWELLING UNITS BY TENURE OF THE OWNER-OCCUPANT WITH RESPECT TO THE LAND, RIZ AND MAIBARARA GPP PIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)



SOURCE: 1989 NAPOCOR-EMD LAND USE SURVEY

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FIGURE III.6-5

EXISTING LAND USE IN THE MGPP PIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)

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Agricultural land use in the PIZ primarily consist of coconut plantations,

banana groves,

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Figure III.6-6

LAND USE PHOTO

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

and cassava patches.

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Figure III.6-7

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LAND USE PHOTO

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

232

The project site.

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Figure III.6-8

LAND USE PHOTO

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

Secondary growth forest found on the eastern periphery of the PIZ.

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Figure III.6-9

LAND USE PHOTO

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

Most houses in the PIZ are clustered in groups located along barangay roads (lower and upper photos)

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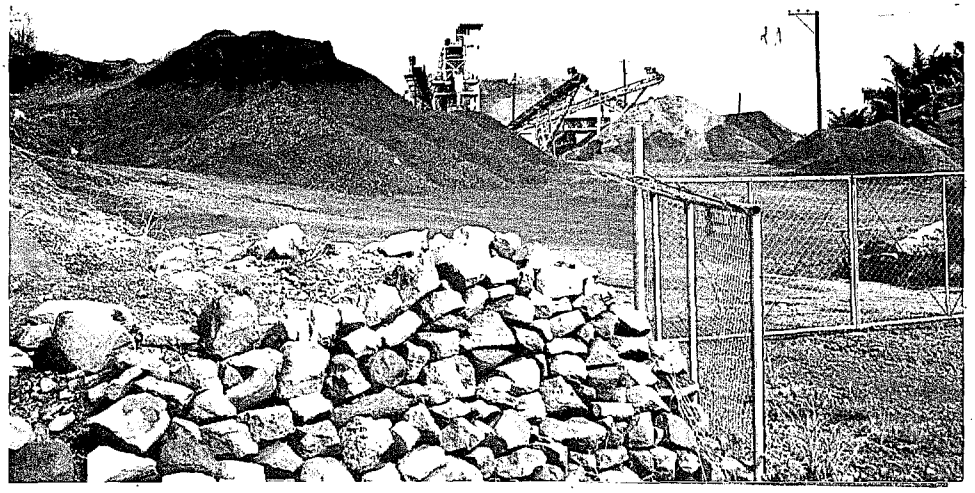
Figure III.6-10

LAND USE PHOTO

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

234



The quarry in the PIZ which extracts sand and gravel is found on the northern base of Mt. Mapinggan.

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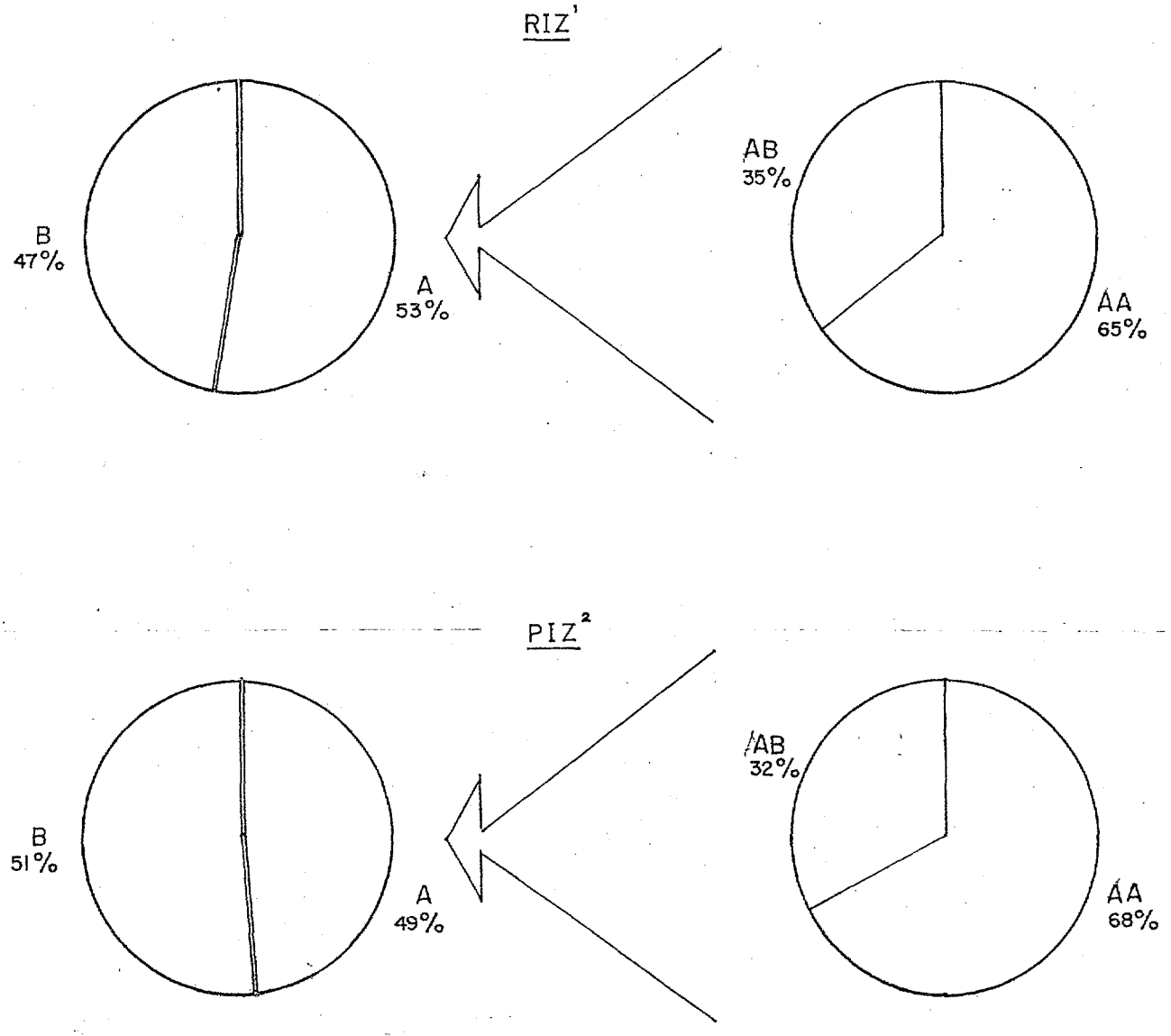
Figure III.6-11

LAND USE PHOTO

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)



Sources: 1 - 1980 NCSO Census of Population and Housing Report, Batangas and Laguna Provinces

2 - 1989 NAPOCOR - EMD Socioeconomic Survey

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FIGURE III.6-12

GAINFUL WORKERS 15 YRS. OLD AND OVER BY SEX, RIZ & MAIBARARA GPP PIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)

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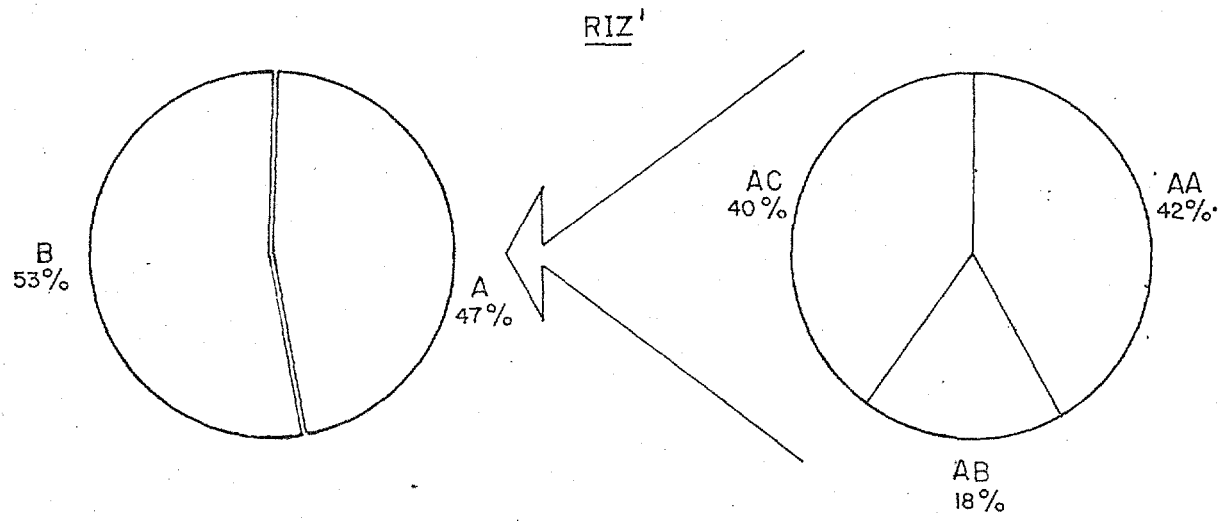

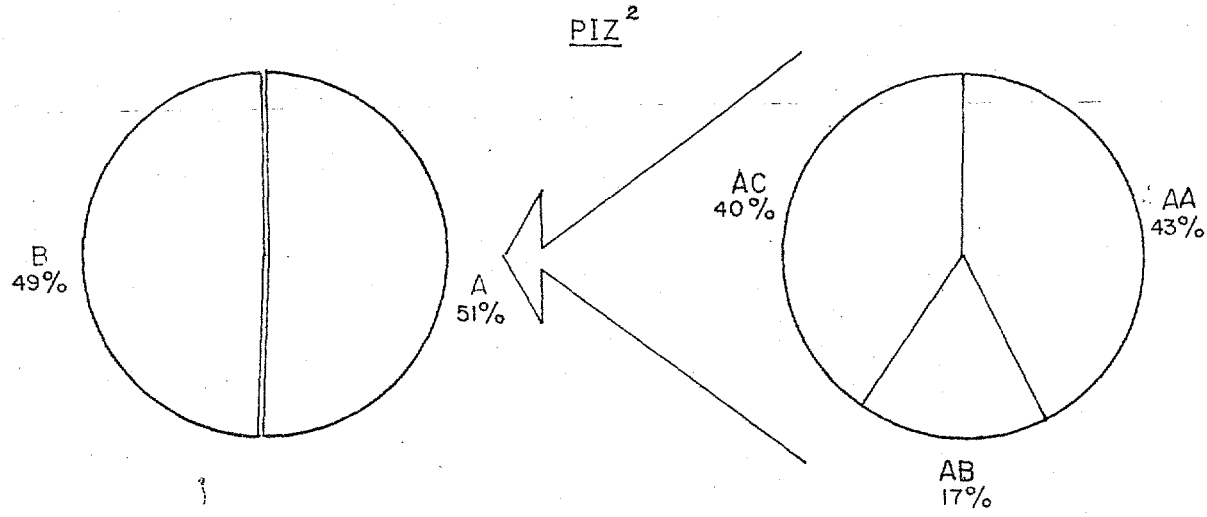

A - Unemployed
B - Employed

AA - Housekeepers
AB - Students
AC - Others Pensioners Disabled and Jobless Individuals seeking / Not Seeking Employment

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Laguna and Batangas provinces
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

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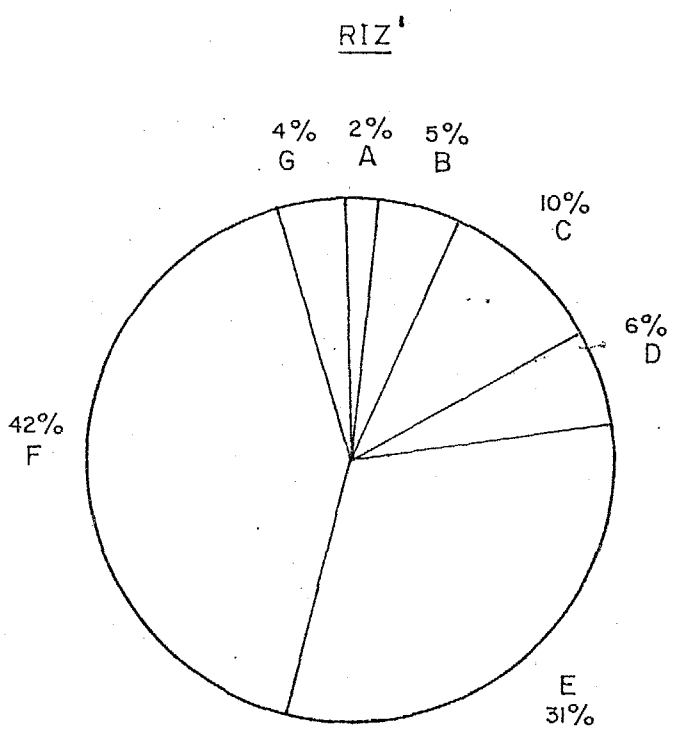
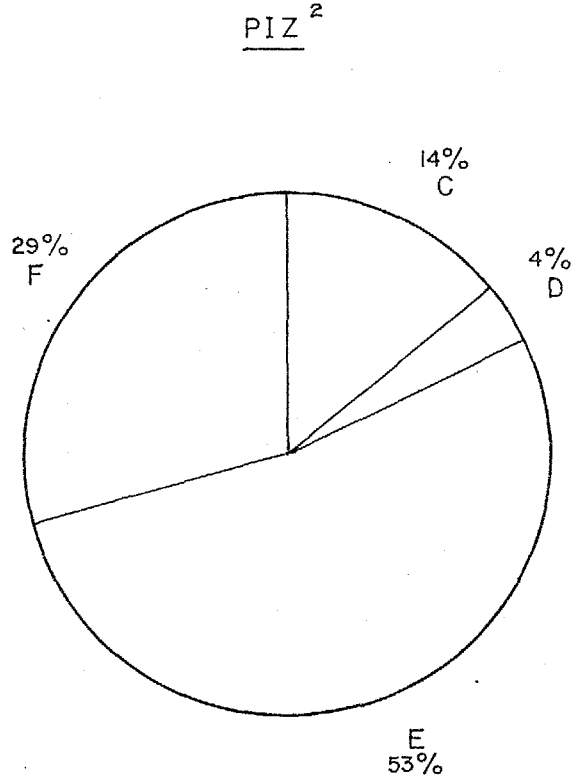
FIGURE III.6-13

UNEMPLOYED POPULATION 15 YRS. OLD & OVER BY NON-GAINFUL OCCUPATION, RIZ AND MAIBARARA GPP PIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)





LEGEND:

A - Professional, Technical and Related Workers
B - Clerical and Related Workers
C - Sales Workers
D - Service Workers
E - Agriculture, Animal Husbandry and Forestry Workers, Fishermen and Hunters
F - Production and Related Workers, Transport Equipment Operators and Laborers
G - Administrative, Executive and Managerial Workers/ Member of the Armed Forces/ Workers Not Classifiable by Occupation

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Batangas and Laguna provinces
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

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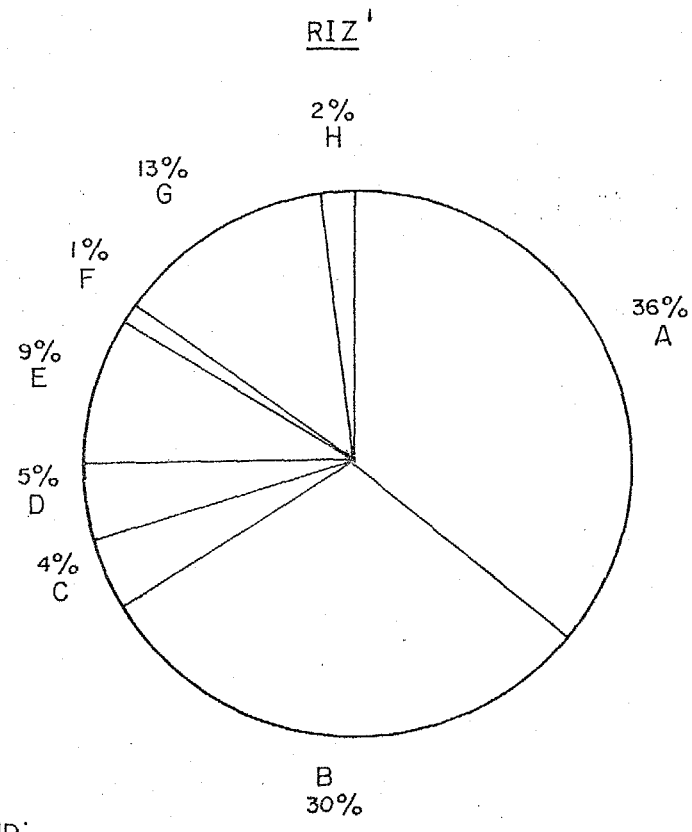
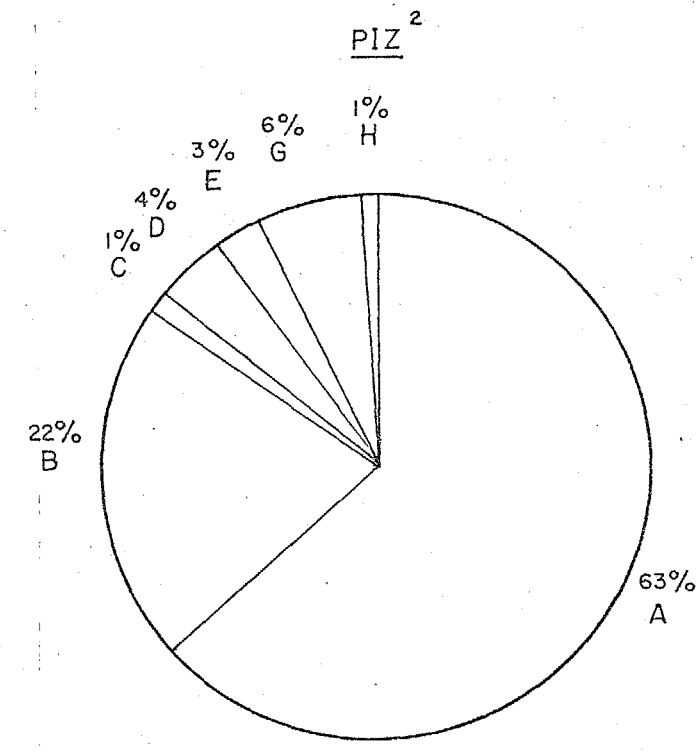
FIGURE III.6-14

