MACAÉ MERCHANT TPP

Environmental Impact Study

E I S

Volume 1

elpaso Energy International

ECOLOGUS
Engenharia Consultiva

October / 2000

EL PASO ENERGY INTERNATIONAL

MACAÉ MERCHANT THERMOELECTRIC PLANT

Environmental Impact Study

E I S

Technical Instruction IT Nº.1013/00 - FEEMA

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VOLUME 1

RELAÇÃO DE QUADROS E FIGURAS

1. INTRODUCTION

1 INTRODUCTION

This document comprises the Environmental Impact Study - EIS for the Macaé Merchant Thermoelectric Plant and corresponding Gas Pipeline to be constructed in the municipality of Macaé in the state of Rio de Janeiro.

The EIS was prepared in accordance with Technical Instruction IT N°.1013/00 issued by FEEMA, and is organized in two volumes. The first volume comprises eleven chapters, including the introduction, and the other volumes corresponding to the basic structure of the EIS. The second volume contains the appendices to the EIS. The contents of each chapter are described below:

- **VOLUME 1**

This Chapter 1 – INTRODUCTION – provides a guide for consulting the document.

Chapter 2 - CHARACTERIZATION OF THE PROJECT – describes the various aspects directly related with the developer and the project, highlighting the basic characteristics, objective and justification for the venture, technological and siting alternatives for the Macaé Merchant thermoelectric plant and gas pipeline. It also describes the location selected for construction, and the technical description of the plant and pipeline, detailing the different systems and components.

Chapter 3 - RELEVANT ENVIRONMENTAL LEGISLATION – presents an analysis of the principal legislative constraints on the study, the licensing process and environmental planning for the project, in addition to the constitutional structure of responsibilities and legal restrictions on the use and occupation of land and natural resources.

Chapter 4 - GOVERNMENT PLANS AND PROGRAMS – presents the plans and programs that define the context within which the project is inserted, from the point of view of government policy, considering from a sectorial point of view the Eletrobrás Ten-year Expansion Plan 2000-2009; from a regional viewpoint - the Integrated Environmental Management of MRA-5; and from the land use management aspect - the Municipality of Macaé Land Classification.

Chapter 5 - ENVIRONMENTAL DIAGNOSIS OF THE INFLUENCE AREA - synthesizes the studies performed on the physical, biotic and socio-economic environments, aimed at characterizing sensitivity aspects within the influence area, which enable the greater or lesser susceptibilities of these environments to the project impact factors to be evaluated.

Chapter 6 – EVALUATION OF POTENTIAL ENVIRONMENTAL IMPACTS - presents the methodology used in the evaluation, highlighting the description and classification of potential environmental impacts, followed by summary tables of the impacts and resulting prognosis on the environmental quality of the influence area, considering the cases of implementing the planned project or not.

Chapter 7 – MITIGATING MEASURES – lists the measures to be taken to mitigate or compensate adverse environmental impacts during the various stages of the project, starting from planning, passing through the implementation and operational phases of the project, up to deactivation.

Chapter 8 – ENVIRONMENTAL PROGRAMS – presents the guidelines to be adopted in environmental monitoring and management of the project, aimed at following up the effectiveness of mitigating measures incorporated into the project and its environmental performance, in addition to priority guidelines for establishing compensation programs and the regional insertion of the venture.

Chapter 9 – CONCLUSIONS – summarizes the principal conditioning factors that justify implementation of the project, and those that must be complied with to mitigate the adverse consequences to the environment resulting from planned construction. A conclusive balance is then made providing the basis for recommending adoption of the project.

Chapter 10 - TECHNICAL TEAM – introduces the team members who prepared this document, with their résumés and registration certificates with the "Federal Technical Registry of Environmental Protection Activities and Instruments".

Chapter 11 – BIBLIOGRAPHY – containing a list of all the geographic references used throughout the report.

- **VOLUME 2**

Volume 2 – APPENDICES – include the technical reports of the risk analysis and atmospheric dispersion studies, lists of species of fauna and flora that occur in the study area and noise modeling performed.

2. CARACTERIZATION OF THE PROJECT

2. CHARACTERIZATION OF THE PROJECT

In order to properly characterize the Macaé Merchant Thermoelectric Plant, the various aspects related with the developer and the project are described below, highlighting the basic characteristics, purpose and justification for the venture, technological and siting alternatives for the plant, plus the location selected for construction, in addition to a technical description of each unit, detailing the different systems and components.

Basically the project under study is composed of the following facilities:

- The Macaé Merchant Thermoelectric Plant
- The Dedicated Pipeline – UTE Macaé Merchant

2.1 THE DEVELOPER

The project and the resulting construction of the Macaé Merchant Thermoelectric Plant and the corresponding gas pipeline connecting with the PETROBRÁS unit at Cabiúnas, located close to the city of Macaé in the state of Rio de Janeiro, is the responsibility of the company EL PASO RIO CLARO LTDA, forming part of the EL PASO ENERGY INTERNATIONAL group.

EL PASO ENERGY INTERNATIONAL is a world leader in energy infrastructure, and provides design, procurement, operation and construction management involving all phases of the venture, from the conceptual design through construction, operation and maintenance. Its multiple experience in different fields of energy generation has made EL PASO ENERGY INTERNATIONAL one of the largest international investors in the natural gas industry, taking part in 28 energy projects located over the five continents, including 7,252 kilometers of gas pipelines and more than 7,000 MW of power generated.

EL PASO ENERGY INTERNATIONAL has successfully developed projects in Argentina, Australia, Chile, China, Czech Republic, Hungary, Indonesia, Korea, Mexico, Pakistan, Peru and United States. In terms of installed power capacity, EL PASO ENERGY INTERNATIONAL has now reached the impressive figure of 7,025 MW in operation, 1,746 MW under construction and 11,000 MW at the design stage, including the installation of around 7,252 kilometers of gas pipelines, distributed as follows:

- **In the Americas**: generation of 4,945 MW, 3,960 km of gas pipelines and reserves involving 95MMBbl of oil and 1,037 Bcf of natural gas reserves/gas treatment installations;
- **In Europe**: generation of 944MW;
- **In Australia**: 3,252km of pipelines;

- **In Asia**: generation of 1,154MW, 40km of gas pipelines and reserves or 533 Bcf of natural gas.

Founded in 1928, EL PASO ENERGY CORPORATION is a totally integrated energy company, taking part in all segments of the energy chain. EL PASO CORPORATION installations cross North American via more than 400,000 miles of natural gas transmission pipelines in operation.

With assets worth more than US$16 billion, EL PASO ENERGY CORPORATION supplies solutions for energy problems through its strategic business unit: Tennessee Gas Pipeline Co., El Paso Natural Gas Co., Southern Natural Gas Co., El Paso Merchant Energy Co., El Paso Energy International Co., El Paso Field Services Co., and El Paso Production Co. In January 2000, EL PASO ENERGY announced an agreement to merge with The Coastal Corp.

The registration data of the company responsible for the project are the following:

Name: El Paso Rio Claro Ltda.
Address: Praia de Botafogo, 440/14th Floor – Botafogo – Rio de Janeiro – RJ
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Responsible: Roberto Almeida

2.2 OBJECTIVE AND JUSTIFICATION OF THE PROJECT

2.2.1 OBJECTIVE OF THE PROJECT

The principal objective of constructing the Macaé Merchant Thermoelectric Plant is to increase guaranteed supplies of electric power to the state of Rio de Janeiro and Espírito Santo, principally when considering that the north of the state of Rio de Janeiro and the entire state of Espírito Santo, although they are integrated with the Brazilian unified grid, are positioned in such a way that they depend on only one supply branch, with only slight possibilities of being served by any other source if this branch is damaged.

Due to this real possibility, the state governments have made efforts to increase local power generation, providing incentives for the installation of thermoelectric plants in the regions, thus increasing the degree of reliability of supply by the utilities attending to the region (LIGHT, CERJ and ESCELSA). The installation of the Macaé Merchant Thermoelectric Plant is located within this context, and is planned to generate around 700 MW under the open market system.

2.2.2 JUSTIFICATION FOR THE PROJECT

As has been widely divulged, the possibilities of electricity rationing in Brazil have increased day by day, as increasing demand is suppressed more and more due to the inability of the state to make available the necessary funds to construct plants at the speed necessary to satisfy demand. Therefore the backlog will tend to increase over the coming years unless alternative measures are taken to satisfy the announced deficits. The deficits are not a result of a transmission crisis, as occurred in 1986, but lack of generating capacity, which considerably aggravates the problem.

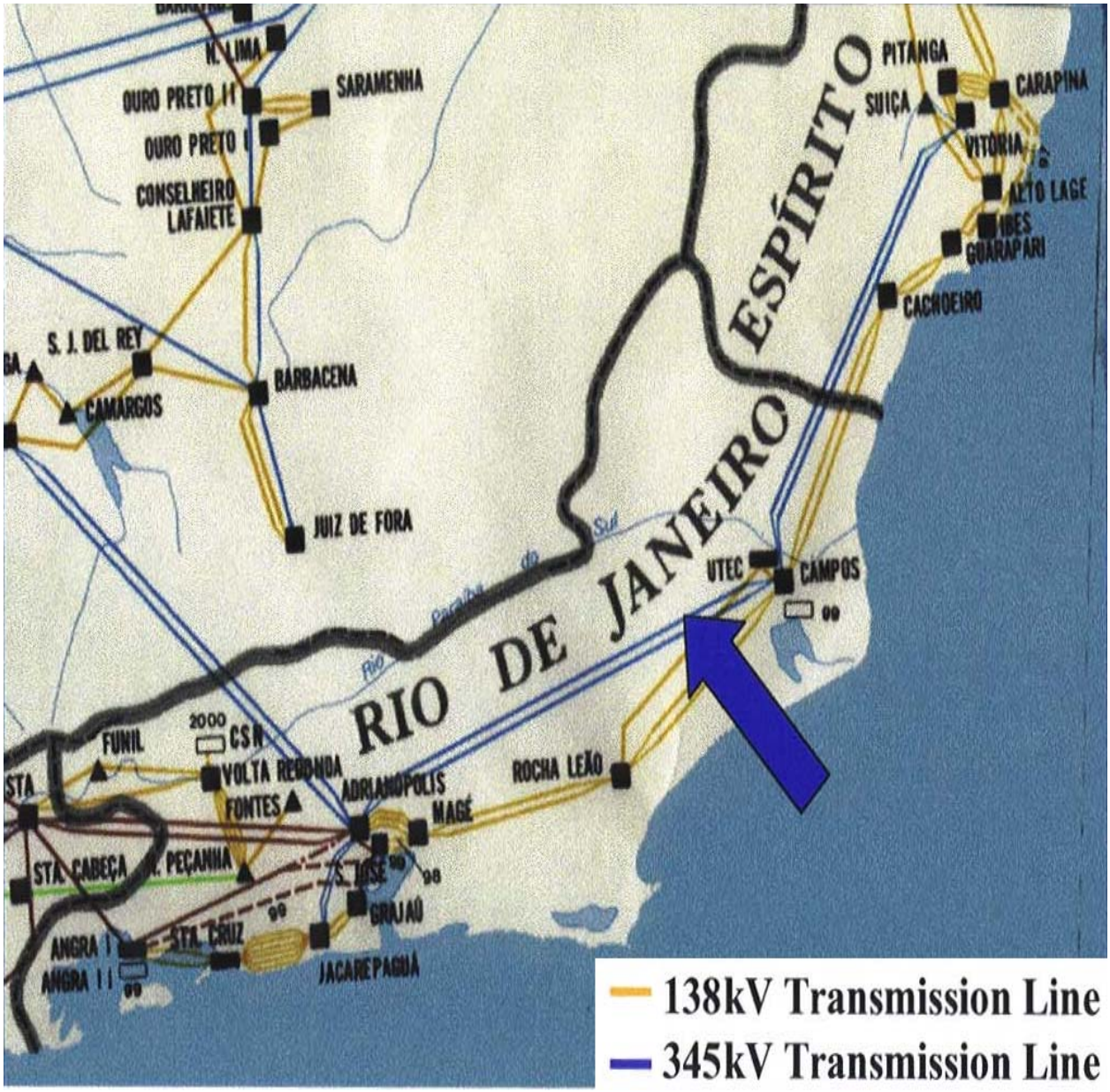
Added to this scenario, we have the progressive privatization of the economy as a result of adopting the neoliberal "Minimum State" model, which leads to believe that the responsibility for satisfying the energy demand will be in the hands of private enterprise much more than federal or state governments. Therefore the situation evolving is to adopt a competitive market model, in which the sale of energy by those offering to produce it will be common.

In addition, it is important to record the sustainable development assumptions envisaged in Agenda 21, in other words that environmental issues become fundamental when installing any large-scale project that could any way affect the environment. In this respect, it should be mentioned that the absolute dominance of the hydroelectric generating model will tend to decline over the coming years, as the environmental issues involved in flooding large areas lead to more complex and costly solutions.

However technological alternatives are now available that indicate the possibility of solving the deficit in generating facilities in the short term. Among them the gas-fired thermoelectric plants should be highlighted as regards their current and future energy potential, reducing dependence on hydroelectric plants and diversifying sources of production. This opportunity is even more attractive when considering the availability of natural gas from Bolivia, and especially from the Campos Basin itself. In addition, other clear advantages are associated with thermoelectric generating projects, such as lower investments, the construction period of around two years, the possibility of locating the plants close to load centers, together with their firm capacity to compensate seasonal variations in hydroelectric generation.

In addition to these factors with national repercussions, the vulnerability of the region where the project is located and the failures in the supply process should be stressed. In effect, the northern region of Rio de Janeiro and the south of Espírito Santo can only count on one main supply route using the FURNAS transmission line from the Adrianópolis substation, passing through Campos and proceeding to Vitória, without any significant generation over the whole length of the circuit. This configuration, shown in Figure 2.2-1, constitutes a considerable vulnerability for the load centers of the region under situations of rationing or low energy supplies in the South-Southeast-Midwest Interconnected System.

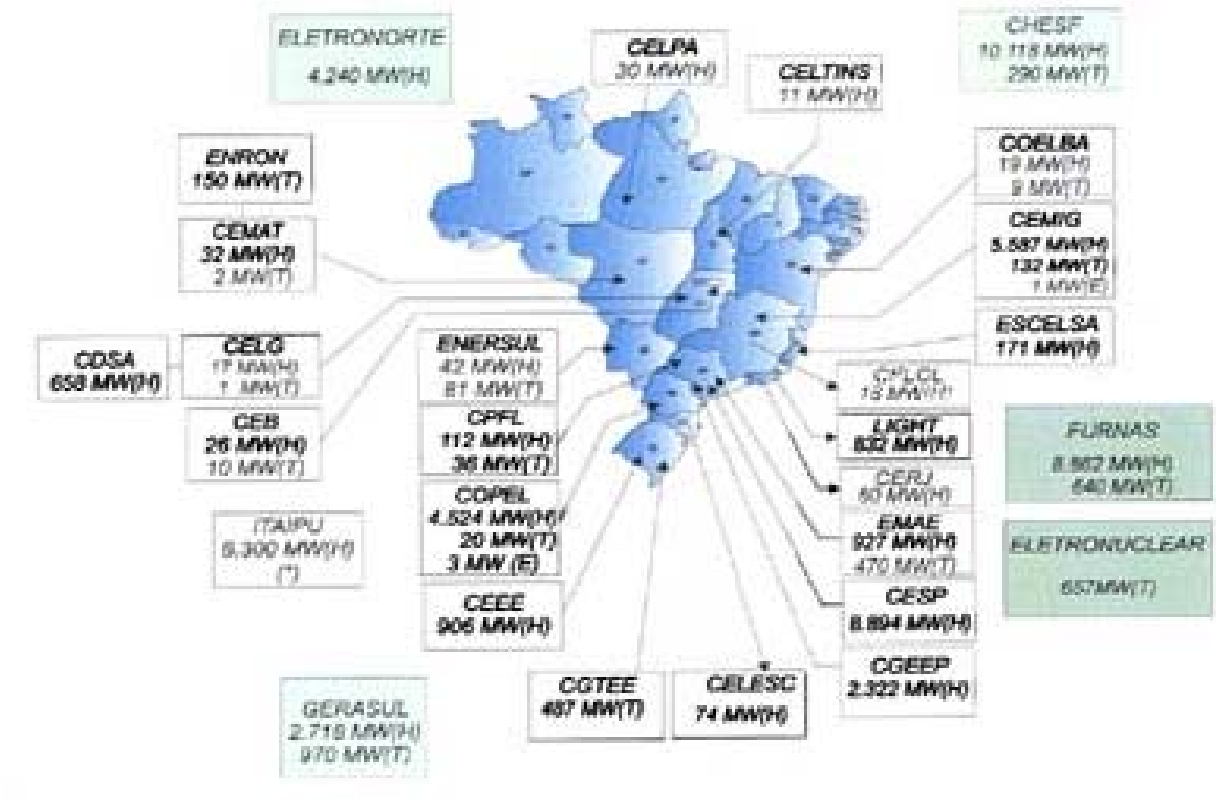
Figure 2.2-1 – Transmission Configuration of the South-Southeast-Midwest Interconnected System.



Source: ELETROBRÁS

A clear notion of the significance of the project in the context of the system of the regional utilities can be obtained by analyzing the current installed capacity of the LIGHT and CERJ systems in Rio de Janeiro as shown in Figure 2.2-2 below, totaling 892 MW, which would be significantly impacted by the 700 MW increase from the Macaé Merchant TEP.

Figure 2.2-2 – Installed Capacity per System in 1999.



Source: ELETROBRÁS

All these factors justify the construction of Macaé Merchant TEP, with a power output of 700 MW, to supply the concession areas in the state of Rio de Janeiro and Espírito Santo, especially contributing to the Northern Rio de Janeiro region, by providing a more stable energy supply, without voltage and frequency oscillations and a lower probability of power cuts, in addition to releasing 700 MW of power into the South/Southeast/Midwest Interconnected System. This will increase the supply flexibility of the system, especially in situations when the generating facilities are insufficient.

It should be highlighted that the projects to be constructed will be under the direct responsibility of the company EL PASO RIO CLARO LTDA, which is part of the EL PASO ENERGY group, and has been operating in the Brazilian market for six years since the signing of the agreement with PETROBRÁS to take part in the Bolivia-Brazil gas pipeline joint-venture. The joint-venture, called Grupo BTB, comprises the companies EL PASO ENERGY, BHP PETROLEUM from Australia and BRITISH GAS from the United Kingdom. As a result, EL PASO, as the leader of Grupo BTB, acquired considerable knowledge of the Brazilian gas system.

In addition, it should be pointed out that EL PASO has a significant number of projects in operation, under construction or at an advanced stage of planning in Brazil, as is the case with the Manaus and Porto Velho thermoelectric plants, with generating capacities

of 400 MW and 64 MW respectively, and recently started construction of 480 MW thermoelectric plant at Araucária in Paraná.

2.2.3 HYPOTHESIS OF NOT REALIZING THE PROJECT

If the project were not implemented, this would be characterized as a contributing factor to the uncertain scenario of electric power supplies in the region, in other words:

- Possibilities of frequent power cuts;
- The need to live with the undesirable frequency and voltage oscillations in the FURNAS transmission line that currently occur;
- Problems with the South/Southeast/Midwest Interconnected System, faced with a generating crisis that is looming closer and closer;
- limitations on regional socio-economic development as a result of a possible lack of power supplies.

Therefore if the project is not implemented, this will mean submitting the population to the risk of power cuts or unreliable energy supplies, in addition to removing the stimulus to install the new projects necessary for social and economic development in the region.

2.3 TECHNOLOGICAL AND SITING ALTERNATIVES FOR THE PROJECT

The technological and siting alternatives considered for the Macaé Merchant Thermoelectric Plant and the Dedicated Gas Pipeline - Macaé Merchant TEP are described below.

2.3.1 TECHNOLOGICAL ALTERNATIVES

With respect to existing alternative technologies for electricity generation, the technologies using hydropower, the combustion of various kinds of material, wind as motive power and others employing photovoltaic cells to transform solar energy in mechanical power are well known.

The so-called alternative sources of electric power, such as wind and solar power, plus those with similar characteristics due to their alternative nature, as is the case with tidal, geothermal and thermal generating plants involving the use of vegetal biomass, can only be used in very special circumstances, either from a technical or economic point of view. Therefore due to factors such as the lack of the large level differences between high and low tides that are required to utilize tidal generating plants, or other combustible materials in economically viable quantities, these alternative sources do not therefore constitute effective alternatives to supply large consumer centers when compared with conventional thermoelectric or hydroelectric plants.

Therefore the only alternatives that are currently viable when considering a large-scale supply constitute thermoelectric plants, utilizing gas, coal or oil, and also nuclear fusion, plus those based on hydropower that are already widely utilized.

As mentioned above, the current predominance of hydroelectric power tends to continue, but at relatively reduced levels, since the water resources still available tend to be located further and further from consumer centers, increasing the cost of transmission, in addition to causing environmental problems linked with the formation of the reservoirs, which imply in loss of territory and the removal of local populations, amongst others.

For these reasons, the sectorial guidelines are gradually being altered to expand the share of thermoelectric generation in the composition of the Brazilian energy matrix. Also the flexibility of thermoelectric plants should be highlighted, which allow the use of various kinds of fuel, such as oil derivatives, coal and nuclear sources. Proof can be found in the world energy matrix, where mineral coal is responsible for more than 40% of electricity production, and oil derived from petroleum for a further 20% of production. However coal does not constitute a competitive alternative in Brazil, due to the lack of availability of the mineral at reasonable distances from the large power consuming regions. The option of oil derivatives is not attractive since it is an input that still depends on imports to a reasonable extent.

The nuclear thermoelectric generation alternative in Brazil is currently restricted to the Angra I and II plants located in the state of Rio de Janeiro, in the municipality of Angra dos Reis. The difficulties involving the construction of this kind of project are notorious. Due to the current uncertainties involved in the Brazilian Nuclear Program, further projects will probably not be implemented, with the exception of Angra III, currently under discussion. Also it should be considered that the cost of electricity generated by nuclear plants is significantly higher than by conventional thermoelectric plants, in addition to the worldwide discussion on the risks associated with this type of generation.

It therefore seems clear that currently the most promising alternatives are in fact thermoelectric plants. In this case it is worthwhile discussing the comparative advantages between the different fuel alternatives. From this point of view it should be observed that although efficient technologies exist to reduce the level of emissions of pollutants generated by the burning of oil or coal, the high levels of control also imply high costs to acquire the equipment and adapt the processes. This makes the alternative of using natural gas more advantageous when compared with these products. The advantage is specifically significant in the case of this project, when considering the large-scale availability of natural gas in the region as a result of production in the Campos Basin.

Due to the above-mentioned, it is considered that thermal generation based on natural gas is the best energy alternative for the context of the project being analyzed, with advantages over other alternatives both from the technical, economic and environmental points of view. It should be stressed that in this case the generation alternative adopted

will contribute to utilize the natural gas produced in the Campos Basin, which is currently largely burnt off, and thus does not bring any social economic benefits.

In addition, it should be mentioned that gas-fired generating technology using a single cycle project is especially suitable in the context of the emergency involving the thermoelectric program in Rio de Janeiro, since this alternative will allow the regional generating base to be increased by 700 MW within a very short term of 12 months. The scale of the increase and speed of availability become clear when we consider that constructing a hydroelectric plant with the same power output would entail building a plant with a size comparable to three plants equivalent to the FURNAS Funil installation, or a nuclear plant with a size exceeding that of Angra I. Both such projects would involve construction periods of not less than 10 years.

With respect to the Dedicated Gas Pipeline - Macaé Merchant TEP, the technological design concept was to make a direct connection with the Cabiúnas station, or alternatively a branch pipeline from GASDUC. The first alternative was selected, although with a higher cost due to its longer length, due to the greater reliability of the supply pressure and lower operating risk, in addition to eliminating the need for compressing the gas on arrival at the plant.

2.3.2 SITING ALTERNATIVES

With respect to siting alternatives, studies involving both the Macaé Merchant TEP and the Dedicated Gas Pipeline were prepared, and are presented below.

2.3.2.1 Macaé Merchant TEP

To evaluate the siting alternatives, the information necessary to provide information for decision-making on the best implementation alternatives for the Macaé Merchant TEP was initially surveyed. The three areas indicated in Figure 2.3-1 were evaluated: one close to the PETROBRÁS industrial area at Cabiúnas, another close to the BR-101 highway and the river Macaé, close to Severina, and a third in the town of Campos dos Goitacazes, close to the Campos substation.

Figure 2.3-1

The process for selecting the area to construct the thermoelectric plant took into account the investigation and evaluation of the following items:

- Availability of water year-round in sufficient quantities and with an acceptable quality;
- The sensitivity of the areas to variations in air quality standards;
- The distance of existing transmission lines and substations, plus interferences and environmental sensitivities along the connection route;
- The possibility of the existing transmission lines and substation being able to handle the additional power load required;
- The distance of the gas supply source - Cabiúnas Station;
- Low probability of flooding of the area, based on historic and topographic data;
- Geotechnical conditions;
- Proximity of homes and other sensitive areas, such as historic sites, military installations, archaeological sites, species threatened with extinction or protected areas and parks close to the selected site;
- Compatibility with the intended planning use of the area by the municipal authorities;
- Facility of access for heavy vehicles to the site;
- Availability and proximity of the kinds of operational support required, such as fuel, landfills, maintenance, etc;
- The infrastructure required external to the site location;
- Acceptance of the project by the community.

2.3.2.1.1 Alternative Sites for Constructing the Macaé Merchant TEP

Based on the criteria described above, three areas were evaluated for installing the Macaé Merchant TEP, two in the municipality of Macaé, the Cabiúnas and Severina sites, and the last in the municipality of Campos dos Goitacazes, the Campos site.

It is important to stress that initially EL PASO already had the Cabiúnas site available with around 60 hectares and satisfactory technical conditions for constructing the plant, principally due to the proximity of the PETROBRÁS installations where the gas will be obtained. This site, located at the industrial area in the municipality of Macaé, was purchased in 1997, in other words one-year before the creation of the Restinga de Jurubatiba National Park, which is located around two km from the site mentioned. However this new constraint changed the panorama of construction at that particular site, given the sensitivity aspects deriving from the proximity of the National Park.

Therefore in the study, EL PASO re-evaluated the feasibility of locating the plant at the Cabiúnas site, and recently acquired another area of around 100 hectares, also in the

municipality, called the Severina site, which then became an alternative location for installing the project..

In addition to these, construction of the plant at the Campos site on an area close to the local substation was also considered.

Based on these initial definitions, a comparison was made between the preselected sites, in which the following measures were taken:

- Initial analysis of the Cabiúnas site, based on IBGE maps, land use legislation and environmental conservation units;
- A visit to the Cabiúnas site for preliminary reconnaissance and a precise check on its location in relation to the Restinga de Jurubatiba National Park;
- An overflight to verify possible alternatives to the Cabiúnas site, identifying an alternative at Severina;
- A visit to the Cabiúnas, Severina and Campos sites for discussions on location aspects of the three alternatives;
- Local contacts to analyze the position of the community with respect to the location of the plant and possible rejection of the venture.

Based on information obtained, a summary of the location factors of the sites analyzed is presented in Table 2.3-1.

Table 2.3-1 – Evaluation of Alternative Sites for Installing the Macaé Merchant TEP

LOCATION FACTOR	CABIÚNAS SITE	SEVERINA SITE	CAMPOS SITE
ACCESSES	Amaral Peixoto Highway (RJ-106)	BR-101 Highway	Campos - Itaperuna Road
EARTHMOVING: Soil Volumes	Lower requirements	Greater requirements	Lower requirements
GEOTECHNICAL CONDITIONS	No geotechnical problems	No geotechnical problems	Need for geotechnical investigations
FLOODING	Area above flood level	Area above flood level	Area above flood level
WATER SOURCE:	Rio Macaé - 15km; Underground water: Being evaluated	Rio Macaé – 0.5km	Rio Paraíba do Sul
TRANSMISSION LINE: Distance TL 345kV FURNAS Transmission Capacity	10 to 12km YES	0.3km YES	Less than 1km YES
NATURAL GAS: Length of supply branch	0.8 to 1.0km	11km	Exceeding 90km
CONSERVATION UNIT: Distance.	Restinga de Jurubatiba National Park, distance 2 km	None	None

LOCATION FACTOR	CABIÚNAS SITE	SEVERINA SITE	CAMPOS SITE
GAS PIPELINE ROUTE	Route crossing an industrial area, within the PETROBRÁS Cabiúnas Station and the TEP site.	From the PETROBRÁS valve yard, following 2 km alongside the RJ-168, crossing a rural area over the whole length (pasture) away from urban areas.	Need for gas pipeline from Cabiúnas to Campos, and distance of around 90km.
AIR QUALITY STANDARDS:	CONAMA Resolution 13 /89 defines the maintenance of air quality over conservation units (Class I conditions).	CONAMA Resolution 03/90	CONAMA Resolution 03/90
ATMOSPHERIC EMISSIONS: Existing industrial units	✓ Cabiúnas Station ✓ Refilling of gas bottles	There are no industrial units in the area.	Campos Thermoelectric Plant
ATMOSPHERIC EMISSIONS: Land industrial installations	✓ Expansion of the Cabiúnas Station; ✓ Thermoelectric plant already licensed; ✓ Thermoelectric plant being licensed; ✓ Future industrial installations.	Thermoelectric plant being licensed.	No new industrial units planned.
LAND USE ZONING (Municipal Law 1.683/96)	Area located in Industrial Zone	Area located in Rural Zone.	Area located in Industrial Zone
LAND USE AND VEGETATION COVER Sites evaluated	Site with totally anthropic characteristics, with pasture vegetation	Site with totally anthropic characteristics, with pasture vegetation	Urban area with real estate development around the perimeter.
LAND USE AND VEGETATION COVER Area surrounding sites evaluated	✓ Located in an industrial area at the perimeter of the town of Macaé, around 1.5 km from residential building concentrations ✓ 2 km from the Restinga de Jurubatiba National Park. ✓ Close to the Cabiúnas sand spit area.	Located in a rural area, characterized by wide expanses of pastures.	Campos Substation. Urban real estate developments.
URBAN CONCENTRATION: Proximity	Around 1.5 km from the closest urban concentration.	Around 11 km from the closest urban concentration.	Forms part of the urban zone.
LIQUID EFFLUENTS Discharge location	Pumped to the Jurumirim channel, flowing into the left bank of the Macaé River, located around 3.5 km from the site; discharge in the sea or lakes should not be considered.	Discharge into the river Macaé, upstream of the intake.	Discharge on the left bank of the Paraíba do Sul River upstream of the CEDAE water intake.
POSSIBLE LOCAL IMPACTS	Cumulative nature of atmospheric emissions, which could affect the Jurubatiba Park, in addition to the expansion of the urban area close to the project. Possible interference with the lake system if the option to use underground water is taken.	Cumulative effect of atmospheric emissions with the Macaé Merchant TEP, but without affecting conservation units or urban concentrations.	Cumulative effect of atmospheric emissions due to the presence of the Campos TEP, which could affect urban areas.

LOCATION FACTOR	CABIÚNAS SITE	SEVERINA SITE	CAMPOS SITE
AVAILABILITY OF AREAS FOR INSTALLATION	The area available is large and enables the project to be better isolated, facilitating the control of noise and risk management.	The area available is large and enables the project to be better isolated, facilitating the control of noise and risk management.	The area available is restricted, implying a high risk factor in the case of accidents and greater intervention to control noise.
ACCEPTANCE BY THE COMMUNITY	Possibility of rejection due to the presence of the conservation unit	Less possibility of rejection due to the location in a rural area.	Greater possibility of rejection, due to its location in an urban concentration.

2.3.2.1.2 Area Selected for Installation of the Macaé Merchant TEP

Due to the aspects mentioned above, the Severina site was selected, due to the lesser complexity of the environmental sensitivity factors at this site.

With respect to the engineering aspects inherent to the design, it was found that the Severina site has comparative advantages with respect to the Cabiúnas side regarding the proximity of the FURNAS transmission line and the river Macaé. This aspect implies a considerable reduction in costs associated with the connection to the transmission line and the water intake to the plant. In addition, in the case of the Severina site, the final disposal of liquid effluents is simpler and cheaper, since in the case of the Cabiúnas site there would be a need for a pressurized pumping main and outfall in the opposite direction to the catchment area. On the other hand, the slight slope of the Cabiúnas site would demand a larger volume of earthmoving to prepare the area. The Cabiúnas site would require a shorter length of dedicated gas pipeline, thus reducing the installation costs of the gas supply system to the plant.