DISTRIBUTION OF EMPLOYED INDIVIDUALS 15 YRS. OLD & OVER BY MAJOR OCCUPATION GROUP, RIZ AND MAIBARARA GPP PIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)





LEGEND:

A - Agriculture, Fishery and Forestry
B - Manufacturing
C - Construction
D - Wholesale and Retail Trade
E - Transportation, Storage and Communication
F - Financing, Insurance, Real Estate and Business Services
G - Community, Social and Personal Services
H - Mining and Quarrying/Electricity, Gas and Water/Activities Not Adequately Defined

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Batangas and Laguna provinces
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

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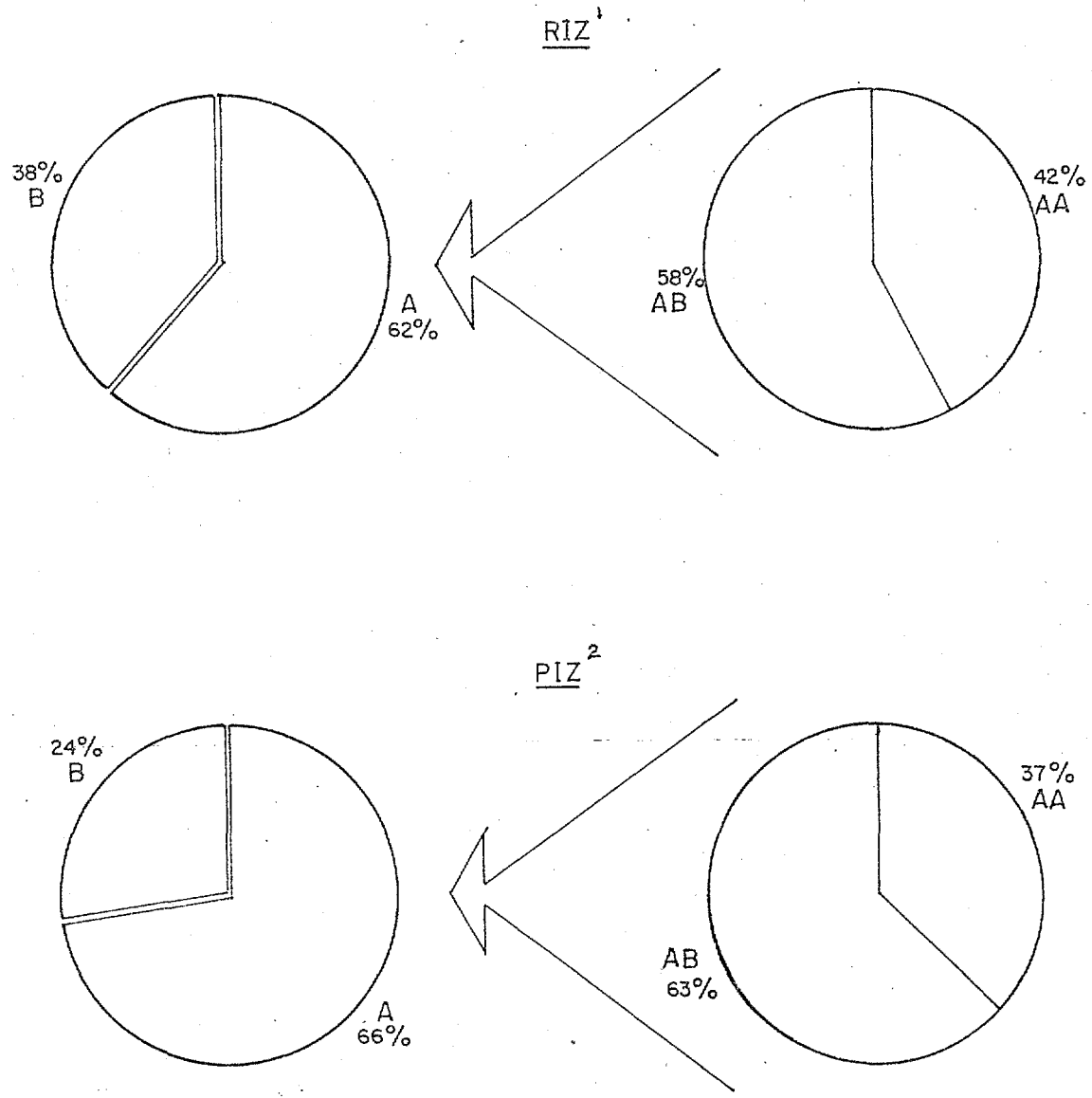
FIGURE III. 6-15

DISTRIBUTION OF EMPLOYED INDIVIDUALS 15 YRS. OLD & OVER BY MAJOR INDUSTRY GROUP, RIZ AND MAIBARARA GPP PIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)



A - Households below poverty line

B - Households above poverty line

AA - Households earning more than half of the poverty line

AB - Households earning less tha half of the poverty line

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Laguna and Batangas provinces
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

NATIONAL POWER CORPORATION

FIGURE III.6-16

DISTRIBUTION OF HOUSEHOLDS BELOW THE POVERTY LINE IN THE RIZ AND MAIBARARA GPP PIZ: 1989

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)

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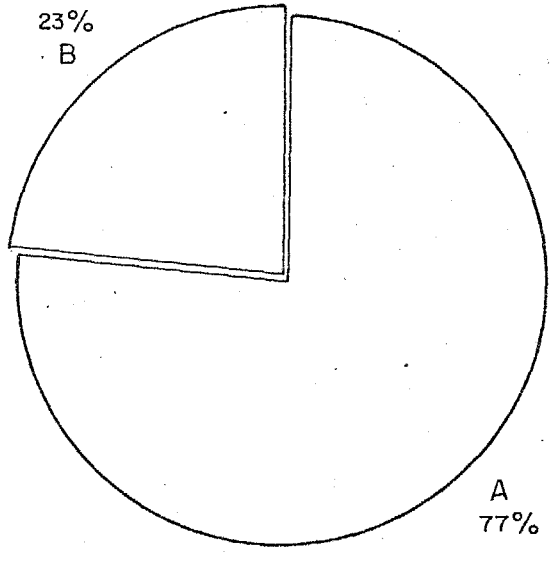
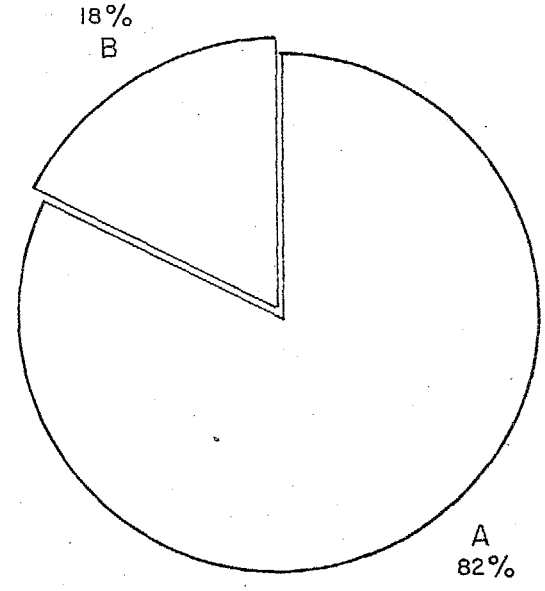
RIZ[1]



A - ₱1,957.00 and Below
B - ₱1,958.00 and Above

PIZ[2]



A - ₱1,957.00 and Below
B - ₱1,958.00 and Above

Sources: 1 - 1980 NCSO Census of Population and Housing Report, Laguna and Batangas provinces
2 - 1989 NAPOCOR-EMD Socioeconomic Survey

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FIGURE III.6-17

GAINFUL WORKERS 15 YRS. OLD AND OVER BY MONTHLY INCOME IN THE RIZ AND MAIBARARA GPP PIZ, 1989

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)

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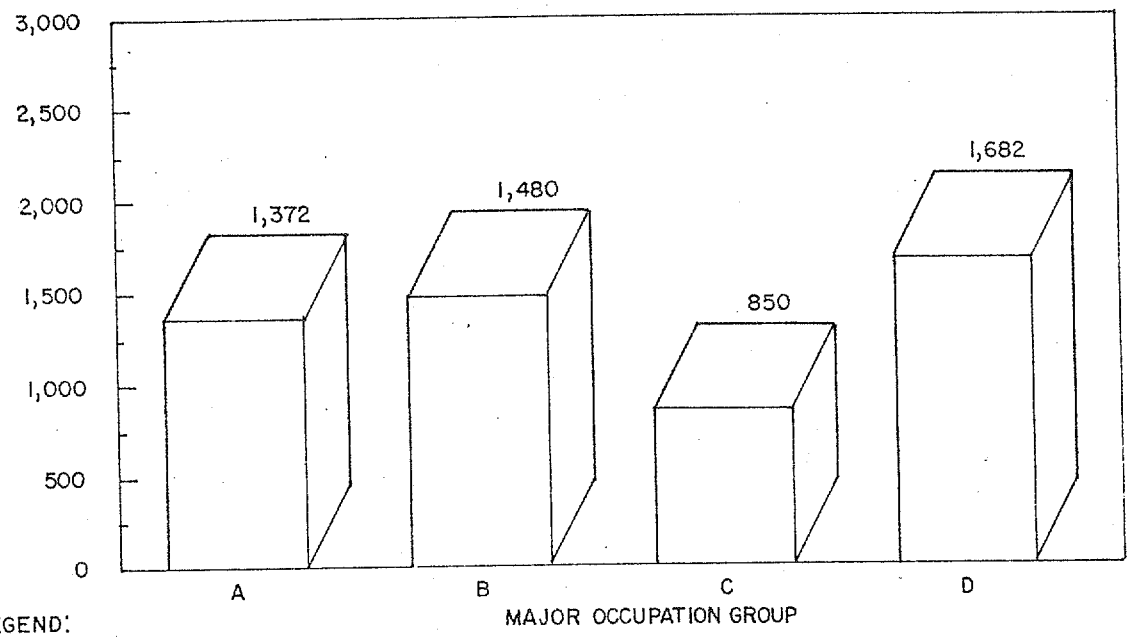
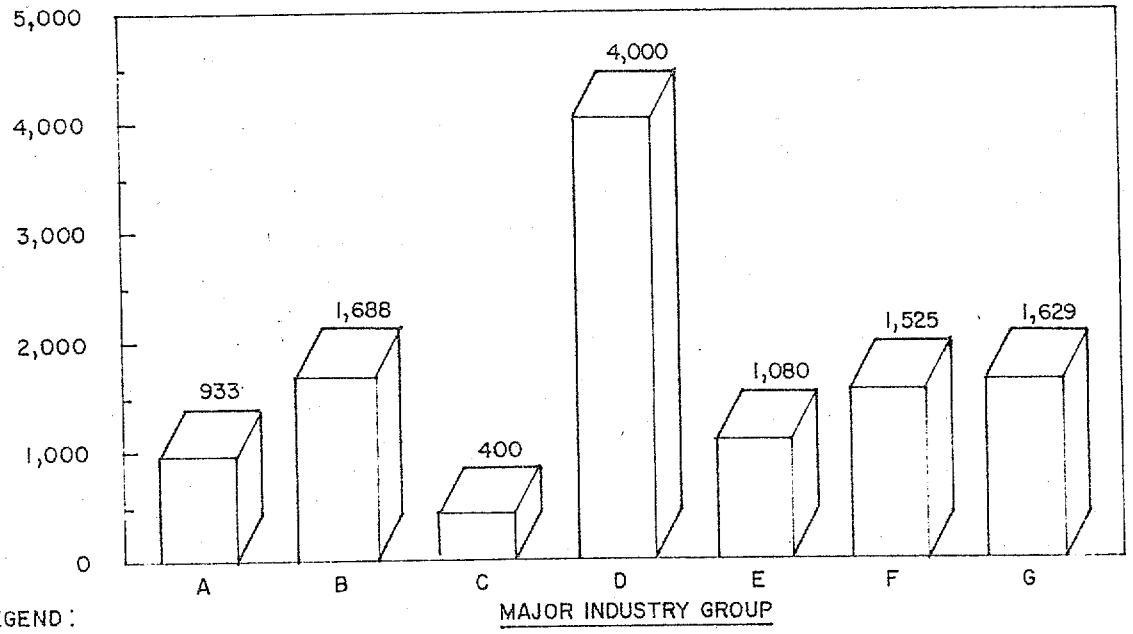
INCOME BY MAJOR OCCUPATION GROUP



LEGEND:
A - Sales Workers
B - Service Workers
C - Agriculture, Animal Husbandry and Forestry, Fishermen and Hunters
D - Production and Related Workers, Transport Equipment Operators and Laborers

INCOME BY MAJOR INDUSTRY GROUP



LEGEND:
A - Agriculture, Fishery and Forestry
B - Manufacturing
C - Electricity, Gas and Water
D - Construction
E - Wholesale and Retail Trade
F - Transportation, Storage and Communication
G - Community, Social and Personal Services

SOURCE: 1989 NAPOCOR-EMD SOCIOECONOMIC SURVEY

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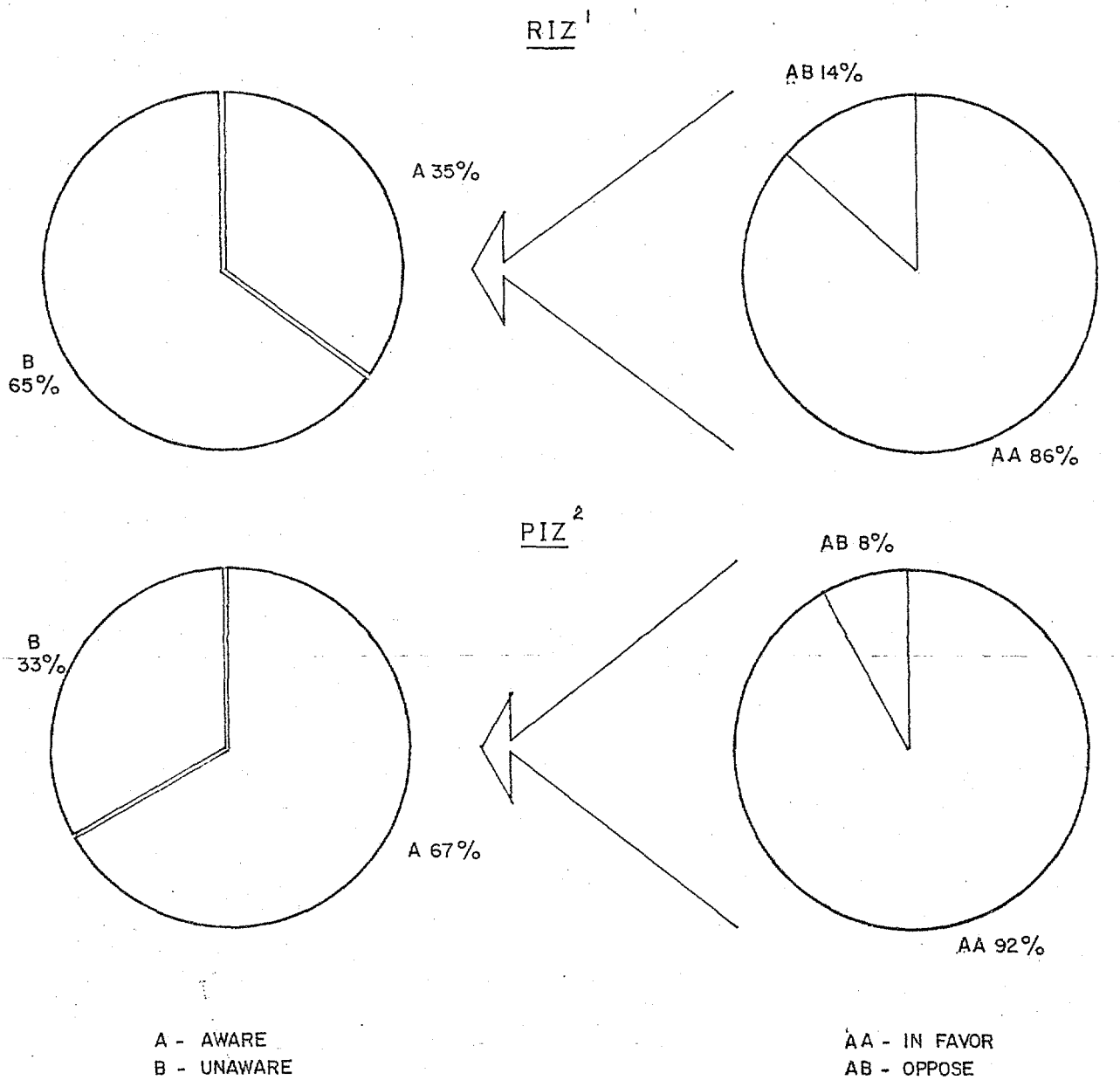
FIGURE III.6-18