This comparison, when made with the Campos site, becomes even more evident when considering the 90 km of gas pipeline that would need to be constructed if this installation alternative was adopted at the town of Campos. In addition, the construction of a thermoelectric plant in an urban area could give rise to discussions with regard to location in an expanding area of the town, thus involving greater risks than installation in a rural or industrial area.

2.3.2.2 Dedicated Gas Pipeline - Macaé Merchant TEP

With respect to the Dedicated Gas Pipeline - Macaé Merchant TEP, studies were performed, culminating with the definition of three alternative routes connecting the PETROBRÁS unit at Cabiúnas with the Macaé Merchant plant. These alternative alignments are described below, followed by the alternative chosen.

2.3.2.2.1 Alternative Alignments for the Dedicated Pipeline

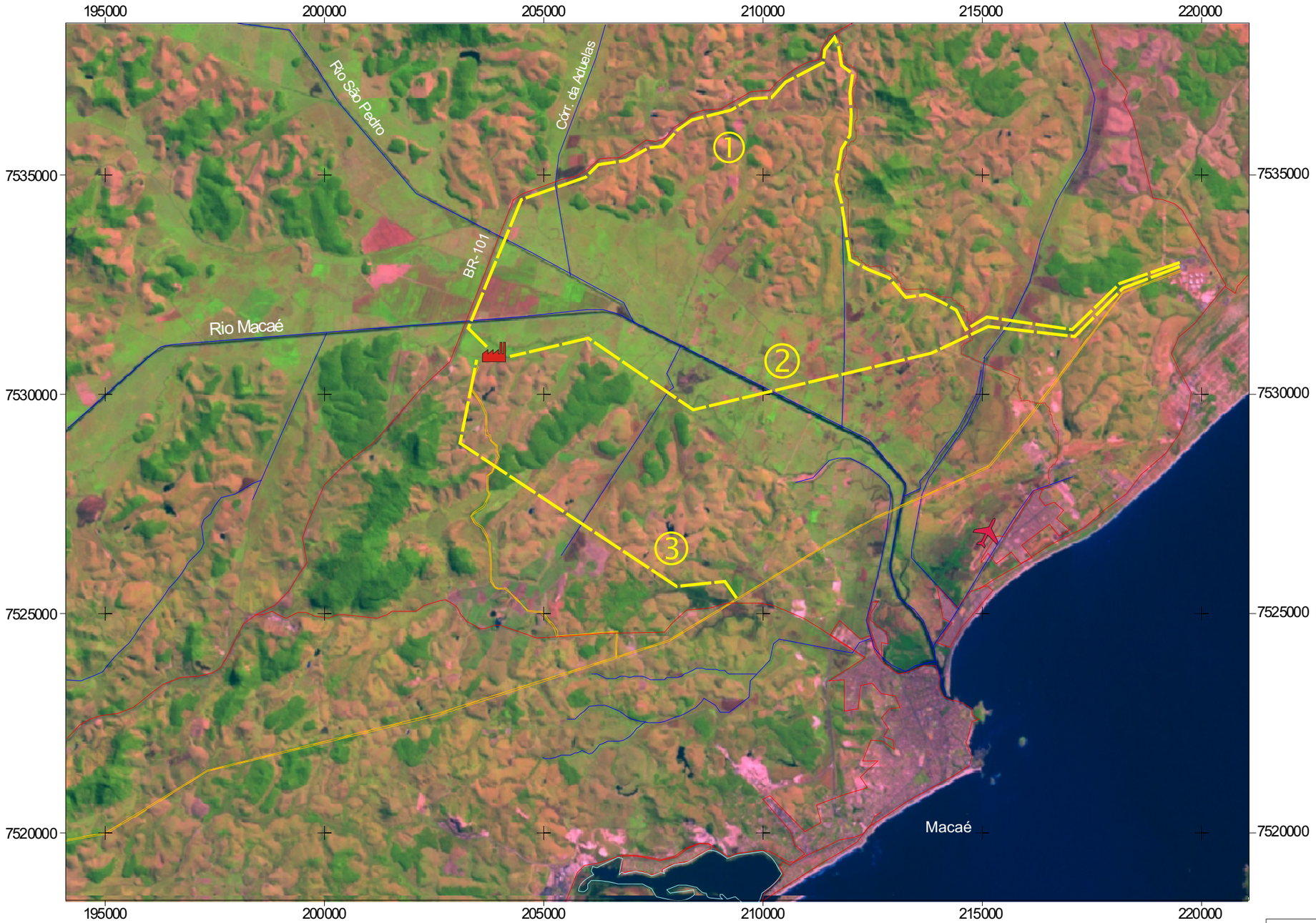
The characteristics of the three alternative routes studied are listed in Table 2.3-2 below and show in the following Figure 2.3-2.

Table 2.3-2 - Alternatives Studied for Installing the Dedicated Gas Pipeline

ASPECT	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
Length	~30km	~20km	~25km
Alignment	Dedicated 20" pipeline from Cabiúnas, crossing the Jurumirim channel to the junction with the RJ-25, and following parallel to the road up to the junction with the BR-101. From this point parallel to the highway, crossing the river São Pedro and the river Macaé, arriving at the Macaé Merchant site.	Dedicated 20" pipeline from the Cabiúnas Station, following the PETROBRÁS untreated water main alignment, parallel to the old bed of the river Macaé and continuing to the Macaé Merchant TEP.	Dedicated 20" pipeline parallel to the GASDUC (14km) as far as the junction with the PETROBRÁS water intake, following along the intake right of way to the Macaé Merchant TEP (11km)
Impacts on the Physical Environment	Interference with watercourses (river Macaé, river São Pedro and others) plus the flood plain.	Interference with watercourses (river Macaé and others) plus the flood plain.	Interference with watercourses (river Macaé and others)
Impacts on the Biotic Environment	Crosses flood of areas/ flood plain of the river Macaé	Crosses flood of areas/ flood plain of the river Macaé	Crosses flood of areas/ flood plain of the river Macaé; Close to the remaining area of woods.
Impact on the Socio-economic Environment due to the right of way strip	Uses the right of way strip of existing highways for the majority of the route.	Implies the need for direct negotiations with land users, usage constraints along the alignment, mining rights and others. Proximity to the INCRA settlement area.	The area is already used by the existing PETROBRÁS water intake and gas pipeline.
Crossings of Infrastructure	Crosses the highway RJ-25	Crosses the highway RJ-25	Crosses the highway RJ-25
Watercourse crossings	Crosses the river São Pedro and the buried river Macaé, in addition to the Jurumirim channel	Crosses the river Macaé in an area without structures, in addition to flood of areas and the Jurumirim channel	Crosses the buried river Macaé at the same location as the GASDUC pipeline; crosses the Jurumirim channel.
Topography	Crosses flat areas subject to flooding, comes close to the RJ-25 at the S. Manuel mountain range	Crosses flat areas subject to flooding	Crosses flat areas and low hills.

Figure 2.3-2

(see Figure 2.3-2.pdf)



ESCALA GRÁFICA

2 0 2 4 km

N

LEGENDA DE USO DO SOLO E VEGETAÇÃO

- Agricultura
- Vegetação arbórea secundária
- Pasto em área alagadiça
- Pasto em área de morros
- Solo exposto
- Área urbana

CONVENÇÕES CARTOGRÁFICAS

- ALTERNATIVAS DE TRAÇADO DE GASODUTO
- HIDROGRAFIA
- RODOVIAS
- DUTO
- TERMELÉTRICA
- AEROPORTO

EL PASO ENERGY INTERNATIONAL

USINA TERMEL TRICA MACA MERCHANT

ECOLOGUS Engenharia Consultiva	FIGURA 2.3-2 - ALTERNATIVAS LOCACIONAIS DO GASODUTO		
EMISS O DATA	REVIS O	N MERO	ESCALA

2.3.2.2.2 Alignment Selected for Installing the Dedicated Pipeline – Macaé Merchant TEP

Bearing in mind the aspects presented above, the alignment alternative that offered the lowest environmental impact was selected for constructing the gas pipeline, considering the following basic criteria:

- Distance from urban and occupied areas;
- Distance from areas with well preserved vegetation;
- Minimizing crossings of water bodies;
- Utilization of existing rights of way.

Based on the environmental considerations presented above, Alternative 3 was selected for installing the dedicated gas supply pipeline to Macaé Merchant TEP. Alternative 2, although equivalent to Alternative 3 in innumerous aspects, was discarded due to the presence of a population settlement close by and unfavorable geotechnical conditions.

The dedicated gas pipeline following the Alternative 3 alignment selected is therefore characterized in item 2.5 below.

2.4 CHARACTERIZATION OF THE THERMOELECTRIC PLANT

The Macaé Merchant Thermoelectric Plant will be a single cycle unit with a maximum generating capacity of 700 MW, comprising 16 generating units made up of gas turbines with an output of 43 MW designed to burn natural gas, each coupled directly to an air-cooled generator. The terminals of the 16 generators will be connected to 8 main step-up transformers, one transformer for each pair of generators.

The Macaé Merchant Thermoelectric Plant will be connected to the South-Southeast-Midwest interconnected system via the 345 kV line owned by FURNAS, through a substation to be constructed at the site.

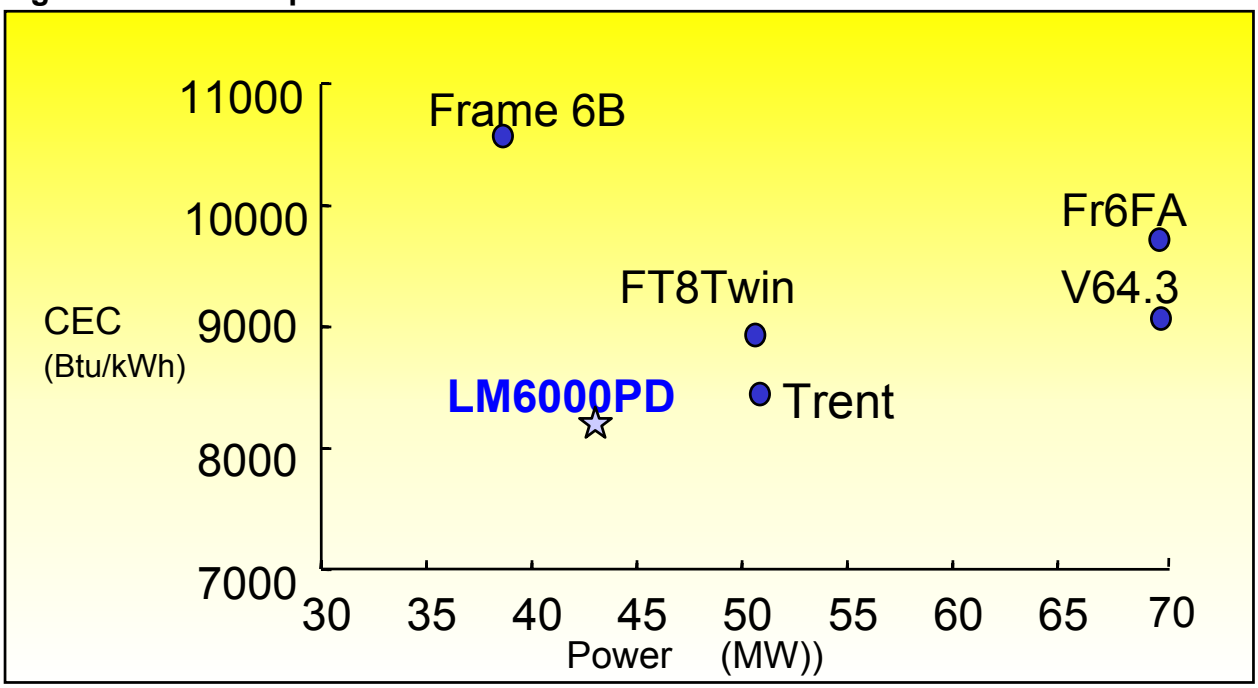
2.4.1 DESCRIPTION OF THE GENERATION PROCESS

The Macaé Merchant TEP will use combustion turbines in which the air and the products of combustion comprise the thermodynamic working fluids. The atmospheric air is compressed before entering the combustion chamber, where it is mixed with the fuel and then burned. The products of combustion, at high pressure and temperature, pass through the turbines, where they generate mechanical energy to operate the generator.

Recent advances in turbine combustion technology have increased the efficiency of these units to the 30% to 35% range, thus coming close to the efficiency provided by steam turbines. This efficiency is limited principally by the energy retained in the turbine's exhaust gases, which are invariably at high temperatures (between 480ºC and 650ºC). This energy is discharged to the atmosphere, without being utilized.

Plants operating under this arrangement are called simple cycle, and are normally used for peak time or standby generation. In the case of the Macaé Merchant TEP, which will use natural gas as fuel, the GE LM6000 turbine was selected, bearing in mind that in the power range between 40 and 70 MW, it offers the lowest specific heat consumption (SHC) per kWh generated, as shown in the following graph:

Figure 2.4-1 – Comparison between efficiencies of various kinds of turbine



2.4.2 CHARACTERIZATION OF BASIC INPUTS

Two basic inputs are required to operate the Macaé Merchant Thermoelectric Plant: natural gas and water.

Natural Gas

Three million cubic meters of natural gas will be consumed daily to operate the plant, obtained from the PETROBRÁS Cabiúnas Station. The gas will be transported to the Plant through a dedicated gas pipeline to be constructed by EL PASO and operated by CEG or PETROBRÁS itself (process under negotiation). The gas will be supplied as established by ANP Administrative Rule No 41/98, dated April 15, 1998, and as specified by Technical Regulation No 001/98, attached to the Administrative Rule.

The natural gas, classified as a group M (medium), should comply with the following specifications according to the ANP standards:

Table 2.4-1 – Natural gas characteristics

CHARACTERISTICS	UNIT	GROUP M
Upper heat power (PCS)	kcal/m^3	8000 to 9000
Relative density	mg/m^3	0.55 to 0.69
Hydrogen sulfide gas content (H_2S), max.	mg/m^3	20
Sulfur content (H_2S and mercaptylic-sulfur), max	mg/m^3	80
Carbon dioxide content (CO_2), max.	mg/m^3	2
Inert gas content, max.	% volume	4
Oxygen content (O_2), max.	% volume	0.5
Dewpoint of water, 1 atm, max.	ºC	-45

Although the above specifications indicate a maximum sulfur content of 80mg/m^3, the gas processed at Cabiúnas by PETROBRÁS has been considered by the CEG as having a zero content.

In addition, it should be noted that the constraints imposed by the equipment do not allow gas with a high sulfur content to be consumed, and in fact the allowable tolerances to obtain good performance are considerably lower than the limits allowed by ANP.

As established by the above-mentioned ANP administrative rule, the gas will be delivered at the TEP free from dust, condensed water, objectionable odors, gum, gum-forming elements, glycols, condensable hydrocarbons, aromatic compounds, methanol or other solid or liquid elements that could interfere with the operation of the systems.

Water

There are two options to release the heat cycle: the open and closed cooling systems, the latter employing cooling towers. For many years of the open cooling system was used more frequently. However due to the increasing restrictions on thermal discharges into water bodies, and also the need to ensure a large quantity of water for the cooling circuit, the use of closed systems with cooling towers has increased. This system requires lower quantities of water and has a lower impact on the temperature of the water body, since the greater part of thermal energy is dissipated through evaporation of the water.

In line with this trend, the Macaé Merchant TEP will use the closed system with cooling towers, for which reason a maximum of flow of 86 l/s will be taken in from the river

Macaé, the minimum seven-day flow rate of which is 4,870 l/s, according to data from the "CEDAE Master Plan for Water Supply of the Lakes Region, Macaé and Casimiro de Abreu". A return flow derived from the effluents of the demineralization process is planned, totaling 4 l/s, in addition to 8 l/s derived from the cooling cycle. Therefore the total flow that will return to the river Macaé will be 12 l/s.

2.4.3 OPERATIONAL AND DESIGN CHARACTERISTICS

The Macaé Merchant TEP will be suitable for operating under base load and cyclic conditions, with an average guaranteed availability factor of 90%. The design includes criteria at the level of redundancies in the instrumentation, control and protection systems and standby equipment, in order to ensure an optimum level of reliability desirable for connection with the integrated transmission system at 345 kV.

During normal operation the load may be varied by operating one or two gas turbines on a partial load basis, and/or by putting units into service or taking them out of service. Considering that the operation of the turbine-generator units at low loads implies a considerable reduction in efficiency, it is not recommendable to operate the plant under low load conditions. The principal equipment and systems comprising the Macaé Merchant TEP are shown below in a simplified form.

2.4.3.1 Turbine - Generator Unit

The turbines will be GE LM 6000 type, consisting of a set of gas turbines with an aero-derived shaft, divided into three main components placed on the CF6-80C2 unit, forming a high-efficiency group with the direct primary drive unit coupled directly to an air cooled generator. These units will operate on a single cycle burning natural gas with water injection to control NOx emissions.

The control of NOx will occur inside the turbine combustion section through the injection of demineralized water. The water will cause a reduction in the adiabatic temperature of the flame, minimizing the production of NOx.

Each turbine is equipped with an axial outlet exhaust fan to facilitate assembly in the outgoing smokestack line. Noise suppressors will be installed inside the exhaust duct to reduce the audible impact in neighboring areas. The height of the smokestack will be optimized to minimize the principal cost of the installation but ensure sufficient height to enable adequate dispersion of the discharge to comply with Brazilian environmental regulations.

The turbine will be coupled directly to the generator through a metal universal joint. The air-cooled generator will operate at 3600 pm, 13.8 kV, 60 Hz, and will be capable of sustaining the continuously rated power of the gas turbine within the design temperature range. A brushless excitation system with a permanent magnet will be used. Voltage

regulation, synchronization and power factor will be controlled by the control panel of the turbine. The journal bearings of the generator will be protected by an oil lubricating system, mounted externally and air cooled, operating on a closed-circuit system. Each generator will be connected to a step-up transformer through a bus that will be connected to the switchyard bus ring.

Turbine and generator will be contained within impermeable acoustic housings. The turbine compartment will be fully ventilator with redundant ventilators, whilst the generator compartment will be ventilated by a fan mounted on the generator shaft. Both compartment will be equipped with an explosion-proof lighting system, and protected by an automatic fire suppression system (CO2). In addition to protection from weather conditions, the turbine and generator containers will ensure that the noise level in neighboring areas is limited to 90 dB.

The following photographs show a turbine of the GE LM 6000 type, and also the turbine-generator set operating at a thermoelectric plant.

Figure 2.4-2 –GE LM 6000 Turbine.

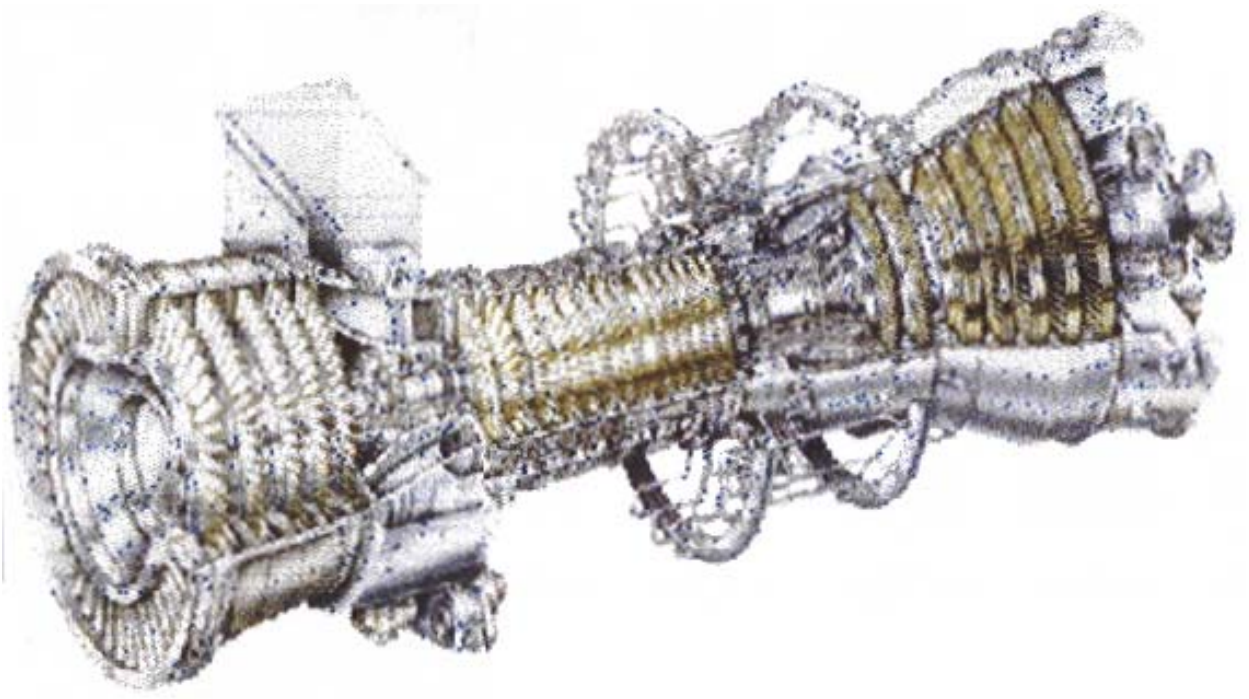
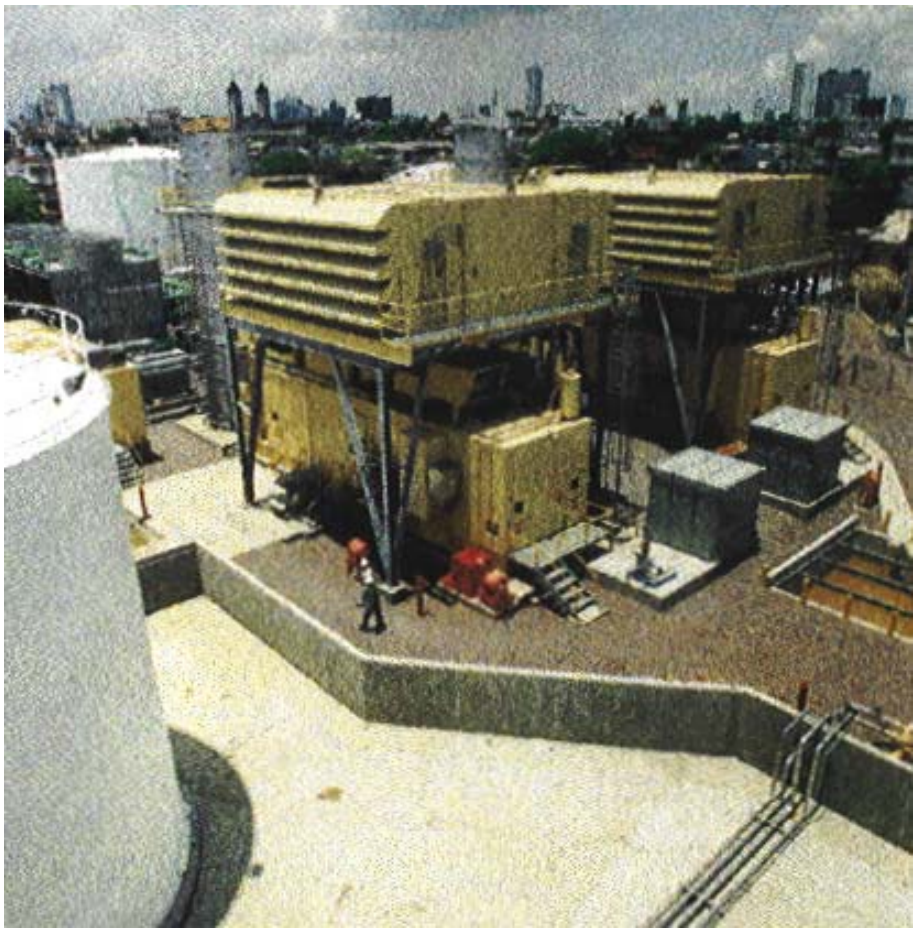


Figure 2.4-3 – Turbine-generator unit similar to the one installed at the Manaus Plant.



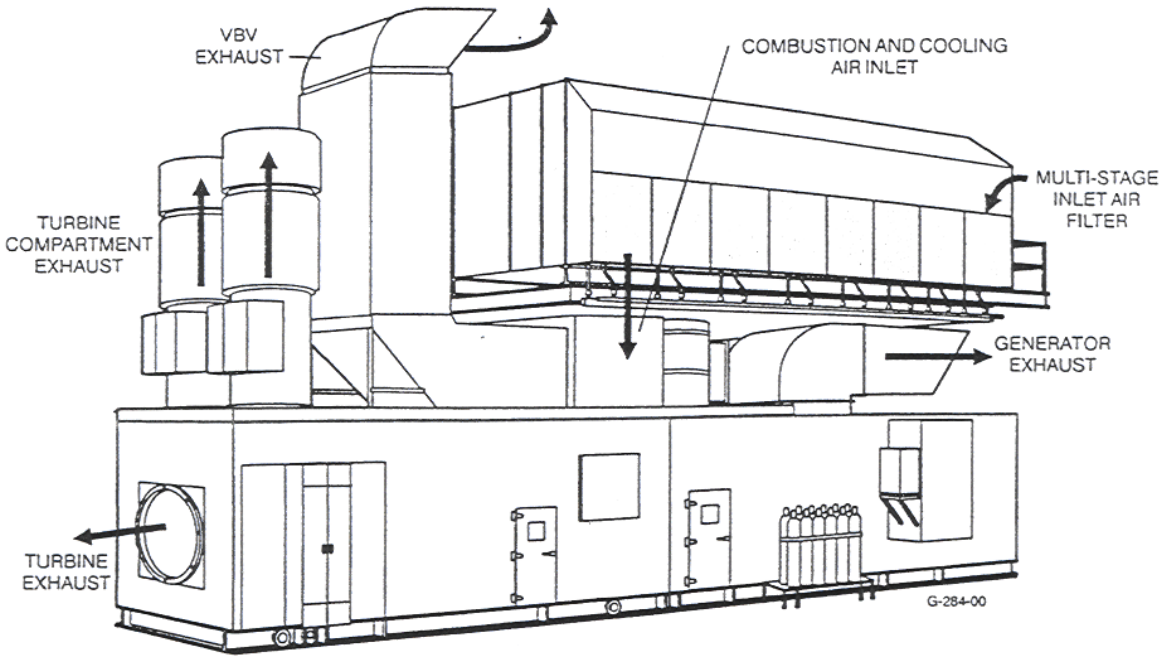
2.4.3.2 Auxiliary Systems for the Turbine-Generator Set

Comprise the systems for fuel supply, air intake, lubricating oil, turbine intake air-cooling and turbine water injection to control NOx, as described below:

- **Fuel System**: will use compressors located at the perimeter of the plant to raise and stabilize the natural gas pressure at 46.5 bar (g), which will ensure a supply of gas to the turbine at a constant pressure for load ranges;
- **Lubricating Oil System**: composed of two separate oil systems, one for the gas turbine and one for the generator. The oil reservoirs and pipework will be in stainless steel and the system of lubricating oil valves will be equipped with stainless steel supports. A duplex filter and cooler will be installed in each lubricating oil system. The coolers, gas turbine lubricating oil system and filters for each system will be mounted on the auxiliary equipment module, close to the base of gas turbine.

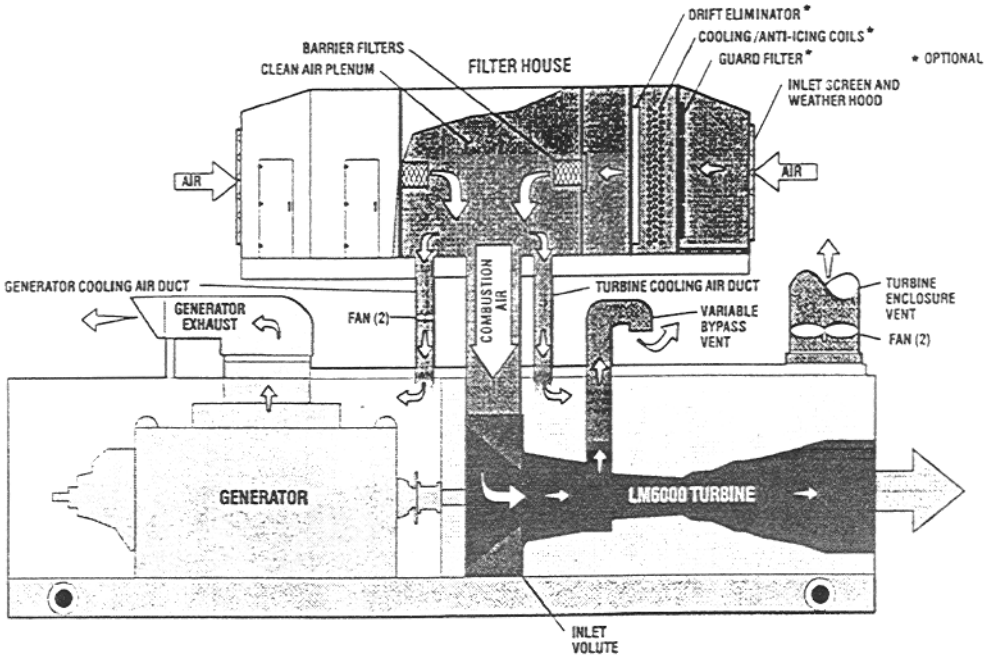
- **Air Intake System:** to provide clean and filtered air to the turbine for combustion and ventilation, an air intake system will be mounted on the turbine housing, as shown in Figures 2.4-4 and 2.4-5 below. It will be installed in modules, composed of a multiple-stage filtering system, consisting of a weatherproof protection, intake screens, pre-filter and final barrier filter. All the air for the ventilation systems will be filtered together with the combustion air for the turbine. The air intake of each turbine will be provided with cooling coils, using air cooled by coolers, to reduce the temperature of the incoming air and therefore increase the power output and efficiency of each unit. Due to the high humidity in the Macaé region, a significant volume of condensate will be generated at the turbine intakes. After collection, the condensate will be reused for the make up of the cooling tower, thus reducing the volume of water required from the river Macaé. Mounting the air system directly on the turbine and generator casing has the advantage of reducing the space necessary for the equipment, and also reducing the length of the air intake ducts to the turbine-generator set compartments. The flow in the air compartment is divided into two, one for combustion in the gas turbine and the other to ventilate the turbine and generator compartments.

Figure 2.4-4 – Assembly arrangement of the air intake system on the turbine-generator set



Combustion And Cooling Air Flow For The LM6000 Package.

Figure 2.4-5 – Air flow diagram



- **Cooling System for Turbine Air Intake:** to cool the air taken into the turbines, water from the river Macaé will be used. After being collected, the water will be clarified by a clarifier station installed close to the river, and then used for make up for the cooling tower. The tower will be an integral part of the water recirculation system, composed of a closed circuit comprising the recirculation water pumps, heat exchangers, piezometric/loss make up tank, additive system, pipework, valves and accessories, in addition to the mechanical cooling tower system mentioned above.
- **Turbine Water Injection System to Control NOx:** in order to control the emission of NOx, water taken from the river Macaé will be used, also clarified at the clarification station and subsequently demineralized for injection into the turbine combustion chambers. The water treatment system proposed will be composed of an untreated water intake and transfer system, pre-treatment of the untreated water (clarification), demineralization and finally the treatment of effluents.
- **Ventilation System:** the turbine casing will be provided with a ventilation system comprising two ventilators for the casing and another for the oil compartment.

2.4.3.3 Plant Electricity Distribution System and Equipment

The system is composed of the step-up substation where the transformers are located. The switching substation will be conventional type and will feed the auxiliary electrical systems, panels, control centers, safety, communication, protection, metering and

lighting systems. The substation will also be provided with a grounding and atmospheric discharge system for protection.

A connection will be made from the substation terminals to the Adrianópolis – Campos – Vitória trunk transmission line forming part of the South-Southeast-Midwest interconnected system via the 345 kV FURNAS line.