MEAN MONTHLY INCOME OF GAINFUL WORKERS BY MAJOR OCCUPATION GROUP AND MAJOR INDUSTRY GROUP, MAIBARARA GPP PIZ: 1989

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)



SOURCES: 1 - 1980 NCSO CENSUS OF POPULATION AND HOUSING REPORT, BATANGAS AND LAGUNA PROVINCES

2.- 1989 NAPOCOR-EMD SOCIOECONOMIC SURVEY

NATIONAL POWER CORPORATION

FIGURE III.6-19

AWARENESS & ATTITUDE OF RIZ AND MAIBARARA GPP PIZ RESIDENTS TOWARDS THE PROJECT: 1989

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)

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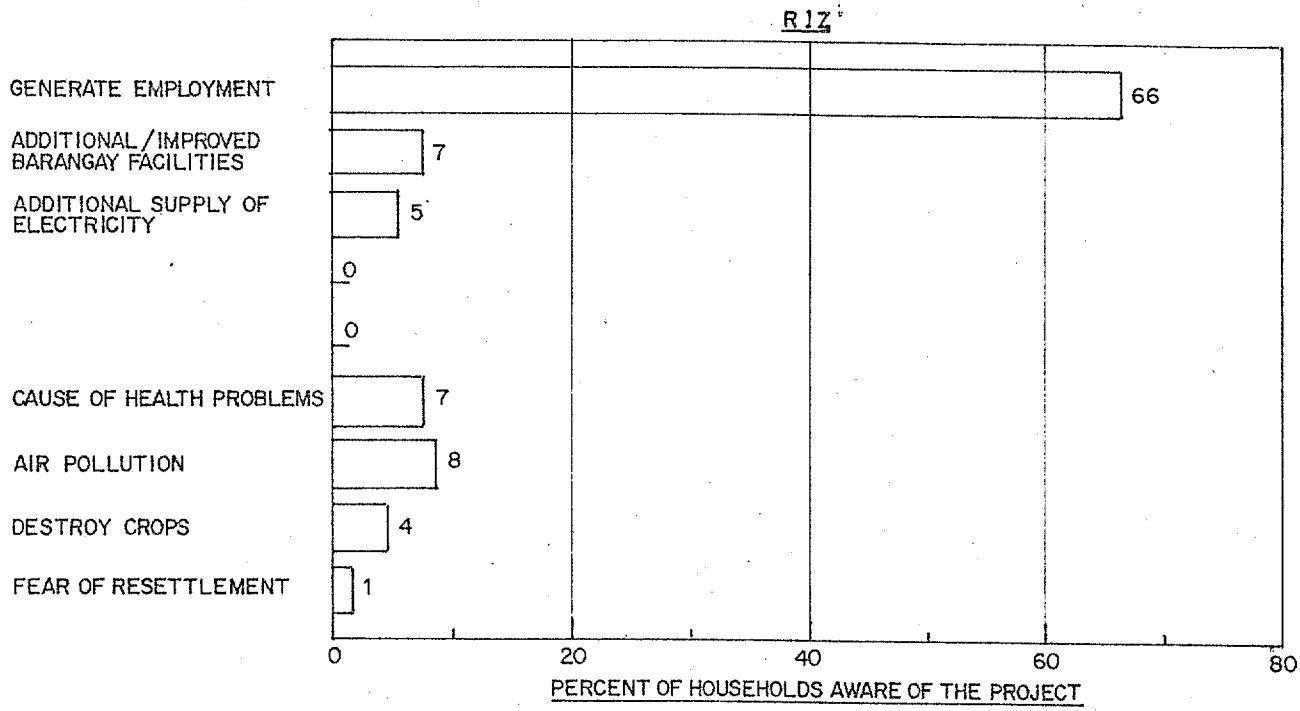
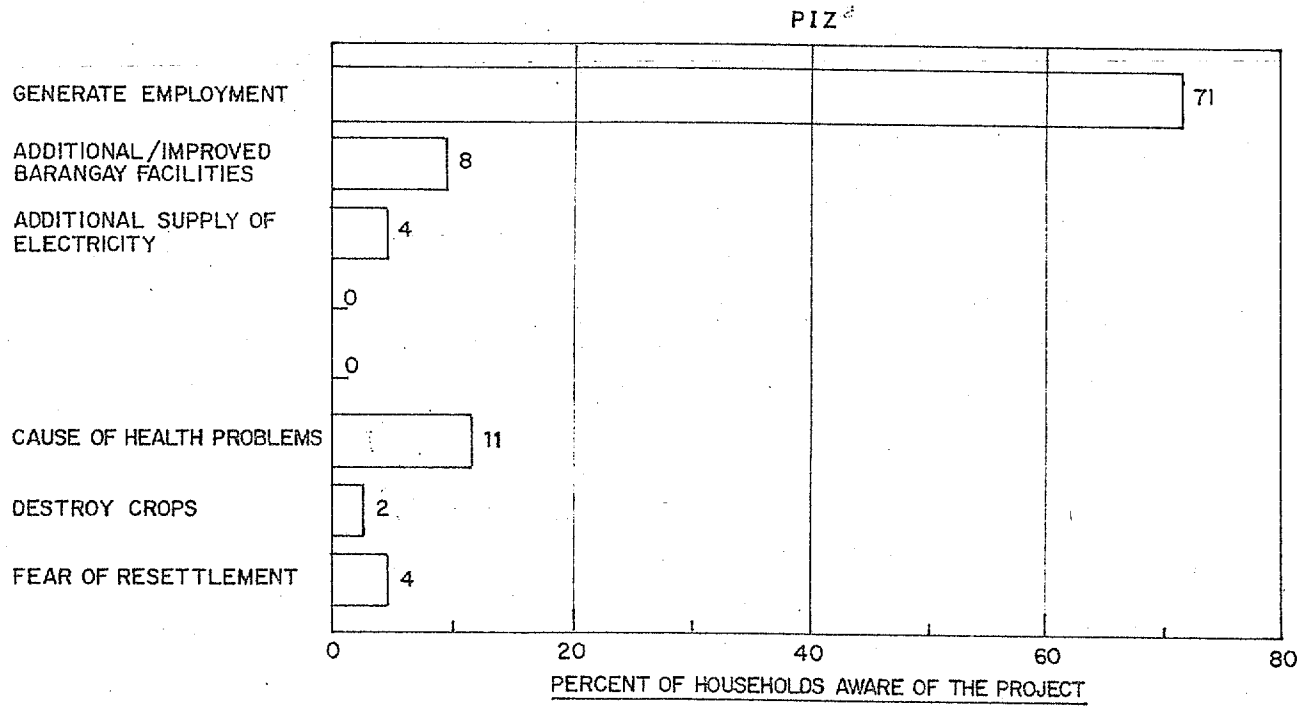




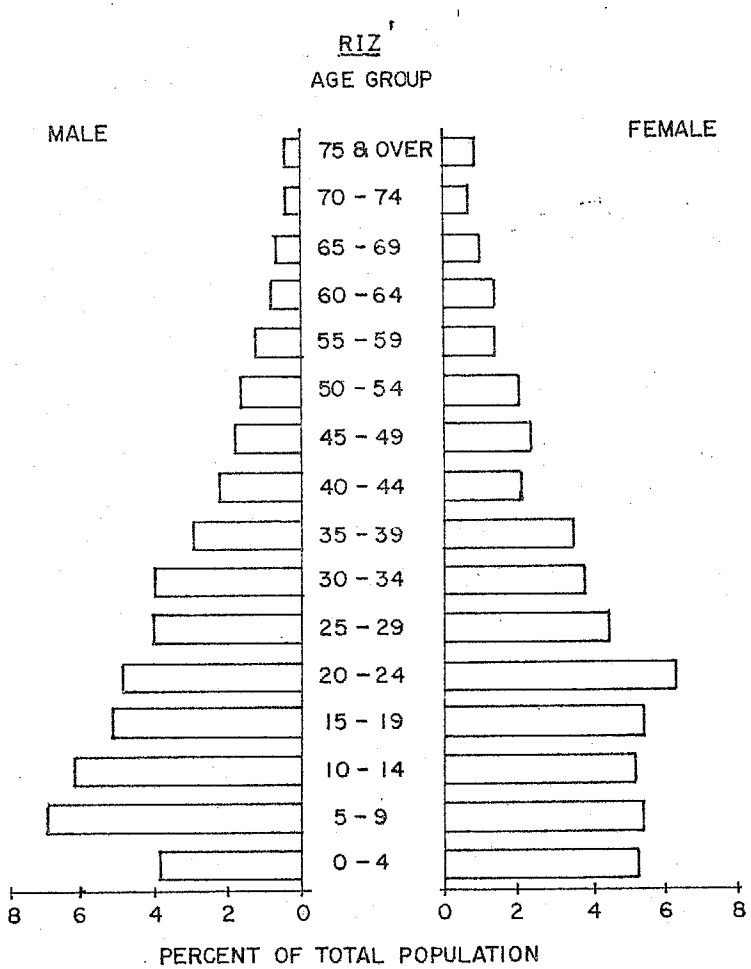
SOURCE: 1989 NAPOCOR-EMD SOCIOECONOMIC SURVEY

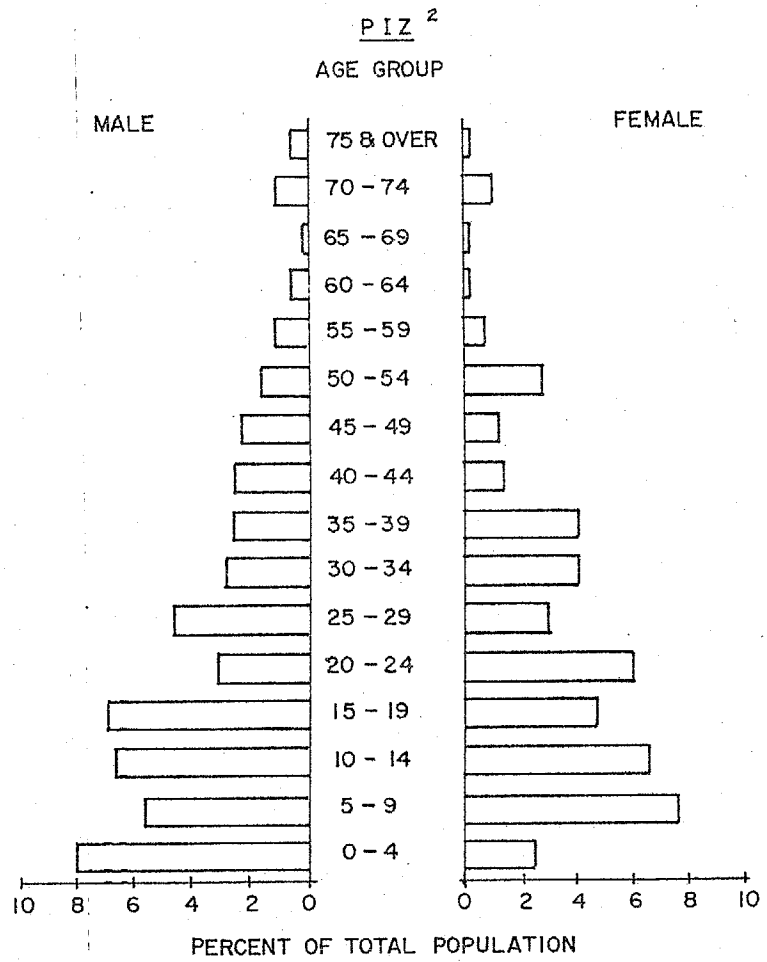
NATIONAL POWER CORPORATION

FIGURE III.6-20

OPINIONS OF RIZ AND MAIBARARA GPP PIZ RESIDENTS ON THE PROJECT

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)





SOURCES: 1 - 1980 NCSO CENSUS OF POPULATION AND HOUSING REPORT, BATANGAS AND LAGUNA PROVINCES
2 - 1989 NAPOCOR-EMD SOCIOECONOMIC SURVEY

NATIONAL POWER CORPORATION

FIGURE III.6-21

POPULATION PYRAMID OF THE RIZ AND MAIBARARA GPP PIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)

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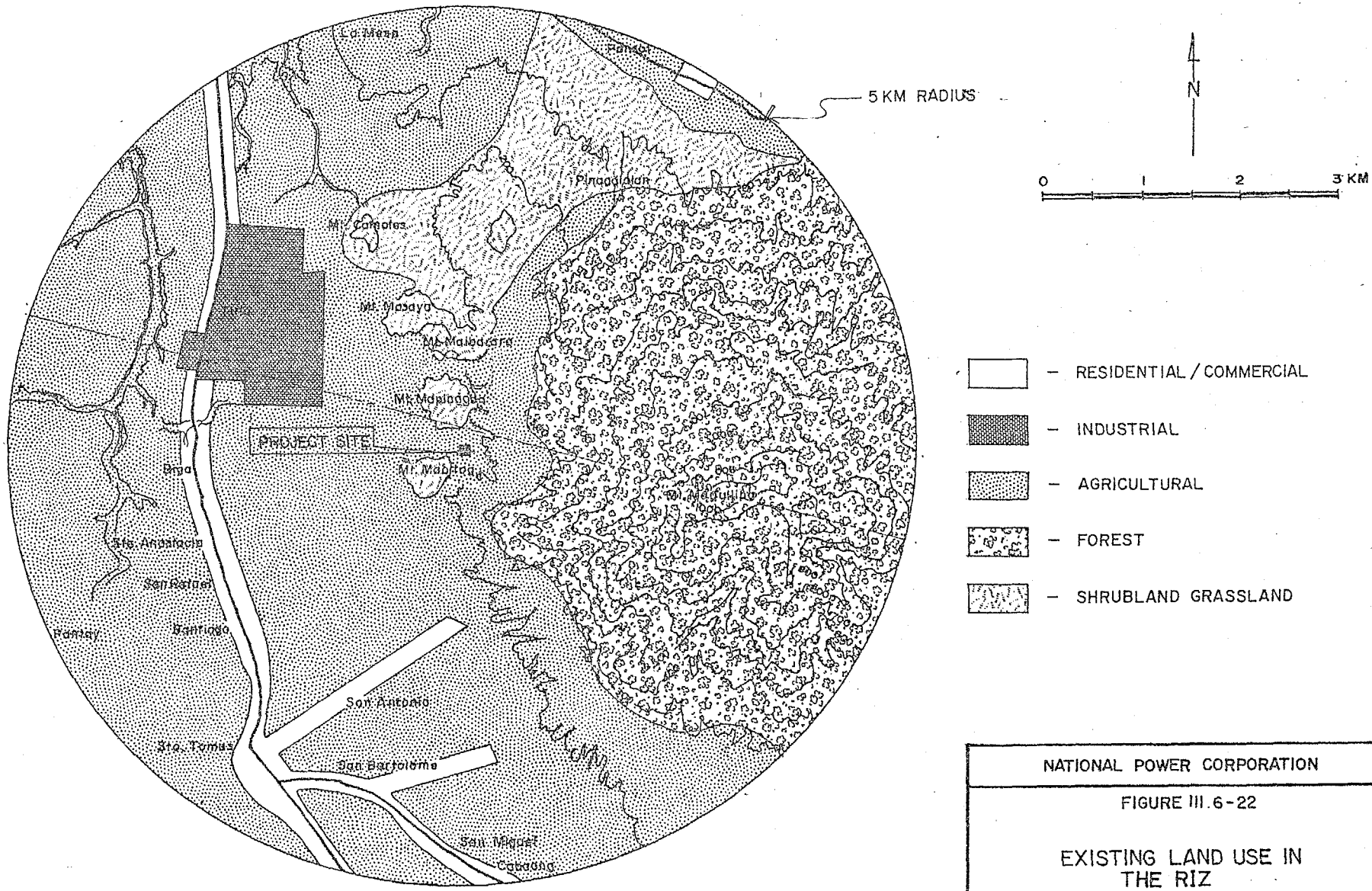