2.4.3.4 Auxiliary Plant Systems

Comprise the fire protection and communication systems described below

- **Fire Protection System**: the plant will be protected by a complete fire protection system composed of optical flame detectors, hydrocarbon detectors, thermal detectors, pipework and spray unit installed in both the turbine and generator casings. The fire protection system will be composed of CO_2 cylinders mounted in a separate module. All alarms will operate at the control panel of the unit. An alarm will sound at the turbine whenever the gas detectors record high gas levels. When activated, the primary cylinders will discharge CO_2 in the turbine and generator casings through multiple nozzles, at which time the ventilation dampers will automatically close. After a time delay, the reserve supply of CO_2 will also be discharged if necessary. The plant will also be equipped with an underground fire pipe network for emergency situations.

- **Communication System:** the plant's communications system will include direct telephone lines. An RTU plant will be installed for transmitting operational data to the closest power control center of the National Grid Operator - ONS. The ONS communication requirements will be followed in the RTU installation, which will be provided with data transmission through the most appropriate means of communication for the location. Therefore telecommunications can be achieved through microwaves, line conductor or telephone.

2.4.3.5 Digital Control and Monitoring Systems

A simple and reliable system will be employed to control the turbine-generator set for the purpose of automatic powering up, in addition to interlocking, shutdown and alarm switches. The system will include:

- Control panel;
- Intelligent controls, sensors and transmitters on the turbine and generator;
- Control batteries and charges;
- Local metering panels.

The control panel will comprise a central unit for operating the turbine, equipped with solid-state electronic components and suitable for installation at the local control center,

which will be installed close to the turbine-generator set. The control panel is made up of a cubicle integrating the turbine and generator commands, in which the sequence control system to command operation start-up, operation itself and shutdown of the turbine-generator set should be highlighted.

There are also other auxiliary control systems, involving speed, pressure and temperature control of the high and low-pressure compressors, in addition to a set of alarms for the turbine-generator set shutdown system. The plant will also be equipped with a set of batteries capable of providing power to the controls during three hours without recharging, and a gas and fire detection system will also be installed.

- **Water Supply System**

The water supply system for the Macaé Merchant TEP will include the following processes: intake and transfer of untreated water, pre-treatment of untreated water (clarification), demineralization and treatment of the effluents.

The untreated water to be processed will be made available in the storage tank by means of an intake and transfer system, dimensioned taking into consideration the demand for pretreated water for the cooling tower make up and to supply the needs for dematerialized water, and also as a function of the backup necessary for the fire protection system hydrants and the Mulsyfire system.

The basic needs for the pre-treatment process will be supplied via the untreated water transfer pumps, with pumping lines connected to the corresponding storage tank. The pre-treatment and demineralization phases will be carried out as follows.

Clarification

The untreated water pumped by the transfer pumps will feed the flocculator-clarifier, initially receiving injections of soda to adjust the pH to the ideal level for the flocculator process. Next aluminum sulfate will be added as a flocculating agent to stimulate the flocculation and clarification process. Finally the water, already clarified by the flocculation-clarification process, will receive sodium hypochlorite for disinfecting. The addition of the chemical products will be controlled according to the state of the untreated water, to avoid excess chemicals and especially aimed at ensuring that the residual aluminum in the flocculator-clarifier effluent is zero. The sludge accumulated in the flocculator-clarifier will be removed automatically by regular bottom discharges. The water processed in the flocculator-clarifier will then be treated by the filtering stage, which is the final section of pre-treatment, and then pumped to the clarified water reserve tank as a basic input for the following applications:

- Make-up for the losses in the cooling tower forming part of the water circulation system;
- Production process for dematerialized water;
- Backup for the Mulsyfire system;

- Drinking water.

The bottom effluent from the flocculator-clarifier is processed by the sludge filtering/concentration system. An overflow line will partially recover the liquids, leading them to the liquid effluent auxiliary tank. After the concentration stage, the portion of sludge remaining in the bottom of the concentrator is processed by a filter press, which recovers any liquids and discharges the solid portion to the external stockpile. This discharge will produce around 3 cubic meters of solid residue per day.

Demineralization

The water for this stage of the treatment is provided by the dematerialized pumps, with a standby capacity of 100%, with the suction side connected to the clarified water tank. The process is carried out as follows:

First Phase: Cation exchange - Extraction of CO_2

The discharge flow from the demineralization pumps will be taken through adequate pumping lines to a vessel containing a bed of positive ion exchanger resin (cationic exchanger), with a standby capacity of 100%, where the following exchange reactions will occur.

The effluent from the cationic exchanger, which is acid, will be carried through ebonite-lined pipes to the conventional degassing towers, where the CO_2 will be extracted. This stage is applicable when the content of carbonate normally present in the natural water justifies it. At the end of this stage the decationized water is stored in a transition tank (decationized water tank), to which the suction pipes of the auxiliary demineralization pumps will be connected, to supply the subsequent phases of the production process.

Second Phase: Anion exchange

The discharge flow from the auxiliary demineralization pump will be carried by process pipelines suitable for the acidic nature of the cationic effluent to a vessel containing a bed of negative ion exchanger resin (anionic exchanger), where the exchange reactions will occur.

The effluent from the anionic exchanger will then be dematerialized water, which in turn will be carried to the final stage of treatment to ensure absolute purity.

Third Phase: Final polishing

Will be achieved by Ionic exchange and using mixed bed exchangers comprising a mixture of anionic, cationic and inert resins, with intermediate densities, that optimize the resin separations for the regeneration operations in the beds. During this stage the ions that pass through the previous phases will be retained.

The effluent from the mixed bed type exchangers is carried to the dematerialized water tank. This tank will have a storage capacity at least sufficient for 12 hours operation based on the consumption of all turbines at the maximum consumption rate.

Regeneration of ionic exchangers

The working cycle of the ionic exchangers will be supervised automatically and reactivation operations of the resin beds will be carried out when the exchange capacity is saturated. This state can be monitored according to the following variables:

- Monitoring the total flow of treated water at a level compatible with the conditions specified in the demineralization plant design.
- Raising the pH of the effluent in the case of cationic type exchangers.
- Raising the conductivity value of the effluent in the case of anionic exchangers and mixed beds.

In these cases, limiting value monitors initiate the shutdown sequences of the depleted exchangers and activate the corresponding alarms, warning the operator to take the measures necessary to carry out the regeneration sequences on the depleted beds. The regeneration operations carried out are similar to those in the production process.

Effluent from the regeneration processes

The chemical effluents from the ionic resin regeneration processes, together with all other effluents from the chemical injection processes, such as those from cleaning the metering tanks, will be carried through suitable process lines to a chemical reject treatment tank before discharge.

2.4.3.6 Drainage System

The design will include a stormwater drainage system for the area occupied by the plant, dimensioned in an appropriate way so as to minimize surface water flow off the yard areas even under heavy rainfall conditions.

The system will consist of peripheral channels along the entire length of the plant perimeter, discharging into an existing natural drain in the area. It will be designed in such a way that any water that could be contaminated by hydrocarbons, and water derived from other industrial areas of the plant, will be carried to an oil and water separator before discharge.

2.4.3.7 Sewage Treatment System

The plant will be equipped with a sewage treatment system to be dimensioned for around 60 people and operated to comply with the requirements of the environmental legislation, especially NT-202 by FEEMA.

2.4.3.8 Process Effluent Treatment System

The design of the plant includes neutralization basins, containment lagoons, oil and water separators and water cooling towers to treat and control the effluents to a suitable stage before discharge into water bodies. The effluents will be treated in such a way as to comply with current legal standards, in this case CONAMA Resolution 20/86 Art. 21 and the discharge standards established by NT-202 R10. It is estimated that the volume of effluent from the plant will be around 12 l/s.

2.4.3.9 Atmospheric Emission Control System

The atmospheric emission control system includes an NOx removal system using water injection that operates in the combustion chambers of the turbines. In addition, the system will be equipped with portable units of the LANCOM Premier type or similar to monitor emissions from the exhaust stacks aimed at controlling emissions with respect to O_2, CO, NOx, temperature and flow parameters. The portable equipment will be of the type accepted under the US EPA standards conforming to emission audits and tests.

The exhaust system and NOx reduction process will be designed to comply with World Bank emission standards (maximum 66 ppmv at source), plus the standards established by Brazilian legislation for the maximum concentration of NOx at ground level. Based on dispersion studies performed, these standards will be achieved by smokestacks with a height of 20 m or more.

2.4.3.10 Noise Control System

A single cycle plant has various sources of noise. The most significant include the combustion turbine, generator and exhaust units. In addition, the design will take into account the alternative technologies necessary to ensure that the increased background noise level at the property limits where the project will be installed fully conform to Brazilian legislation at the standards established by the World Bank.

The noise derived from the equipment will be attenuated by using casings equipped with acoustic protection by means of fiberglass and silencers on the air intakes. The expected noise levels at 1 m from the equipment will not exceed 85 dB(A).

2.4.3.11 Solid Residue Collection and Final Disposal System

The solid residues from the filter press process carried out at the final stage of water treatment will be temporarily stored under conditions compatible with Class II residues, and sent for final disposal by a specialized company licensed by FEEMA. The generation of these residues is estimated at around three cubic meters per day.

The solid domestic residue produced by the administration and canteen facilities of the plant will be placed in adequate containers and removed to the Macaé city landfill.

2.4.4 PROJECT IMPLEMENTATION STAGES

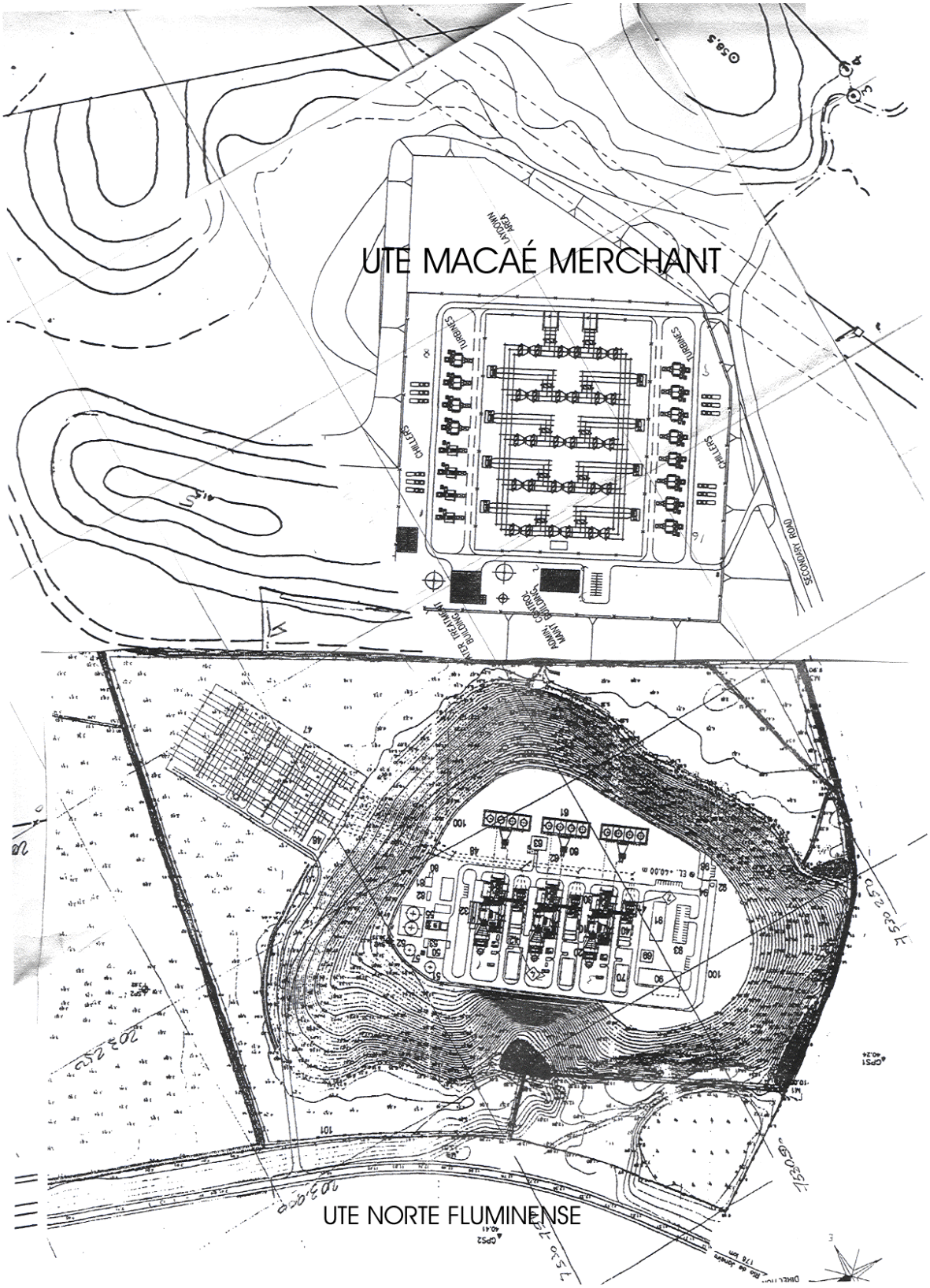
The plant will be constructed in three stages, with a total completion time of 12 months, comprising the earthworks stage, civil construction stage and assembly and pre-operational testing stage.

2.4.5 GENERAL LAYOUT OF THE PLANT AND EARTHMOVING

The general arrangement of the Macaé Merchant Plant is shown on Figure 2.4-6 below, which also shows the layout of the Norte Fluminense TEP. The main structures envisaged are the Pressure Control Unit, Water Treatment Unit, Administration Building, Turbine-Generator Yards and Substation.

It should be stressed that in order to establish a level platform to construct the plant, the natural land elevation to the level 50 will be partially removed to reach the level 20. The material removed will be used to extend the platform and placed along the south face of the elevation. This procedure reduces the need for borrow material and dumping areas to a minimum.

Figure 2.4-6 General Layout



2.4.6 LABOR AND CONSTRUCTION SCHEDULE

The labor contingent necessary to construct the Macaé Merchant Plant is estimated at 500 people at the peak of the works. Bearing in mind the town of Macaé nearby and a considerable number of construction and erection companies, a policy of giving priority to contracting local companies will be adopted. This policy is aimed at optimizing the mobilization phase of the work and minimizing the migration of labor from other regions.

During the operational phase, it is estimated that the staff required will be 40 people, including specialized professionals which may come from other cities or even abroad. However it is intended to establish a training program through agreements with local institutions (SESI/SENAI Macaé) to train local labor.

Figure 2.4-7 - Construction Schedule for Macaé Merchant TEP

DESCRIPTION	MONTHS											
	1	2	3	4	5	6	7	8	9	10	11	12
CONSTRUCTION												
Site preparation												
Construction of turbine-generator bases												
Construction of remaining structures												
Assembly of turbine-generators												
Construction of transformer yard												
Installation of water treatment unit												
Construction of control building												
Construction of dedicated gas pipeline												
Installation of water intake pipeline												
START-UP & COMMISSIONING												
Start-up of water supply system												
Commissioning of gas supply												
Turbine-generator start-up												
Synchronization with electricity grid												

2.5 CHARACTERIZATION OF THE DEDICATED PIPELINE

After completing the process that culminated with the selection of Alternative 3 for the alignment of the dedicated gas pipeline, the characterization was completed as follows.

Basically the dedicated pipeline for the Macaé Merchant Thermoelectric Plant will be constructed using 20"(508 mm) external diameter welded pipes, manufactured from API 5L Gr. X65 standard carbon steel plates. It will have a total length of approximately the 25 km, and will comprise three different sections, according to the locations, as follows:

- Main section comprising 23 of the 25 km, will be calculated using a yield strength of 72% of the maximum allowable stress of the steel selected, which will correspond to a minimum thickness of 5.54 mm (0.218"). In addition, out of the 23km, 750m will be externally cased in concrete for stream crossings;
- The second section, basically comprising road crossings, comprising 1 out of the 25 km, will be calculated using a yield strength of 60% of the maximum allowable stress of the steel selected, which will correspond to a minimum thickness of 6.50 mm (0.256"). In addition, out of the 1000m, 250m will be externally cased in concrete, located immediately below the highway lanes.
- The third section, comprising the pipeline sections located inside the PETROBRÁS Cabiúnas unit and the Macaé Merchant TEP, comprising 1 of the 25 km, will the calculated using a yield strength of 50% of the maximum allowable stress of the steel selected, which will correspond to a minimum thickness of 7.82 mm (0.308").;

In addition to this basic specification, it should be added that with respect to the pipes making up the dedicated pipeline:

- Modifications will be allowed in the basic specification of the steel used (API 5L Gr. X65) provided that the thicknesses are recalculated to obtain the allowable stress of the material;
- The line, accessories and main equipment items will be calculated for a pressure class of 1000 psi (70kg/cm^2 maximum allowable operating pressure = MAOP);
- The pipes will be protected externally by an FBE (fusion band epoxy) or triple laminated anticorrosion coating, with thickness and continuity totally verified using ultrasound. Where crossing areas are subject to uplift, the pipes will be provided with an additional concrete casing to avoid flotation problems. It is estimated that there is a need for this treatment along a length of 1000 m.
- The pipeline will be provided with an inlet at Cabiúnas and an exit at the plant site to introduce Magnetic Flux Loss (MFL) type inspection equipment;
- Five road crossings, fourteen stream crossings and a main crossing over the river Macaé are planned, all of them underground.

The operating characteristics of the fluid carried, used in dimensioning the pipeline, are the following:

- Operating pressure: 55kg/cm^2 ;
- Maximum daily flow rate: 4,300,000m^3;
- Minimum daily flow rate: 268,000m^3;
- Gas temperature at the exit from the Cabiúnas unit: 20^{o}C;
- Gas temperature at the Macaé Merchant TEP intake: 18^{o}C;
- Head loss along the Cabiúnas - Macaé Merchant TEP route: 2kg/cm^2.

2.5.1 PHYSICAL AND TOXICITY PROPERTIES OF NATURAL GAS

The following table gives the physical and toxicity properties of the natural gas carried by the dedicated pipeline to supply the Macaé Merchant TEP:

Product Name	***Natural Gas***
Chemical Identification	
Synonym	Garbage gas
Registration number with CAS:	
Chemical Family:	Mixture of gases, saturated / aliphatic hydrocarbons
Molecular Formula:	CH_4 (>80%), C_2H_6, C_3H_8 and C_4H_{10}
Structural Formula:	CH_4 (>80%), C_2H_6, C_3H_8 and C_4H_{10}
Description	
Appearance and Odor:	Colorless odorless gas.
Identification of Hazards	
General Emergency Analysis:	Gas is lighter than air at ambient temperature; easily inflammable; in unconfined spaces normally results in rapid combustion of the cloud; vapors may detonate if ignited in a confined space.
Potential Effects on Health	
Inhalation:	Is not toxic by itself. The inhaled vapors may produce respiratory difficulties and loss of conscience due to lack of oxygen. In large quantities it may cause asphyxia. (CH_4)
Potential Effects on Health	
Contact with the Skin:	It is not an irritant. Contact with liquefied gas may cause ulceration due to the cold (CH_4)
Contact with the Eyes:	It is not an irritant. Contact with liquefied gas may cause ulceration due to the cold and serious problems to the cornea (CH_4)
Ingestion:	Not applicable to gases

Exposure during a long/critical period:	None reported (CH_4)
Carcinogenic:	No specific data. Probably not carcinogenic (CH_4)
Teratogenic and Toxicity to Embryos:	Abnormalities in the brains of mouse fetuses were reported. Fatal cases of brain hemorrhages occurred in fetuses.(CH_4).
Reproductive Toxicity:	No specific data. Probably does not cause reproductive toxicity (CH_4)
Mutagenicity:	No specific data. Probably not mutagenic (CH_4).
Materials Toxically Synergic:	-
Accumulation Potential:	Does not accumulate (CH_4)

Fire and Explosion Parameters

Flash Point:	Inflammable Gas	
Lower Flammability / Exposure Limit:	5%	
Upper Flammability / Exposure Limit:	15%	
Spontaneous combustion / Ignition Temp.:	537°C	999°F
Sensitivity to Mechanical Impact:	Probably not sensitive. Stable material (CH_4).	
Sensitivity to Electrostatic Load:	May undergo instant ignition due to electrostatic discharge.	
Products of Combustion and Thermal Decomposition:	CO, CO_2 and H_20	

Measures for Accidental Leaks

Precautions:	Maintain any kind of ignition source well away; contain leak provided there is no risk to people, restrict access to area until completely clean; use adequate protection equipment; ventilate the area

Procedure for Removing the Product:	Use water spray to disperse vapor; isolate the area until the gas has dispersed.

Control of Personal Exposure/Protection

Exposure Limits:	IDLH (NIOSH) = 2,100 ppm; TLV- TWA = simple asphyxiating agent; PEL-TWA "Transitional Limits" (OSHA) = not established (CH_4)
NIOSH recommendations:	Up to 2,100 ppm use air mask (CH_4)

Physical-Chemical Properties

Molecular Weight:	17.3	
Conversion Factor:	1 ppm = 0.708 mg/m^3; 1 mg/m^3 = 1.412 ppm at 25^{o}C	
Fusion Point Temperature:	^{o}C	^{o}F
Boiling Point Temperature:	-161^{o}C	-257.8^{o}F
Relative Density:	Liquid: 0.466 a -164^{o}C (water = 1) (CH_4)	
Solubility in Water:	Slightly soluble (3.3 ml of gas/100 ml of water at 20^{o}C and 1 atm) (CH_4)	
Solubility in Other Liquids:	Slightly soluble in ethanol and acetone; soluble in ether, benzene and toluene.	
Vapor Density:	0.55 (air = 1)	
Vapor Pressure:	Not applicable	
Vapor Saturation Concentration:	Not applicable	
Evaporation Rate:	Not applicable	
Value of pH:	Not applicable	
Critical Temperature:	^{o}C	^{O}F

Physical-Chemical Properties

Partition Coefficient:	LogP(oct) = 1.09. (CH_4)	
Dynamic Viscosity:	-	
Critical Pressure:	01 kPa	0 atm

Surface Tension:	-
Stability and Reactivity	
Stability	Chemically stable
Danger of Polymerization:	Does not occur (CH_4)
Special Conditions:	Avoid static discharges, sparks, open flames and other sources of ignition
Hazardous Products of Decomposition:	None
Incompatibilities:	Strong oxidizing agents (such as peroxide and perchlorates), halogen compounds (CH_4)
Corrosiveness to metals:	Non-corrosive (CH_4)

2.5.2 GAS PIPELINE ALIGNMENT

For the purpose of presenting the alignment of the dedicated pipeline, Figure 2.5-1 shown below will be used.

The alignment starts at the Cabiúnas Station (PETROBRÁS), passing parallel to the existing GASDUC gas pipeline, until close to the crossing with the RJ-168 highway. As from this point, the alignment deflects approximately 90^o to the right, passing parallel to the PETROBRÁS water intake pipe, passing through areas with predominantly sugarcane plantations and pastures, in an almost straight line, crossing farmland to the Macaé Merchant TEP site.

2.5.3 CONSTRUCTION

This item presents the principle relevant aspects for constructing the dedicated pipeline, involving information regarding the labor to be employed, construction site, gas pipeline construction methods, necessary inputs and residues, plus a forecast of vehicle and special equipment traffic for construction.

Figura 2.5-1 Gas pipeline alignment

Labor

The forecast of labor to be used in constructing and operating the dedicated pipeline involves engineers, general foremen, storemen, timekeepers, helpers, guards, drivers, chargehands, welders, grinders, painters, operators, erectors and other professions normally employed in this type of work.

Existing company employees will initially be used for direct and indirect labor, which will be transferred to the site. At the end of the project, these employees will be demobilized and reallocated to other company contracts. In addition, it will be necessary to hire labor in the region, which will be laid off at the end of the work if there is no possibility of transfer to other company projects.

Construction site

In the area reserved for the construction site, the technical and administrative infrastructure necessary to construct the works will be installed, in addition to materials storage yards and parking areas for the construction machinery. The site facilities, which do not envisage lodgings for workers, will be deactivated during the last month of construction.

Construction Methods

The construction methods described below include preliminary work, cleaning the right of way strip, earthmoving, pipe bending, welding, trench opening, lowering the pipeline in the trench and backfilling, assembly of ancillary units, road crossings, planted and flooded areas or watercourses, hydrostatic testing, final cleaning and signs to be installed on the right of way strip after completion of the works.

Preliminary Work	It will be necessary to prepare a detailed line and level and land use survey to provide information for the final design of the dedicated gas pipeline. The existing access roads should be prepared to withstand construction traffic for the dedicated pipeline. The materials to be used in construction will be transported to the application locations by truck, from the storage yard at the site facilities.
Cleaning	Implies the removal of trees or other types of vegetation along the right of way strip and site facilities area.

Since the alignment follows the existing right of way, and in some places coincides with the latter, the need to remove bush or tree-sized vegetation will be reduced, with low vegetation prevailing.

Earthmoving Access to the selected alignment can be gained via various existing roads, reducing the need for earthworks, which should be limited to certain sections of the alignment.

Pipe Bending The pipeline will be curved wherever bends are required in the alignment. Appropriate machinery will be used for bending to ensure that no deformations occur that could subsequently affect the quality of the pipeline.

Welding Before commencing welding the pipes, they will be cleaned and inspected, and any necessary repairs made, principally at the ends. The pipes will then be lined up and held in place with clamps in order to commence welding. The welding system may be automatic or semiautomatic.

The welding quality will be evaluated, initially by visual inspection and subsequently using radiography techniques or other similar testing methods. If any defect is detected, repairs will be arranged immediately.

Trench Opening The trenches will be cut in such a way that the pipes have a minimum cover of 0.80 m from the upper level of the pipe. Since opening the trench is a stage that could lead to environmental risks, interfering in the productive potential of the land or causing an impact to the vegetation and water resources, the following measures should be taken:

- Storing the soil in separate layers, principally in flooded or cultivated areas, in such a way that the natural soil layers can be reinstated at the end of the work;
- Avoiding interference with existing drainage by the excavated material;
- Providing trench crossings for farms and locations where people or animal traffic is necessary;
- Maintaining the trenches open for the shortest time possible.

During execution of the works, the trenches will be protected by closed fences with daytime and nighttime signaling. Timber accesses will be provided with guardrails, and steel crossings for vehicles.

Laying the Pipeline and Backfilling the Trench

After concluding the trench opening and welding processes, the pipeline will be gradually lowered, distributing its weight uniformly on the ground. The following techniques will be used during this stage:

- Compaction of the soil to avoid future erosion problems. Either heavy equipment can be used or higher level backfilling of the trench to ensure that the future settlement of the soil will be compensated, with the exception of cultivated areas, locations where the drainage system could be obstructed, or a passage of any kind, in which case only the stipulated compaction may be used;
- Any water that remains in the trench may not be discharged directly onto exposed soil or flooded areas under any circumstances. If necessary, the discharge of internal water should be slow in order to minimize potential erosion and silting-up risks;
- The stratification of the original soil should be maintained during backfilling the trench, principally in flooded and cultivated areas, which may only begin after certifying that no defects exist in the pipeline or coating;
- The upper layer of soil should never be used as bedding material.

Assembly of Ancillary Items

Ancillary items such as block valves, air vents, drains and the cathodic protection system should be assembled or installed.

The cathodic protection system to be installed will be responsible for protecting the pipeline against corrosion, consisting of the installation of beds of anodes at various points along the pipeline. Due to the electrochemical process, it is possible to avoid oxidation of the pipe, since the reaction will occur primarily in the anode bed material. The potential difference will be continuously monitored during operation of the dedicated pipeline.

The position of the pipeline and other installations will be clearly signposted in a standardized manner.

The installation of sectioning valves is foreseen at the beginning and end of the pipeline to enable it to be isolated and minimize possible risks in the case of damage or breakage of the pipes.

The principal criteria for selecting the location of valves include facility of access, proximity to future consumption areas, stability of the ground where they are installed, etc, according to Brazilian

Standard NBR-12712.

The sectioning valves will be adequately protected against damage and operation by unauthorized individuals. The operating mechanism should be easily accessible.

Each sectioning valve position will be provided with purging valves, to enable the section of the pipeline between the two sectioning valves to be safely and rapidly purged.

Road Crossings

Along the alignment, the dedicated gas pipeline will cross roads which, due to their importance, require special care, which implies adopting specific construction methods to avoid interrupting them or minimizing interruptions.

Road crossings can be made using open trenches or nondestructive methods if necessary. The depth below the surface will vary according to the importance of the crossing, and should conform to the assembly details stated in the final design.

Crossings of Cultivated or Flooded Areas and Watercourses

The special care that should be taken to minimize impacts derived from constructing the dedicated gas pipeline at the crossings mentioned are described below:

- Determine the depth of soil that should be separated, as mentioned above and the location for storing the soil;
- Maintain the natural flow of drainage systems during construction;
- Inspect all drainage systems. If any damage occurs during construction of the gas pipeline, the system should be repaired until the original conditions are achieved or better;
- Provide the landowners with detailed information on any repairs carried out for future reference;
- Limit the quantity of equipment or construction activities;
- Reinstate the flooded areas and watercourses to their original configurations and shapes;
- Stabilize higher areas close to flooded areas to avoid erosion;
- Maintain the flow rates of watercourses, avoiding damming and reductions in the flow sections;
- Reduce the initial cleaning stage to a minimum close to watercourses, maintaining the maximum possible number of trees;

- Remove all materials and structures related with construction of the bed of each watercourse, and restore the banks and beds of watercourses after completing construction, thus avoiding contamination of watercourses with materials used.

At river and stream crossings, the pipeline should have a thickness corresponding to the upper category to be installed to ensure that the pipe remains secure against possible flooding and flotation.

The bedding should be carried out taking erosion into account. To achieve this, the pipeline should be buried at a sufficient depth to avoid it being affected, or designed with adequate protection.

Hydrostatic Test

After installation of the dedicated pipeline, the pipe sections should be filled with water to perform the hydrostatic tests necessary, to verify the integrity of the line. These tests basically consist of pressurizing the pipeline with water during a 24-hour period, and observing any pressure drops that would indicate the presence of leaks.

The water used in the test will be taken from rivers or other local watercourses. After concluding the test, the water will be removed from the pipeline and if necessary, filtered, analyzed for contaminating agents, treated and discharged in well-drained locations through a system specifically constructed for this purpose. Impacts on the environment will be minimized by using the following techniques:

- hydrostatic tests on sections of pipeline crossing watercourses should be performed before installation at the location;
- Filling and emptying the pipeline should be carried out according to the necessary licenses;
- Discharge of water into watercourses with sufficient capacity or areas with vegetation, controlling the discharge of flow to avoid erosion of flooding.

Final Cleaning

The cleaning should commence immediately after concluding the trench backfilling work. This cleaning should be complete, including the right of way area, roads and accesses and supporting areas used during construction of the pipeline.

Pipe support material, residues from welding operations and packaging should be removed, stored and adequately disposed of.

	The areas involved should be restored as far as possible to return them to their original appearance and drainage, stability and vegetation conditions, or condition related with land use.
Signposting	After concluding the works, the pipeline alignment should be marked out by placing identification streamers for the buried pipeline, along the entire alignment, and identification signs installed.

Inputs and Residues

The main inputs to be used during construction of the project are the water to be consumed principally at the site facilities, diesel oil used for internal combustion engines of movable equipment, lubricants, electricity and materials to be applied directly to the works, such as pipes, welding consumables and consumption materials typical of construction sites, such as food, office materials and others.

The most significant residues are scrap, used lubricants, domestic garbage (cardboard boxes, canteen remnants, etc), sanitary effluents from the site facilities, and water used for filling the pipeline and performing hydrostatic tests, which will be discharged to the local drainage at the end of the test. .

Domestic garbage will be disposed of at the public landfills. Sanitary effluents from the site facilities will be treated by chemical toilets..

Control measures will be implemented on the discharge of products (fuel, oil, lubricants and other potentially hazardous materials), and also measures will be planned for activating in the case of the spillage of any product during the construction phase of the gas pipeline. The spill control measures comprise the following:

- Preparing an inventory of material that could be accidentally spilled during construction;
- Training the construction teams to avoid accidental spillage of chemical products, including providing information to the teams with respect to the laws and regulations applicable to their work;
- Inspection and maintenance of the equipment involved;
- Ensuring that fuelling or lubrication of equipment is carried out at least 15 m from watercourses or flooded areas;
- Storing sufficient containment equipment and material at locations close to where the potentially hazardous products are stored, sufficient to contain or absorb them in the case of spills.