NATIONAL POWER CORPORATION

FIGURE III.6-22

EXISTING LAND USE IN THE RIZ

MAIBARARA GPP EIS: MAY 1992
(Socioeconomics and Land Use)

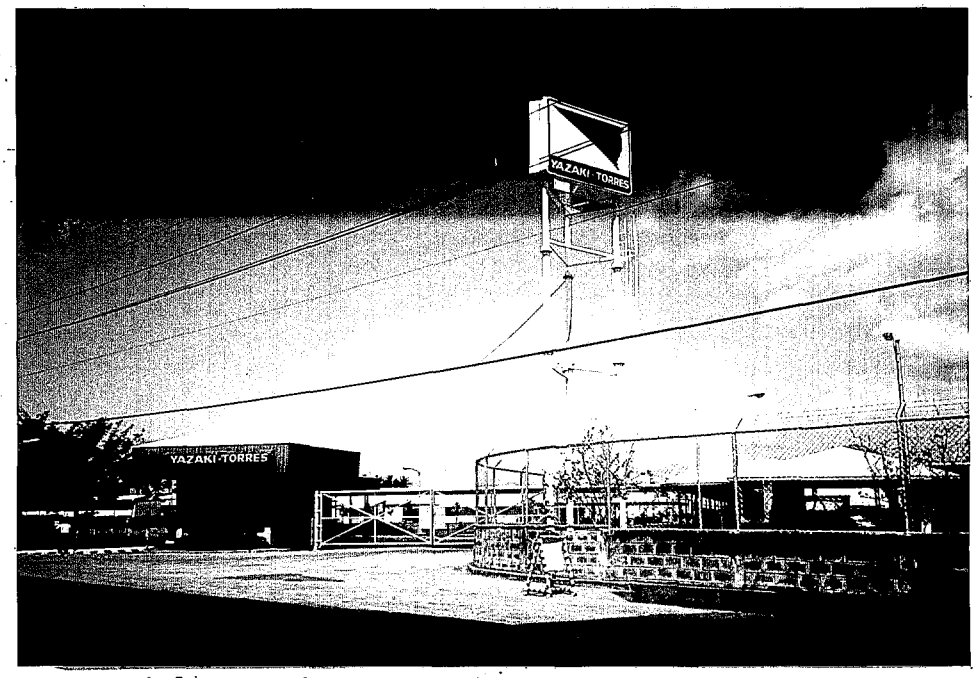
Sugar plantations such as shown in the picture, along with coconut plantations constitute most of the agricultural land use in the RIZ.

NATIONAL POWER CORPORATION

Figure III.6-23

LAND USE PHOTO
(SUGARCANE PLANTATION)

(Socioeconomics and Land Use)



Industrial companies found within the RIZ include the Yazaki-Torres Manufacturing Corporation .....

Yakult .....

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Figure III.6-24

LAND USE PHOTO

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

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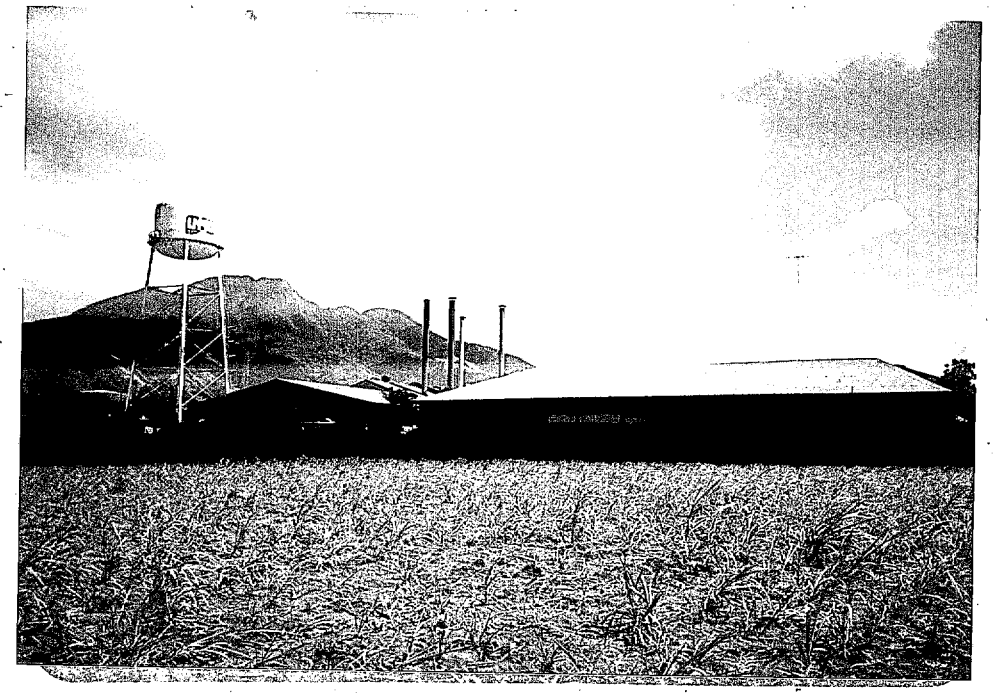
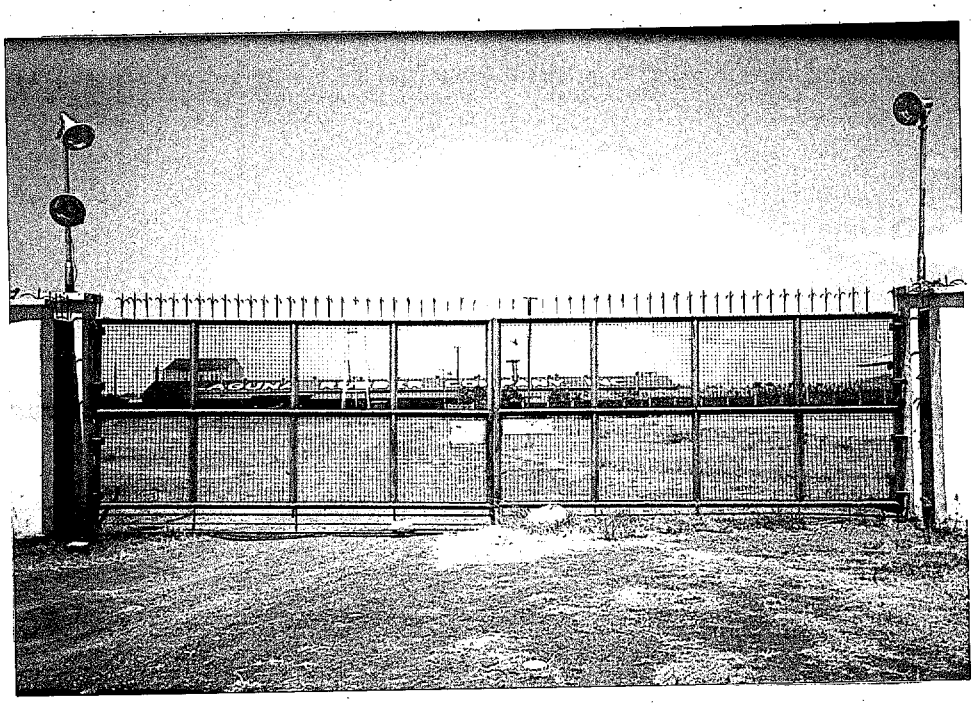


Unisol Industries and Manufacturing Corporation



and Laguna Rubber Company, Inc.

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Figure III.6-25 250

LAND USE PHOTO

Maibarara GPP EIS: May 1992
(Socioeconomics and Land Use)

III.7.1 Public Health

The study area covered by the public health survey covers the area within 5-km radius of the project site. It includes the municipalities of Sto. Tomas in Batangas and Calamba in Laguna.

Within the study area is the smaller region referred to as the primary impact zone (PIZ) encompassing only the vicinity within 1-km radius of the proposed project site. Included in the PIZ are portions of two barangays, namely, Barangay San Rafael of Sto. Tomas, Batangas, and Barangay Puting Lupa of Calamba, Laguna.

The study uses the the primary data from the NAPOCOR-EMD socioeconimic survey in the PIZ, which covers 78 households. More than half (51%) of these are located in Barangay San Rafael. The rest are located in Barangay Puting Lupa.

Secondary data were obtained from the Rural Health Units (RHU) of the municipalities comprising the study area.

The above parameters are used to discuss the existing health conditions in the study area. The morbidity and mortality data will serve as baseline health statistics prior to plant operation. The existing health condition in the study area is presented so that subsequent health impact could be realistically assessed.

The public health study precludes the records from the existing private clinics/hospitals in the study area. The data in the study area presented however is limited to the health profile of the residents who avail the services of the RHUs. However, the data on environmetal sanitation covers the municipal data of the municipalities comprising the study area.

III.7.1.1 Description of the Existing Environment

III.7.1.1.1 Environmental Sanitation

Sanitation is centered on the home and its immediate environment. The control factors in the environment that affect public health include: water supply, waste water disposal, sewage system and solid waste disposal.

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III.7.1.1.1.1 Water Supply

A primary requisite for good health is an adequate supply of water that is of satisfactory sanitary quality.

Table III.7-1 presents the uses and sources of water supply in the study area in 1980. Figure III.7-1 comparatively shows the sources of drinking water of households in the study area. The community water system (CWS) supplies 43.17 percent of the drinking water requirements, 42.13 percent for kitchen uses and 37.48 percent for washing clothes in the study area. About 9 % and 43 % of the households in the study area get their drinking water supply from shallow and deep wells, respectively. More than 3 percent of the households obtained their drinking water from dug well.

In the PIZ, more than one-third (37.18%) of the households obtain their drinking water requirements from the community water system (Table III.7-2). Almost 22 percent of the households get their water supply from open well. Nearly 27 percent of the households obtain their drinking water requirements from spring.

At the project site in Sitio Capus, there are no artesian wells or deepwells. The residents depend on a developed spring located at the upper part of the community for their domestic needs. The spring water is impounded and piped into concrete reservoirs located at the center of the sitio and near the cluster of houses in the lower part of the community. Normally, water supply dwindles during dry months.

Water is hand carried in open containers which provides a convenient vehicle for pathogens to contaminate water wells and containers used for carrying drinking water.

III.7.1.1.1.2 Toilet Facilities

The improper disposal of human excreta and sewage is one of the major factors threatening the health and comfort of individuals in areas where satisfactory sewerage systems are not available. Very large numbers of different disease-producing organisms can be found in fecal discharges of ill and apparently healthy persons.

Table III.7-3 and Figures III.7-2 show the NCSO survey on the types of toilet facilities used in the study

area. As of 1980, majority (78.09%) of the households in the study area have water-sealed toilets. About 8% of the households do not have any toilet facility. The remaining households use the closed pit type, open-pit or other types of toilet facilities.

In the PIZ, nearly half (47.44%) of the households have open pit toilets. A little more than (20.51%) of the households have these watersealed type (Table III.7-4). Roughly 14% do not own any toilet facility.

III.7.1.1.1.3 Drainage and Wastewater Disposal

The type of drainage facilities used in municipality of Sto. Tomas, Batangas and Calamba, Laguna are either open canal or blind drainage.

III.7.1.1.1.4 Solid Waste

Open dumping is the disposal method used in the province of Laguna and Batangas. In open dumps, refuse is generally spread over a large area, providing a source of food and harborage for rats, flies and other vermin. It is unsightly, an odor and smoke nuisance, a fire hazard and often a cause of water pollution.

The common practice in those areas without regular garbage collection is to burn or bury their garbage.

The municipal government has the responsibility of solid waste collection and disposal in their respective municipalities. Solid waste collected are transported directly to dumpsites.

In the PIZ, about one-third (35.90%) of the households throw and burn their garbage (Table III.7-5). About 28% throw and burn their garbage in the pit. About 17% of the households throw their garbage elsewhere.

III.7.1.1.2 Environmental Hazards

Our relationship with our environment necessarily must be regarded in two context: (1) the elements of the natural environment that are hazardous to our health and safety and (2) our actions within our environment that threaten our health.

III.7.1.1.2.1 Outdoor Air Pollution

In Sitio Capus, the odor of H_2S is observed due to the presence of natural springs and well drilling/testing/venting by PGI.

The presence of insignificant levels of SOX and NOx, HC, CO and air particulates are due to the emissions from vehicles and industrial establishments and drilling rigs.

The particulate and gaseous irritants in polluted air are reported to increase susceptibility to upper respiratory disease, such as common cold and to aggravate existing illness.

Based on the air quality monitoring of the PCES and ESD, the existing H_2S, SO_2 and NO_2 concentration in the sampling stations are below the NPCC standard (Refer to Air Quality Module).

III.7.1.1.2.2 Indoor Air Pollution

Indoor combustion can give rise to CO, NOx, SOx, formaldehyde and a variety of particles (Table III.6-6. These oxides and respirable suspended particulates can reach very high levels, especially if charcoal or wood are inefficiently combusted in indoor cooking.

The concentration of some air contaminants may be higher indoors than outdoors and that estimates of exposure based only on outdoor measurements may be inaccurate.

In the study area, 1980 NCSO survey revealed that almost 14% of the households use kerosene for cooking. More than 60% of the households use charcoal and wood. About 19% of the households use LPG (Table III.6-7).

Tobacco smoke indoor generates particles, nicotine, CO, NO_2 and acrolien and many other substances. Sidestream tobacco smoke may be the principal hazard to health in the indoor environment. Sudden infant death syndrome also occurs significantly higher in smoking than non-smoking households.

Socioeconomic and environmental sanitation survey in the DIA reveals that 78% are smoking households.

It should be noted that whereas smoking is a major contributor to respiratory disease in the smoker, air pollution, climate, age, sex, and socioeconomic conditions affect the incidence of respiratory disease in the general population.

Formaldehyde may be generated indoors from a variety of sources including plywood and particleboard, ureaformaldehyde foam insulation, carpets and furnishings, and tobacco smoke. Eye and nose irritations resulting in tearing and sneezing are characteristic symptoms.

III.7.1.1.2.3 **Noise**

The main sources of noise in domestic noise, insects and birds, and the vicinity of the project site are motor vehicles.

The existing noise levels around the proposed site ranged from 48 - 52 dBA. These values are within the NPCC ambient noise level for residential areas.

III.7.1.1.3 **Health Profile**

III.7.1.1.3.1 **Morbidity**

Table III.7-8 presents the leading causes of morbidity in the study area. Communicable and infectious diseases are prevalent in the study area. Residents in the area are commonly afflicted with respiratory diseases such as bronchitis, pulmonary tuberculosis (PTB), pneumonia and influenza. Enteric diseases such as diarrhea, parasitism and anemia are also common. It was reported that URTI is considered the number one cause of morbidity for the past five years, followed by bronchitis, skin disease, diarrhea and parasitism.

In the PIZ, there was no unusual illness reported by the residents; common illnesses observed included the common colds, influenza, measles, chicken pox, diarrhea, hypertension and asthma (Table III.7-9).

III.7.1.1.3.2 **Mortality**

The number one cause of death in the study area is bronchopneumonia followed by PTB. Heart diseases, cerebrovascular accidents and cancer were also reported (Table III.7-10).

In the PIZ, hypertension, senility and accidents are the common causes of death among family members (Table III.7-11).

III.7.1.1.4 Mode of Treatment of Illness

Table III.7-12 shows the mode of treatment of illness in the PIZ. About 47% of the households in the PIZ consult private doctors. Roughly 13% of the households avail of medical services from the government health centers and about 31% apply self-medication. Family members who got sick were usually brought to the local herbal doctors by 8% of the households. More acute cases were brought in the government hospital in Calamba, Laguna, or in private clinics and hospitals in the study area.

III.7.1.1.5 **Existing Health Institutions**

The nearest government health facility from the project site is Barangay Puting Lupa Health Center (Calamba), located approximately 1-km from the project site. No government or private physician or any medical personnel served Sitio Capus. According to the residents in the area, the last time they were visited by a physician was about nine years ago. The town health center reported that in 1986, there was a medical civic action program conducted by the Philippine Army in the area.

The government health facilities presently serving the municipality of Sto Tomas includes the main rural health center (RHU I) in the poblacion area and the RHU II in Barangay San Juaquin. These RHU's are composed of 10 barangay health stations. In Calamba, there are also two RHU's. RHU I is located in the poblacion area while RHu II is located in Barangay Maasin.

Table III.7-1

Sources of Water Supply in the Study Area : 1990

MGPP EIS: May 1992
(Public Health)

Sources of Water Supply	Calamba		Sto. Tomas		Study Area	
	Number	Percent	Number	Percent	Number	Percent
Deepwell	13,555	48.74	15,073	91.32	28,628	64.60
Shallow Well	8,298	29.83	0	0.00	8,298	18.72
Developed Spring	869	3.12	151	0.91	1,020	2.30
Water Works System	2	0.01	1,131	6.85	1,133	2.56
River, Dugwell etc.	5,089	18.30	151	0.91	5,240	11.82
Unimproved Spring	2	0.01	301	1.82	303	0.68
T O T A L	27,813	100.00	16,506	100.00	44,819	100.00

Source: Annual Health Reports
Calamba Rural Health Units & Sto. Tomas Rural Health Units

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Table III.7-2

Sources of Drinking Water Supply in the PIZ

MGPP EIS: May 1992

(Public Health)

Source of Water Supply	Number	Percent
Community Water Sytem	29	37.2
Open Well	17	21.8
Drilled Well	6	7.7
River Creek	5	6.4
Spring	21	26.9
T O T A L	78	100.0

Source: NAPOCOR Socioeconomic Survey, March 1989

Table III.7-3

Types of Toilet Facilities in the Study Area : 1990

MGPP EIS: May 1992
(Public Health)

Types of Toilet Facilities	Calamba		Sto. Tomas		Study Area	
	Number	Percent	Number	Percent	Number	Percent
Watersealed	19,126	68.77	12,283	73.08	31,409	70.40
Open Pit	2,067	7.43	1,158	6.89	3,225	7.23
Closed Pit	1,894	6.81	2,165	12.88	4,059	9.10
None	4,724	16.99	1,201	7.15	5,925	13.28
T O T A L	27,811	100.00	16,807	100.00	44,618	100.00

Source: Annual Health Reports
Calamba Rural Health Units & Sto. Tomas Rural Health Units

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Table III.7-4

Types of Toilet Facilities Used in the PIZ

MGPP EIS: May 1992
(Public Health)

Types of Toilet Facilities	No. of Households	Percent of Households
Open Pit	37	47.44
Watersealed	16	20.51
Closed Pit	14	17.95
None	11	14.10
T O T A L	78	100.00

Source: NAPOCOR Socioeconomic Survey, March 1989

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Table III.7-5

Mode of Garbage Disposal System in Calamba, Laguna: 1990

MGPP EIS: May 1992
(Public Health)

Mode of Garbage Disposal	Number	Percent
Burying	14677	52.8
Open Dumping	6949	25.0
Municipal Garbage Collection	1320	4.7
Burning	4865	17.5
T O T A L	27811	100.0

Source: Annual Health Report : 1990
Calamba Rural Health Unit

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Table III.7-6

Mode of Garbage Disposal System in the PIZ

MGPP EIS: May 1992
(Public Health)

Mode of Garbage Disposal	Number	Percent
Thrown-Elsewhere and Burned	28	35.9
Pit-Burned	22	28.2
Thrown-Elsewhere	13	16.7
Pit	8	10.3
Others	7	9.0
T O T A L	78	100.0

Source: NAPOCOR Socioeconomic Survey, March 1989

Table III.7-7
SUMMARY OF INDOOR POLLUTANTS AND EMISSION SOURCES

MGPP EIS: MAY 1992
(Public Health)

POLLUTANT	MAJOR EMISSION SOURCES
Concentration lower indoors than outdoors:	
Sulfur oxides (gases, particles)	Fuel combustion, smelters
Ozone	Photochemical reactions
Pollens	Trees, grass, weeds, plants
Lead, manganese	Automobiles
Calcium, chlorine, silicon, cadmium	Suspension of soils, industrial sources
Organic substances	Petrochemical solvents, natural sources, vaporization of unburned fuels
Concentration higher indoors than outdoors:	
Nitric oxide, nitrogen dioxide	Fuel burning
Carbon monoxide	Fuel burning
Carbon Dioxide	Metabolic activity
Particles	Resuspension, condensation of vapors, combustion products
Water vapor	Biological activity, combustion evaporation
Organic substances	Volatilization, combustion, paints, metabolic action, pesticides
Spores	Fungi, molds
Radon	Building construction materials (concrete,stone), water
Formaldehyde	Particleboard, insulation, furnishings, tobacco smoke
Asbestos, mineral and synthetic fibers	Fire retardant materials, insulation
Organic substances	Adhesive, solvents, cooking, cosmetics
Ammonia	Metabolic activity, cleaning products
Polycyclic hydrocarbons, arsenic, nicotine, acrolien, and so forth	Tobacco smoke
Mercury	Fungicides, paints, spills in dental-care facilities or labs thermometer breakage
Aerosols	Consumer products
Microorganisms	People, animals, plants
Allergens	House dust, animal dander, insect parts

Source: Preventive Medicine and Public Health

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Table III.7-8

Morbidity Rate in Sto. Tomas, Batangas

MGPP BIS : May 1992
(Public Health)

Causes of Morbidity	Rate (No. of Cases/10,000 Population)					Annual Difference (In Percent)			
	1983	1984	1985	1986	1987	1983-1984	1984-1985	1985-1986	1986-1987
URI	1299.09	276.43	964.25	985.44	---	(78.72)	248.82	2.20	---
Parasitism	9.01	153.67	75.65	429.65	393.07	1,605.95	(50.77)	467.96	(8.51)
Gastroenteritis	138.12	113.51	122.04	591.26	---	(17.82)	7.52	384.46	---
HPN	---	172.63	43.77	143.87	294.32	---	(75.23)	236.42	42.01
Neuro Circulatory Asthenia	---	---	118.41	601.12	788.09	---	---	407.64	31.10
PTB	7.94	9.03	---	11.63	---	13.74	---	---	---
Anemia	---	---	205.76	---	---	---	---	---	---
Bronchitis	6.22	---	---	---	---	---	---	---	---
Rheumatism	---	---	18.56	---	---	---	---	---	---
Influenza	19.73	---	---	---	---	---	---	---	---

Source: Rural Health Unit
Sto. Tomas, Batangas

Table III.7-9

Leading Causes of Morbidity in Calamba, Laguna

MGPP EIS : May 1992
(Public Health)

Causes of Morbidity	Rate (No. of Cases/10,000 Population)					Annual Difference (In Percent)			
	1986	1987	1988	1989	1990	1986-1987	1987-1988	1988-1989	1989-1990
URI	920.31	587.92	486.79	170.65	165.84	(36.12)	(17.20)	(64.94)	(2.82)
Parasitism	69.67	77.24	71.10	26.84	49.01	10.86	(7.85)	(62.25)	82.59
Diarrhea	69.74	35.21	81.93	---	29.06	(49.51)	132.69	(100.00)	---
Avitaminosis	114.39	37.46	14.38	---	37.09	(67.25)	(61.61)	(100.00)	---
Anemia	37.15	37.59	22.16	29.42	81.06	1.18	(41.04)	(7.89)	297.05
Influenza	40.15	---	86.56	---	15.04	(100.00)	---	(100.00)	---
Hypertension	30.00	39.91	53.23	13.81	3.18	33.05	33.38	(74.05)	(77.01)
Dermatitis	26.86	33.56	5.29	17.65	15.46	24.93	(84.23)	233.60	(12.44)
PTB	26.86	34.88	10.71	7.03	14.50	29.86	(69.30)	(34.39)	106.38
Skin Problem	---	---	18.18	---	34.39	---	---	(100.00)	---
Wounds	29.65	6.68	11.39	---	---	(77.46)	70.43	(100.00)	---
Gastritis	---	14.43	15.81	---	---	---	9.60	(100.00)	---
Bronchopneumonia	29.86	---	1.87	---	---	(100.00)	---	(100.00)	---
Nutritional Deficiency	---	---	---	30.08	---	---	---	---	(100.00)
Gastrointestinal Disorder	---	---	---	13.39	16.90	---	(100.00)	---	26.17
Measles	10.70	---	---	7.03	---	(100.00)	---	---	(100.00)
Chronic Diseases	---	---	---	7.03	---	---	---	---	(100.00)

Source: Annual Health Report
Calamba Rural Health Unit

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Table III.7-10

Leading Causes of Illness in the PIZ *

MGPP EIS : May 1992
(Public Health)

Causes of Morbidity	Number of Households	Percent of Households
Fever, Cough, Colds & Headache	17	21.79
Influenza	9	11.54
Asthma	3	3.85
Bronchopneumonia	2	2.56
Amoebiasis	1	1.28
Chicken Pox	1	1.28
Diarrhea	1	1.28
Diptheria	1	1.28
Heart Disease	1	1.28
H-fever	1	1.28

Source: NAPOCOR Socioeconomic Survey, March 1989
* - for the past 12 months from the date of the survey

Table III.7-11

Leading Causes of Mortality in Calamba, Laguna

MGPP EIS : May 1992
(Public Health)

Causes of Mortality	Rate (No. of Cases/10,000 Population)					Annual Difference (In Percent)			
	1986	1987	1988	1989	1990	1986-1987	1987-1988	1988-1989	1989-1990
Bronchopneumonia	17.79	11.38	7.10	4.86	6.23	(36.02)	(37.65)	(31.47)	28.11
CVA	17.38	7.55	8.03	3.60	6.89	(56.60)	6.44	(55.14)	91.24
PTB	10.63	7.74	5.29	5.70	5.81	(27.19)	(31.66)	7.80	1.88
Gen. Arteriosclerosis	9.07	5.89	4.30	4.92	4.79	(35.03)	(27.07)	14.62	(2.66)
Malnutrition	5.04	2.79	1.81	1.74	2.04	(44.90)	(35.05)	(3.55)	16.98
Cancer (all types)	4.16	2.18	2.49	0.00	1.68	(47.48)	14.02	(100.00)	---
Wounds (all kinds)	3.41	0.60	2.49	2:52	1.92	(82.52)	318.07	1.27	(23.98)
Myorcardial Infarction	4.29	1.79	---	1.20	---	(58.39)	(100.00)	---	(100.00)
Cardio Resp. Arrest	1.84	---	2.30	2.40	0.60	(100.00)	---	4.27	(75.06)
Pneumonia	---	2.45	1.81	1.56	---	---	(26.27)	(13.53)	(100.00)
Prematurity	1.09	0.79	1.00	1.20	0.78	(27.19)	25.42	20.56	(35.15)
Still Birth	---	1.52	0.62	0.96	---	---	(59.10)	54.32	(100.00)
Congestive Heart Failure	---	1.72	---	1.02	---	---	(100.00)	---	(100.00)
Hypertension	---	---	---	---	0.78	---	---	---	---

Source: Annual Health Report
Calamba Rural Health Unit

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Table III.7-12

Mortality Rate in Sto. Tomas, Batangas

MGPP EIS : May 1992
(Public Health)

Causes of Mortality	Rate (No. of Cases/10,000 Population)					Annual Difference (In Percent)			
	1983	1984	1985	1986	1987	1983-1984	1984-1985	1985-1986	1986-1987
Cancer	2.79	6.54	4.24	3.94	---	134.71	(35.27)	(6.95)	---
Homicide	5.15	3.38	5.45	2.76	2.53	(34.24)	60.91	(49.34)	(8.32)
Asteriosclerosis	5.79	6.32	5.04	4.73	---	9.11	(20.18)	(6.21)	---
PTB	---	0.90	2.62	1.38	1.75	---	190.53	(47.39)	26.94
CVA	---	---	2.42	2.76	1.56	---	---	13.98	(43.58)
Cardio Resp. Arrest	---	7.45	3.23	---	---	---	(56.66)	---	---
Hypertension	3.22	2.03	---	---	---	(36.87)	---	---	---
Pneumonia	---	---	2.22	---	---	---	---	---	---
Asphyxia	1.29	---	---	---	---	---	---	---	---
Malnutrition	---	---	1.21	---	---	---	---	---	---
Prematurity	---	---	---	---	---	---	---	---	---

Source: Rural Health Unit
Sto. Tomas, Batangas

Table III.7-13

Causes of Death in the PIZ *

MGPP EIS: May 1992
(Public Health)

CAUSES OF DEATH	NUMBER OF HOUSEHOLDS	PERCENT OF HOUSEHOLDS
Hypertension	32	41.03
Senelity	12	15.38
Accidents	10	12.82
Lung Diseases	3	3.85
Ulcer	3	3.85
Pulmonary Tuberculosis	2	2.56
Cancer (all forms)	2	2.56
Gunshot Wounds	1	1.28
Asthma	1	1.28
Leukemia	1	1.28
Measles	1	1.28
Diabetis	1	1.28

Source : NAPOCOR Socioeconomic Survey, March 1989

* - Multiple Response Survey

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Table III.7-14

Mode of Treatment of Diseases in the PIZ

MGPP EIS: May 1992
(Public Health)

Mode of Treatment of Diseases	Number of Households	Percent of Households
Self-Medication	24	30.8
Health Center	10	12.8
Private Doctor	37	47.4
Herbal Doctor	6	7.7
Other	1	1.3
T O T A L	78	100.0

Source: NAPOCOR Socioeconomic Survey, March 1989

Chapter IV

Environmental Impacts and Mitigating Measures

IV. Predicted Impacts and Mitigating Measures

IV.1 Geology/Terrain/Soil

IV.1.1 Foundation/Seismicity

The site geologic foundation is considered very stable since it is made up of tuff, lapilli, breccia and andesite. For a small plant like the Maibarara (1 x 10 MW), the subsurface formation is adequate to support the required loads. In fact, the site it is capable to support foundation of a large power plant.

As to the seismic condition, although there are fault structures that exist in the area, there are no indication of near surface manifestation that would cause serious geologic disturbance at the site.

At the Bulalo projects, the faults which are believed closely associated with the Maibarara geothermal fields recorded low magnitude background seismic events which are characteristic features of geothermal areas.

Geothermal activities are not expected to have significant changes in the Maibarara seismic rigume considering that the the extraction rate for a 1 x 10 MW plant is very small.

While seismic occurence can be measured and monitored, the phenomenon cannot be prevented because it is not related to project activities. Mitigating measures could take the form of design consideration specifying adequate resistance to damage by probable large magnitude earthquakes.

IV.1.2 Subsidence

Field investigations revealed that there are no surface indication of recent slumping/landslides that may be caused by earth subsidence on the area.

Past studies on geothermal resource extraction seems to indicate effects on surface subsidence. Such effects may be minimized through the reinjection program in the Maibarara field.

Monitoring of subsidence will be undertaken by setting baseline elevation levels which can be compared to the results of future surveys.

IV.1.3 **Erosion**

The proposed site is gently rolling and will be levelled up to an elevation 200 masl. Some amount of vegetatvie cover and spoils will be removed but will be disposed of in areas away from drainage route of Siam-siam River and nearby creeks in the area. Such conditions will only be of short duration and temporary. Prior to operation open areas will either be concreted or re-vegetated to guard against future soil erosion.

IV.1.4 **Scenic Feature of Hot Springs**

The heat and mass flow of steam and water from geothermal system give a rough minimum measure of its utilization potential. Heat escapes from an area through conduction and convection processes in the top rock formations by evaporation, and by direct discharge of steam and water

The loss of geothermal resource can be farther accelerated by extraction of geothermal fluid through power utilization, hence, it is expected that hot springs existing at the surface of the geothermal resource may dissipate with time.

In the case of Maibarara field, except for a few fumeroles, there are no known hot springs of notable scenic importance, thus, effect of geothermal operation will be insignificant.