A solid residue management program will be prepared for the project, to provide guidelines for material management, reduce adverse impacts on the environment, reduce risks and ensure compliance with existing standards.

Forecast of Vehicle Traffic and Special Equipment

Various vehicles and large equipment will be used during the construction work of the gas pipeline, which will follow the construction fronts. These include cars, trucks equipped with hydraulic cranes, backhoes, tipper trucks, side booms, welding machines, welding sets, pipe beveling machines, pickups and air compressors.

2.5.4 OPERATION

After completing the installation and testing of the dedicated gas pipeline, the natural gas supply operation will commence from the PETROBRÁS unit at Cabiúnas. EL PASO has wide experience in operating similar and more complex systems. However the pipeline should be operated by CEG or PETROBRÁS itself, depending on the conclusion of negotiations currently underway. For the purposes of this characterization, the standards of CEG, which holds the concession to transport and distribute gas in Rio de Janeiro, are presented.

The operations planned include those connected with observation and leak detection as described below:

Observation Operations

The Observation Operations comprise Type A Route Inspections, to be carried out by aerial means, by vehicles or on foot, and Type B Route Inspections, which should be carried out in the area surrounding the pipeline, on foot or using low-speed vehicles. In addition, the frequencies used for each of these types of inspection depend on the definition of the classes given below:

- **Class 1**: regions where 10 or less single-family dwellings exist;
- **Class 2**: regions where more than 10 or less than 46 single-family dwellings exist;
- **Class 3**: areas with more than 46 buildings for human occupation or where the pipeline is less than 90 m from buildings or defined external areas occupied by 20 persons or more during normal use;
- **Class 4**: regions where there is a predominance of buildings of 4 or more floors.

The above information is used to define the yearly frequency of inspections, according to the CEG NT-200 internal regulation, shown in the following table:

Class	Inspection Type A	Inspection Type B
1	2	1
2	2	2
3	4	2
4	4	2

Leak Detection Operation

The leak detection operation should be carried out according to the CEG internal regulation, at leak detection frequencies according to the following table:

Network Characteristics	Frequency of Procedure
High pressure, outside urban areas	Every 4 years
High pressure, inside urban areas	Annually
Medium pressure, polyethylene ducts (or other material except steel)	Annually
Gas pipelines with more than 3 leaks/km	Annually
Others	Every 2 years

2.5.5 MAINTENANCE

Maintenance of the dedicated pipeline will be according to the standards established for each component of the project and the frequencies defined in the Gas Pipeline Maintenance Plan. The maintenance plan covers the systems defined below.

- **Maintenance of Regulating Stations:** these will be carried out according to the class of each station and following the number of checks established in the following table.

Class	Procedure/year		
	Inspection	Review	Maintenance
1	6	3	Every 3 years
2	4	2	Every 3 years
3	2	2	Every 3 years

- **Valve Maintenance:** The gas pipeline valves should be reviewed annually.

- **Maintenance of Cathodic Protection Installations:** will comprise inspection, review and maintenance services. The inspection work on cathodic protection stations and stray current drainage stations should be inspected monthly. The review will involve measuring the potential at common potential points on a half yearly basis, at principal potential points on a quarterly basis and essential potential points monthly. With respect to recording the 24-hour potential for common potential points, these should be annual, whilst those for the principal potential points will be two-monthly, and monthly in the case of essential potential points. The remaining review operations will be carried out every six months.

- **Maintenance Service:** the maintenance services on the cathodic protection stations will be carried out yearly.

The vehicles used for maintenance will be vans for programmed services and trucks in the case of heavy emergency work. The frequency of the programmed services should be according to the Gas Pipeline Maintenance Plan, in other words quarterly inspections; annual stray current detection; monthly cathodic protection and annual valve maintenance.

2.5.6 DEACTIVATION

The deactivation process for the dedicated pipeline will occur after its minimum useful life of 20 years has elapsed. Its life may reach 50 years if the cathodic protection installed is effective. At the end of this period, depending on the state of the pipeline and the operational requirements of the plant, it could be deactivated or continue operating.

If the pipeline is replaced or distribution of gas through the pipelines discontinued, both ends will be disconnected and all openings closed and sealed. At locations where the pipeline is subject to pressure or external forces, the line will be closed at the ends.

2.5.7 ENVIRONMENTAL INSPECTION

To ensure that the gas pipeline is monitored over its entire length and in this way possible adverse environmental impacts mitigated, a qualified inspector will be contracted with the following main responsibilities, amongst others:

- Ensure that all construction activities occur in authorized working areas, and that only approved access roads are used

- Inspect the construction activities daily to ensure that the requirements aimed at reducing adverse environmental impacts are being complied with;
- Ensure that the correct techniques for crossing flooded areas and watercourses are being adopted;
- Monitoring the hydrostatic testing and any spills of other products;
- Monitoring the collection and disposal of residues.

2.5.8 SAFETY

Right from conception, passing through the design and construction and subsequent operation, safety will always be the principal guideline for the gas pipeline. Therefore maximum security measures will be taken from the initial alignment concept, continuing through construction and assembly, and remaining during the entire useful life of the equipment. This object of this concern is to avoid possible accidents with workers and residents.

The dedicated gas pipeline will be designed, constructed, operated and maintained according to Brazilian and international standards, and also based on standard engineering procedures to protect the public from any failures, complying with Brazilian requirements stated in NBR-12712 and also ASME B31.8, which contains specific and rigorous requirements.

Safety training will be given in groups to construction and inspection personnel after commencing construction. Weekly safety meetings will be established for all personnel involved in the construction, who will be made aware of the need to follow the established procedures. In addition, the provisions of Administrative Rule No. 3214 from the Ministry of Labor will be adopted, which regulate the formation of safety committees – CIPA, according to Brazilian legal requirements.

NBR-12712 also defines an area classification based on the population density close to the gas pipeline and determines more rigorous safety requirements in highly populated areas. The class allocation unit is composed of an area extending over 200 m on each side of the pipeline with a continuous length of 1600 m. The four areas defined using this criterion are the following:

- **Class 1**: areas with more than 10 constructions for human occupation;
- **Class 2**: areas with between 10 and 46 constructions for human occupation;
- **Class 3**: areas with more than 46 constructions for human occupation or where the pipeline is less than 90 m from buildings or external areas occupied by 20 or more people during normal use;
- **Class 4**: areas with buildings of 4 or more floors.

The area classification will determine parameters such as the depth of the pipeline, distance between block valves, design pressures for the pipes, hydrostatic test pressures and inspection frequencies.

Signposting of the right of way strip will be according to the criteria established in the CEG Technical Standard NT-816.

2.5.9 STANDARDS APPLIED

The design criteria to be adopted to completely define the pipes making up the dedicated pipeline that will connect the PETROBRÁS unit at Cabiúnas with the Macaé Merchant Thermoelectric Plant are listed below.

- For calculating the thickness of the pipes used to construct the pipeline, the Brazilian Standard NBR-12712 and the US Standard ANSI-B.31.8 will be used, also taking into account the minimum thicknesses required for assembling and handling the pipeline which, if less than the calculated values for the design temperature, pressure and external loadings, will be adopted;
- For constructing the pipes comprising the pipeline, mild steel to the API 5L grade X65 or better will be used;
- To quantify the welding procedures, approve the welders and for radiographic inspection, chapter 28 of the NBR-12712 Standard will be used, complemented by the API 1104 specification;
- The watertightness and mechanical strength will be inspected using chapter 29 of the NBR-12712 Standard;
- The external coating will be placed in accordance with the AWWA, DIN 30.670 or similar standards;
- To inhibit external corrosion of the pipes, a cathodic protection system in accordance with Brazilian Standard NBR-12712 will be adopted.

In addition to those cited above, the following standards, procedures and regulations will also be used:

- **NBR-12712/1993**: Design of combustible gas transmission and distribution systems;
- **API 1104**: Standard for Welding Pipelines and Related Facilities;
- **API 5L**: Specification of line pipe.
- **API 6D**: Valves
- **API RP 1102**: Railroad and highway crossings
- **ASTM A 216**: Cast carbon steel components for welding and high temperature service;
- **ASTM A 106**: Carbon steel pipe-seamless for high temperature service;

- **ASTM A 105**: Carbon steel forgings for high temperature service;
- **ASTM A 193**: Alloy steel bolts and protection;
- **ASTM A 194**: Carbon steel and alloy steel bolts and nuts;
- **ASTM A 234**: Piping materials and accessories;
- **ASME B31.8**: Gas Transmission and Distribution Piping Systems;
- **ANSI B36.10**: Welded and Seamless Wrought Steel Pipe;
- **ANSI B36.19**: Stainless Steel Pipe;
- **ANSI B16.9**: Factory-Made Wrought Steel Buttwelding Fittings;
- **ANSI B16.5**: Pipe Flanges and Flanged Fittings;
- **ANSI B16.11**: Forged Steel Fittings, Socket Welding and Threaded;
- **ANSI B16.10**: Face-to-Face and End-to-End Dimensions of Ferrous Valves;
- **ANSI B16.20**: Ring Joint Gaskets and Grooves for Steel Pipe Flanges;
- **ANSI B16.21**: Nonmetallic Gaskets for Pipe Flanges;
- **ANSI B16.25**: Buttwelding Ends.

Complementing the specifications cited, DNER Service Order DG N° 003/98, DER-RJ Instructions for Constructing Pavements, the Regulations of Administrative Rule No 3214 dated June 8, 1978 and Chapter V, Item II of the Consolidated Labor Laws (CLT) will also be taken into consideration.

2.6 LANDSCAPING REHABILITATION DESIGN

In parallel with the detailing of the final design for the Macaé Merchant Plant and the dedicated pipeline, aspects will be identified to orient the concept of the landscaping and rehabilitation design for the areas degraded by the construction process.

In principle these designs should observe the following guidelines:

- Preservation of remaining vegetation;
- Conservation of topsoil for reapplying during replanting activities;
- Planting over the whole area not used for construction or yards, accesses, parking, etc;
- The use of native plants in landscaping designs, especially those attractive to fauna;
- Installation of hedges and vegetation barriers, large trees and other resources suitable for the visual integration of the buildings with the scenery, and establishing acoustic protection;
- Programming maintenance and monitoring performance of the designs up to consolidation.

3. PERTINENT ENVIRONMENTAL LEGISLATION

3 PERTINENT ENVIRONMENTAL LEGISLATION

This Chapter contains a review of the environmental legislation falling on and pertinent to the licensing of the Macaé Merchant Thermoelectric Plant, located in the Municipality of Macaé, RJ. In addition to specific matters of environmental licensing, special attention has been paid to aspects of environmental and institutional control and protection.

This chapter aims to assist the environmental agency responsible for the licensing and provide information to enable the developer to make informed decisions in respect of perfecting the project, with a view, based on prior licensing, to consolidating its installation and operation.

Certain aspects are important for an understanding of the environmental questions associated to the implementation of a project. Of these, the following apply particularly to the Macaé Merchant Thermoelectric Plant:

a) The National Environmental Policy, established by Law nº 6.938/81 and confirmed by the Federal Constitution of 1988, and other Federal laws pertinent to the area and the project;

b) The requirements of the project in relation to water resources, and the associated infrastructure (gas pipeline and transmission line; highways);

c) The legal and institutional framework for environmental protection in the state of Rio de Janeiro, with the emphasis on the pollution control regulations, which are the responsibility of FEEMA;

d) The legislation of the municipality of Macaé, especially that referring to land use, and in compliance with its Municipal Charter, enacted on April 5, 1990, and in respect of its Directive Plan;

e) The recent setting up of an inter-municipal consortium for the environmental management of the basins of the rivers Macaé and Macabu, Lagoa Feia and the adjacent coastal zone.

Considering the diversity of the themes, the most relevant laws have been selected and are presented below in accordance with the natural resource or the use to be made of it by the Macaé Merchant Hydro Electric Plant.

Analysis of the environmental legislation in force and applicable to this project will make it possible to envisage the existing obstacles to the project and to obtain a prior license, as well as assisting in adopting measures and action programs to minimize the impacts identified.

3.1 ENVIRONMENTAL LICENSING AND THE CONSTITUTIONAL STRUCTURE OF JURISDICTIONS

3.1.1 GENERAL ASPECTS OF THE FEDERAL CONSTITUTION

The Federal Constitution of 1988 provided a powerful stimulus to environmental protection by establishing, in article 225, that "everyone has the right to an ecologically balanced environment, an asset for the common use of the people and essential to a healthy quality of life, it being incumbent on the public authorities and society to defend and preserve it for present and future generations ".

In fact, the theme of the environment was included in the Federal Constitution in different forms:

- Title II - Fundamental Duties and Guarantees, refers to popular environmental action (art. 5, LXXIII)
- Title III - Organization of the State - highlights the sharing of jurisdiction mentioned on the theme from the global and sectorial viewpoints: forests, fauna, water, nuclear activities, protection of the land, preservation of nature, protection of natural resources (arts. 22 and 24);
- Title IV - Organization of the Authorities - the insertion of the current exclusive jurisdiction of the National Congress in the field of nuclear activities will be noted (art. 49, XIV), and also, the inclusion of protection of the environment among the institutional duties of the public ministry (art. 186, II);
- Title VII - Economic and Financial Order - the protection of the Environment was included as one of the general principles of economic activity (art. 170, VI) and in the chapter on agricultural and agrarian policy and agrarian reform, ownership fulfils its social function when it preserves the environment (art. 123,III);
- under Title VIII - Social order - the theme is mentioned in the chapters on Health (art. 200, VIII), Culture (art. 216, V) and the Indians (art. 231, § 1), in the form of a chapter totally and specifically dedicated to the environment (art. 225 and paragraphs);

In the chapter dedicated to the Environment, the Constitution establishes that the Public Authorities shall (art. 225):

> *I – protect and establish the essential ecological processes and promote the ecological management of species and ecosystems;*
>
> *II – preserve the diversity and integrity of the genetic patrimony of the country;*
>
> *III –establish, in all the Federal units, territorial areas and their elements to receive special protection, whereby changes and cancellation are permissible only through laws, and any use that may compromise the integrity of the features that justify its protection is prohibited;*

IV – demand, in accordance with the law and prior to the commencement of works or activities that could potentially cause significant damage to the environment, a study of the environmental impact, to be published;

V – control the production, commercialization and use of techniques, methods and substances that endanger the quality of life and the environment.

VI – promote environmental education at all levels and public awareness in respect of preservation of the environment.

VII – protect fauna and flora, whereby any acts that endanger the ecological function, promote the extinction of species or expose animals to cruelty are prohibited.

Furthermore, article 225, paragraph 4, declares the Atlantic Rainforest, the Serra do Mar and the Coastal Zone, ecosystems present in the area in question, as a natural heritage, ensuring that "it must be used in accordance with the law, under conditions that ensure the preservation of the environment, including in respect of the use of natural resources".

Article 225 of the Federal Constitution also establishes the obligation of individuals and legal entities to repair environmental damage, without prejudice to legal and administrative sanctions (Paragraph 3).

These constitutional regulations served to ratify what was already taking place, in practice, at the level of ordinary federal and state legislation. In the last two decades, numerous laws, decrees and rulings for the conservation of the environment have been incorporated into Brazilian law.

With regard to jurisdiction to legislate on the Environment, the Federal Constitution instituted a change by establishing the concurrent jurisdiction of the Federal Government, States and Federal District (Article 24), limiting the jurisdiction of the Federal Government to that of establishing general rules, that is, rules that, by their nature, may be applied to the whole of the Brazilian territory. Article 24, Paragraph 1 of the Federal Constitution establishes this general nature of the federal regulations; Paragraph 3 of the same article establishes the particular nature of the state regulations and Article 30, sub-item I, establishes the local interest of municipal regulations. Municipalities have, however, an additional jurisdiction. It is not the purpose of the general regulations to encroach on the field of the regional or state peculiarities or exclusively local interests, and to do so would be unconstitutional.

3.1.2 THE NATIONAL ENVIRONMENTAL POLICY

The National Environmental Policy was established by Federal Law 6.938 of August 31,1981, amended by Laws 7.804, of July 18 1989 and 8.028, of April 4,1990. It is currently regulated by Decree 99.274, of June 6,1990, which repealed Decree 88.351/83 and a number of others that governed it. Decree 99.274/90 was subsequently amended by Decrees 99.355, of June 27, 1990 and 122, of May 17,1991. The

environment is defined by Law 6.938/81 as the "combination of conditions, laws, influences and interactions of a physical, chemical and biological order that permits, shelters and governs life in all its forms" (art. 3, sub-item I).

Under Law 6.938/81, environmental resources are considered to be "the atmosphere, surface and subterranean inland waters, estuaries, territorial seas, the land, the subsoil, the elements of the biosphere and the fauna and flora " (art. 3, V).

The objective of the National Environmental Policy *"is the preservation, improvement and recovery of environmental quality propitious to life, with a view to ensuring, in Brazil, conditions for social and economic development, in the interests of national security and the protection of the dignity of human life ",* establishing the principal that *"government action in maintaining the ecological equilibrium should consider the environment as a public heritage that must necessarily be guaranteed and protected, bearing in mind its collective use "* (art.2).

The National Environmental Policy is put into effect through the drawing up of rules and plans to guide the actions of the Federal, State, Federal District, and Municipal Governments with regard to the conservation of the environment, and also those of public and private business activities. On the organizational front, article 6 of the environmental law created the National Environmental System - SISNAMA, with the following structure:

- Higher body: the Government Council;
- Advisory and decision-making body: the Conselho Nacional do Meio Ambiente (CONAMA);
- Central body: the Ministry of the Environment, Water resources and Legal Amazonia;
- Executive body: the Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis - IBAMA;
- Sectional bodies: those organizations and institutions of the direct or indirect Federal Public Administration whose activities relate to the environment;
- Departmental bodies: the organizations or state agencies responsible for the coordination of environmental management;
- Local bodies: the organizations or municipal agencies responsible for the coordination of environmental management.

The Government Council was created in 1990 by Law nº 8.028. In the ambit of SISNAMA, the role of the Government Council is to *"advise the President of the Republic in setting up the national policy and on government directives for the environment and environmental resources"* (art. 6º, I of Law 6.938).

The National Environmental Council - CONAMA, is made up of representatives of Federal Government and State bodies, of business and workers' class associations and by representatives of environmentalist NGO's. The presidency of CONAMA is held by the Minister of the Environment. Within the SISNAMA structure, the purpose of

CONAMA is to *"assist, study and propose to the Government Council guidelines for government policies for the environment and natural resources and decide, within its sphere of jurisdiction, on rules and standards compatible with an ecologically balanced environment, essential to a healthy quality of life"* (art. 6, II of Law 6.938).

In SISNAMA, the attributes of the Ministry of the Environment are to "*plan, coordinate, supervise and control, as a federal body, the national policy and the government guidelines established for the environment*" (art. 6, III of Law 6.938), with the function of IBAMA, a body linked to the Ministry of the Environment, being to "*carry out and cause to be out, as a federal organization, the government policy and guidelines set for the environment*" (art. 6, IV of Law 6.938). It is also an attribute of IBAMA "*to promote the inspection of activities of exploitation...of water resources, with a view to their conservation and development, and also the protection and improvement of the environment*" (art. 1, X, of Decree 78 of April 5, 1991).

The sectional bodies of SISNAMA are "*those organizations or agencies of the direct or indirect Federal Public Administration, and Foundations set up by the public administration, whose activities are, directly or indirectly, associated with the protection of the quality environmental or with disciplining the use of the environmental resources*" (art. 6, V of Law 6.938).

The departmental bodies are the *"organizations or state agencies responsible for the execution of programs and projects and for the control and supervision of activities capable of provoking environmental deterioration"* (art. 6, VI of Law 6.938). All the departmental bodies are part of CONAMA. In the case of Rio de Janeiro, the sectional body is the Environment Agency (SEMA/RJ).

The local bodies are *the organizations or municipal agencies responsible for the control and inspection of activities susceptible to degrading the quality of the environment, in their respective jurisdictions"* (art.6, VI of Law 6.938).

Article 9 of Law 6.938 lists the instruments for enforcing the National Environmental Policy; namely:

> *"I - the establishment of environmental quality standards;*
>
> *II - environmental zoning;*
>
> *III - evaluation of environmental impacts;*
>
> *IV - the licensing and review of effectively or potentially pollutant activities;*
>
> *V - the promotion, production and installation of equipment, and the creation or absorption of technology, leading to an improvement in environmental quality;*
>
> *VI - The creation of territorial areas, specially protected by the Federal, state and municipal public administration, such as environmental protection areas, of significant ecological interest and extractive reserves;*
>
> *VII - the national environmental information system (SINIMA);*

VIII - the Federal Technical Register of Activities and Instruments for Environmental Protection;

IX - the disciplinary or compensatory penalties for non-compliance with the measures required for protection from or correction of environmental deterioration;

X - The institution of the Environmental Quality Report, to be published annually by the Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis - IBAMA;

XI - The guarantee to provide information relating to the Environment, which the Public administration undertakes to produce, where none is available;

XII - the Federal Technical Register of potentially pollutant activities and/or those using environmental resources".

Article 1, Sub-item I, Decree nº 99 274/90, which substituted Decree nº 88 351/83 in regulating Laws nºs 6.902/80 and 6.938/81, establishes the authority of the Public administration, at the different levels of government, to maintain the permanent supervision of environmental resources, with a view to combining economic development with protection of the environment.

3.1.3 ENVIRONMENTAL LICENSING

Among the instruments listed in Law 6.938/81, which created the National Environmental Policy, those referred to in sub-items III and IV (evaluation of environmental impacts and the licensing and review of effectively or potentially pollutant activities) are of special note. These instruments enable the state environmental department to permit, promote, modify or even reject the implementation of public or private ventures and activities involving the use of environmental resources.

According to Art. 10 of the above-mentioned Law, *"the construction, installation, extension and functioning of establishments and of activities using environmental resources, considered effectively or potentially pollutant, and of those capable, in any way, of causing environmental deterioration, will require additional prior licensing by the pertinent state department, part of the Sistema Nacional do Meio Ambiente - SISNAMA, and of the Instituto Brasileiro do Meio Ambiente e Recursos Naturais Renováveis, IBAMA, without prejudice to other licenses required."*

There are three licenses that can be issued by the state environmental organizations and IBAMA (Art. 19 of Decree nº 99.274), namely:

I – Preliminary License (LP), at the preliminary planning stage for the activity, stating the basic requirements to be met at the localization, installation and operation stages, paying attention to the municipal, state or federal plans for land use.

II - Installation License (LI), authorizing implementation to begin, in accordance with the specifications given in the approved Executive Project and;

III - Operating License (LO), authorizing, after the necessary checks, the start of the licensed activity and the functioning of its pollution control equipment, in accordance with the terms of the Preliminary and Installation Licenses.

To obtain one of the licenses, Article 9, sub-item III, of Law 6.938/81 establishes as a prerequisite the "appraisal of environmental impacts". The appraisal of environmental impacts (AIA), according to Rohde (1990), is an "instrument of environmental policy made up of a series of procedures with the aim of ensuring, from the beginning of the process, that a systematic examination is carried out of the environmental impacts of a proposed action (project, program, plan or policy), and of its alternatives, whereby the results are adequately presented to the public and to those responsible for decision-making, and are thus duly considered by them before the decision is taken".

The Environmental Impact Study (EIA) and the Environmental Impact Report (RIMA) were created by Decree 88.351/83 (art. 18) in order to provide an appraisal of environmental impact. As this Decree lost its effect, having been revoked by Decree 99.274/90, the EIA and the RIMA were defined in article 18 of the latter Decree.

On regulating Law 6.938/81, Decree 88.351/83 (currently substituted by Federal Decree n^{o} 99.274/90), in its article 7, sub-item III, delegated to the National Environmental Council (CONAMA) the authority to establish rules and general criteria for the licensing of potentially pollutant activities.

Thus in 1986, CONAMA, in its sphere of authority, issued Resolution 001 of January 23, defining environmental impact as "any change in the physical, chemical and biological properties of the environment, caused by any type of matter or energy resulting from human activities that, directly or indirectly, affect (i) the health, safety and well-being of the population; (ii) social and economic activities; (iii) the biota; (iv) the aesthetic and sanitary conditions of the environment; and (v) the quality of the environmental resources".

Recently, considering the need for a review of the procedures and criteria used in environmental licensing and for the establishment of criteria for the exercise of the authority to license – among other considerations - CONAMA approved Resolution n^{o} 237, of December 19, 1997, which deals with the same subject and updates some of the concepts laid down in 001/86.

This Resolution, while maintaining the structure of Resolution 001/86, carried on to specify the basic criteria for the preparation of the Environmental Impact Study (EIA) and the Environmental Impact Report (RIMA), as instruments of the National Environmental Policy, and requirements for the licensing of work or activities that could potentially cause significant deterioration of the environment.

The EIA must comply with a series of requirements, laid down by CONAMA Resolution 001/86: it must consider all the technological alternatives and those relating to localization of the project, and compare them with the hypothesis of not putting the project into effect; systematically identify and appraise the environmental impacts generated at the installation and operational stages of the activity; define the limits of

the geographic area that will be directly or indirectly affected by the impacts, referred to as the area of influence of the project, considering, in all cases, the hydrographic basin in which it is located; consider its compatibility with government plans and programs, proposed and in the process of implementation in the area of influence of the project (CONAMA Resolution 001/86, Article 5).

The RIMA, in turn, should be presented "in an objective and suitably understandable form". Disclosure of the RIMA is a fundamental requirement, to enable public organizations and the population to voice their opinions (Resolution 001/86, Article 9, sole paragraph, and Article 11, and Resolution 237/97, art. 3).

CONAMA Resolution 237/97 established that the proposer of the project should be responsible for the expenses and costs of carrying out the Environmental Impact Study (art. 11), such as the collection and acquisition of the data and information, field work and inspections, laboratory analyses, technical and scientific studies and observing and monitoring the impacts, preparation of the RIMA and supplying at least five copies.

Only individuals and corporate entities registered in the Federal Technical Register of Activities and Instruments for Environmental Protection may carry out environmental impact studies (Art. 17 of Law nº 6.938/81). The studies should be "carried out by legally qualified professionals" (art. 11 of CONAMA Resolution 237/97), and these professionals are responsible, together with the developer, for the information submitted, being subject to administrative, civil and penal sanctions (CONAMA Resolution 237/97, sole paragraph of art. 11).

In accordance with CONAMA Resolution nº 237/97, the implementation of a project such as the Macaé Merchant Thermo-electric Plant is subject to environmental licensing.

Requests for licensing, renewal and the actual concession should be published in the official state newspaper, as well as in a regional or local periodical with wide circulation (Law 6.938, article 10, § 1).

In accordance with art. 19, § 2 of Decree nº 99.274/90, CONAMA is responsible for fixing the timeframes for concession of the licenses (LP, LI and LO) taking into account the technical nature of the activity; thus CONAMA Resolution nº 237, of December 19, 1997, fixes a timeframe of up to six months for the granting of a license in cases which do not involve the holding of a public hearing, and of up to one year if there is a hearing.

Among the new features introduced by CONAMA Resolution nº 237, of 1997, in addition to those already mentioned, it is worth noting the prominence given to municipalities. According to article 6 of this Resolution, “the environmental licensing of projects and activities of local environmental impact and those which have been delegated by the State through a legal document or agreement falls to the municipal environmental department, after hearing the pertinent Federal, State and Federal District bodies, where applicable”. In the case in question, the licensing will be responsibility of the state environmental department.

It should be noted that article 10, paragraph 1, of this same resolution establishes that the licensing procedure should commence with the classification of the project (description of the engineering), and must include the City Hall certificate to the effect that the type of project or activity complies with the municipal legislation for the use and occupancy of the land; authorization from the pertinent environmental department for the elimination of vegetation; and the granting of the right to use the water.

3.1.4 GENERAL ASPECTS OF THE STATE CONSTITUTION AND OF THE STATE ENVIRONMENTAL POLICY

The Constitution of the State of Rio of Janeiro, enacted on October 5, 1989, similarly to the Federal Constitution, includes in its text a specific chapter devoted to the environmental question, establishing principles or imposing rules for the management of the environment and its resources.

In the Provisional Constitutional Provisions Act, the following articles are worthy of mention: 26, 27 and sub-items, 39, 43, 44 and 58.

The State Environmental Control Policy was introduced in the State of Rio of Janeiro in 1975, through Decree-Law 134 of June 16, and includes "the set of administrative and technical directives intended to establish the government action in the field of the rational use of the environment, with a view to protection from and control of all forms of environmental pollution". Subsequently, the Decree-Law was regulated by Decrees 1.633, of December 21, 1977, 2.330, of January 8, 1979 and 8.974, of May 15, 1984.

Environmental policy is put into effect through its main instrument, SLAP – the Pollutant Activities Licensing System. The objective of SLAP, created by Decree 1.633/77, is to "discipline the implementation of any equipment or activities considered pollutant or potentially pollutant, and of any equipment for combating environmental pollution". The regulation and improvement of SLAP are controlled by a series of Executive Branch Decrees and the decisions of the State Environmental Control Commission - CECA.

Decree 21.258, of January 1, 1995, established the new structure of the Executive Branch, creating the Environment Office - SEMA, linking to it the following bodies:

- State Environmental Engineering Foundation - FEEMA
- State Forestry Institution Foundation - IEF
- State Superintendency of Rivers and Lakes Foundation - SERLA
- Department of Mineral Resources - DRM
- Environmental Control Fund - FECAM
- Coastal Protection Council - CODEL
- State Council for the Control of Pesticides and other Biocides - CECAB
- State Environmental Council - CONEMA

- State Environmental Control Commission - CECA

It is CONEMA's role to establish the guidelines of the State Environmental Control Policy and guide the state government in the protection of the environment. CECA has the authority to exercise the policing power inherent to pollution control and environmental protection, applying sanctions, approving measures and technical rules and authorizing the implementation of potentially pollutant activities. It counts on the technical and administrative support of FEEMA.

CODEL's function is to draw up proposals for macro-zoning and development of the coastal area of the State, implement a state plan for the prevention and control of accidental pollution, and to review and approve plans, programs and projects located in the coastal zone.

FEEMA is the executive department of the State Environmental Control Policy, and is responsible for providing technical support and suggesting to CECA measures for the protection and improvement of the environment; performing licensing, on behalf of CECA, and supervision of compliance with the pollution control regulations; measuring, being informed about and controlling environmental pollution, in all its forms, adopting measures to provide solutions; planning, coordinating and executing activities to combat vectors of diseases and promoting research and technical studies in the field of environmental protection.

SERLA is responsible for the water resource management policy in the state field of action, which includes the improvement and recovery of lake and river basins, carrying out and conservation of works for the control of floods and erosion, of macro and micro-drainage, the evaluation and study of hydrographic basins, and inspection of the lands bordering on the beds and channels of the bodies of water.

The IEF acts as the executor of the Forestry Policy of the State of Rio of Janeiro, with the duties of preserving the fauna, flora and the land; encouraging reforestation; creating and administering conservation units; organizing the replacement, exploitation, circulation and consumption of raw forestry materials, studying and researching the floral and faunal heritage, its use and commercialization.

The State Environmental Control Fund - FECAM, serves to implement programs and projects for the recovery and preservation of the environment.

In 1999, with the change of government, changes were made to the State structure, with the creation of SEMADS – the Environment and Sustainable Development Office, with practically the same duties. The most significant change in structure was the withdrawal of the DRM to form part of the State Power Office.

3.1.5 ENVIRONMENTAL LICENSING IN THE STATE OF RIO OF JANEIRO

In general, the process of licensing and appraisal of environmental impacts adopted by the State of Rio of Janeiro is similar to that described in the federal regulations and is

consolidated in Decree 1.633/77, which created SLAP – the Pollutant Activities Licensing System.

The SLAP licensing process, which pre-dates Federal Law 6.938/81, involves three separate stages, through the granting of the environmental licenses referred to in article 4 of Decree 1.633/77. The State Environmental Control Commission - CECA and FEEMA are responsible for making SLAP operational.
The regulation and improvement of SLAP are controlled by a series of Executive Branch Decrees and the decisions of the State Environmental Control Commission - CECA.