IV.1.5 **Pedology**

The removal of vegetative cover and soil overburden during construction will disturb existing topography around the power plant and its facilities. If not properly managed, this will result to the exposure of the subsurface layer which can accelerate sliding and soil erosion.

However, this impact is temporary and is considered minor due to the relatively small area required for site development. Disturbed areas will be rehabilitated prior to operation.

Similarly, the soil chemistry in the surrounding areas may be altered due to the introduction of small quantities of chemicals from the airborne drift from cooling towers and other sources of droplets of

geothermal steam and brine.

Periodic soil sampling and analyses during operation will be undertaken to assess and evaluate if there is any alteration in soil chemistry.

IV.2 Meteorology and Air Quality

IV.2.1 Meteorology

Heat and steam vapor are two of the primary industrial products generated by geothermal plants. These forms of excess energy are normally generated in two ways: (1) as heat generated at the different geothermal wells during the testing period, and (2) the non-condensing turbine discharges that arise from the unused heat from the turbine steam.

The possible immediate consequences of such heat releases are the speeding up of atmospheric reactions and the localized increase in relative humidity and temperature. In geothermal plants, the heat and steam vapor released diffuse directly to the atmosphere and serve as a source of heat convection at the base of the lower cloud formations. This phenomenon causes a partial expansion of the cloud base and may provide a very good venue for enhanced atmospheric reactions. The ultimate result will be a highly unstable atmospheric conditions.

To establish local site meteorology/climatology a meteorological monitoring station should be operated at the project site. Wind speed and direction, temperature, pressure, relative humidity and rainfall data should be gathered and recorded on a long term basis and used in the assessment of the short and long term air quality impacts of the project.

IV.2.2 H_2S Releases

The proposed 10 MW Maibarara Geothermal Power Project shall use approximately 77,477 kg/hr of steam containing 1.75 % noncondensable gases (NCG). The NCG contains 0.704 % H_2S (Table IV.1).

Hydrogen sulfide reaching the condenser with the exhaust steam from the turbine is partitioned between the gaseous (noncondensable) phase and the condensate phase. For direct contact condensers, H_2S retention with the condensate is about 25 to 30 %. The model

used assumed % retention equal to 25 %. The expected H2S releases is 7.29 kg/hr. When ducted to the cooling tower, the expected H2S emission concentration is 146.82 mg/scm.

The H2S emission exceeds the DENR emission standard of 15 mg/scm (10 ppm). The DENR regulations however, allows that "if the emission standard cannot be met due to economic and technical limitations, then the ambient air quality standard should prevail."

IV.2.3 Ambient H2S Levels

Stack Gas Dispersion Model. The resulting ambient H2S levels when the Maibarara Pilot Power Project becomes operational were predicted using the Gaussian Plume Equation and the Brigg's Plume Rise Equation. The dispersion coefficients used were those of Pasquill presented in equation form by Mcmullen. The basic Gaussian Dispersion Model represents an ideal steady state of homogeneous meteorological conditions, idealized plume geometry, uniform flat terrain, complete conservation of mass, and exact Gaussian distribution. Though such ideal condition will not apply to the Maibarara Geothermal Field, the model can give a conservative approximation of the ambient H2S levels resulting from the stack releases. The consistent prediction of actual plume concentrations within a factor as high as ten is probably a more realistic assessment for the short time average models (M.R. Beychok, 1979). Seemingly, small inaccuracies in the input data and assumptions can result in changing the plume concentration predictions of the Gaussian dispersion models by factors ranging from 6 to 80. Judicious use of the model however enables project planners and environmental engineers to avoid problems.

The model is not applicable for source receptor distances more than 10 kilometers. Ground plume concentrations at receptor locations lower or higher than the base of the source stack is approximated by adjusting the effective stack height to reflect the difference in terrain elevation.

Predicted H2S Ambient Ground Level Concentrations. The operating data used in the predictive modeling are given in Table IV.1. The prevailing wind direction, NE and SW, were based on the regional meteorological data taken from Ambulong, Batangas. Wind speed is assumed at 3 mps. The most prevalent stability

condition is slightly unstable condition.

The predicted ambient H2S concentration during the NE and SW winds using an average wind speed of 3 mps are given in Figures IV.1 to IV.2.

Results show that during slightly unstable atmosphere, predicted H2S levels exceed the DENR ambient H2S standard of 30 ug/scm up to downwind distances of 850 meters during SW winds and 980 meters during NE winds.

The slightly sloping terrain NE (slope of .026) of the project site shall cause impingement of the H2S plume during SW winds. Likewise during NE winds, the ascending receptor area causes high H2S concentration at the hillside of Mt. Mabilog.

Because of the complex terrain meteorology of Maibarara field, the probability of occurrence of the H2S levels given above are uncertain. Wind flow pattern may vary depending whether local winds or moderate to strong synoptic (prevailing) winds occur. Local winds result from the non-uniform heating of mountain/valley slopes. The worst possible condition that may occur when local winds prevail is when an inversion layer developed above the plume trapping the plume or causing inversion breakup (fumigation). For strong to moderate synoptic winds, the worst possible condition may occur when the wind speed is higher than the gas exit velocity forcing downwash of pollutants to nearby residences.

IV.2.4 H2S Effects

Odor threshold values of H2S range from 0.007 (9.71 ug/scm) to 0.03 ppm (41.61 ug/scm, Hartley). Complaints of nausea, headache and sinus congestion have been reported from chronic exposure to H2S levels greater than 0.1 ppm (138.7 ug/scm). Comparing the values sited above with the DENR ambient H2S standard of 0.02 ppm (30 ug/scm), it is concluded that the H2S odor (similar to that of a rotten egg) can already be detected at the DENR limit. DENR ambient standard, however, is well below the 0.1 ppm value which may cause physical illness.

The major air quality problem associated with geothermal power development has been the nuisance caused by the odor of the H2S gas. Predicted ambient H2S values (Figures IV.1 to IV.2) show that H2S odor can be detected up to 1 km radial distance from the

proposed power plant during slightly unstable conditions. H_2S odor is expected to be frequently felt at Sitio Capus of Brgy. San Rafael though the H_2S levels are well below the level (0.1 ppm) that may cause physical illness.

Normally, routine H_2S emissions from generating geothermal power plants are not expected to be high enough to cause damage to plants and crops. The concentrations of H_2S that cause injury to vegetation are far in excess of the concentrations that are readily obnoxious or injurious to human beings.

IV.2.5 Noise

Noise levels during construction shall vary depending on the site activities. Transport of materials to the site by heavy trucks may reach up to 90 dB(A) disturbing the populace living near the access road. Impulsive noise shall also be of high proportion at the project site. However, construction noise is only temporary which will last up to 16 months.

If the noise level 100 m from the project site is 65 dB(A), residential areas should be relocated 400 meters away from the plant site to meet the DENR noise standard at daytime (55 dB(A)).

The noise generated by the powerhouse may affect the residents of Sitio Capus. The nearest house at the project site is less than 300 meters. Other residences are scattered around at a distance less than 1km.

IV.2.6 Air Quality Mitigating Measures

During the project construction phase, dirt roads in front of residences should be watered whenever necessary to minimize dust suspension from passing motor vehicles and to keep ambient dust levels within acceptable levels. During project operation, access roads should be asphalted or concreted.

Although predicted ambient H_2S levels are much lower than those shown to produce chronic health impacts, relocation of the residents within a one-km radius of the proposed power plant is strongly recommended to protect the sensitive population, the young and very old, from noise, and chronic low level ambient levels and occasional high level exposures during emergencies or unfavorable weather.

Periodic air quality monitoring will be undertaken during the operational phase of the Maibarara Geothermal Power Project to document and assess any air quality changes within the project area. Table IV.2 presents the air quality monitoring program.

Occupational noise and H2S exposure levels of personnel should be closely monitored. In-place continuous are H2S monitors with audible alarm should be installed to prevent acute H2S exposures within and outside plant buildings. Noise "refuges" should be provided, if necessary. The plant ventilation system should be provided a standby H2S gas filter (such as activated carbon) for use during abnormal weather conditions such as inversions that do not allow atmospheric dispersion of H2S emissions and may result in abnormally high ambient H2S concentrations.

IV.3 Hydrology/Water Quality

IV.3.1 Construction Phase

Site clearing and earth moving works for the construction of power plant and its facilities could cause localized soil erosion and sedimentation of Siam-siam River and adjacent creeks.

At the Maibarara field, spoils which may be produced during site leveling and excavation will be backfilled in low lying areas away from the drainage routes. Similarly, sewage and domestic wastes will be generated by construction workers and, if not properly disposed of, may eventually end up in Siam-siam River and streams/creeks near the project sites thereby increasing turbidity and cause sedimentation.

To mitigate these adverse effects, Civil Works Guidelines (Table IV.3) will be enforced by the Civil Works Committee to contractors and sub-contractors. The committee will be responsible for the site selection, establishment and maintenance of spoils disposal areas, garbage landfills and sedimentation ponds.

Vegetative stabilization measures, terracing of cut and fill slopes, and replanting will be implemented as soon as practicable to open areas and slopes exposed during construction. The immediate vicinity not affected by plant construction will be likewise stabilized to prevent these areas from the direct impact of heavy

rains, thus, minimizing soil erosion.

Excavation will be of short duration and will be moderately significant only during construction.

IV.3.2 Operation Phase

Liquid wastes that will be generated in the operation of the Maibarara Geothermal Power Plant are cooling tower blowdown, laboratory wastes, rainfall run-off, sewage effluents, and geothermal well water containing large quantities of chloride, sodium, potassium, high levels of boron, silica, arsenic and sulfates but relatively low in iron and mercury.

Solid wastes will comprise mainly of garbage and refuse from regular maintenance activities, including the sludges and machinery scales. Except for the cooling tower sludge and machinery scales, solid wastes will be hauled and properly disposed at designated garbage dump site.

Cooling tower blowdown will be contained in a thermal pond and reinjected into the geothermal reservoir. Reinjection is considered the most environment-friendly wastewater disposal in geothermal fluid utilization. This method will minimize subsidence and cushion reservoir pressure reduction that accompanies fluid withdrawal from the geothermal reservoir. However, during occasional over capacity of thermal pond or breakdown of the reinjection system, controlled discharges of cooling tower blowdown to nearby surface water maybe resorted to according to effluent limits prescribed by DENR.

Accumulated sludge in the cooling tower is removed once a year during the periodic maintenance shutdown. Cooling tower sludge contain significant amounts of Hg, As, Cr, Cd, Ag and Pb, hence, requires special handling to prevent the possibility of groundwater contamination. Similarly, machinery scales removed from equipment in contact with geothermal steam contain significant amount of Hg, As, Cr, and Pb.

The cooling tower sludge, machinery and pipeline scales, and laboratory wastes will be mixed with a suitable proportion of cement to capture the wastes within the solid structure. The solidified waste will then be stored in a secured toxic waste repository.

Rainwater shall be discharged to drainage canals while domestic wastes shall be diverted to a septic tank.

Since project wastewater will be injected back into the reservoir through Maibarara Wells #4 and #8, no significant water quality deterioration of Siam-siam River or any other surface water is expected.

Pre-operational and regular operational water quality monitoring of rain, ground, surface and waste waters shall be implemented to ensure that the DENR standards are not violated and to monitor the effectiveness of pollution control devices. Table IV.2 presents the water quality monitoring program for Maibarara Geothermal Power Project.

IV.4 TERRESTRIAL ECOLOGY

IV.4.1 CONSTRUCTION PHASE

During construction activities like ground cover clearing and levelling direct loss of vegetative cover at 1.2 ha proposed plant site will occur. Ecologically this impact is minimal since the affected area is a small agricultural land characterized by low species diversity of flora and fauna. Economic loss, however, will result due to decreased hectarage of croplands. Increased levels of noise due to increased heavy equipment and vehicular traffic would also drive away wildlife particularly birds to relocate to undisturbed areas. After plant construction, revegetation of the project site and its environs either through landscaping, afforestation and reforestation would be implemented in order to improved ecological conditions in the area. This would also provide habitat and refuge for displaced wildlife species.

IV.4.2 OPERATION PHASE

Hydrogen sulfide (H_2S), the major gaseous pollutant from geothermal power plant operation, could affect growth and productivity of vegetation crops especially those found around the proposed plant site. Fast growing plants (particularly crops species) rapidly accumulate sulfur and are more susceptible to the pollutant than slow growing plant forms like trees (Appendix). The predicted maximum short term ambient H_2S concentration as a result of MGPP operation (Air Quality Module) are below levels which could cause acute effects on vegetation. Monitoring of

important crops species will be implemented during operation phase of the project and special studies will be conducted to determine if long term exposure to low levels of pollutant would have cumulative and synergistic effects over time. This study would include assessment of leaf injury symptoms, number and distribution of plant species, chlorophyll content in leaves and percentage of photosynthetically active leaf area over different pollution gradients.

Finally NAPOCOR will initiate rehabilitation of denuded portions of Mount Makiling Reservation near the plant site. Coordination with the University of the Philippines at Los Banos (UPLB) College of Forestry, which is tasked with administering and managing Makiling Forest, will be done in order to provide framework for the management and administration of Makiling Forest. Emphasis on the following activities will be made:

1. Information campaign drive to educate and build public awareness on needs and importance of forest resource conservation and utilization.

2. Information dessimination to upland farmers on methods of effective soil conversion and erosion control like building of interceptor canals, soil traps and check dams as well as planting of erosion control hedgerows.

3. Implementation of reforestation program using forest and agroforest species that would not only serve for erosion control but also act as source of charcoal, leafmeal, fruits and timber.

4. Establishment of nurseries and seedling distribution system that would complement the reforestation of denuded areas.

IV.5 Aquatic Ecology

IV.5.1 Construction Phase

During the construction phase of the project, short-term impacts such as sediment loading as a result of civil works may lead to eutrophication and increased turbidity of the river system and affect the aquatic environment within the vicinities of the project site. Clearing and earthworks for power plant, routes of pipelines and other areas can enhance soil erosion and

thus increase sedimentation in the river especially during heavy precipitation.

The major effects of increased sediment loading on aquatic organisms include:

1. decrease in the photosynthetic activity of phytoplankton due to less light penetration caused by sediment-laden waters,

2. disruption of physiological processes such as feeding, reproduction and behavioral activities of benthic dwelling organisms due to increased amount of suspended solids in the water, and

3. decrease in diversity index with a consequent dominance of sediment-loving (mud tolerant) organisms.

These effects would, however, be temporary as conditions would stabilize after the completion of plant construction activities. Moreover, proper land management and strict erosion control measures (see Geology and Pedology Module) during construction activities will be implemented to lessen, if not preclude the occurrence of the aforementioned impacts.

IV.5.2 Operation Phase

During operation phase of the project wastewater in the form of spent brine from the steam separators will be generated and subsequently must be disposed of. This wastewater brine contains heavy metals notably mercury (Hg), zinc (Zn), arsenic (As), cadmium (Cd) and lead (Pb) which could be toxic to aquatic organisms. Factors that determine the toxicity of these heavy metals in water are their concentration, solubility and chemical or physical forms in the effluent. Toxicity effects of heavy metals vary from inhibition of photosynthetic activity of phytoplankton to death of other organisms.

In view of this, reinjection of as much wastewater brine will be implemented in order to prevent contamination of Siam-Siam River. If wastewater brine has to be disposed to river system during emergency conditions these will be diluted with freshwater in order to prevent high concentrations of pollutants in the water. Construction of adequately-sized

sedimentation ponds and sumps will be made to impound geothermal effluents and preventing overflows in case of failure of reinjection system and very heavy rainfall.

Aside from maintaining effluent levels within the standards set by the Department of Environment and Natural Resources (DENR) and other measures to limit contamination of the aquatic environment, a bi-annual monitoring program must be undertaken to be able to assess the long-term effects of the project. Studies that will be implemented will include evaluation on the variations in species composition, abundance and distribution as well as analysis of aquatic flora/fauna and sediments to determine levels of bioaccumulable heavy metals.

IV.6 Socioeconomics and Land Use

IV.6.1 Displacement of Population

A total of 16 households were identified to be located in the vicinity of the power plant which will be affected by H2S emission once the plant becomes operational. To prevent their exposure to possible health and safety risks, these households will have to be relocated. The relocation of the 16 households will be enforced before construction commences so as to avoid unnecessary technical delays and to prevent the incursion into the PIZ of unscrupulous individuals who may take advantage of the benefit package NAPOCOR will offer to project-affected residents.

Prior to project construction, NAPOCOR shall promote awareness of the project among residents of surrounding barangays through dialogues and other information dissemination campaign programs.

Since the 16 would-be affected households will be relocated prior to construction, NAPOCOR, in consultation with the would-be-affected families, shall identify and acquire a resettlement site beforehand. Initial land development and the construction of essential community facilities and/or utilities would, likewise, be under- taken by the same.

Two (2) resettlement schemes would be offered to the would-be-affected households: they could either relocate on their own or in the NAPOCOR designated

resettlement site. Resettlement Incentive Assistance (RIA) shall be provided for these households to enable them to reconstruct their houses and to help tide them over while adjusting to their new life. Compensation will be given for houses/structures that would be affected by the project. Qualified members of the households that would be displaced would be given priority employment in the project.

IV.6.2 Conversion of Agricultural Land to Industrial Use

To accommodate the construction of power plant and its associated facilities, approximately 3 hectares of agricutural land will have to be acquired by NAPOCOR.

To mitigate this debilitating impact, the resettlement program that will be formulated shall provide for the following: The resettlement site to be acquired by NAPOCOR shall have potential livelihood opportunities and shall be suitable for physical development. Sizeable arable land shall be made available to replace those that will be affected by the project. If this is not feasible, just compensation shall be given to affected landowners based on fair market values agreed upon by NAPOCOR and the real property owners. Crops and improvements shall also be compensated based on existing provincial schedule of values.

IV.6.3 Migration of Construction Workers

During the construction phase of the project, there will be an expected gradual but continuous migration into the PIZ of professional/technical and skilled workers who will be hired by project contractors.

However, once the project is finished, the number of these migrant workers will be greatly reduced since only about thirty (30) will be needed to operate the power plant.

IV.6.4 Increase in Employment Opportunities

The construction phase of the project is expected to last for 17 months and during this period, about 100 workers will be directly involved in construction activities. With the imposition of NAPOCOR's policy on local hiring to project contractors, many of the PIZ's and the Study Area's unemployed able-bodied male population will be hired for jobs not requiring skilled manpower.

After the 15 MW binary cycle geothermal power plant becomes operational, the number of workers will be reduced and only about 30 percent of the original workforce will be retained.

IV.6.5 Multiplier Effect on Employment and Manufacturing

The upsurge in employment opportunities during construction and the subsequent increase in income in the Study Area will induce a multiplier effect in the wholesale/retail trade sector. Variety stores, small eateries, and inexpensive evening entertainment spots are expected to proliferate in the PIZ as well as in the poblacion of Sto. Tomas.

Project construction will, likewise, create a multiplier effect on the manufacturing sector, particularly in industries engaged in the manufacture of products needed in construction, such as iron/steel, cement, and structural concrete products.

IV.6.6 Increase in Housing Demand

The need to house migrant workers during project construction may prompt contractors to construct temporary quarters for the workforce. Other workers, however, may rent rooms or houses in the area. This will create a demand for housing in the PIZ. As a result, enterprising residents may construct extensions or additional rooms, or build small houses to capture this temporary market.

IV.6.7 Foreign Exchange Savings

Power generation necessitates the piling up of import bills because a large number of existing power plants use imported fuel oil. Maibarara GPP, on the other hand, will be using indigenous geothermal steam and will be generating an annual output of 107 GWH; to duplicate this capacity, a diesel plant will require 24 M liters of fuel oil which will cost P94.5M*. The operation, therefore, of Maibarara GPP will substantially reduce the consumption of expensive fuel

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* Based on September 1990 level

oil and consequently bring about considerable savings in badly needed foreign exchange.

IV.6.8 Increase in Luzon Grid Power Supply

Power that will be generated by Maibarara GPP will be added to the Luzon Grid. This is expected to augment existing supply of electricity to meet the ever increasing domestic and industrial demand in the island.

IV.7.1 Public Health Impacts

IV.7.1.1 Construction Stage

The operation of heavy equipment and transport of construction materials may increase the ambient noise level and dust generation in the vicinity of the project site, particularly in Sitio Capuz, Barangay San Rafael in Sto. Tomas, Batangas and in Puting Lupa in Calamba, Laguna.

The unpaved road going to the project site will be dusty during the dry season due to the passing of heavy equipment vehicles. The dust and noise that will be generated will create nuissance to the residents.

A small construction workforce may be generated by the project. Although housing is provided by contractors to their workers, it has been observed that some workers still look for alternative housing in the surrounding communities. These migrant construction workers might bring new diseases which are not common to the community.

The overcrowding of temporary dwellings with poor and unsanitary conditions will possibly enhance the occurrence and spread of diseases. Gastrointestinal infections brought about by unsanitary conditions are the potential causes of morbidity in the area during the project construction phase.

IV.7.1.2 Operation Phase

The major impact of geothermal power plant operation is the release of H_2S in the environment.

Hydrogen sulfide is a toxic gas with a very offensive odor which human nose can detect to as low as 0.002 ppm. The median odor perception threshold is estimated

to be 0.005 ppm. From a public health standpoint, odor annoyance is the primary effect of H2S emissions. However, there are suggestions that chronic exposures to low levels of H2S may produce other health effects, such as headaches, sinus congestion, abrupt weakening, etc.

On the other hand, sulfur dioxide has been observed to cause irritations in the respiratory tract. Morbidity in man have been observed after a 5-min exposure to SO2 concentrations of about 1.0 ppm, and at concentrations of about 0.015 ppm, ill effects have been reported after about 1-year exposure.

Although it is well known fact that the presence of H2S and SO2 in the ambient air have effect on the respiratory system of humans, and although health data collected show that the leading cause of morbidity in the area is respiratory or respiratory-related infection, H2S and SO2 emissions from the power plant operations cannot be directly said to aggravate existing respiratory disease and pinpointed as the cause. The baseline data may however, initiate efforts from the concerned agencies to try to correlate public health with the emission from natural geothermal spring.

From the air quality module, the predicted H2S and SO2 concentration the from the proposed plant will not violate the DENR ambient air quality limits. However H2S odor can be detected up to 1-km radial distance from the plant.

The predicted noise level 100-m from the project site will exceed the NPCC noise limits for residential areas. The nearest residence is located 100-m from the proposed site. However, the center of the populace in Sitio Capuz and Barangay Puting Lupa are located more than 500m from the proposed plant. The slight increase in the background noise level will not cause significant health effects.

Frequently exposed areas are Sitio Capus and Barangay Puting Lupa.

The leading causes of morbidity and mortality in the study area are expected more or less the same.

IV.7.2 Mitigating Measures

To prevent the potential outbreak of disease in the DIA during construction, the Department of Health will be requested by NAPOCOR to implement a health program aimed at promoting sanitary practices, among others. In addition, the contractors will be required to provide construction camps with adequate sanitary waste disposal facilities.

To minimize dust suspension from passing motor vehicles, dirt roads in front of residences should be watered whenever necessary to keep ambient dust levels within acceptable levels. During project operation, access roads should be asphalted or concreted.

To reduce H2S emission, the NCG from the gas extraction system shall be ducted to the cooling towers to dilute the out-going gas stream and increase the effective height of release.

To minimize the noise level at the source silencers and mufflers shall be installed in the plant.

Relocation of houses within 100-m from the proposed plant will be made to minimize public exposure to noise and H2S gas.

To determine the extent of MGTPP's impact on public health, an annual health survey shall be conducted in the study area.

Table IV.1

OPERATING PARAMETERS USED IN THE PREDICTION OF AMBIENT H2S CONCENTRATION AT THE PROPOSED MAIBARARA GEOTHERMAL POWER PLANT

Maibarara GPP EIS: May 1992
(Meteoroloy/Air Quality)

Plant Capacity	10 MW
Steam Composition (weight percent):	
Steam	98.25
NCG	1.75
NCG Composition:	
H2S	0.74
CH4	0.007
CO2	98.248
O2	0.007
N2	0.355
NH3	0.678
Steam Requirements	77,477.0 kg/hr
H2S Releases	7.29 kg/hr
Cooling Tower Data:	
Height	5.54 m
Diameter	1.545 m
Gas Velocity	8.3 mps

Table IV.2

Recommended Environmental Monitoring Program for
Maibarara Geothermal Power Plant Project

Maibarara GPP EIS: May 1992
(Meteorology/Air Quality)

Parameter	Method	Frequency	Stations
AIR			
H2S	Jerome Analyzer or gas bubbling for 30 min and 24 hour sampling	Quarterly	Project Site Well Pad No. 9 & 11 Well Pad No. 5 & 6 Sitio Capus, Brgy. San Rafael Brgy. Pulang Lupa
	Lead Acetate tabs	Weekly	100 to 200 m from the cooling tower of Maibarara plant sites Maibarara plant site Sitio Caopus, Brgy. San Rafael
SO2	Gas bubbling for one (1) hour sampling	Quarterly	Same stations as H2S
Air Particulates	High Volume Sampler	Quarterly	Same stations as H2S
Noise	Noise meter	Quarterly and at different plant operations such as start-up, shutdown, low load operation and full load operation	All plant sites and at 100, 200, 500 and 800 m from the plant site

FN: IV2.WR1/10cpi
PCES-05/18/92

Table IV.2

Recommended Environmental Monitoring Program for
Maibarara Geothermal Power Plant Project

Maibarara GPP EIS: May 1992
(Meteorology/Air Quality)

Parameter	Method	Frequency	Stations
WATER			
River Water			
pH, temp., turbidity, conductivity, DO, Chemical Analysis (TDS, TSS, nitrates, PO4, alkalinity, Cl, sulfates) Trace Elements (As, Hg, Pb, Cr, Cd, B, Cu, Ca, Zn, Fe, K, Na)	In-Situ and Laboratory Measurements	Quarterly	Siam-Siam River Talon Falls
Groundwater			
pH, temp., turbidity, conductivity, DO, Chemical Analysis (TDS, TSS, nitrates, PO4, alkalinity, Cl, sulfates) Trace Elements (As, Hg, Pb, Cr, Cd, B, Cu, Ca, Zn, Fe, K, Na)	In-Situ and Laboratory Measurements	Semi-Annual	Spring water (source of drinking water of Sitio Capus residents)
Rainfall			
pH, SO4, and trace elements	In-Situ and Laboratory Measurements	Monthly	Plant Site Pulang Lupa Sto. Tomas, Batangas (access road to plant site, near highway)

FN: IV2.WR1/10cpi
PCES-05/18/92

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Table IV.3

CIVIL WORKS GUIDELINES TO PREVENT OR MINIMIZE WATER POLLUTION AT POWER PLANT CONSTRUCTION SITES

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

Whereas power projects are carried out to generate electricity and thereby help improve the people's economic status and their quality of life, power projects shall be undertaken without undue environmental degradation. Power plant site preparation and civil works involve the establishment of a worker's colony, quarry and borrow areas, material storage and construction of access roads and site excavation, clearing/grading. Such activities, if not properly managed and undertaken could pose a risk to water quality from soil erosion, improper handling/management of potentially pollutive materials, wastewaters and solid wastes, and the introduction of pathogens in water bodies.

The Civil Works Committee hereafter referred to as Committee will be responsible for the enforcement and implementation of these Civil Works Guidelines. The Committee will be composed of one or two representatives each from the NAPOCOR Environmental Management Department (EMD), the Engineering Project Management group, and each contractor and subcontractor. The Committee members will elect among themselves the Chairman, Vice-Chairman and Secretary of the Committee. The Committee shall also be responsible for access road planning as well as the site selection, establishment and maintenance of spoils disposal areas, garbage landfills, sedimentation ponds, and oil-water separator, if any. The Committee will convene monthly or as often as needed to plan and discuss implementation of environmental protection measures for the project site. Copies of the minutes of these meetings will be submitted to the respective managers of the Project (NAPOCOR and contractor's side) and the Environmental Impact Assessment Division (EIAD) of EMD.

To prevent or minimize water pollution at/around power plant construction sites, the following guidelines shall be implemented:

1. Access and site roads shall be planned, aligned and constructed such that landslides and erosion are guarded against and minimized.

2. As far as practicable, site stripping and grading, excavations and road cutting should be undertaken during dry weather.

Table IV.3

CIVIL WORKS GUIDELINES TO PREVENT OR MINIMIZE WATER POLLUTION AT POWER PLANT CONSTRUCTION SITES

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

3. Worker camps, batching plants, warehouses and equipment yards shall be sited away from river banks and provided with adequate and properly designed drainage channels.

4. Identify areas with high slide/erosion risks and institute mechanical and biological control measures to prevent siltation of surface waters.

   Mechanical procedures include the establishment of stable fills, compacting of loose soils/slopes, rounding of corners, and protecting of slopes along river banks with rock or wood support, riprap or revetments. Biological control includes the maintenance of vegetation buffers to shield streams/rivers from sedimentation and the planting of vegetative cover over erodible surfaces.

5. Vegetative stabilization measures (such as sodding of grass, planting of creeping vines, herbs, shrubs and trees) will be implemented as soon as practicable on open areas especially slopes not affected by plant construction to protect areas from the direct impact of strong rain resulting in heavy surface run-off and formation of numerous small gulleys, and soil erosion. Shallow-rooted species such as grasses, herbs or creepers shall be introduced immediately to provide ground cover to open slopes/surfaces.

6. The destruction of vegetative cover especially cutting of existing trees shall be minimized and revegetation of disturbed areas shall be immediately undertaken.

7. Cut and fill slopes shall be terraced if needed and stabilized or protected by reasonable grading and proper draining. Fill slopes and spoil heaps shall be kept out of drainage routes. Spoil heaps shall be removed and properly disposed of as soon as practicable.

8. Avoid areas of unstable ground, if possible, or excessively erodible soil unless erosion control measures can be adopted.

9. Preserve natural drainage patterns, if practicable, or replace them (when disturbed by civil works) with suitable drainage channels.

Table IV.3

CIVIL WORKS GUIDELINES TO PREVENT OR MINIMIZE WATER POLLUTION AT POWER PLANT CONSTRUCTION SITES

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

10. Stripped top soil, spoils from quarry and borrow sites, and excavated materials must be properly stockpiled (and covered from rain if possible) for restoration activities or hauled to properly constructed dump sites provided with suitable drainage equipped with sediment traps.

11. Refrain from opening unnecessary areas or indiscriminately cutting trees and other vegetation for fuel or other purposes.

12. Barriers should be established along contours from upper to lower slopes of the project area to slow down flow of surface runoff, and to trap the washed out soil particles.

13. Solid wastes such as empty cement sacks, scraps of tin or wood, used wires, domestic garbage, etc. shall be properly classified for recycling or collected and/or hauled to designated disposal areas (landfill) for burying.

14. Construction safety measures and good housekeeping as well as proper inventory, storage, handling and use of potentially hazardous or pollutive materials/chemicals shall be implemented.

15. Wastewaters from workshops, showers, laundry, sinks and mess halls and storm drains shall be provided with adequately sized sedimentation basins or sediment traps to ride the water of suspended solids prior to discharge.

16. Oil-contaminated wastewaters from workshops, garages or gas filling stations shall be passed thru an oil trap (improvised oil water separator) prior to discharge.

17. Construction camps shall be provided with adequately designed and maintained conventional sanitation systems such as lavatories, showers, urinals and toilets with standard septic tanks provided with blind drains isolated from surface waters.

18. There shall be health screening of the workforce and medical treatment facilities for sick workers. Workers with communicable diseases shall be sent off site for treatment or

Table IV.3

CIVIL WORKS GUIDELINES TO PREVENT OR MINIMIZE WATER POLLUTION AT POWER PLANT CONSTRUCTION SITES

Maibarara GPP EIS: May 1992
(Hydrology/Water Quality)

properly treated and quarantined to avoid contamination of surface waters, other workers or the public.