State Law 1.356, of October 3, 1988, which deals with procedures relating to the preparation, analysis and approval of the Environmental Impact Studies, and establishes additional obligations for the developer, especially in articles 3, 4 and 5, paragraphs 1 and 7, transcribed below:

> *"Art. 3 - the Environmental Impact Report will summarize, in an objective fashion, the information provided in the Environmental Impact Study, and will be prepared using everyday language, understandable by the representatives of the communities affected."*
>
> *"Art. 4 - the name and professional qualifications of all the technical personnel responsible for preparation of the Environmental Impact Study should be stated in the document."*
>
> *"Art. 5, Paragraph 1 - the start of preparation of the Environmental Impact Study, and, after its completion, the place, times and periods in which the documents referred to in the main clause of this article, and the invitations to the public hearings referred to in article 6 of this Law, must be published in the main section of at least 3 (three) daily newspapers with a large circulation in the whole of the State of Rio of Janeiro, under the title "Environmental Impact Study" or "Public Hearing".*
>
> *"Art. 7 - All the following expenses will be for the account of the proposer of the project:*
>
> *a) preparation and copying of the Environmental Impact Study and the Environmental Impact Report - RIMA;*
>
> *b) publications in newspapers referred to in article 5, paragraph 1, of this Law;*
>
> *c) analysis and issuance of technical reports on the Environmental Impact Study;*
>
> *d) supervision."*

CECA's main resolutions in relation to evaluation of environmental impacts are:

- CECA Resolution 003/77 – regulates the Pollutant Activities Licensing System.
- CECA Resolution 1.078/87 – Guidelines for implementation of the Environmental Impact Study (EIA) and the respective Environmental Impact Report (RIMA).
- CECA Resolution 1.173/87 - Participation and supervision of the community in the Evaluation of Environmental Impact process (AIA).

- CECA Resolution 1.344/88 – Regulates the holding of public hearings as part of the Pollutant Activities licensing process, subject to presentation of the EIA/RIMA.
- CECA Resolution 2.117/90 - Guidelines for the implementation of the EIA/RIMA.

3.1.6 AUTHORITY FOR THE ENVIRONMENTAL LICENSING OF THE PROJECT IN QUESTION

The authority for environmental licensing of the present venture falls to the State Office of the Environment and Sustainable Development of the State of Rio of Janeiro, the department qualified to carry out the analysis of the EIA/RIMAs of the electric power concession holders, and also to grant the above-mentioned license in accordance with Decree 99.274/90 (which regulated the National Environmental Policy - Law nº 6.938/81); with Law nº 7.804/89 (which, along with other measures, redefined the area of prerogatives of each of the organizations belonging to SISNAMA) in accordance with the above-mentioned CONAMA Resolutions nº 006/87 and nº 237/97.

The licensing is under the jurisdiction of the state, since, in accordance with a CONAMA Resolution 237/97:

- no environmental impacts of a regional nature affecting other States, and that might come under federal jurisdiction, are expected or are likely to occur;

- there are no apparent federal interests (there is no Federal ownership of any area or natural resource, such as state-owned properties, conservation units, archeological sites, caverns; etc) that might place the licensing under the jurisdiction of IBAMA;

- the developer is private, and, although it holds a concession from the Federal Government, it is not a part thereof (these are not public resources);

- some interference is expected, albeit localized and in remaining patches of vegetation of little significance for the local ecological equilibrium, with permanently protected areas, thereby confirming the jurisdiction of the state, in accordance with CONAMA Resolution 237/97;

- the Federal Government is not the sole authority in terms of the environment; and energy matters today are supervised by society through ANEEL.

It is, however, the responsibility of CECA (normative and deliberative) and FEEMA (technical and executive jurisdiction), as organizations belonging to the State Office of the Environment and Sustainable Development - SEMADS, to give their approval, bearing in mind at this point the requirement for a hearing by SERLA - State Superintendency of Rivers and Lakes, a department that also belongs to the same Office, responsible for authorization of the intake and use of water.

It should be noted, however, that the government of the State of Rio of Janeiro should consult the City Hall of the Municipality of Macaé, through its Municipal Environmental Council, created by article 230 sub-item XIV of the municipal charter, which might

impose additional supplementary and specific demands in order to guarantee compliance with the environmental excellence indicators in its territory, as well as to organize the inclusion of the project in the regulation of the land occupancy and use in the municipality and any Environmental Control programs that may exist and already be in progress, with the emphasis on those included in the “Inter-municipal Consortium for the Environmental Management of the Macaé and Macabu river basins, Lagoa Feia and the coastal zone”, in accordance with Municipal Law nº 1.947/99.

3.2 LEGAL ASPECTS OF THE USE AND OCCUPANCY OF LAND AND NATURAL RESOURCES

We have selected the most relevant laws applying to the region under study in the municipality of Macaé, with the objective of providing a wide legal and institutional scenario. The legal aspects are set forth below according to the environmental question to which they relate.

3.2.1 WATER RESOURCES AND AQUATIC ECOSYSTEMS

The Federal Constitution reserves as assets of the Federal Government lakes, rivers and any water courses on land under its ownership, or that run through more than one State, act as borders with other countries, or extend into or come from foreign territory, as well as the bordering lands and river beaches. Other bodies of water are considered to be state assets, reserving, however, as Federal Government property “*hydro-electric power supplies*”. The Macaé River is therefore a state river, as its whole course lies within the territory of the State of Rio of Janeiro.

With regard to the private jurisdiction of the Federal Government, in accordance with article 22, it is exclusively responsible for legislating about "*waters*". It also falls to the Federal Government, in accordance with the Federal Constitution, "*to introduce the national system of management of water resources and define criteria for granting rights to the use thereof*" (art. 21).

The conservation of fresh water ecosystems is a task falling under the common jurisdiction of the Federal Government, the States and the Municipalities, in accordance with the terms of the Federal Constitution (art. 23, VI). Article 24 of the Federal Constitution also established that "*it is the joint responsibility of the Federal Government, the States and the Federal District to legislate*" about " *nature conservation, protection of land and natural resources, environmental protection, and pollution control* ".

The Federal Constitution established a number of rules relating directly or indirectly to the conservation of the fluvial ecosystems. In the chapter dedicated to the Environment, the Constitution imposes on the Public Administration the task of *"preserving and restoring the essential ecological processes and promoting the ecological management of species and ecosystems"* (art. 225, I).

The aquatic ecosystems are legally protected, at various levels, by the following resolutions:

A. The natural breeding grounds of animals are State property, and as lakes are recognized breeding grounds for aquatic fauna, their destruction is prohibited (Law 5.197/67);
B. Effluents from any pollutant source may only be discharged in accordance with the conditions stipulated in Article 21 of CONAMA Resolution 020/86 (and also in FEEMA NT – 202 R-10 - Criteria and Standards for Discharge of Liquid Effluents).
C. The discharge of oily residues in inland waters is not permitted (Decree 50.887 of June 29, 1961);
D. Those who provoke, “through the discharge of effluents or transportation of materials, the elimination of specimens of aquatic fauna found in rivers, lakes, dams, lagoons, bays or waters under Brazilian jurisdiction” are committing a crime “punishable by imprisonment” (Law nº 9.605/98, art. 33);
E. Intake from water courses for industrial purposes shall always take place downstream from the point at which the liquid effluents of the industry in question are discharged, in accordance with the Law (State Constitution, art. 261, paragraph 4);
F. The following are considered by the Constitution of the State of Rio of Janeiro to be permanent preservation areas: “ (...) lakes, lagoons and shallow estuaries and estuary areas”, “ (...) the protective strips bordering on surface waters” (art. 265, I and II).

In terms of water resources, the old 1934 Waters Code is still valid. Articles 98 and 109 to 116 of the Waters Code expressly prohibit any type of *“pollution*” of waters, and establish, to this end, penalties defined by the Penal Code, and it should be emphasized that the expression *“pollute”* covers the total or partial rendering unserviceable or contamination of the water by any means or agent.

The Waters Code (Law nº 24.643, of July 10, 1934) substituted the articles dealing with this matter in the Civil Code, revoking articles 563 to 568, 575 to 584 and 586 of the latter code.

The more recent Federal Law nº 6.938, of August 31, 1981, deals with the National Environmental Policy and creates SISNAMA – the National Environmental System, already mentioned earlier in this study. In January 1997, in compliance with the terms of article 21, sub-item XIX, of the Federal Constitution, Law nº 9.433 was enacted, introducing the SNGRH - National Water Resources Management System, changing the centralizing scenario of the Waters Code.

The National Environmental Policy thenceforth considered as environmental resources "*internal surface and subterranean waters* " (art. 3, V). The use of these resources should be based on the following principles: "*rationalization of the use ... of the water*",

also providing for "*imposition ... on the user, of dues for the use of environmental resources for economic purposes*" (Law 6.938/81, arts.2 and 4, VII).

Recently, article 54 of the Law of Environmental Crimes, Law nº 9.605/98, defined as a crime subject to imprisonment or confinement, according to the circumstances, any actions that *"cause pollution of any nature, at levels that result or may result in damage to human health, or that provoke the slaughter of animals or significant destruction of flora"*, leaving clear, in paragraph 3, that *"those who fail to adopt precautionary measures, when so required by the pertinent authority, in cases where there is a risk of serious or irreversible environmental damage, will incur the same penalties as laid down in the previous paragraph".* The fine for the offences mentioned, according to Dec. nº 3.179/99, can range from R$ 1.000,00 (one thousand reais) to R$ 50.000.000,00 (fifty million reais).

With regard to water quality, CONAMA Resolution nº 20, of June 18, 1986, classifies fresh, briny and salt water according to its main uses, in nine categories. The maximum permissible limits for the parameters appraised are established for each category. CONAMA Resolution 20/86 also defines the possible characteristics for the discharge of effluents from any source of pollution (art.21).

The State of Rio of Janeiro, through SEMA, and by means of NT-202-R-10, carried out a classification of its water courses and classified the Macaé river as Class 2, corresponding to waters intended, after conventional treatment, for domestic supply; for the protection of aquatic communities; for primary recreation; the irrigation of cultivated trees, grains and forage; and for drinking water for animals.

This same NT-202.R-10, approved by CECA Resolution nº 1.007/86, defines the maximum limits of certain parameters permissible for effluents to be discharged into bodies of water.

The water use, however, should be regulated by setting up Water Basin Committees for the whole of the State of Rio of Janeiro within the structure imposed by Federal Law nº 9.433/97, which introduced the National Water Resources policy of creating a National System for the Management of Water Resources, ascribing to it, among other duties, that of proposing criteria for the granting of rights to water use and for its taxation, on the principle that the polluter (namely the user) should pay. In effect, the State of Rio of Janeiro took a pioneering role, and had already introduced the TRH – Charge for the Use of Water Resources, by means of Law nº 1.803, of March 25, 1991.

In relation to the environmental management of basins, the recent creation of the Inter-municipal Consortium for the Environmental Management of the Macaé and Macabú river basins, of Lagoa Feia and the adjacent coastal zone – MRA5 (June 2000) should also be noted. The Consortium will comprise the municipalities of Macaé, Rio das Ostras, Casimiro de Abreu, Trajano de Morais, Nova Friburgo, Conceição de Macabú, Carapebús, Quissamã, Santa Maria Madalena, Campos dos Goytacazes and São João da Barra, as well as Non-Governmental Organizations and other businesses.

It should also be noted that Ministry of the Interior Resolution nº 124, of August 20, 1980, prohibits the installation of any potentially pollutant industry, or of buildings or structures in which substances capable of causing water pollution are stored, at a distance of less than 200 (two hundred) meters from water intakes, or the nearest watercourses.

It is also important to point out, in this item, that article 258 of the State Constitution of Rio de Janeiro, showing early consistency and consonance with the guidelines of the current National Water resources Policy, established among the charges of the Public Administration that of *"promoting, with due observation of the jurisdiction of the Federal Government, integrated management of water resources, in accordance with the law, based on the following principles:*

a) *adoption of the areas of hydrographic basins and sub-basins as units for the planning and execution of plans, programs and projects;*

b) *unity in the administration of the quantity and quality of waters;*

c) *seeking compatibility between the various actual and potential uses;*

d) *participation of users in management and mandatory contribution for the recovery and maintenance of quality in accordance with the type and intensity of the use;*

e) *emphasis on the development and use of methods and biological criteria for the evaluation of water quality;*

f) *prohibition of the discharge into the water of residues or distillery waste, residues or excrement, liable to render the water unfit, even temporarily, for normal consumption and use or for the survival of the species."* (sub-item VII).

Paragraphs 3 and 4 of the same article 258, which establish the following, are also worthy of note:

- *"Users of environmental resources are obliged, in accordance with the law, to carry out supervisory programs to be established by the pertinent bodies".* (paragraph 3);

- *"Intake from watercourses for industrial purposes must take place downstream from the point at which the liquid effluents of the industry concerned are discharged, in accordance with the law"* (paragraph 4).

It should be noted that the requirement to discharge industrial effluents upstream from the point at which the water is taken in is also quoted in the Municipal Charter of Macaé (art. 158).

Finally, the Auto Control Programs (PROCON) for liquid effluents should be mentioned, such as:

- CECA Resolution 044, of February 1, 1979, which approved NT - 943 and which establishes the frequency of measurement, collection of samples and analyses;

- CECA Resolution 1.079, of June 25, 1987, which imposes guidelines for the control of industrial liquid effluents;

- CECA Resolution 1.995, of October 10, 1990, which establishes guidelines for the Liquid Effluents Autocontrol Program.

3.2.2 FAUNA, FLORA AND CONSERVATION UNITS

Although the area chosen for implementation of the project is located in a rural zone, considerably affected by human influence, and calls for the elimination of small patches of vegetation, the region in question forms part of the Atlantic Rainforest bioma. The legal aspects applying to this ecosystem are therefore noted below.

Article 2 of the Forestry Code enacted in the mid-60s, with the amendments and additions made by Law nº 7.511, of July 7, 1986 and Law nº 7.803/89, and the clarifications and definitions given in CONAMA Resolution nº 004/85, considers as permanently protected, irrespective of any other acts or formalities, woodlands and other forms of natural vegetation situated:

"a) in a marginal strip along rivers or other watercourses, with a minimum width of:

- 30 (thirty) meters, for rivers less than 10 (ten) meters wide;

- 50 (fifty) meters, for watercourses 10 (ten) to 50 (fifty) meters wide;

- 100 (one hundred) meters, for watercourses measuring from 50 (fifty) to 200 (two hundred) meters wide;

- 200 (two hundred) meters, for watercourses of between 200 (two hundred) and 600 (six hundred) meters wide; and

- of 500 (five hundred meters), for watercourses wider than 600 (six hundred) meters.

b) around lagoons, lakes or natural or artificial water reservoirs;

c) by springs, even those referred to as "olhos-d'água" (fountains), whatever their topographical situation, within a minimum range of 50 (fifty) meters wide;

d) on the top of hills, mounts, mountains and sierras;

e) on gradients or parts thereof with a declivity of more than 45, equivalent to 100% (one hundred percent) on the line of steepest slope;

f) on sand bars and stabilizers of dunes or of swamps;

g) at the edges of tablelands or plateaus, from the line breaking the relief, for a strip of not less than 100 (one hundred) meters in horizontal projections;

h) any type of vegetation at altitudes over 1800 (one thousand eight hundred) meters."

Article 18 of the same Code establishes that, on private land on which permanently protected forestation or reforestation is required, this may be done by the Federal Public Administration, without expropriation of the land, if not done by the owner.

If such areas are being used for crops, the owner should be indemnified according to their worth (paragraph 1), and the areas will be exempt from taxation (paragraph 2).

The Forestry Code established as a criminal misdemeanor, liable to three months to one year of detention, or a fine of one to one hundred times the monthly minimum salary of the place and at the time of the offense, or both penalties, cumulatively, to destroy or damage permanently protected woodlands or to cut trees in such woodlands without the authorization of the pertinent authorities (art. 26 “a” and “b”).

The more recent Law nº 9.605/98 classified any type of offense to permanently protected flora or in Conservation Units, not simply as a criminal misdemeanor, but as a crime, making the authors thereof liable to detention of from one to three years and/or a fine ranging from R$ 1.500, 00 (one thousand five hundred reais) to R$ 50.000,00 (fifty thousand reais) per hectare or fraction of a hectare, in accordance with Decree nº 3.179/99 (Art. 2.).

With regard to the applicability of art. 2 and art. 3 of the Forestry Code, which established that the Executive Branch may declare other areas permanently protected in addition to those mentioned above, the following should be noted:

- A SERLA study, supported by Law nº 650, of January 11, 1983, dealing with the State Policy for the defense and protection of the liver and lake basins of Rio de Janeiro, and by Decree nº 2.330, of January 08, 1979, which introduced the System for the Protection of Lakes and Watercourses - SIPROL. One of the instruments drawn up was the Marginal Protection Strip (FMP) project, providing for the demarcation of such areas and its power to police them.

- The provisions of article 157 of the Macaé Municipal Charter, which considers as permanently protected, among others:

  I - the swamps of the Macaé river and its estuary area;

  II - sandbar vegetation;

  III - springs and the marginal protection strips of surface waters; and

  IV - plant cover that contributes to the stability of hillsides subject to erosion and landslides.

From what has been said about concurrent jurisdiction, the State is not denied the power to set specific rules governing the use of these reserves. Under current legislation, therefore, woodlands and other forms of permanent vegetation (art. 2. of the Forestry Code), may be used rationally, provided that this is in a manner compatible with natural ecosystems of regional or local importance, with a view to environmental conservation, in accordance with rules and criteria established by the pertinent public authority.

The total or partial elimination of permanently protected woodlands will also be permitted, although only with the prior authorization of the Federal Executive Branch, and when it is necessary to carry out works, plans, activities or projects of public utility or social interest (art. 3, paragraph 1 of Law nº 4.771/65).

This item should also consider the applicability of Decree nº 750, of February 10, 1993, which regulates the cutting and exploitation of areas of the Atlantic Rainforest, always at the discretion of the pertinent environmental department, and if necessary in the light of the evaluation of environmental impacts, such as that produced in this study, making a distinction between the advanced, medium and initial stages of regeneration, prohibiting clearance:

- of primitive forests or in States which have less than 5% of their original cover;
- of woods that shelter flora and fauna threatened with extinction;
- of woods that provide protection for fountains or serve to prevent and control erosion;
- of woods that have exceptional landscape value;
- of those which serve as corridors between remnants of vegetation; or,
- that have the function of protecting the surroundings of the Conservation Units.

It will also be noted that none of the possibilities considered by the above-mentioned Decree 750/93 applies to the situation of the Macaé Merchant UTE project, since the area directly affected is not covered by vegetation that falling into the categories described above; it should also be noted that the above-mentioned decree also listed as possible exceptions the question of public utility and social interest, designating Environmental Impact Studies as suitable instruments for the analysis of projects that interfere with the successive stages of the Atlantic Rainforest.

Finally, we should mention the possibility that CONAMA Resolution nº 002/96, calling for the allocation of 0.5% of the total value of the project to forest compensation, might apply, bearing in mind the environmental impacts on the flora, necessary for installation of the gas pipeline.

With regard to fauna, Law nº 5.197, of January 3, 1967 (amended by Laws nº 7.584/87, nº 7.653/88 and nº 7.679/88) regulated by Decree 97.633/89, assures support for the protection of animals of any species, at any stage of their development, that live naturally outside captivity, and constitute wildlife, and their nests, shelters and natural habitats, in State properties, their use, persecution, destruction, hunting or capture being prohibited (art. 1).

Special attention should be paid to Law nº 7.653/88, which considers as a crime without bail any action against wildlife; and IBAMA Resolution nº 1.522, of December 19, 1989, which published the official list of Brazilian species threatened with extinction.

Finally, the predominance should be recalled of the recently issued Environmental Crimes Law, which enlarged the spectrum of legal protection to fauna, maintaining the strict classification of acts against animal species as crimes with penalties of detention and imprisonment.

With regard to the Conservation Units in the region, the following areas should be noted:

- the Restinga de Jurubatiba National Park (created on April 29, 1998, covering areas in the municipalities of Macaé, Carapebus and Quissamã);

- Atalaia Municipal Park, created by Municipal Law No. 150098, of June 24, 1995, covering part of the municipality of Macaé;

- Fazenda União Biological Reserve (REBIO), located in the Macaé river basin, upstream from the area chosen for the implementation of the project, in the municipality of Casemiro de Abreu (Decree No.76, of April 22, 1998).

3.2.3 AIR

In order to establish strategies for the control, preservation and recuperation of air quality, valid throughout Brazilian territory national, in accordance with Law nº 6.938/81, CONAMA Resolution nº 005/89 established the PRONAR National Program for the Control of Air Quality, providing definitions and guidelines for prevention and management.

Based on this rule, CONAMA issued Resolution nº 003, of June 28, 1990, establishing air quality standards, methods for sampling and analysis of atmospheric pollutants and quality levels relating to an emergency plan for critical incidents of air pollution, calling for measures by the state and municipal governments, with the objective averting grave and imminent risks to public health.

This supervisory work is carried out in the State of Rio of Janeiro by FEEMA, with the support of the actual private developers, in view of the obligatory Autocontrol Programs

established for atmospheric pollution by CECA Resolutions nº 021, of March 15, 1978, which approved NT 603 (establishing standards and regularity) and nº 935, of August 7, 1986, which approved DZ-545.

In principle, no venture should discharge atmospheric pollutants in such a way as to generate densities exceeding the air quality standards in its neighborhood.

Table II.1, below, sets forth the air quality standards, according to CONAMA Resolution nº 003/90, for the main atmospheric pollutants:

In this table, the primary standard values represent the maximum density of each pollutant admissible in the atmosphere, in accordance with the sampling time, but still present a minimum risk of adverse effects on health, and comprise the targets to be achieved in the short term. The secondary standard is the amount below which total safety from damage to the environment and to public health is anticipated, and constitutes the medium and long-term targets.

Table 3.2.3-1 - Air Quality Standards

POLLUTANT	SAMPLING TIME	PRIMARY STANDARD μg/m³	SECONDARY STANDARD μg/m³
Inhalable particles	24 hours Annual Average	150 50	150 50
Particles in Suspension	24 Hours Annual Average	240 80	150 60
Smoke	24 Hours Annual Average	150 60	100 40
Sulfur Dioxide	24 hours Annual Average	365 80	100 40
Nitrogen Dioxide	1 hour Annual Average	320 100	190 100
Ozone	1 hour	160	160
Carbon Monoxide	1 hour 8 hours	40.000 10.000	40.000 10.000

3.2.4 NOISE AND SOUND POLLUTION LEVELS

The National Environment Council, through Resolution nº 001, of March 8, 1990 (DOU of April 2, 1990) established that the production of noise, as a result of any industrial,

commercial, social or recreational activities, including political propaganda, shall, in the interests of health and public well-being, conform to the standards, criteria and guidelines established in the NBR-10152, ABNT Technical Rules, which set acceptable noise levels, with a view to the comfort of the community and the protection of health.

"Due to the constitutional system of jurisdictions, it should be seen that the guidelines of CONAMA Resolution nº 001/90, incorporating the values of the NBR - 10152, are general rules in accordance with art. 24, paragraph 1, of the Federal Constitution. Thus, the states and municipalities may amend these values, in order to demand more, that is, fix lower decibel counts in order to increase acoustic protection" (Machado, Paulo Afonso Leme. 1995)

In the State of Rio of Janeiro, compliance is required with Law nº 126, of May 10, 1977, which deals with protection against sound pollution, considering prejudicial to the health and well-being of the population, and as such, a transgression to be punished in accordance with the Law, the production of any noises that reach, in the environment outside the limited area in which they originate, a noise level of more than 85 decibels, measured on sequence C of the "Sound Intensity Measure", in accordance with ABNT method MB-268.

This rule, however, should be interpreted in the light of the Ministry of the Interior Ruling nº 92, of June 19, 1980, which is more restrictive, and therefore overrules, since it considers as prejudicial to human health sounds and noises that:

"- reach, in the environment outside the limited area in which they originate, a noise level of more than 10 (ten) decibels higher than the background noise existing in that place, without traffic;

- irrespective of the background noise, reach, in the environment outside the limited area in which they originate, more than 70 (seventy) decibels during the day and 60 (sixty) decibels during the night;

- reach, inside the space in which they are produced, sound levels higher than those acceptable under Rule NB-96 of the ABNT, Brazilian Technical Rules Association, or any succeeding thereto".

Therefore, there are in fact two maximum standards to be complied with simultaneously, one in absolute terms and the other relating to the pre-existing noise level. Thus, if a region has a very low background noise level, the legal limit for sound emission will be lower than that for a noisier region.

3.2.5 CONTROL OF INDUSTRIAL RESIDUES

The conditions for the treatment and disposal of solid residues were established in Ruling nº 053, in March 1979. This indicates that specific projects for the treatment and

disposal of solid residues, as well as the monitoring of their implementation, operation and maintenance, are subject to the approval of the state environmental control department.

CONAMA Resolution n° 006/88, of June 1988, legislation at the federal level in respect of residues, establishes that in relation to company licensing, an inventory should be made of the industrial waste generated or existing in the country. It does not distinguish between dangerous and non-dangerous industrial waste. Established companies would have a maximum of 90 days to comply with this Resolution.

The industrial activities expected to submit this information are:

- Metallurgical industries with more than 100 employees.
- Chemical industries with more than 50 employees.
- Industries of any type with more than 500 employees.
- Industries having treatment systems for wastewater generated by the process.
- Industries that generate dangerous waste, as defined by the pertinent environmental authorities.

In addition to these industrial sectors, other sectors that store, among other items, equipment contaminated with polychlorinated biphenyls (PCB's) should also submit the information.

One of the difficulties noted in respect of industrial residues concerns their classification. One classification system used follows that established by the Basle Convention, and another is that adopted by the *Recovery Conservation Resource Act* (RCRA, 1984) of the United States.

There is also a Brazilian Technical Rule (NBR n° 10.004) for the definition of dangerous waste. This rule dates from 1987, prior to the Basle Convention, and is more similar to that adopted by the RCRA.

There is also ambiguity in respect of the definitions established by the National Environmental Council (CONAMA) and the Brazilian Technical Rules Association (ABNT). CONAMA defines Class III residues as not inert, while NBR n° 10.004 classifies this waste as Class II.

Some provisions have been established for management of the handling and disposal of certain residues, such as used lubricating oils. The criteria for management of used lubricating oils were established by CONAMA Resolution 009/91. This determines that it is mandatory for all used or contaminated oil to be collected and to receive suitable treatment. It may not be discharged into the earth, surface or subterranean waters, territorial waters or in any other drainage system.

The basic aim is for all used lubricating oil to be recycled, and attention has therefore been paid to its formulation, in order to meet this objective. If it cannot be recycled, another possible alternative is for it to be used as an energy source.

The Declaration of Industrial Waste system was established as part of the Pollutant Activities Licensing System (SLAP), aimed at assisting in the control of industrial waste generated in the State of Rio of Janeiro, from its origin to its final destination.

This system, implemented by FEEMA (Instruction DZ-1.310, CECA Resolution n° 673, of June 27, 1985) involves the generator, the transporter and the final receiver of the industrial waste, in order to ensure that it is not sent to places not authorized to treat or finally dispose of it and to avoid the risk of it being diverted to clandestine refuse pits.

The declaration applies to industrial residues classified as dangerous, as well as to common industrial waste.

These guidelines define as dangerous solid, semi-solid and liquid industrial residues to which conventional treatments cannot be applied, resulting from industrial activity and the treatment of its liquid and gassy effluents which, due to their characteristics, represent an actual or potential danger to human health and to the environment, and require special care in their packaging, re-collection, transportation, storage, treatment and disposal; they also define as common industrial residues all solid and semi-solid industrial waste with characteristics similar to urban waste.

The final disposal of industrial residues is regulated by Instruction DZ-1.311 (CECA Resolution n° 3.327, of November 29, 1994). These Guidelines establish the lines for licensing the designation of solid, semi-solid and liquid residues, originating from any source of pollution, which cannot be treated conventionally.

An important criteria to be considered is that it is not permissible to transfer industrial residues from a less critical hydrographic basin to another more critical one, for disposal of the same in the earth; nor is it permitted to dispose in the earth of industrial residues without first establishing the necessary controls, not even in floodable zones, in areas of recharging of aquifers, in protected areas or in fragile ecosystems.

Any activities that, at any time, dispose of residues without FEEMA's knowledge, in unlicensed places, should advise the quality and quantity of the residues disposed of, as well as providing information as to the place and date of the disposal.

Inert residues (Class III) may be disposed of in sanitary dumps, if they cannot be recycled. Such waste includes paper, cardboard, glass and waste from offices and restaurants. It is also possible to dispose of sludge from residual water treatment stations, if prior approval is obtained from FEEMA. In this case, the humidity content of the waste is limited to 70%.

One of the strategies proposed for environmental management of industrial residues is to make it obligatory to install a program to reduce waste generation, mainly through the re-use of the residues (Law n° 2.011, of July 10, 1992).

The programs to be put into effect for industrial activities must comply with various alternatives, such as the adoption of clean or less pollutant production technology, the

substitution of raw materials, or changes in the characteristics of the final product and of its packaging.

They should also consider the recycling of the materials at the various production stages, or re-use of the residues in the industry itself or by another industry. They should also take into account improvement of the quality or substitution of fuels, increased power efficiency and the implementation of closed circuit systems.

Another program that may bring advantages in the management of industrial residues is the Residues Exchange Program. This Program, approved by CECA Resolution n° 307, of June 1982, (Instruction DZ-949), will in turn support the Waste Reduction Program mentioned above.

The Program allows for the re-use of the residues by means of the exchange between companies, resulting in benefits for the environment, through the reduction in the final amounts generated, and for developers, through the reduction in the cost of contamination control, and, in some cases, through the use of these residues as raw materials.

By means of an Available or Discarded Residues Form (Formulário de Resíduos Disponíveis or Descartados - RDD), companies advise FEEMA of the type and quantity of waste available, to be published in a four-monthly Bulletin to be circulated among companies, not restricted to those installed in the State of Rio of Janeiro.

The Macaé Merchant Thermo-Electric Plant is likely to generate solid waste, largely produced by treatment of the water for industrial use. The sludge from the treatment station is consequently regarded as Class II non-dangerous waste, according to NBR 10.004, and may be suitably disposed of in the plant area, after removal of the humidity. This waste will contain traces of the chemical compounds used in the water treatment, notably aluminum sulfate. The final disposal of this waste should be in a dump licensed by FEEMA, in compliance with FEEMA Instruction DZ-1310. Other waste generated in the plant will include office waste, and non-dangerous and inert residues, which may be sent to the Macaé municipal sanitary disposal dump, licensed by FEEMA.

3.2.6 TERRITORIAL REGULATION OF THE MUNICIPALITY OF MACAÉ

The municipal urban legislation comprises the set of provisions made in the Land Division, Zoning, Use and Tenure Laws, and in the Municipal Charter. In its most developed form, the urban legislation consists of an Urban Master Plan that, based on a broad diagnosis of the urban trends and problems, defines a concept for growth and tenure directed towards the regulation of land tenure and improvement of the quality of life of its population. The instructions provided in the Master Plan guide the public administration in establishing urban policies, resulting in the definition of the form, type and localization of the regulatory involvement in land tenure.
The zoning of the municipality of Macaé defines as a Rural Zone the land area that includes the site on which the project is to be installed, and municipal approval is at the discretion of the local Executive Branch.

4. PLANS E PROGRAMS

4 PLANS AND PROGRAMS

The region and project's characteristics indicate three major areas of planning:

- at federal level: the sector area of energy planning, specifically matters relating to the Ten-Year Expansion Plan 2000-2009, which includes the thermoelectric generating program;
- at state level: integrated planning of hydrographic basins as the basis for the formulation of sustainable environmental management and development policies;
- at municipal level: directives and definitions on the municipalities ordinance and territorial management.

4.1 ELETROBRÁS TEN YEAR EXPANSION PLAN – 2000-2009

The 2000-2009 Ten-Year Expansion Plan was concluded and approved by the Electrical Systems Planning Coordinating Group's (GCPS) Steering Committee, coordinated by the ELETROBRÁS Engineering Directorate, with the participation of 46 electricity concessionaires. The Plan was subsequently approved by the Ministry of Mines and Energy – MME, through the issue of Ordinance No. 84, dated April 17, 2000.

The Ten-Year Plan is prepared annually in compliance with Decree Nº 96.652/88, as under the new Electricity Sector regulations and legislation its role is to make recommendations and indicate a sequence of projects, without defining the agents responsible for their implementation in cases where no permit or concession has been granted.