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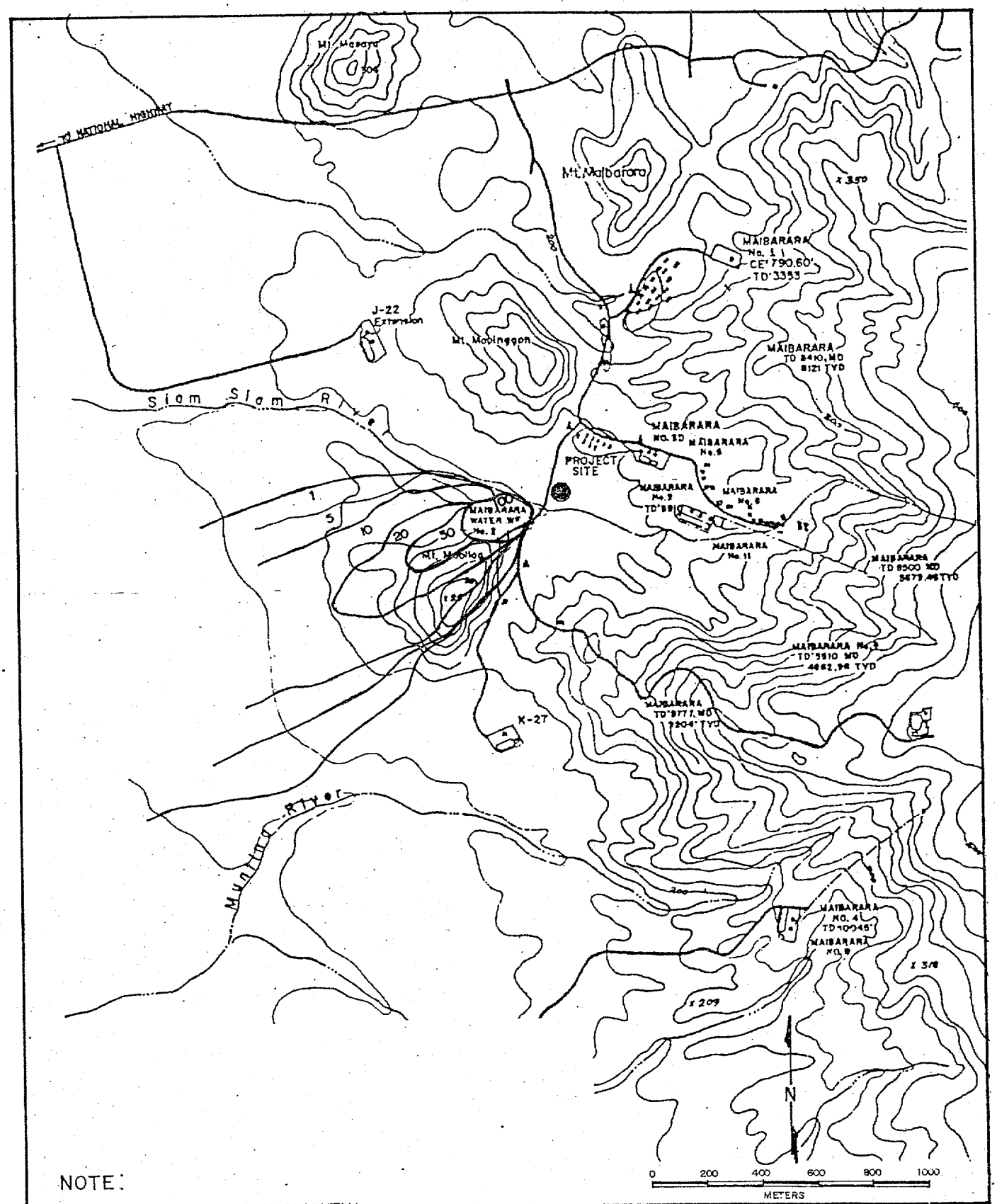


NOTE:

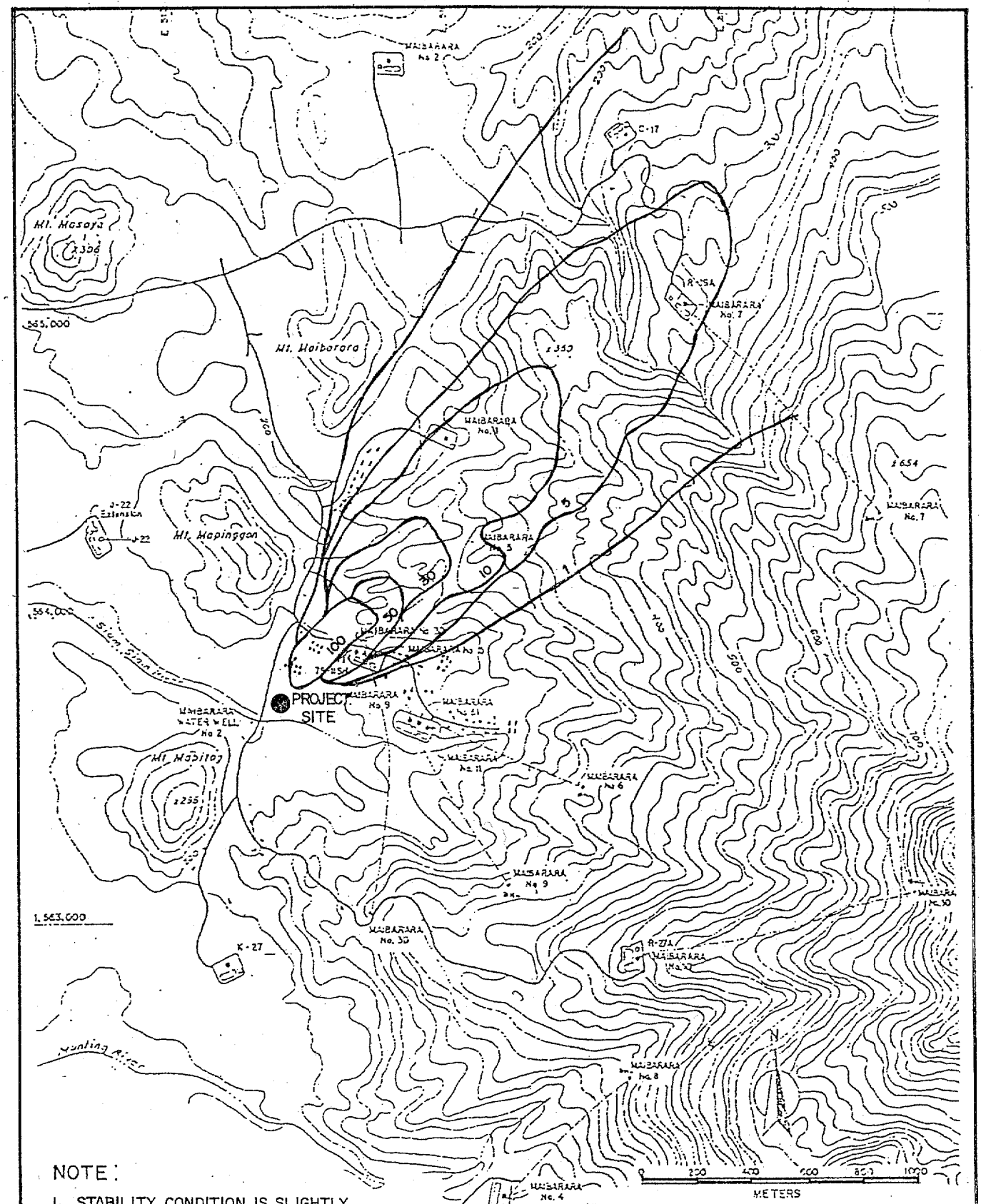
1. STABILITY CONDITION IS SLIGHTLY UNSTABLE
2. WIND SPEED IS 3mps
3. DENR STANDARD FOR H_2S IS 30 ug/scm.
4. SEE TABLE IV.1 FOR OPERATING DATA USE IN THE MODEL.

NATIONAL POWER CORPORATION

FIGURE IV-1

PREDICTED AMBIENT H_2S GROUND LEVEL CONC. DURING N.E. WINDS, ug/scm.

MAIBARARA GPP EIS: MAY 1992
(Meteorology/Air Quality)



NOTE:

1. STABILITY CONDITION IS SLIGHTLY UNSTABLE
2. WIND SPEED IS 3mps
3. DENR STANDARD FOR H_2S IS 30 ug/scm.
4. SEE TABLE IV.1 FOR OPERATING DATA USE IN THE MODEL.

NATIONAL POWER CORPORATION

FIGURE IV-2

PREDICTED AMBIENT H_2S GROUND LEVEL CONC. DURING SW WINDS, ug/scm

MAIBARARA GPP EIS: MAY 1992
(Meteorology/Air Quality)

Chapter V

Appendices

APPENDIX A

Abbreviations

AC	-	alternating current
ARI	-	acute respiratory infection
B/C	-	benefit-cost ratio
BFAR	-	Bureau of Fisheries and Aquatic Resources
BHS	-	Barangay Health Station
BTU	-	British Thermal Unit
°C	-	degree Celcius
cm	-	centimeter
CO		Carbon Monoxide
CO2	-	carbon dioxide
cu m	-	cubic meter
CVA	-	cardio vascular arrest
CWS	-	Community Water System
D	-	density
d	-	species diversity index
dB(A)	-	deciBel
DC	-	direct current
DENR	-	Department of Environment and Natural Resouces
DIA	-	Direct Impact Area
DOH	-	Department of Health
E	-	east
EIAD	-	Environmental Impact Assessment Division
EIRR	-	economic internal rate of return
EIS	-	Environmental Impact Statement
EMB	-	Environmental Management Bureau
EMD	-	Environmental Management Department
ENE	-	east-northeast
ESE	-	east-southeast
F/C	-	foreign component
g	-	gram
GT	-	gas turbine
GPP	-	geothermal power project
GWH	-	gigawatt-hour
ha	-	hectare
H2S	-	hydrogen sulfide
HC		Hydrocarbons
HFO	-	heavy fuel oil
HP	-	horsepower
HPN	-	hypertension
hr	-	hour
IH	-	Industrial Health
IHAS	-	Industrial Health and Abatement Section
J	-	joule
kg	-	kilogram
kJ	-	kilojoule
km	-	kilometer

KV	-	kilovolt
KVA	-	kilovolt-ampere
kW	-	kilowatt
KWH	-	kilowatt-hour
lb	-	pound
L/C	-	local component
li	-	liter
m	-	meter
masl	-	meter above sea level
mb	-	millibar
MCM	-	million circular mill
mg	-	milligram
ml	-	milliliter
mm	-	millimeter
MMT	-	million metric tons
mps	-	meter per second
MSLP	-	mean sea level pressure
MW	-	megawatt
N	-	north
Na	-	sodium
NAIA	-	Ninoy Aquino International Airport
NAPOCOR	-	National Power Corporation
NCG	-	non-condensable gas
NCSO	-	National Census Statistics Office
ND	-	not detectable
NE	-	northeast
NEPC	-	National Environmental Protection Council
NNE	-	north-northeast
NO2	-	nitrogen dioxide
NOx	-	nitrogen oxide
NPCC	-	National Pollution Control Commission
NPV	-	net present value
NSDW	-	National Standards for Drinking Water
O & M	-	operation and maintenance
PAGASA	-	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PDP	-	Power Development Program
PGI	-	Philippine Geothermal inc.
PIZ	-	Primary Impact Zone
ppm	-	parts per million
PTB	-	pulmonary tuberculosis
RH	-	relative humidity
RHU	-	Rural Health Unit
RPM	-	revolution per minute
S	-	south
scm	-	standard cubic meter
SE	-	southeast
SF6	-	sulfur hexafluoride
SO2	-	sulfur dioxide
SOx	-	sulfur oxide

sp	-	species
SPM	-	suspended particulate matter
sq m	-	square meter
sq mm	-	square millimeter
SSE	-	south-southeast
SSW	-	south-southwest
STN	-	station
ST/SC	-	steel tower single circuit
SW	-	southwest
T	-	ton
ug	-	microgram
umhos	-	micromhos
UPS	-	uninterruptible power supply
URTI	-	upper respiratory tract infection
US	-	United States
VDC	-	volt direct current
W	-	west
WNW	-	west-northwest
WSW	-	west-southwest
Yr	-	year

APPENDIX B

REFERENCES

B.1 PROJECT DESCRIPTION

1. System Planning Department. 1991. Power Development Program, NAPOCOR, Diliman, Quezon City.

2. Thermal Power Engineering Department, Bid Documents of 10 MW Geothermal Power Project, NAPOCOR, Diliman, Quezon City.

3. Thermal Projects Development Division. 1988. Feasibility Report of 20 MW Geothermal Power Project, NAPOCOR, Diliman, Quezon City.

B.2 GEOLOGY/TERRAIN/SOIL

1. Guidelines on Managing Hazardous Solid Wastes from PGI Facilities. December 1988. PGI, Makati.

2. Maibarara Feasibility Study Report. 1988. PGI, Makati.

3. Boweles, J.E.. 1967. Foundation Analysis and Design, 3rd Edition.

B.3 METEOROLOGY AND AIR QUALITY

1. Environmental Management Department. May 1988. Maibarara Geothermal Pilot Plant EIS, NAPOCOR, Diliman, Quezon City.

2. Joseph Kestin. March 1980. Sourcebook on the Production of Electricity from Geothermal Energy, Brown University, Rhode Island.

3. Kintanar, R.L.. March 1987. Climatological Data, National Institute of Climatology, PAGASA.

4. Pasquill, F.. 1974. Atmospheric Diffusion, John Wiley and Sons Inc., New York, USA.

B.4 HYDROLOGY AND WATER QUALITY

1. Maibarara Feasibility Study Report. 1988. PGI, Makati.

2. Otte, Carel and kruger, Paul. 1973. Geothermal Energy Resources and Production Simulation, Stanford University Press, Stanford, California.

B.5 TERRESTRIAL ECOLOGY

1. Alcala, A.C. 1986. Guide to Philippine Flora and Fauna (Amphibians and Reptiles) Natural Resources Management Center, Ministry of Natural Resources and University of the Philippines.

2. Borror, D. J. and White, R. E. 1920. A field guide to the insects north of America. Mifflin Co., Boston

3. Brown-Blanquet, J. 1932. Aims and Methods of Vegetation study. Springer-Verlag; Berlin

4. Brinchmann, E. et. al 1971. Ber. Deut. Bot. Ges: 84 523-524

5. Darley, E. F. 1966. J. Air Pollut. Contr. Ass. 16: 145-150

6. De Padua, L.S., G.C. Lugod and J.V. Pancho, 1978. Handbook on Philippine Medicinal plants: vol. 1-4 UPLB

7. Du Pont, J.E. 1971. Philippine Birds. Delaware Museum of Natural History: Delaware, USA.

8. Mansfield , T.A. (ed.) Effects of Air Pollutants on Plants. Cambridge University Press; England

9. Luettge, T. A. Plant Cell Physiology 13:505-514

10. Merill, E.D. 1912. Flora of Manila. Keystone Printing Press, Makati.

11. Mudd, J.B. and T. T. Kozlowski. 1975. Responses of Plants to Air Pollution. Academic Press New York.

12. Pancho, J.V. and S. R. Obien. 1983. Manual of Weed of Tobacco Farms of the Philippines. Philippine Tobacco Research and Training Center, Mariano Marcos State University: Batac, Ilocos Norte.

13. Pack, M. R., Hall, A. C. Thomas and L.G. Transtrum. 1959. Amer. Soc. Test. Mater. Spec. Tech. Publ. 282:27-44

14. Pandey, S. N. 1983. Impacts of Thermal Power Plant Emissions on Vegetation and Soil. Water and Soil Pollution. (1983) 87-100

15. Parker, H.W. 1977. Air Pollution. Prentice Hall: New Jersey

16. Rabor, D. S. 1977. Guide to Philippine Flora and Fauna. U.P. Natural Science Research Center: Diliman, Quezon City.

17. Rabor, D. S. 1977. Philippine Birds and Mammals. University of the Philippines Press: Quezon City

18. Rao, D. N. and F. Le Branc. 1966. Bryologist 69: 69-75

B.6 AQUATIC ECOLOGY

1. Davis, R. C.. 1955. Marine and Freshwater Plankton, Michigan State University Press, Detroit.

2. Fauchald, K.. 1977. The Polychaete Worms, Definitions and Keys to the Orders, Families and Genera, University of Southern California.

3. Needham, J. G. and P. R. Needham. 1962. A Guide to the Study of Freshwater Biology, Halden-Day. 108 pp.

4. Odum, E. P.. 1971. Fundamentals of Ecology. 3rd Edition. W. E. Saunders Co., Philadelphia.

5. Raymont, J. E. 1963. Plankton Productivity in the Oceans. Pergammon Press, Oxford, England.

6. Smith, G. M. 1950. The Freshwater Algae of the United States. London. 2nd ed.

7. Whitton, B. A. 1975. River Ecology. University of California.

B.7 SOCIOECONOMIC AND LAND USE

1. National Census and Statistics Office. 1980. Census of Population and Housing, Final Report, Laguna and Batangas Province.

2. National Statistics Office. 1990. Census of Population and Housing Report 2A (Population by Province/City/Municipality/Barangay).

B.8 PUBLIC HEALTH

1. Annual Health Reports, Rural Health Unit, Calamba, Laguna.

2. Annual Health Report, Rural Health Unit, Sto. Tomas, Batangas.

3. Honlon, John J. 1984. Public Health Administration and Practice, 8th Edition.

4. Last, John, M. 1986. Preventive Medicine and Public Health.