The GCPS seeks to identify the sequence of tasks that provides the lowest cost-benefit ratio, including those relating to social-environmental questions for the expansion of the South/Southeast/Midwest. North/Northeast and Northern Region Isolated Systems.

For the 2000-2009 period, an annual growth rate of 4.8% in the energy concessions' total consumption was adopted for reference purposes on a nationwide basis. The offer of electrical energy should increase during that period from the present 64,3000 MW to 109,400 MW, including energy packages imported using interconnections with neighboring countries (these expansion indicators are illustrated in the tables below). The thermoelectric facilities' market share will increase from 9.2% to 24.8% during the period. It is expected that during the Plan's lifetime some 49,000 kilometers of transmission lines and 92,000 MVA in substations will be installed throughout the country. In order to achieve thee targets annual investments totaling some R$8.5 billion will be required over the first five years.

Table 4-1 – Electrical Energy Consumption (Twh)

REGION	CURRENT 1999 (*)	FUTURE 2004	FUTURE 2009	10-YEARLY GROWTH RATE (%)
South/Southeast/Midwest	228.7	282.4	349.5	4.3
North/Northeast	56.8	78.9	102.6	6.1
Isolated Northern Systems	5.3	8.1	12.4	8.9
Concessionaires - Total (**)	290.8	369.4	464.5	4.8
Own Production	20.9	41.6	45.2	8.0
Total: Brazil	**311.7**	**411.0**	**509.7**	**5.0**

(*) Verified Values (**) Firm Energy

Table 4-2 – Regional Consumption (%)

SYSTEM	CURRENT 1999	FUTURE 2004	FUTURE 2009
South/Southeast/Midwest	78.7	76.5	75.2
North/Northeast	19.5	21.3	22.1
Isolated Northern Systems	1.8	2.2	2.7
Concessionaires: Total (*)	100.0	100.0	100.0

(*) Firm Energy

Table 4-3 – Increase in Energy Offered (GW)

SYSTEM	CURRENT 1999	FUTURE 2004	FUTURE 2009	10-YEARLY INCREMENT
South/Southeast/Midwest (1)	47.3	72.1	77.8	30.5
North/Northeast	14.7	20.3	25.6	10.9
Isolated Northern Systems	2.3	3.1	3.8	1.5
Interconnection with Argentina	-	2.0	2.0	2.0
Interconnection with Venezuela	-	0.2	0.2	0.2
Total: Brazil (*)	**64.3**	**97.7**	**109.4**	**45.1**

(*) UHE Itaipu: Only includes 50%

Table 4-4 – Installed Capacity per Type (GW)

TYPE	CURRENT 1999	FUTURE 2004	FUTURE 2009	10-YEARLY INCREMENT
Hydroelectric	58.4	70.5	80.1	21.7
Thermoelectric	5.9	25.0	27.1	21.2
Interconnection with Argentina	-	2.0	2.0	2.0
Interconnection with Venezuela		0.2	0.2	0.2
Total: Brazil (*)	**64.3**	**97.7**	**109.4**	**45.1**

(*) UHE Itaipu: Only includes 50%

The participation of the private sector within this scenario is fundamental, and it is expected that partnerships will be sought both for the construction of new hydroelectric facilities and the increase in thermoelectric generating capacity. The growth rate in electrical energy consumption currently exceeds that of the economy as a whole, a factor which only serves to emphasize the importance of investment in the sector.

Analysis of the above tables shows that thermoelectric facilities, which represented 9.2% of Brazil's generating capacity in 1999, is expected to rise to 24.8% of total installed capacity (including energy imported from Argentina and Venezuela) by 2009. The acceleration of the thermoelectric program which the electrical energy sector is currently seeking to achieve, particularly in the South/Southeast/Midwest System where the Macaé Merchant Thermoelectric project is situated, is primarily intended to prevent a generating crisis likely to occur in the absence of investment, given the regions' expected rise in demand over the short to mid-term. The thermoelectric program is of fundamental importance, particularly in the short term (up to 2004) where its rapid implementation will permit it to account for 26.6% of total installed capacity.

Particularly in the case of the Rio de Janeiro and Espirito Santo regions, the Ten-Year Plan emphasizes the greater viability of the thermoelectric solution for the availability of natural gas, which is currently burnt in large volumes by PETROBRÁS' offshore units in the Campos Basin.

In light of the above, we conclude that the project is not merely compatible, but rather a priority in relation to the perspectives of the sectorial planning analyzed.

4.2 STATE/REGIONAL WATER RESOURCE AND ENVIRONMENTAL MANAGEMENT PLANNING

On March 14, 2000, the Rio de Janeiro State Government established the state's sub-division into seven Environmental Macro Regions – MRAs (Figure 4.2.1 at the end of Chapter 4), in response to a proposal by the Secretary of State for the Environment and Sustainable Development – SEMADS-RJ through Decree N º 26.058.

The environmental macro regions, whose definition is based upon the arrangement of areas delimited by hydrographic basins, constitute formal planning units for the purpose of defining public environmental and sustainable development policies at state government level. Additionally, in view of the modern approach to the integrated management of water resources reflected in both the relevant federal and state legislation, the creation of environmental macro regions is intended to encourage the establishment of integrated management models on a regional scale, whose organization is mainly based upon the joint efforts of the municipal units within each region.

On a national basis, it is hoped that a regional management base be established in each MRA, from which to implement an integrated state water resource management policy. The decentralized management model envisaged by state policy also includes the installation of SEMADS Environmental Management Agencies in each MRA, to decentralize and redefine the areas of activity of entities linked to the Ministry, refine environmental services and rationalize the respective costs.

Throughout 1999, due to the fact that SEMADS had not yet begun this administrative decentralization program, the Ministry concentrated on raising interest amongst each MRA's municipal authorities in a regional articulation process which culminated this year (2000) in the formation of various inter-municipal consortia which should lead to the creation of future regional management bodies.

The Macaé Merchant Thermoelectric Project's area of influence lies within the basin of the Macaé River, part of MRA-5 (Figure 4.2-2 at the end of this chapter). In addition to the basin of the Macaé River, this MRA also includes the Macubu River, Lagoa Feia and Coastal Zone hydrographic basins.

In the case of MRA-5, an inter-municipal consortium was formed on 28-06-00, which submitted an initial planning and regional policy proposal for the area. The MRS-5 Consortium is subject to a law of adherence covering seven of the basin's municipalities (Conceição de Macabu, Rio das Ostras, Quissamã, Santa Maria Madalena, Carapebus, Casimiro de Abreu and Macaé), whilst an authoritative law is currently being considered by the remaining municipalities (Campos de Goytacazes, Nova Friburgo, São João da Barra and Trajano de Moraes).

In addition to the municipalities, the consortium also includes a forum of environmental and social NGOs comprising 12 different organizations.

It should be stressed that the approach to the integrated management of water resources by both federal legislation and Rio de Janeiro State Law N º 3239/99, requires that the management models of basins or hydrographic regions be based upon a water resource management plan involving:

- Diagnosis of the water resources' current situation;
- Analysis of alternative scenarios relating to demographic growth, economic development and modifications to soil use standards;
- Balance between the availability of water resources and future demand, considering potential areas of conflict both from a water quality and quantity viewpoint;
- Establishment of integral quality, conservation and use rationalization targets for available water resources;
- Definition of measures, programs and projects necessary to achieve the targets set.

Of the State's seven MRAs, only Sepetiba has a Water Resource Management Plan which is included in the Environmental Sanitation and Management Macro Plan drawn up for the region in 1998.

MRA-5 does not yet possess any integrated planning on a regional scale and has therefore yet to define both those planning elements required by water resource

legislation and those governing macro management activities to be observed by the users of the Basins therein.

Activities intended to ensure the present project's compatibility and use of the basin with a future integrated water resource management model for the MRA-5 region are therefore based upon the observance of the state's current general environmental and water resource management instruments, particularly:

- Submission of a concession requisition to SERLA substantiated by the necessary technical information;
- Compliance with obligatory environmental performance standards during the project conception stage, particularly in relation to water impounding and discharge points, liquid effluent quality and the management of solid and semi-solid residue;
- Compliance with applicable conservation legislation, particularly those dispositions dealing with the forest code.

These directives seek to prevent future conflict involving demand for water resources, avoid environmental degradation processes from occurring, particularly in permanent conservation areas and guarantee performance levels compatible with the maintenance of the environmental quality within the project's area of influence.

4.3 MUNICIPALITY OF MACAÉ - TERRITORIAL ARRANGEMENT.

In order to assess the project's compatibility with plans and programs established at municipal level, the directives and definitions relating to territorial arrangement contained in the 1990 Macaé Municipal Management Plan were analyzed.

The Municipal Management Plan does not consider the geographic planning of conditions governing the territory's use, stating that they should be defined after the municipality's macro-zoning exercise has been concluded. However, according to current administrative definitions, the chosen area lies in a rural section of the district where the municipal headquarters are located. This region is predominantly given over to farming and cattle ranching and is subject to periodic flooding by the Macaé River and therefore not considered suitable for urban development. However, the project's implementation in the region is viable as the proposed construction site lies above the flood level.

A formal approach was submitted to the Local Authority during the course of a study into another like project (the Norte Fluminense Thermoelectric Facility) located in a region adjoining the proposed UTE Macaé Merchant site. No objection was raised against the facility's implementation in the chosen area, it having already been the subject of an analysis and report by the municipality's Works and Environmental

departments confirming the project's compatibility with the area's proposed soil use directives.

4.4 OTHER PROJECTS

Apart from the Macaé Merchant Thermoelectric Facility, other natural gas fueled thermal generating projects utilizing natural gas from the Campos Basin are currently at the study and/or environmental licensing stage. These include:

- Norte Fluminense Thermoelectric Facility – belonging to UTE Norte Fluminense S.A., currently at the environmental licensing stage, having recently submitted its environmental studies to FEEMA;
- Cachoeira Dourada Thermoelectric Facility – currently owned by the INDESA Group; located near to the Restinga de Jurubatiba National Park. Has already obtained both Preliminary and Installation Licenses but has not yet begun implementation;
- Macaé Thermoelectric Facility – belongs to a consortium which includes LIGHT and CERJ. Currently at the study stage;
- Cabiúnas Thermoelectric Facility – belongs to the Cataguazes Group – Leopoldina. Currently at the study stage.

In order to increase the offer of natural gas produced in the Campos Basin, finance contracts were signed in March this year with international financial institutions for the implementation of the Cabiúnas Project, whose objective is to increase the offer of natural gas produced on the state's northern coastline.

5. INFLUENCY ÁREA - ENVIRONMENTAL DIAGNOSIS

5 INFLUENCE AREA – ENVIRONMENTAL DIAGNOSIS

5.1 GENERAL METHODOLOGY

The environmental diagnosis was prepared based upon the findings of a technical team tasked with obtaining existing cartographic data and information, aerial photographs, satellite imaging, hydrological, climate and socioeconomic data, as well as data relating to vegetation cover, flora, fauna, water quality and other information necessary for environmental assessment purposes. Field recognition exercises were conducted in order to classify physical-biotic data and contacts were made with the local community, public institutions and non-governmental organizations for the purpose of characterizing motivational aspects of interest to the study program as well as government plans, policies and programs at municipal level.

5.1.1 DATA AVAILABILITY

Various public agencies, federal, state and municipal institutions were contacted to obtain the necessary data and information, including:

FEDERAL LEVEL	STATE LEVEL	LOCAL LEVEL
• IBAMA; • Restinga de Jurubatiba National Park Administration • Infraero • Macaé Airport • ANP • ELETROBRÁS • IBGE • UFRJ –Macaé Research Center -NUPEM	• FEEMA • SERLA • DRM • SEINP • CIDE Foundation • CEDAE • UNENF	• Executive Secretary for Environmental Macro Region – MRA5 • Plenary of NGOs for Environmental Macro Region – MRA5 • Macaé Secretary for Agriculture, Supply and the Environment; • Macaé Secretary for Planning; • Macaé Cultural Foundation • Macaé Industrial and Commercial Association.

Additionally, aerial photogrammetric data was obtained from PROSPEC and meteorological data from the International Data Bank.

The scope of the studies undertaken was based upon the requirements of FEEMA Technical Instruction 1013/O0, in addition to local consultations to identify items of

interest, or those likely to raise doubts or queries within the local community, to ensure that they were suitably addressed and/or explained when preparing the EIA/RIMA (Environmental Impact Assessment / Environmental Impact Report).

Areas likely to suffer any impact attributable to the project were pre-defined in order to establish guidelines governing the extent of diagnostic studies, based upon the knowledge of different specialists.

5.1.2 STUDY AREAS

Area directly or indirectly affected by the project were divided into three groups, These groups were then the subject of physical-biotic and socioeconomic studies:

- **Indirect Influence Area - AII**: Area actually or potentially under threat of indirect impacts attributable to the project, therefore including the region susceptible to change. From the physical-biotic aspect, the basin of the Macaé River, the hydrographic unit in which the project is located was considered as the area of indirect influence. The State's Northern Region was considered for the purpose of the socioeconomic study, from an energy viewpoint, whilst the Municipality of Macaé was considered for all other aspects.
- **Direct Influence Area - AID**: corresponds to the area subject to direct impact attributable to the Thermoelectric Facility's implementation and operation. Consequently established in keeping with the range of air pollution emissions, noise and liquid effluent.
- **Intervention or Directly Affected Area:** area effectively occupied by the Thermoelectric Facility in which changes attributable to its implementation will occur. Includes gas pipeline implementation area.

5.2 PHYSICAL ENVIRONMENT

5.2.1 CLIMATE –METEOROLOGICAL CONDITIONS AND AIR QUALITY

5.2.1.1 Climate – General Aspects

In general, a region's climate is determined by its general atmospheric circulation, the effect of synoptic and sub-synoptic disturbances and both the land cover and orography.

The Municipality of Macaé can be classified as sub-tropical, with moderate humidity, dry winters and humid summers (classified by Köppen, see Trewartha, 1954).

The proposed site of the Macaé Merchant Thermoelectric plant lies on the coastal strip approximately 15 kilometers inland, but nevertheless is strongly affected by marine influences. The region is largely flat and low-lying. Although some low hills are located in the area, they are not capable of having any orographic effect upon local rainfall levels. The topography of the region studied is illustrated in Figure 5.2.1-1.

The behavior of the main climatic elements is moderated by the proximity of the ocean.

From a large-scale viewpoint, atmospheric circulation dynamics at continental level control the region's weather through the following atmospheric systems: TA – Tropical Atlantic; TC – Tropical Continental and PA – Polar Atlantic. The Tropical Atlantic system is responsible for controlling the weather in the subject area for the majority of the year.

This system is responsible for stabilizing the weather and for the sequences of dry years. The interchange with the Polar System during the summer months brings with it fine weather and sudden temperature rises, a phenomenon known as pre-frontal temperature increase.

From the mid- spring to mid-autumn, the entire Brazilian mid-tropical region is periodically subjected to successive waves of O and NO, brought by lines of Tropical Instability (IT), characteristic of the effect of Western Disturbance Currents. These are elongated barometric depressions induced along small ridges.

As the Polar Atlantic Front (FPA) advances towards the equator, the ITs move off to the SE, bringing with them heavy cloud and typically tropical rainfall, giving 24-hrs advance notice of the FPA's arrival. These rains generally occur in the late afternoon or evening, and are known as summer rains, which in contrast to frontal rain (which tends to persist for three or more days), are very short-lived, rarely lasting for more than an hour.

PROJECT: EL PASO- MACAE MERCHANT THERMOELECTRIC PLANT TOPOGRAPHY - SECTION OF AREA OF INFLUENCE

MUNICIPALITY OF MACAÉ - RJ

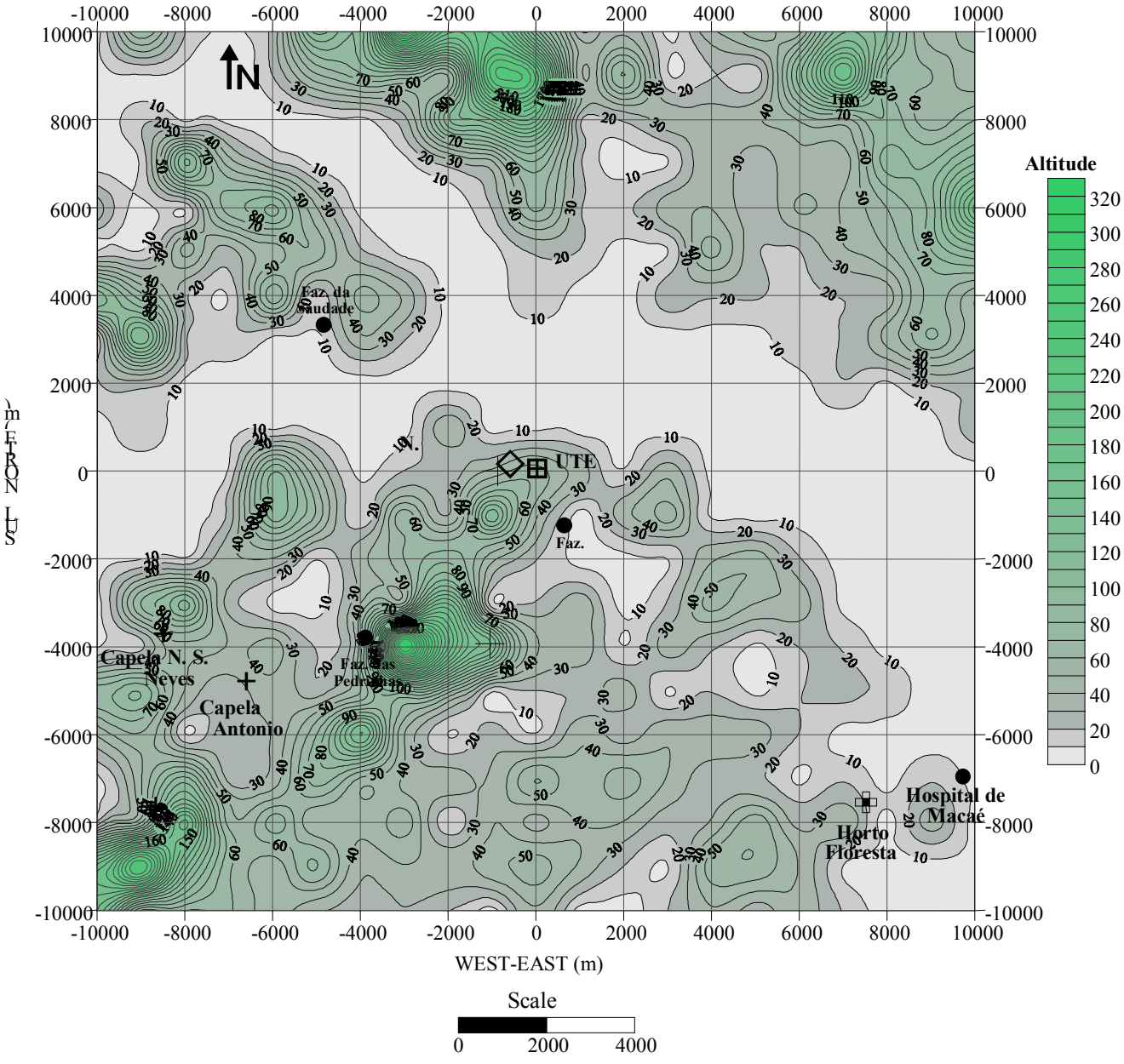


Figure – 5.2.1-1 – Topographical chart of the Macaé Merchant Thermoelectric Plant's influence area.

5.2.1.2. Behavior of the Region's Main Climatic Elements

- **Rainfall**

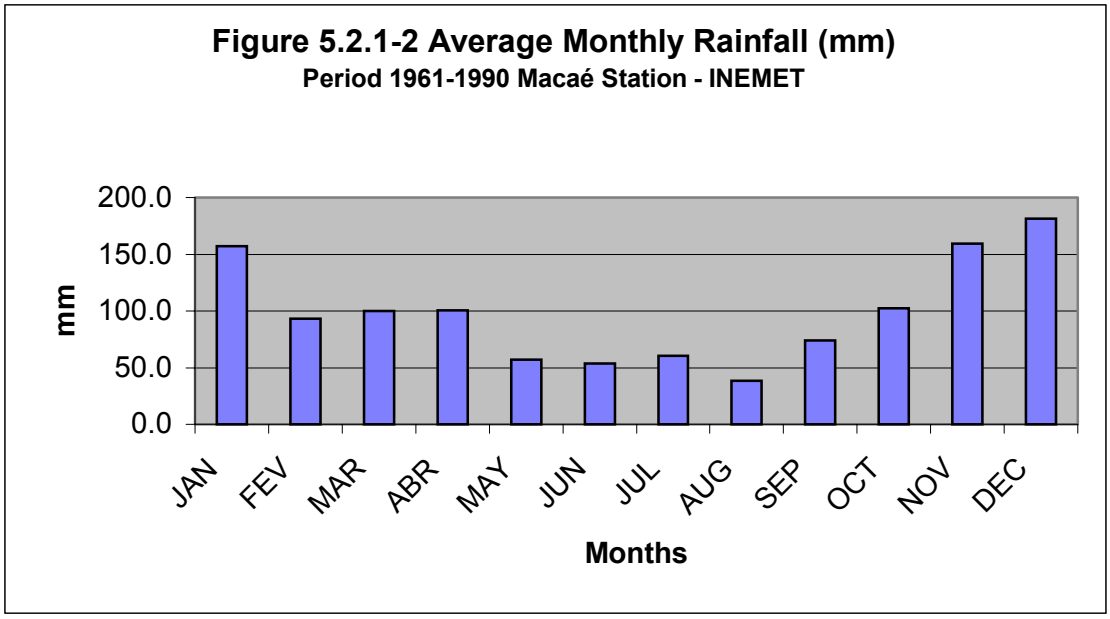
Annual rainfall throughout the State of Rio de Janeiro's predominantly low-lying coastal strip varies between 1,100 and 1,200 mm.

Average annual rainfall for Macaé stands at 1,177.6 (average for 1961-1990 period). May and September account for the lowest rainfall figures, while the heaviest rainfall occurs during the three-month period between November and January.

Macaé has an annual average of 122 rainy days (those with rain exceeding 0.1mm), varying between 6 days/month (August) up to 14days/month (December).

Rainfall figures in excess of 120 mm are recorded in Macaé in a 24-hour period, even in the winter months (130.9 mm in June and 124.8 mm in July), up to 191 mm in April, which is greater than the average monthly figure recorded for the period (181.6 mm in December). Figure 5.2.1-2 below illustrates average rainfall variation for the Municipality of Macaé.

Figure 5.2.1-2 Average Monthly Rainfall (mm)
Period 1961-1990 Macaé Station - INEMET

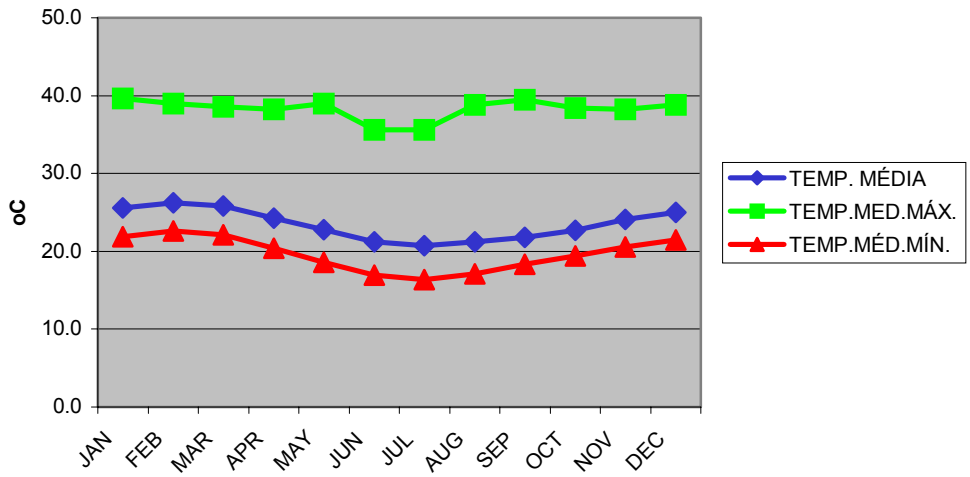


- **Temperature**

Temperature is an important parameter, being an atmospheric equilibrium indicator in terms of air stability for dispersion purposes. The data utilized in this study was collated over a thirty-year period at the Macaé meteorological station. This parameter is an indicator of the region's air temperature for the municipalities closest to the proposed project.

The weather data obtained from the Macaé Meteorological Station (83749 - INEMET) for the 1961-1990 period appearing in Table 5.2.1-1 shows average temperatures ranging from 19.7 °C in the coldest month to 39.6 °C in the hottest. The annual average is 23.5 °C. Figure 5.2.1-3 shows monthly distribution of average temperatures, average maximum and average minimum.

Figure 5.2.1-3 Average Temperatures
Period 1961-1990 - Macaé Station INEMET



July is the coldest month, with an average temperature of 20.7 °C and a minimum of 16.4 °C recorded during the study period. This fact indicates that during the month of July the atmosphere is subjected to little turbulence and is therefore less capable of dispersing pollutants. An analysis of the May to September period shows that this is when the lowest average and minimum temperatures occur. This low-temperature period coincides with the months in which the lowest rainfall combined with high evaporation rates is recorded. This combination of factors results in late autumn, winter and early spring being a critical period for the dispersal of pollutants, a situation which reaches its peak in the months of July and August.

Table 5.2.1-1 (see Tables 5.2.1-1&2-Climate-Winds.pdf)

On the other hand, the hottest period of the year showed average maximum temperatures of between 39.6 ^{o}C (January) and 38.2 ^{o}C (November and April). The excessive increase in temperature common to this region at this time of year causes an increase in rising vertical air currents which favor the creation of turbulent conditions, helping to improve the area's dispersal capabilities.

Being located in a sub-tropical region, temperatures are subject to modest variations throughout the year, with average monthly temperatures between 20.7^{o}C (July) and 26.2 ^{o}C (February). The coldest months are June, July and August, whilst the hottest temperatures are recorded during the period between December and March.

- **Relative Humidity**

Average relative humidity for the Macaé area remains practically constant throughout the year, at between 80% and 82%. This variation is much more pronounced throughout the day, however these figures are not available.

- **Wind**

In order to categorize surface wind circulation, we have utilized data obtained from DEPV/ INFRAERO in Macaé itself.

However, the information obtained relates to a single observation year (1997) and does not cover the months of November and December. Nor was any data provided on average monthly frequency and direction or occurrences of wind-lull.

Although scarce, data on the region shows a prevailing N-NE direction during the period defined in Table 5.2.1-2. Average wind speeds of between 9.3 km/h (March through July 1997) and 14.8 km/h (August 1997) were recorded.

5.2.1.3. Atmospheric Dispersion Study Data

The subject region is influenced by the coastal climate which predominates throughout the full extent of the State of Rio de Janeiro's coastline, characterized by the effects of secondary flows of maritime and terrestrial breezes. Considering that no mountains capable of distorting the natural air flow between continent and ocean exist between Guanabara Bay and the state's northern coastline, it can be assumed that wind circulation in the Macaé region is similar to that observed in the coastal regions adjacent to Guanabara Bay.

Table 5.2.1-2 (see Tables 5.2.1-1&2-Climate-Winds.pdf)

MACAÉ MERCHANT THERMOELECTRIC PLANT

Table 5.2.1-1 - Climatic Data and Information

Station: **83749** Altitude : **2,83** Data Period: **1961 / 1990**
Municipality: **MACAÉ** Location: **lat. 22º23' long. 41º48'**

CLIMATIC ELEMENT		MONTHLY CHARACTERISTIC VALUES												
TYPE	UNIT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
AVERAGE RAINFALL	mm	156,9	93,3	100,1	100,5	56,9	53,9	60,5	38,2	74,0	102,4	159,3	181,6	1.177,6
MAX RAIN 24 hs	mm	170,6	147,2	116,2	191,0	58,2	120,9	124,8	67,0	116,3	62,5	117,2	176,7	191,0
DAYS RAIN	nº of days	13,0	9,0	10,0	10,0	9,0	8,0	8,0	6,0	9,0	13,0	13,0	14,0	122,0
AVERAGE TEMP.	ºC	25,6	26,2	25,8	24,3	22,8	21,2	20,7	21,2	21,8	22,7	24,1	25,0	23,5
MAX. AVER. TEMP.	ºC	39,6	39,0	38,6	38,2	39,0	35,6	35,6	38,8	39,5	38,4	38,2	38,8	39,6
MIN. AVER. TEMP.	ºC	21,9	22,6	22,1	20,4	18,6	16,9	16,4	17,1	18,3	19,4	20,6	21,5	19,7
ABSOL. MIN. TEMP.	ºC	16,3	17,4	16,9	13,7	11,3	9,5	10,5	10,0	10,3	10,7	14,3	14,7	9,5
EVAPORATION	mm	108,0	94,9	94,1	95,3	92,6	85,5	97,8	100,4	93,3	92,0	95,8	88,1	1.137,8
SUNSHINE	hours													
RELATIVE HUMIDITY	%	81,0	80,0	81,0	81,0	80,0	80,0	80,0	80,0	82,0	82,0	81,0	81,0	81,0

SOURCE OF DATA : DENMET (INEMET) - DEPARTAMENTO NACIONAL DE METEOROLOGIA - NATIONAL METEOROLOGY DEPARTMENT

MACAÉ MERCHANT THERMOELECTRIC PLANT

Table 5.2.1-2 - Climatic Data and Information - Surface Winds

Station: **MACAÉ** Data Period: **1997**
Municipality: **MACAÉ**

CLIMATIC ELEMENT		MONTHLY CHARACTERISTIC VALUES					
TYPE	UNIT	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE
Average velocity	km/h	11,1	11,1	9,3	9,3	9,3	9,3
Prevailing direction	--	N / NE	N / NE	E / NE	N / NE	W / NW	W / NW
Gusts - Direction	.º	90	50	80	200	200	40
Gusts - Velocity	km/h	31,5	33,3	27,8	24,1	55,6	27,8

SOURCE OF DATA : DEPV / INFRAERO

CLIMATIC ELEMENT		MONTHLY CHARACTERISTIC VALUES			
TIPO	UNIT	JULY	AUGUST	SEPTEMBER	OCTOBER
Average velocity	km/h	9,3	14,8	11,1	11,1
Prevailing direction	--	N / NE	N / NE	N / NE	N / NE
Gusts - Direction	.º	60	230	200	60
Gusts - Velocity	km/h	31,5	48,2	29,6	37,0

Hourly surface wind and altitude data is routinely measured by the launching system of two radio-probes located at Meteorological Station 83746, at Galeão International Airport, situated at latitude 22° 49'S and longitude 43° 14'W, at a height of 10.3 meters.

The hourly data package obtained from this station consists of: wind direction and speed, temperature, cloud conditions and insolation. Altitude data consists of the thermal profile, comprising dry air temperature and vertical dew point measured at various atmospheric levels.

This station lies 130 kilometers from the site of the Macaé Merchant site, as the crow flies. The altitude of the site itself varies between 5 and 20 meters, illustrating the minimal height difference between the two locations. The existing Galeão Airport station is capable of collating coastal climatic behavior very efficiently, being installed in an unobstructed position near the runway. The station complies with all positioning and measuring criteria established by the World Meteorological (OMM) WMO-265 (1970)[1].

In spite of the distance between the two locations, the data obtained by this station is valid for the Macaé Region, in view of Technical Note No. 153, issued by the World Meteorological Organization –WMO-153 (1964)[2] . This note states that data obtained by radio-probe is representative of an area within a 300 kilometer radius of the launch station, provided that the area in question does not contain any mountainous area capable of disturbing natural wind flow patterns.

This validation permitted data obtained at Galeão Airport to be used as entry data for the atmospheric dispersion model in the absence of local data. The dispersion study is attached to this report.

Figure 5.2.1-4 illustrates the four wind diagrams for the four semesters, based upon data obtained from the Galeão Airport station. The figure shows that a prevailing SE wind, with Northeasterlies prevailing during the winter months (July, August and September). It is worth remembering that S or SE winds prevail during the day, while N or NE winds prevail at night, when average wind speeds tend to be less.

[1] World Meteorological Organization WMO, 1970, N°. 265 TP 149. Technical Note – The Planning of Meteorological Station Networks. 35 pp.
[2] World Meteorological Organization, WMO; 1964, N°. 153 . Technical Note – Meteorological Soundings in the Upper Atmosphere, Geneva. 47 pp

MACAÉ MERCHANT THERMOELECTRIC PLANT

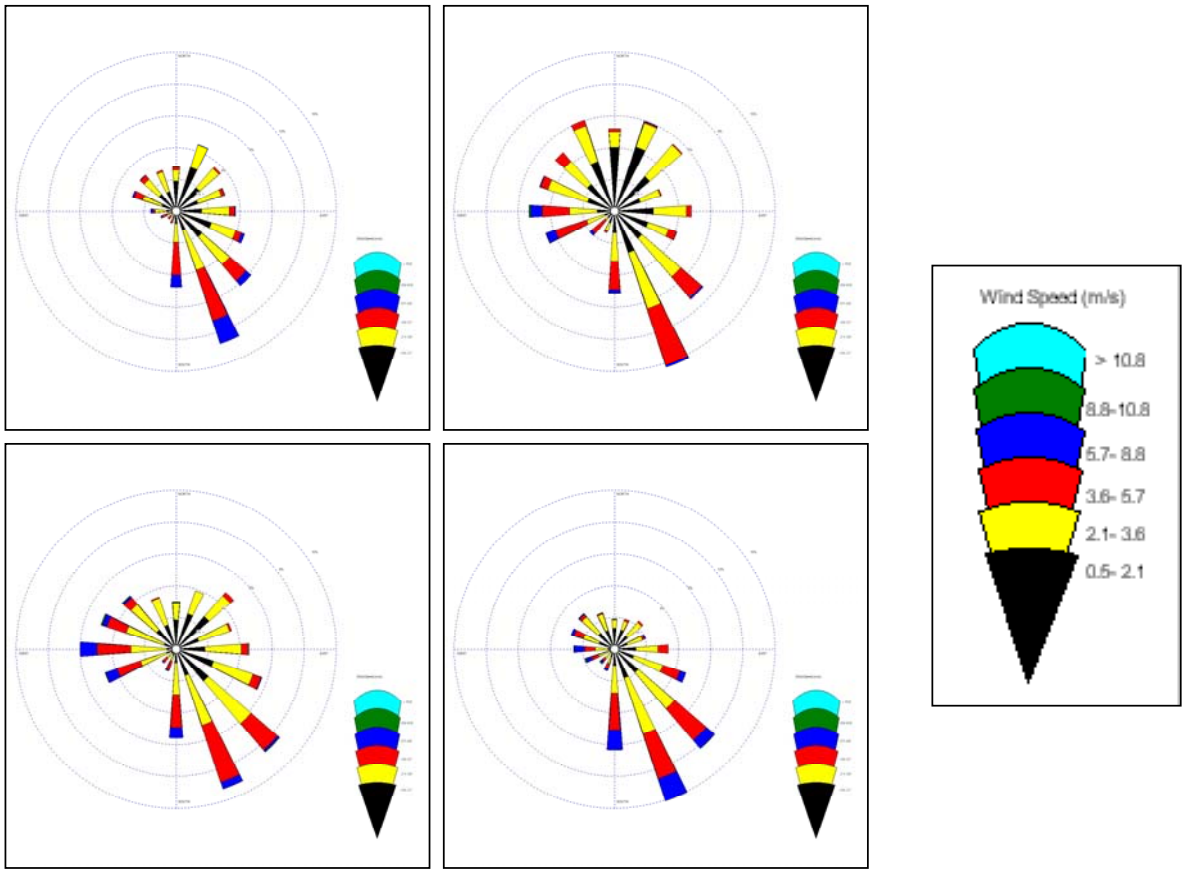


Figure 5.2.1-4 – Wind Diagram

- **Atmospheric Stability**

Atmospheric stability is the degree of equilibrium within a column of air in terms of atmospheric warming and cooling. Hourly temperature, insolation and wind speed data were utilized during the attached atmospheric dispersion study to classify atmospheric stability in accordance with the criteria established by Pasquill Gifford[4]. Stability classification is associated with favorable or unfavorable atmospheric dispersion weather conditions. During mathematical processing, all possible weather situations resulting in both high and low concentrations of pollutant are cross-referenced.

- **Mixture Level**

The mixture level concept is understood to refer to a layer of air which extends from the surface up to the level of the first thermal inversion observed on the vertical profile of temperature measured by radio probe. Within this layer the free air temperature tends to fall as height decreases, at a rate of–1^{o} C/100m. This process occurs due to thermal and mechanical air turbulence which favors vertical and horizontal dispersion of atmospheric suspensions. This layer reaches its maximum height in the afternoon (good dispersion) and its minimum in the pre-dawn and early morning period (critical dispersion condition), particularly during the winter months.

Throughout the full extent of the coastline the mixture layer behaves in a relatively complex manner in relation to the inner-continental layer. During the day the sea breeze blows onshore, displacing the marine mixture layer. At night, the less turbulent land breeze blows offshore taking the continental air with it. The urban mixture layer rises more slowly during the day than the rural layer because the latter possesses a more homogenous soil type than the urban zone. These differences result in either a slower or faster rate of atmospheric heat retention, dependent upon whether the region is urban or rural by nature.

[4] F. Pasquill, " The Estimation of the Dispersion of Windborne Material ". Material Magazin. Vol. 90, pp. 33-49 (1961).

5.2.2 AIR QUALITY

Scenario 1 – Air Quality in the Area – Without the Project's Implementation

The project area is basically composed of grazing land, with five houses located some 500 meters distance. The BR 101 highway lies within 700 meters of the land acquired for the implementation of the Macaé Merchant Thermoelectric Plant. During field checks carried out as part of the environmental diagnosis exercise, traffic volume averaged out at 5 to 7 vehicles per minute, a rate that coincides with that observed during environmental studies on the Norte Fluminense Thermoelectric Project [1].

No air quality data for the region was found amongst the available literature. This had been expected, as there are no other emission sources in the area capable of posing a problem, other than the highway itself. Recent air quality assessment studies which took place 500 meters from the Presidente Dutra Highway [2] analyzed SO_2 and NO_2 concentrations over a five-day period. Results obtained showed values below the detection limits of the methods employed (<0.006 mg for SO_2 and <0.002 mg for NO_2).

Considering that atmospheric conditions, dispersion and other weather conditions in the area adjacent to the Presidente Dutra highway and the Macaé Merchant implementation area (near to the BR 101 highway) are the same, the results obtained were utilized as entry data for the atmospheric dispersion model.

Air quality measurement studies and subsequent background measurements will be conducted prior to implementation work on the Macaé Merchant Thermoelectric Project beginning.

Scenario 2 - Air Quality in the Area – With Implementation of the Norte Fluminense Project

In this case, the air quality for the region is as defined by the Norte Fluminense EIA/RIMA. The values and results of these reports appear below.

[1] EIA/RIMA – UTE Norte Fluminense
[2] BRANDT, EIA/RIMA - UTE RioGen (Anexo V – VolumeII)

"*Atmospheric dispersion calculations were conducted considering the most critical atmospheric stability conditions. The results thus obtained illustrate the maximum concentrations of pollutants at ground level, permitting an assessment of their impact upon the region's air quality.*

The dispersion of each pollutant analyzed was checked under the most critical atmospheric condition, i.e: stability class A and N/NE wind blowing at a speed of 2.5 m/s, which corresponds to the lowest characteristic wind speed for the region. Under these conditions, the point where the greatest concentration of pollutants would be most likely to occur was identified.

In all cases, the maximum concentration of pollutants at ground level will occur approximately 700 meters downwind from the plant. The maximum concentration of pollutants likely to be found at these locations are shown in the following table:

Pollutant	***Maximum concentration at ground level ($\mu g/m^3$)***	***Max. recommended level ($\mu g/m^3$)***
CO	*36.0*	*40,000*
Total Particles	*9.5*	*240*
NO_x	*97.0*	*320*

It can be seen that the maximum concentrations of the three pollutants analyzed are well below the respective standard, thus indicating a negative, low relevance, low magnitude, localized impact.

These conditions were utilized as the basis of the air quality simulations whose results appear in item 6.2.3.1 of this document, and in greater detail in Annex 2 – Atmospheric Dispersion Study (Volume 2).

5.2.3 NOISE

Noise pollution in a determined area is related with anthropic activities (industry, commercial activity, shows, rallies, motor vehicles, planes, trains, ships, tractors, etc) and natural causes (wind, volcano, electrical discharge, precipitation, tidal effects, animals, etc).

Sound is produced when pressure variations in a certain characteristic waveband reach the ear. Given the wide range of frequencies and variations in pressure levels, noise measuring equipment utilizes a scale based on a weighting curve known as dB(A) to attempt to achieve an accurate assessment of the susceptibility of the human ear.

The dBA scale is logarithmic, given the wide variety of frequencies which the human ear is capable of detecting. Table 5.2.3-1 below shows some well-known methods of measuring noise levels.

TABLE 5.2.3-1- NOISE LEVELS

Noise Level (dBA)	Condition/ Situation
40	Forest Region, quiet room
45	Residential area in small community
51	Urban residential area
60	Conversation, typewriter
65	Motor vehicle traveling at 100 Km/h
75	Heavy truck traffic
85	Industrial mill
95	Newspaper printing press
120	Pain limit
125	Jet aircraft (pure jet)

CONAMA Resolution 01 dated 08/03/90 “Established Norms to be complied with in the interest of health relating to noise emissions”.

Subsection II of this same resolution establishes that “for the purpose of the preceding item, noise levels in excess of those considered acceptable by Norm NBR 10151 – Noise Assessment in Inhabited Areas intended to Guarantee the Community’s Well Being: issued by the Brazilian Technical Norm Association (ABNT) are prejudicial to public health and well being”.

ABNT NBR 10.151 defines the basic criteria for external noise in keeping with the use to which the land is put during the period, as illustrated in Table 5.2.3-2.

TABLE 5.2.3-2 – BASIC EXTERNAL NOISE CRITERIA

Land Use and Occupation	Noise Level (dB_A)	
	Day (06:00 – 20:00)	Night (20:00 – 06:00)
Hospitals	45	40
Urban Residential Area	55	50
Commercial Activities	65	60
Predominantly Industrial	70	65

Paragraph II of Ministry of the Interior Ordinance GM/nº 092, dated 19/06/1980, establishes that the following sounds and noises are harmful to public health, safety and well being:

- those that reach sound levels in excess of 10 (ten) decibels (dBA) over and above the existing background traffic noise in the environment outside their point of origin;
- those that independent of background noise, reach sound levels in excess of 70 decibels during the day, or 60 decibels at night, in the environment outside their point of origin;
- those that reach levels within their point of origin that exceed those deemed acceptable by Norm NB-95, issued by the Brazilian Technical Norms Association (ABNT) or its replacement.

People tend to react negatively and begin to complain when a sound source exceeds the 65 dBA level. These complaints become more constant when the noise level reaches the 75 dBA mark. In general, a source which generates noise 3 decibels above the background level causes great discomfort.

In order to classify the noise levels generated by the operation of the Macaé Merchant Thermoelectric Facility measurements were obtained of noise levels within the area under scrutiny on 18-10-2000. The main noise source in the region is traffic using the BR-101 highway. Estimated traffic volume during the measurement period ranged from 5 to 7 vehicles per minute.

Background noise levels are illustrated in Table 5.2.3-3 below.

TABLE 5.2.3-3 – BACKGROUND NOISE LEVELS

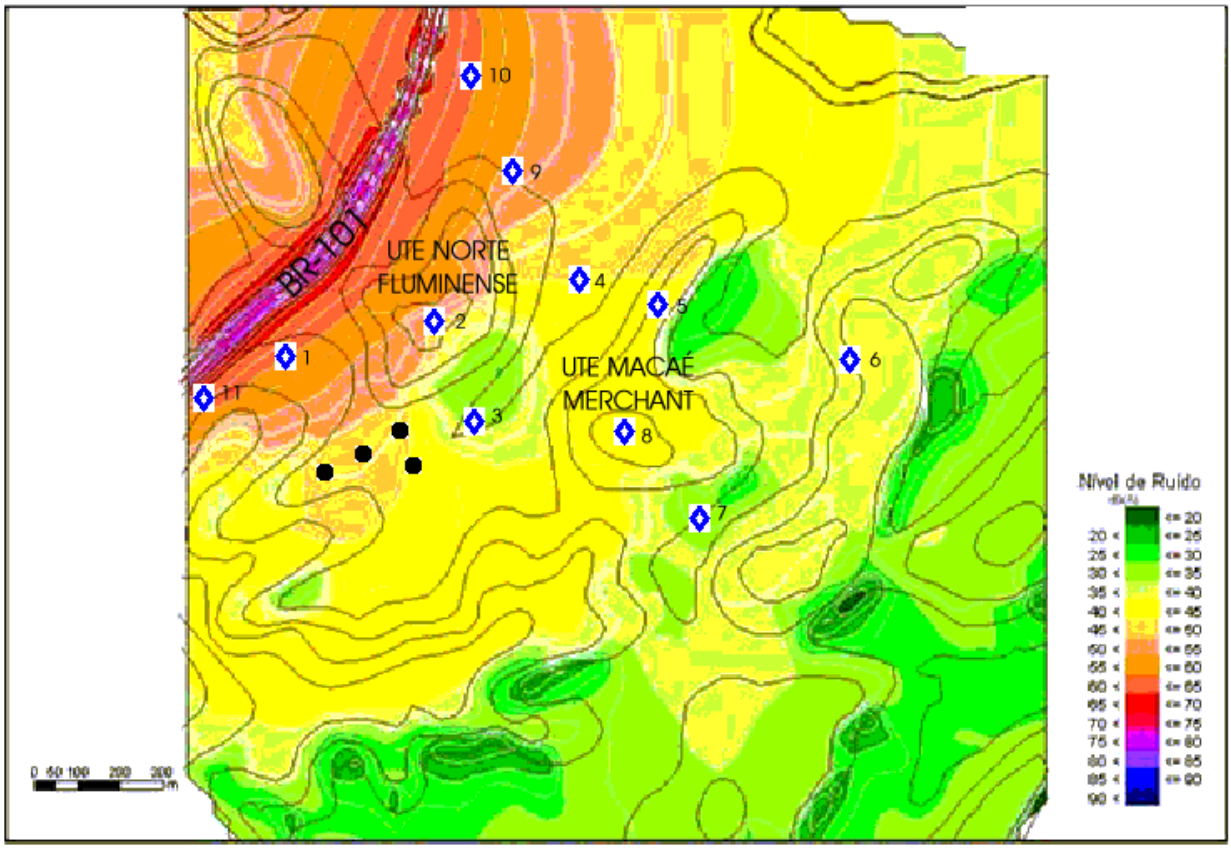
Measurement Location	Background Noise dB(A)	Time	Measurement Period
Point 01	58.1	14:27	180 s
Point 02	65.7	14:44	181 s
Point 03	46.2	16:15	189 s
Point 04	42.1	15:10	184 s
Point 05	62.1	15:19	180 s
Point 06	41.9	15:45	180 s
Point 07	49.1	15:56	184 s
Point 08	53.5	15:34	180 s
Point 09	51.8	14:56	180 s
Point 10	60.7	16:32	190 s
Point 11	67.3	16:41	150 s

NB: NE Wind, blowing at approximately 5 m/s

Figure 5.2.3-1 presents the results of simulations of background noise levels for the region under scrutiny. Note that a significant deviation exists between values measured and those presented in the graph, attributable to the region's winds.

As can be seen, the BR-101 highway is the region's only noise source, where noise levels in the region of 67 dB(A) are reached (Point 11). As you move away from the highway and approach the four houses (close to the UTE Norte Fluminense site) noise levels reach 50 dB(A). Moving even further from the highway (Point 7), background noise levels are very low (35 db(A)), characterizing an area extremely sensitive to noise pollution.

FIGURE 5.2.3-1 - BACKGROUND NOISE LEVELS IN THE REGION – RESULTS OF SIMULATIONS



Measurement Locations Dwellings

5.2.4 GEOLOGY AND GEOMORPHOLOGY

5.2.4.1 Indirect Influence Area (AII)

The hydrographic basin of the Macaé River forms extensive Quaternary areas which cut through Archeozoic provinces and constitute the region's main physical features.

According to the physical-environmental map published by CIDE (Rio de Janeiro, 1995), the area is mainly composed of hills and hillocks with crystaline substrata. The area also contains mountains and scarps, the most notable feauture being the Serra da Pedrinhas range, which runs in a northeasterly direction. Alluvial areas exist in the high to mid drainage areas, whilst the lowlying watercourses through to the mouth of the Macaé River are occupied by marshland.

The geology within the area of indirect influence is composed of two units: Pre-Cambrian crystaline rock and Quaternary alluvia. The crystaline rocks are classified as: Paraíba do Sul Complex (Archean) and Serra dos Orgões Intrusive (Pre-Cambrian).

The Paraíba do Sul Complex, particularly the area known as the Undivided Unit, is petrographically composed of intensely tectonic gneiss and pegmatite (RADAMBRASIL PROJECT 1983). The area in focus is not affected by the intense catachlase observed throughout the full extent of the Paraíba River, where reliefs typical of the homonymous Complex were observed. The foliation generally runs in a northeasterly direction. However, in the area near to Macaé northwesterly foliation has been observed, transverse to the northeasterly foliation.

The Macaé River forms an extensive alluvial plain filled with Quatenary sediment mainly composed of gravel, sand and unconsolidated silt, covered with pelitic sediment.

The region's relief reflects the geological substrata, in that the Macaé River's recent alluvia form the geomorphic region known as the Coastal Plains, which consists of wide flat fluvial valleys and coastal ranges. The crystaline rocks excavated by the drainage process form the Coastal Hills and Massif.

The most important drainage areas which form the right bank of the Macaé River within the Area of Indirect Influence (AII) are the Purgatório River, the Pedrinhas Canal and the Imboacica River. Various canals, including the one which renews the bed of the Macaé River, cuts through the alluvial deposits and marshlands, constituting an important anthropic intervention in the natural drainage process.

Exploitation of mineral resources in the Municipality of Macaé is not carried out in any significant volume, and is restricted to the production of crushed and ornamental gneiss and granite. Mineral reserves for the Municipality of Macaé, measured in 1990. amounted to 19,879 tons of crushed and ornamental granite (Source: DNPM – 1990). This reserve places Macaé in a modest 16th place out of a total of 19 municipalities.

It should be noted that oil exploration in the Campos Basin, which contains 82.65% of proven oil reserves and 40.89% of all natural gas reserves, is an important activity throughout the north of the State of Rio de Janeiro, particularly in the municipalities of Campos and Macaé.

5.2.4.2 Direct Influence Area (AID)

The thermoelectric plant's direct influence area is located in the Macaé Geographic Micro-Region. Its geology, similar to that of the Area of Indirect Influence, is composed of two units: crystaline Pre-Cambrain rock and Quaternary alluvia.

To the south and southwest of the hill upon which the plant will be located are massifs between 100 and 400 meters in height, sustained by granite rock described as post-tectonic manifestations of the Serra dos Orgãos Intrusive Suite. These massifs form the Serra das Pedrinhas range, which runs through both the project's Direct and Indirect Influence Areas. The site selected for the thermoelectric facility lies on a hill 50 meters in height at its highest point, less than 1 kilometer from the right bank of the Macaé River.

The Macaé River forms an extensive alluvial plain along the left bank, filled with quaternary sediment. These plains are cut by various drainage channels. The Pedrinhas Canal runs close to the Area of Direct Influence.

The AID is located in an area between the Macaé River's mid-section and mouth, where the underlying soil is predominantly organic. This soil possesses various levels of organic material in fluvial-lacustrine sediment. These areas tend to have a surface water table and poor drainage. Amongst the crystaline rocks the Yellow and Red Latosol and Podzolic varieties predominate, both of which are mainly found in pastoral areas.

a. Geology

General Considerations

The region lies within the southeastern section of the Brazilian Platform, represented by the geotectonic domain of the Mobile Atlantic Belt or Coastal Belt. Within this area archeozoic and proterozoic Pre-Cambrian features predominate, mostly composed of mid to high-grade metamorphytes (gneisse, migmatites, granitoids, kinzigites and mylonites). These rocks were injected in certain locations by acid rock (granite and post-tectonic) at the end of the Pre-Cambrian period and by alkaline rocks of tertiary/cretaceous age.

The recent unconsolidated cover (Quatenary/Holocene) is formed by sedimentary fluvial-marine or marine deposits of granulated sand or clay, along with colluvial and alluvial/colluvial deposits.

These deposits partially cover the pre-cambrian rocks and contain the project area's drainage network.

These rock formations were affected by different cycles of intense deformation, when they were partially remobilized and rejuvenated by phenomena such as migmatization, granitization and various different degrees of tectonic processes.

The rock formations display features such as fractures, folds and granitic intrusions attributable to these tectonic processes.

Lithostratographic Units

Paraíba do Sul Complex (Pεpsgr,Pεpskz)

The Paraíba do Sul Complex (ancient Pre-Cambrian – Archuean) predominates in the project's area of influence. It is basically composed of banded gneisse, mygmatites, generally stromatic with ample recrystalization and catachlase. Calcisilicatic, metabasic, anphybolitic, marble, charnoquite, kinzigites and granitoid gneisse rocks of granitic and tonalytic composition are also found in the area.

The dominant gneisse and migmatities are minerologically composed of quartz, mica and feldspar, arranged in foliation structures with acute angled axial planes, showing evidence of transposition.

The original surface soil of this lithology generally consists of a layer of a sandy-clay consistency about 2 meters thick, at its thickest in the least salient areas. Can be classified as first class for excavation purposes. The altered rock can be classified as second class.

This unit usually occurs in low hilly terrain and is generally associated with the small hill geomorphologic sub-unit.

These land-types are suscepible to erosion and mass movement in areas containing steep slopes and used as grazing land.

Serra dos Órgãos Intrusive Suite (Pεγso)

This Pre-Cambrian Superior unit is represented in the study area by plutonic masses of granitic and granudioritic composition. Generally speaking, the rocks are foliated (foliation in keeping with the inlaid rock), i.e. ortogneissic. They have cataclastic structures, light grey in color, with mid to thick granulation. They are composed of quartz, mica, feldspar and amphibole. Porphyroblastic zones are common, with centimetric crystals.

Small bodies of amphybolite and hornblende gabbro quartz are found within these foliated plutonites. These plutonites are cut by various thicknesses of aplogranite, aplite and pegmatite.

The superficial layers resulting from the weathering of these rocks are usually deep, with a clay or sand-clay consistency.

The steeper slopes intensely utilized for grazing purposes are subject to instability, with the occurence of ravines, cave-ins and landslides.

Fluvial, Fluvial-marine and marine deposits (Qa, Qam and Qm)

Fluvial sediment is composed of unconsolidated clay, sand and gravel present in the fluvial plain. These occurences are restricted to the west of the mapped region.

The resulting soil has a medium, clay and sand consistency directly related to the nature of the sediment deposited, whose thickness varies from less than one to several meters.

This soil is considered to be first class for excavation purposes and normally requires the use of retaining walls during excavation operations.

Fluvial-marine sediments are generally organic clay in nature, from the bottom of bays or fluvial sections dominated by tidal action, such as the basin of the Macaé River downstream of the preceding lithology and therefore closer to the ocean.

Superficial soil produced from these sediments is of a clayey texture with medium to soft consistency.

These soil types are considered to be first class for excavation purposes. Special retaining wall methods are normally necessary when cutting through this material, as excavations often intercept the water table. Foundations generally prove complicated due to the low bearing capacity.

The marine sediment to be found in the area is composed of sedimentary material discharged into the sea by both the Macaé and Paraíba do Sul Rivers.

These sediments were re-worked by coastal agents (waves and drifting currents) and deposited in ranges parallel to the coastline.

They basically consist of fine to heavy-grained white or yellow quartzes.

The soil produced from these sediments is of the Podzol type. Geomorphologically the area is known as a sandstrip formation area.

The lythostratographic units in the distribution pipeline area are illustrated in Figure 5.2.4-1.

b. Geomorphology

General Considerations

The site of the proposed undertaking lies within two Morphostructural Domains, known as the Sedimentary Deposits and Remobilized Fold Corridors which in turn are represented by two Geomorphological Units in the area.

The Sedimentary Deposits domain began to evolve during the Upper Tertiary period as a result of the paleoclimatic conditions and the positive epirogenesis which allowed sediments to be deposited through the action of continental and marine waters.

The Remobilized Fold Corridors domain encompasses distinct model types sustained by pre-cambrian terrain (Archean and Proterozoic), formed mainly of gneiss, migmatite, granito-gneiss and intrusive granite. Its morphology is the result of folds, reactivated faults and remobilized blocks which, combined with climatic factors and successive erosive phases, led to the creation of isolated hills and elongated crests reaching 400 meters in height, such as the Serra das Pedrinhas range.

This morphological package also includes hills and massifs of lesser topographic amplitude which are also related to the regional tectonic effects and morphoclimatic factors both preterite and recent. Medium and small hills have been identified in the study area.

Geomorphological Units

- Units of the Geomorphological Region: Coastal Lowlands and Fluvial Accumulation Models

Fluvial Plains / Fluvial-marine and Coastal (PF, PFM e PL)

Composed of two sub-units which basically differ according to the origin of their fluvial and fluvial-marine sediments, generally represented by sandy, clayey, silt and organic sediment as well as the degree of flooding in the valleys in which they are situated.

These are sub-horizontal surfaces, with a shallow gradient which interface with the continental (fluvial and abutment) and marine deposition systems.

The Fluvial Plains (PF) are normally composed of short terraces, generally with only one interconnecting causeway to colluvial areas. These terraces are gently inclined with a downward rupture running in the direction of the beds of bodies of water and the small newly-formed meadows situated at lower levels. Located upstream from the Fluvial-Marine Plain.

The Fluvial-Marine Plain (PFM) is, or was subject to tidal influences, forming plains containing lakes and silt-laden depressions, as well as swampy plains and mangrove swamps near to the mouth of the Macaé River.

Coastal Plain (PL) is characterized by the fact that it is almost completely flat. The land is gently undulating, varying between 0 and 2 meters above sea level, with horizontal expansions in the form of sandy, elongated crests, sub-parallel amongst themselves and in relation to the coast (coastal ridges or sand spits). Extended lakes occur in the depressions between the coastal ridges, many of which have already silted up, creating swampy conditions in the rainy season. They lie to the east of the mapped area.

The rivers within this unit are nearly all channeled (Macaé River and its tributaries), thus improving the area's drainage conditions and permitting the meadows adjacent to these rivers to be put to better use by the area's farmers and ranchers. These improvements are easily visible on the Geomorphological image chart.

- Units of the Geomorphological Region: Hills and Coatsal Massifs

Small Hills (CP)

This unit is characterized by gentle hills generally less than 80 meters in height with shallow gradients, rectilinear and slightly convex profiles, open valleys and dendritic drainage.

These hills are interspersed with Fluvial and Fluvial-marine Plains. The Macaé Merchant Thermoelectric Plant will be installed on one such hill, close to the point where the BR-101 highway crosses the Macaé River valley.

This protuberance is supported by pre-cambrian rock, predominantly varieties of gneiss, migmatite and granitoid from the Paraíba do Sul Complex, and exceptionally, by granite from the Serra dos Orgãos Intrusive Suite.

Medium Hills (CM)

Characterized by an undulating landscape of hills with convex/concave slopes. Topographic amplitude is predominantly within the 80 to 400 meter mark with gentle gradients. Very few are within the project's Indirect Influence Area (AII).

The rocky sub-strata consists mainly of plutonic masses of granitic through granodioritic composition from the Serra dos Orgãos Intrusive Suite.

The highest of the region's hilly features shows evidence of deep seated change.

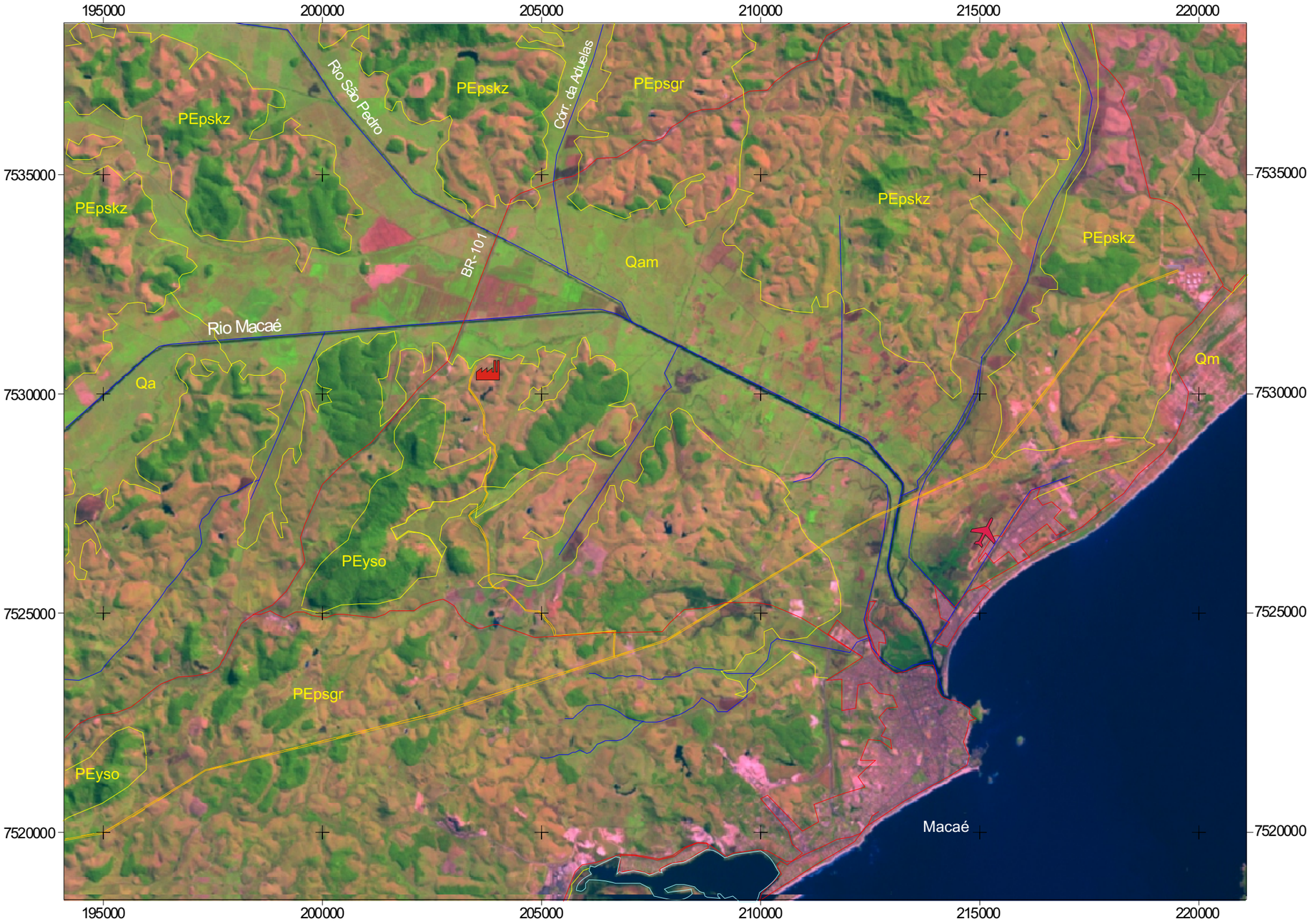
The Serra das Pedrinhas and Morro do Ouro are the most significant features in this unit.

The geomorphological units located in the area in which the distribution pipeline is to be constructed are illustrated in Figure 5.2.4-2.

Figure 5.2.4-1

(see Figure 5.2.4-1.pdf)

CARTA IMAGEM DE GEOLOGIA



ESCALA GRÁFICA

2 0 2 4 km

N

LEGENDA DE GEOLOGIA

Pepsgr, PEpskz: Complexo Paraíba do Sul (ganisses, migmatitos,kinzigitos).

PEyso: Suíte Intrusiva Serra dos Órgãos (granitos e granodioritos).

Qa, Qam, Qm: Sedimentos Quaternários sedimentos inconsolidados aluviais, aluviais-marinhos e marinhos.

CONVENÇÕES CARTOGRÁFICAS

- LIMITE DE UNIDADE
- HIDROGRAFIA
- RODOVIAS
- DUTO
- TERMELÉTRICA
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ECOLOGUS Engenharia Consultiva	FIGURA 5.2.4-1 - GEOLOGIA		
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Figure 5.2.4-2

(see Figure 5.2.4-2.pdf)

CARTA IMAGEM DE GEOMORFOLOGIA

ESCALA GRÁFICA

2 0 2 4 km

N

LEGENDA DE GEOMORFOLOGIA

CP: Colinas pequenas

CM: Colinas médias

PF: Planície fluvial

PFM: Planície Flúvio-Marinha

PL: Planície litorânea

CONVENÇÕES CARTOGRÁFICAS

- LIMITE DE UNIDADE
- HIDROGRAFIA
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ECOLOGUS Engenharia Consultiva	FIGURA 5.2.4-1 - GEOMORFOLOGIA		
EMISS O DATA	REVIS O	N MERO	ESCALA

5.2.5 SOILS

5.2.5.1 Indirect Influence Area

The soils also reflect the course of the Macaé River. From its mid-course through to the mouth, organic soils are found containing various levels of organic material in fluvo-lacustrine sediments. They are characterized by their surface water table and poor drainage. Alluvial soils predominate at the rivers' sources and upper reaches, suitable for a variety of agricultural uses, such as rice, pasture, etc. Within the crystaline rocks' domain, Red and Yellow Latosol and Podzol predominate, both of which are used for grazing lands.

5.2.5.2 Direct Influence Area and Directly Affected Area

a. Introduction

The objective of the following soil survey is to identify the types of soil which occur within the area of direct influence and the natural gas distribution line used to supply the facility and to provide information for the environmental impact study relating to construction and operation. Particular emphasis should be given to aspects involving the stability of hillsides, excavation, effective depth, erosion potential and capacity to support surface vegetation cover.

With this in mind, soils were described at large group level and as taxonomic units, divided according to their dominant features, such as: structure, consistency, permeability, natural fertility, etc. They were mapped individually or in association with others, permitting a wide range of characteristics of interest to the project to be obtained.

Soil classes or taxonomic units were established in accordance with the criteria and norms proposed by Embrapa Solos (Embrapa 1988) and Lemos & Santos (1996).

b. Description of soil classes

Red-Yellow Latosol

Encompasses non-hydromorphic mineral soils, with B latossolic horizons and a clay-like texture, yellowy-red in color containing low levels of ferrous oxides (Fe_2O_3 < 11%).

This soil type is deep or very deep, well drained, predominantly caulinitic, with a moderate A horizon and more rarely proeminent. Presents an A, B, C horizon sequence.

Possess a low texture gradient, with relatively unifirm clay distribution throughout the profile.

The thickness of the solum (A+B) is normally greater than 1.5 meters with a B horizon of variable coloration and clayey or very clayey texture.

In relation to chemical properties, these soils are strongly acidic, with low levels of exchangeable bases and high levels of exchangeable aluminum, reflecting the strong desaturation conditions.

They are found under tropical sub-evergreen, evergreen and sub-decidous forest vegetation in areas ranging from rolling hill country through to mountainous terrain.

Their main limitations are their low natural fertility and high susceptibility to erosion, mainly on the sides of mountain ranges, where they occur in strongly undulating and mountainous reliefs, as well as hindering the movement of implements and machinery.

The site where the thermoelectric facility is to be installed comes under this soil category. It stands on a hill approximately 50 meters in height with a gradient of less than 10% and its susceptibility to erosion is restricted.

The gas distribution line mainly runs through Yellow-Red Latosol and Yellow-Red Podzol soils, predominantly of shallow gradient. These soils occur throughout the route and right-of-way occupied by the previously installed Petrobrás gas pipeline and adductor, a factor which makes the land in which the duct is to be laid a region with low erosion potential.

Red-Yellow Podzol

Encompasses non-hydromorphic mineral soils, of the B horizon, generally yellowy-red or burnished red under a moderate B horizon. Predominantly consists of low-activity, alic or dystrophic clay with an A, Bt, C horizon sequence.

Includes both deep and shallow soils, ranging from moderately to extremely well drained, with a 5YR and 10YR coloration blend.

This soil type is not generally waxen, but when it is the effect is both little and weak. In the clayey varieties waxing is normally weak and moderate to moderate and little.

These soil types were found in gentle rolling terrain, with original vegetation, predominantly of the tropical sub-evergreen and sub-deciduous forest types, which have almost all been replaced by pasture in the area of the proposed site. Susceptibility to erosion is moderate to high.

Dark Red Podzol

Includes non-hydromorphic mineral soils, with a B horizon, the greater part of which are dark red in color, under a predominantly moderated A horizon.

Red-Yellow Podzol soils can be distinguished due to their redder, darker and brighter colors, in the 2.5YR to 5Yr range, and due to their Fe_2O_3 content.

Includes deep soils with A, Bt and C horizon sequences, including both eutrophic and dystrophic varieties, as well as low activity clay types.

Occur in areas of undulated and strongly undulated relief, under tropical climate conditions dominated by tropical sub-deciduous forest with moderate to strong erosion susceptibility.

Yellow Podzol

Includes non-hydromorphic mineral soils, with a B horizon, abrupt or not, of yellow coloration, with gradual or diffused transitions between sub-horizons, low activity clay and very low Fe_2O_3 levels, normally below 7%.

This soil type has a moderated A horizon, with a thickness of around 20 cm, with colors in the 10YR range or yellower, is alic or dystrophic with a predominantly medium/clayey binary texture.

This soil type was found in areas of gently undulating to undulating relief, i.e. predominantly in small and medium sized hills distributed throughout the meadowlands in tropical climate conditions dominated by tropical sub-evergreen and sub-deciduous forest vegetation. Erosion susceptibility is low to moderate.

Cambissol

Includes non-hydromorphic mineral soils, with an extremely heterogeneous incipient B horizon, both in terms of color, thicknes and texture and in relation to base saturation. This horizon lies immediately below the moderated and more rarely preeminent A horizon, and has an A, Bi and C sequence.

These are soil types which display a certain degree of evolution insufficient however to completely weather primary minerals with easier weathering properties, such as feldspar, mica, horblende, augite and others. They do not possess significant accumulations of ferrous oxides, humus and clay, allowing them to be identified as possessing textural B or espodic B features.

Are moderately to well drained, of little depth, with medium or clayey texture, alic (dominant), dystrophic or eutrophic; always with low-activity clay.

These soil types are found in the areas containing the more pronounced gradients (Serra das Pedrinhas), in reliefs that vary from level to escarpment, although the

majority are found in areas of strong undulating relief. Have been found under tropical forest vegetation of the evergreen, sub-evergreen, meadowland evergreen and sub-deciduous type, with susceptibility to erosion varying between nil to extremely high.

Humic Gley

Includes poorly developed hydromorphic mineral soils with a humic type superficial horizon directly over a gley diagnostic horizon.

The soils in this category are characterized by strong gleyzation, due to the reduction climate to be found in an anaerobic environment, with a marked defficiency or absence of oxygen due to flooding over long periods, sometimes throughout the year.

These soil types present an A, Cg horizon sequence and are generally shallow, reaching as far as ground water level, badly or very badly drained, with low permeability, particularly those with clayey texture, solid structure and high-activity clay.

The gley horizon is grey, dark grey or dark burnished grey in color, with or without speckles, clayey or very clayey.

They are evolved from recent sediments in areas subject to flooding as well as the margins of water courses in low-lying level areas. Are predominantly found under tropical forest vegetation of the meadowland evergreen or tropical pasture type.

They are alic or dystrophic, composed of high and low activity clay, with clayey or very clayey texture. Mainly found in the areas around the Macaé River Fluvial-marine Plain.

Slightly Humic Gley

Includes poorly developed hydromorphic mineral soils, with a horizontal gley presence within 50 cms of the surface. Characterized by strong gleyzation due to the reduction climate found in an anaerobic environment, with a marked defficiency or absence of oxygen due to flooding over long periods, sometimes throughout the year.

These soil types present an A, Cg or Ag Cg horizon sequence and are generally shallow, badly or imperfectly drained, with very low permeability, particularly those with clayey texture and high-activity clay

The gley horizon is grey (grey, burnished grey, light burnished grey) with neutral or near neutral color quality, with or without speckles. Texture is clayey, very clayey or medium and the structure has a solid aspect when the soil is wet.

Formed from recent sediments, near to or on river banks in colluvial-fluvial materials subject to hydromorphism conditions in fluvial, lacustrine or marine terraces, under vegetation of a tropical meadowland and tropical meadowland evergreen forest type.

Are alic, dystrophic or eutrophic and are composed of both high and low activity clay. Erosion susceptibility is nil.

Organic Soils

Include hydromorphic soils with appreciable levels of organic compounds at various stages of decomposition forming accumulated layers in a marshy environment. Dark in color due to the high level of organic carbon. They settled on mineral layers of variable texture and composition with practically no pedogenetic development.

The originating material is composed of recent residual organic accumulations whose constitution depends on the type of vegetal formation from which they were derived and the biological actions to which they have been subjected. Additional fine material in varying proportions may also be present.

The majority are strongly to extremely strongly acid soils, with low saturation (V%) and base soma (S), high saturation with exchangeable aluminum (alic properties) and high cation exhange capacity (T).

Found on level surfaces in the lowest-lying areas, they predominate in the meadowlands surrounding the Macaé River, with original tropical meadowland vegetation. Erosion susceptibility is nil.

Hydromorphic Podzol

Includes mineral soils with spodic B horizon, usually in a well-differentiated, A, E, Bh and C sequence.

Composed of low-activity clay, generally with medium levels of organic materials on the surface horizons, originating from sandy Holocene marine sediments. Bad or very badly drained and rapid permeability at the A horizon and even impeded at the B horizon, causing flooding of the soil during the rainy season.

This soil type tends to be deep, with solum thickness normally exceeding 150 cm. Texture is always sandy throughout the profile, with very low levels of clay (2 to 3%). The spodic B horizon is characterized by the concentration and precipitation of active amorphous materials, composed of organic material and aluminum, sometimes accompanied by fluvial iron.

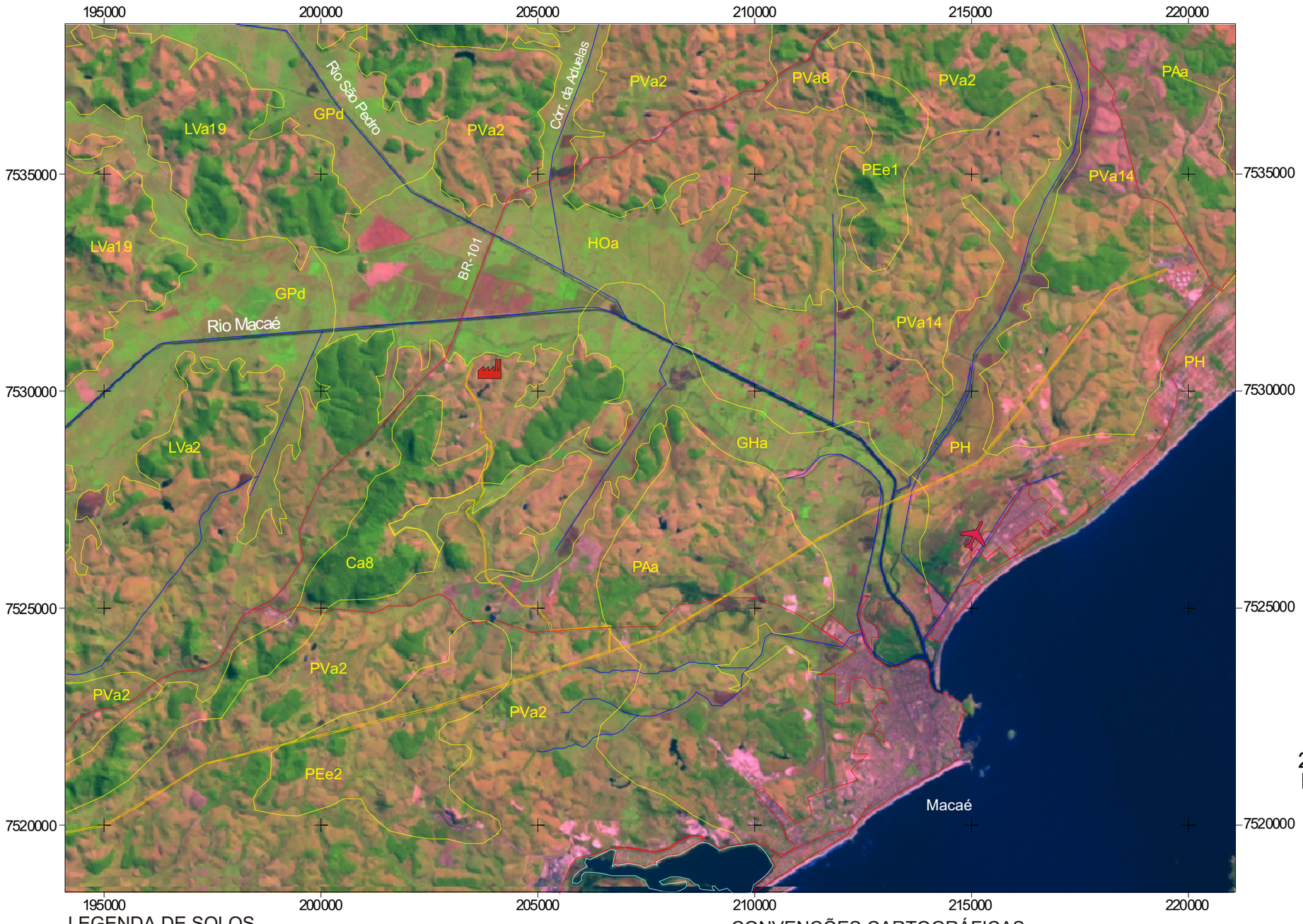
Strongly acidic with low nutrient reserves. Found along the coastal strip on level areas close to sea level. Related with marine sand, this soil type is found to the east of the mapped area, and has vegetation of the primitive forest and tropical sandspit type. Susceptibility to erosion is nil.

The topology of the soils found in the implementation area are illustrated in Figure 5.2.5-1.

Figura 5.2.5-1

(see Figure 5.2.5-1.pdf)

CARTA IMAGEM DE SOLOS



ESCALA GRÁFICA

2 0 2 4 km

N

LEGENDA DE SOLOS

LVa2, LVa19: Latossolo Vermelho-Amarelo álico.

PVa2, PVa8, PVa14: Podzólico Vermelho-Amarelo álico

PAa: Podzólico Amarelo álico

PEa: Podzólico Vermelho-Escuro

Ca8: Cambissolo álico

GHa: Glei Húmico álico

GPd: Glei Pouco Húmico distrófico

HOa: Solos Orgânicos álicos

PH: Podzol Hidromórfico

CONVENÇÕES CARTOGRÁFICAS

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ECOLOGUS Engenharia Consultiva	FIGURA 5.2.4-1 - SOLOS		
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5.2.6 WATER RESOURCES

5.2.6.1 All Hydrographic Basin

The region's main fluvial system is the Macaé River basin, which encompasses some 1,765 sq. kms., partly limited by the Macacu River basin to the north (a Lagoa Feia tributary), the São João River basin to the south, the Macacu River basin to the west and the Atlantic Ocean to the east.

The basin includes the greater part of the municipality of Macaé and portions of the municipalities of Nova Friburgo (where the rivers rise), Rio das Ostras, Conceição de Macabu and Carapebus. Nearly 82% of the basin's surface lies within the municipality of Macaé.

Formerly known as the Rio dos Bagres, the Macaé river rises in the Serra do Macaé near to Pico do Tinguá (altitude 1,560m), in Nova Friburgo. It runs for some 136 kms before emptying into the Atlantic Ocean near to the city of Macaé. The main tributaries on its right bank are the Bonito, Purgatório and Pedrinhas rivers; the Abacaxi and Carão rivulets; the Teimoso River, the Roça Velha and Belarmino rivulets and the Três Pontes River. The main tributaries on its left bank are the Sana, Atalaia, São Domingos, Santa Bárbara, Ouro Macaé, São Pedro and Jurumirim rivers and the Genipapo, Guanandirana and Sabiá rivulets.

The DNOS cleared a 25 km section of the lower portion of the Macaé River and carried out similar operations on the São Pedro River's tributaries, amongst others (SEMADS, 2000).

The Macaé River basin, along with the adjacent basin which contributes to Lagoa Feia and the adjoining Coastal Zone together form Rio de Janeiro State Environmental Macro-Region No. 5 - MRA5, which lies in the state's southern area bordered by the following basins: Paraíba do Sul river to the north and west – São João river to the south and the Atlantic Ocean to the east (Figure 5.2.6-1).

Average annual rainfall is approximately 1,800 mm at the rivers' sources and 1,200 mm at their mouths. The rainy season is generally between November and February and the dry season between May and August.

The last significant rise in river water levels occurred in February 1998, flooding various areas and destroying several road bridges in the area.

5.2.6.2 Macaé River Basin - Flow-Rates

The Electrical Energy Agency (ANEEL) has three fluviometric stations operating in the Macaé River Basin, as listed below. The table depicts the average long-term flow-rates recorded.

Table 5.2.6-1 – Fluviometric Station – Macaé River Basin

Code	Station	RIVER	Coordinates		Area (km^2)	Flow m^3/s	Period
			Lat	Long.			
59120000	Macaé de Cima	Macaé	22º 22'22"	42º 27'44"	67	2,73	05/67-12/95
59125000	Galdinópolis	Macaé	22º 22'09"	42º 22'46"	101	4,44	08/50-12/95
59135000	Piler	Bonito	22º 24'21"	42º 20'18"	75	3,46	08/50-12/95

Water resource studies conducted during the preparation of the Região dos Lagos, Macaé and Casimiro de Abreu Water Supply Director Plan (CEDAE 1989) showed a minimum flow-rate of 4.87 m^3/s ($Q_{7,10}$) at the Severino post, obtained from the minimum discharge regionalization curve. The Severino post corresponds to the BR-101 storage point on the Macaé River, downstream from the water impounding system for CEDAE's water treatment station.

This location has a drainage area of 896 km^2 and is responsible for a high level of sediment production (562 t/km^2.year) [1], denoting the reduced presence of the basin's original vegetation.

On the Macaé River, at Ponte do Baião (where the RJ-162 highway crosses the river) upstream from the junction with the Purgatório River, the same studies showed a minimum flow-rate $Q_{7,10}$ of 3,61 m^3/s, obtained from the minimum discharge regionalization curves.

More recent studies conducted by SEMADS as part of the Planagua Project in 2000 established a flow-rate Q7 of 5.3 m3/s for the Macaé River Severino station, with a minimum observed rate of 3.85 m3/s. For the purpose of this study the most conservative minimum flow rate for the Macaé of 4.87 m3/s obtained from CEDAE's Water Supply Director Plan – Use of the Basin's Existing Water and Impoundment - is being adopted in relation to water availability.

The waters in the Macaé basin are mainly used to supply public demand. According to CEDAE's Região dos Lagos, Macaé and Casimiro de Abreu Water Supply Director Plan, there are currently two impoundment points on the Macaé River: one located at Ponte do Baião, serving the cities of Macaé and Barra de Macaé and the other at Severina, serving Rio das Ostras and Barra de São João.

[1] Diagnosis of Sediment Conditions in Brazil's Principal Rivers (ELETROBRÁS, 1998)

According to the Plan, which contains population projections through to 2012, these areas will continue to be supplied by waters obtained from the Macaé. It also considers alternative arrangements, such as impoundment at Ponte do Baião and Severina.

The city of Macaé's needs – an estimated 600l/s of treated water, may be achieved without increasing the impoundment at Severina, provided that responsibility for Rio das Ostras and Barra de São João is transferred to Ponte do Baião. The other alternative is the damming of the Macaé River at the 600 meter mark, which would provide a constant 9.60m^3/s.

The SIPOT projects the implementation of a hydroelectric facility with a maximum 740 meter water level, intended to generate 272.4 GWH. There is no information available on any conflict between the impoundment alternatives for public supply and the hydroelectric use defined in SIPOT.

5.2.7 MACAÉ RIVER BASIN – WATER QUALITY

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The Macaé River receives discharges of domestic waste and industrial effluent. The region's river valleys are mainly given over to agricultural and pastoral activities, particularly sugar cane production and cattle ranching.

The basin's total population in 1980 was estimated by FEEMA (State Environmental Foundation) to be 56,083, with the flow of domestic waste estimated at 14,021 m^3/day (with a *per capita* of 250 l/inhabitant/day) and a total load of 3,029 kg of DBO/day (with a *per capita* of 0.054 kg-DBO/inhabitant/day).

CEDAE monitors the quality of water impounded for treatment at the Macaé water treatment station. This analysis process covers parameters such as color, turbidity, pH, alkalinity, hardness and chlorates, all of which are relevant to any adjustments to the water treatment station. Results obtained for 1999 and 2000 (January to April) appear in Figures 5.2.7-1 to 5.2.7-4 below.

With the exception of the color and turbidity results, which were significantly affected by hydrological influences, the other parameters analyzed showed little variation throughout the study period. Therefore, all the parameters analyzed fall within the limits established by CONAMA Resolution 20/86 for Class 2 waters.

In addition to data obtained during CEDAE's monitoring activities, FEEMA conducts systematic analyses to monitor and classify the quality of the basin's waters. For this study, data obtained from Station MC-2, located on the Macaé River close to the BR-101 road bridge is considered. This data is illustrated in Table 5.2.7-1 below.

Figure 5.2.7-1 – Variations in Brute Water Quality Parameters

ETA-Macaé – CEDAE – 1999

ENTER GRAPH No. 1

Figure 5.2.7-2 – Variations in Brute Water Quality Parameters

Macaé Water Treatment Station– CEDAE – 1999

ENTER GRAPH No. 2

Figure 5.2.7-3 – Variations in Brute Water Quality Parameters

Macaé Water Treatment Station – CEDAE – 2000

ENTER GRAPH No.3

Figure 5.2.7-4 – Variations in Brute Water Quality Parameters

Macaé Water Treatment Station – CEDAE – 2000

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TABLE 5.2.7-1 –WATER QUALITY RESULTS AT STATION MC-02 – MACAÉ RIVER

PERIOD: 1990 TO 1996

PARAMETERS	CONAMA 20/86	NUMBER OF DATA	Min. VALUE	PERCENTILE 10%	PERCENTILE 90%	MAX. VALUE
Lead – mg/l	0.03	32	0.002	<0.02	<0.02	0.02
Cyanide – mg/l	0.01	20	0.01	<0.01	<0.01	0.025
Copper – mg/l	0.02	32	0.001	<0.005	<0.005	0.005
DBO $_{5,20}$ – mg/l	5	35	2	<2.0	<5.28	60
DQO – mg/l		35	10	<10	<30	35
Total Phosphorus – mg/l	0.025	33	0.01	<0.036	<0.1	0.4
Phenols – mg/l	0.001	21	0.001	<0.001	<0.005	0.009
Mercury – ug/l	0.2	28	0.1	<0.1	<0.13	0.35
Nitrite – mg/l	10	11	0.001	0.002	0.02	0.02
Ammoniac Nitrogen –mg/l	0.5	35	0.01	<0.01	0.066	0.3
Kjeldahl Nitrogen –mg/l	-	32	0.15	0.255	0.8	3
Dissolved Oxygen – mg/l	5	35	0.1	6.4	8.4	9
pH	6 a 9	34	6.4	6.53	7.57	7.8
Total Filterable Residue – mg/l	500	2	40	46	94	100
Non-Filterable Residue – mg/l	-	35	8	10	75	120

Sample Temperature – oC	-	33	19	21	27	28
Turbidity (UT)	100	34	3.5	5	30	35

Source: FEEMA

The DBO parameter in 10% of the measurements remained above 5 mg/l (maximum permitted level for Class 2 waters), reaching an extreme of 60.0 mg/l. This pollution reading meant that the concentration of dissolved oxygen remained below the upper 6.40 mg/l level acceptable for Class 2 waters in only 10% of the readings obtained, reaching a minimum value of 0.1 mg/l for what was probably the most critical organic pollution condition.

The total phosphorus parameter produced a maximum value of 0.4 mg/l, very high in relation to the Class 2 standard. In 90% of the measurements, total phosphorus concentrations exceeded 0.036 mg/l (the norm being 0.025 mg/l). Fifty percent of samples obtained during the period showed concentrations in excess of 0.05 mg/l.

Phenol concentrations in 10% of samples obtained were found to be in excess of 0.005 mg/l, with a maximum recorded value of 0.009 mg/l. It should be remembered that the Class 2 limit stands at 0.001 mg/l.

The levels of dissolved oxygen are above the limits set by CONAMA Resolution No. 20/86 for Class 2 waters in 90% of samples obtained, indicating good water quality from that aspect. A sample obtained during this period showed a dissolved oxygen content of 0.1 mg/l, an extremely low value and an anomaly in relation to the other values obtained.

The water impoundment locations on the Macaé River within the section studied, and the location where FEEMA obtained its samples are shown in Figure 5.2.6-1 below.

Fig.5.2.6-1

5.3 BIOTIC ENVIRONMENT

5.3.1 Methodology Considerations

The biotic environment study was structured on the need to provide information on different scales of approximation, considering the sectors both directly and indirectly influenced by the gas pipeline, the route of the Transmission Line and the proposed Thermoelectric Plant site.

The sector examined during the other environmental initiatives has been adopted as the area of indirect influence: i.e. the lower course of the Macaé River, notably the section lying further inland. Coastal environments were dealt with more briefly.

The Thermoelectric Plant site and a strip of land 20 meters in width along the full length of the pipeline installation routes was considered when assessing the biotic impact upon the area of indirect influence.

Studies of the areas of direct and indirect influence produces secondary data obtained from field observations. During these exercises, samples were taken and observations made with the aim of obtaining other information on the region's countryside and its the flora and fauna, particularly the mastofauna, ornithofauna, herpetofauna and ichthyofauna.

It was decided to emphasize physiognomic and floristic aspects for the diagnosis of vegetation within the areas of direct (AID) and indirect (AII) influence. In order to do so observations were made and samples obtained throughout the areas of influence. All fieldwork was based upon the standard 1:50.000 (IBGE) map. The accuracy of the routes covered was confirmed by GPS receiver, and the coordinates of the principal observations recorded.

In order to document the vegetation and certain aspects of the local flora photographs were taken, some of which appear in this report. Additional information was obtained through bibliographic research, though few reference works on the region's local flora and vegetation were available, due to the fact that few previous environmental studies have been conducted therein.

A list of species collated during the study appears at the end of the chapter. The botanical material, both fertile and vegetative, was pressed and dried for determination. The fertile material deemed to be of more research value will be incorporated into the collection held by the Rio de Janeiro National Museum's Herbarium.

Studies on fauna concentrated mainly on the analysis of ornithofauna and mastofauna, considered the most suitable biotic groups following a viability study on the subject. Other groups were dealt with more briefly.

The local inhabitants were interviewed in a spontaneous manner, without the use of questionnaires in order to obtain data on local fauna. This data was only used as an indicator of species to be sought after, and not as a record of actual sightings, given that the people who have occupied these degraded areas for almost a century have almost completely lost their forest culture, a fact which is reflected in their almost total lack of knowledge of animals originating from the area's original wildlife composition.

Mammals were recorded by direct observation, indirect identification of animal track and/or droppings as well as interviews. Animals that had been run over on the public highways were also identified. The lists produced for this segment of the local biota comply with the nomenclature proposed by FONSECA ***et al***. (1996), HONACKI (1993), EMMONS (1990) and WILSON (1993).

Bird life was basically determined through direct observation with the use of binoculars. Work in the area was greatly facilitated by the open environment which permitted species to be identified safely at distance. Fine nets were hung in forest areas and all species captured immediately released following identification. No bird died during these operations.

Tape recorders were used to obtain direct bio-acoustic recordings, thus enabling species to be identified later under laboratory conditions, comparing the recordings obtained with those held in public sound archives. Identification problems were solved by comparing recordings using the COOL EDIT program**.**

Photo 1 – Recording and play-back for observation purposes and assembly of catch net

Herpetofauna were registered by direct observation, manual capture, and trapping and in the case of amphibians, through the use of bio-acoustics. The listings, currently under preparation, comply with the nomenclature proposed by PETERS & DONOSO-BARROS (1970), PETERS & OREJAS-MIRANDA (1970) - reptiles and FROST (1995) - amphibians.

Aquatic ecosystem studies were based especially on the description of ichthyofauna, producing data obtained during the analyses of the AID and AII of other components of these ecological systems.

In order to obtain specimens of the ichthyofauna present in the Macaé River and the drainage channels different fishing strategies were employed, namely: nets of various

gauges (10, 15, 20 mm), 0.5 mm hand nets, cubic collectors (60x80x60 cm) with 0.2 cm webbing and manual drag nets with 15 mm mesh.

5.3.2 BIOTIC ENVIRONMENT - DIAGNOSIS

5.3.2.1 Indirect Influence Area (AII)

As a rule, the ecosystems of the coastal plains are the target of a series of impacts caused by man. In the case of the territory covered by the municipality of Macaé, human occupation combined with the easy accessibility of its flatter areas led to the gradual extermination of the majority of vegetal formations within these environments.

Having been submitted to intense anthropic interference since the 17th century, firstly by sugar cane cultivation, later followed by the introduction of livestock, the Macaé plain, which had originally been a predominantly forest environment (some sections of which were subject to periodic flooding), rapidly saw its native forests almost entirely replaced by grazing land and sugar cane plantations. Nowadays, the few remaining pockets of native forest are restricted to the sides and tops of mountain ranges and isolated hillocks, mainly represented by woodland at the secondary regeneration stage, or at the very least subject to profound changes to its original structure and composition, the result of the intense and continuous exploitation of the region's native species.

The marked degree of environmental degradation, combined with the lack of studies or descriptive references to local flora and vegetation makes it difficult to formulate an opinion on the composition of the Macaé plain's original forest cover, particularly the now extinct lowland forests. Furthermore, its is possible that the contact between the distinct formations may originally have conferred a certain peculiarity to the local flora, due to the inter-penetration of species of both vegetal types.

As a rule, the majority of the vegetation within the area of indirect influence has undergone profound modifications to its original appearance, composition and structure. The area is largely given over to anthropic fields, occasionally interspersed with isolated pockets of forest, the majority of which are located on the upper elevations, covering the sides and tops of the area's hills and mountain ranges.

In terms of appearance, the existing vegetation surrounding the site of the proposed project can be divided into anthropic/grazing fields and forest.

Vegetal cover and the current land use in the project's area of indirect influence is shown in Figure 5.3.2-1 at the end of this section.

a. Anthropic fields (pastures)

The area of indirect influence is largely given over to pasture (Photo 2) predominantly *Brachiaria sp.,* associated with coarse invasive grasses such as *Ageratum conyzoides*,

Sida rhombifolia, *Andropogon bicornis*, *Cordia corymbosa*, *Lantana camara*, *Hyptis brevipes*, *Vernonia scorpioides*, *Panicum* sp., *Borreria* sp., and others. In low-lying humid sections *Mimosa bimucronata* is commonly to be found, forming dense bushy colonies, while *Typha angustifolia* and *Acrostichum danaefolium* are predominant in the marshland areas.

Photo 2 – Countryside – General Aspect within the Area of Indirect Influence

These biotypes display low environmental diversity and a lack of resources with which to sustain fauna, resulting in a poor variety of species. Common species and those that usually gather in large flocks predominate, and account for the largest number of sightings.

Groups such as *Elanus leucurus*; *Milvago chimachima*; *Falco sparverius*; *Cariama cristata*; *Crotophaga ani*; *Guira-guira*; T*apera naevia*; *Sicalis flaveolis*, *Colaptes campestris*; *Furnarius rufus*; *Xolmis cinerea*; *Elaenia flavogaster*; *Progne chalibea*; *Mimus saturninus*; *Molothrus bonariensis*; *Zonotrichia capensis*; *Volatina jacarina*, *Speotyto cunicularia* , C*athartes aura* and *Ammodramus humeralis* are relatively conspicuous. Other species observed are listed in Table I (attached.

Photo 3 - *Cathartes burrovianus and Rupornis magnirostris*

The same applies to the area's mastofauna, which displays little variety and is essentially composed of groups of apparently elevated ecological valence. Species such as *Didelphis aff. marsupialis*, *Cerdocyon thous*, *Euphractus sexcinctus*, *Galictis cuja* and certain rodents, such as *Akodon cursor* and *Oligoryzomys eliurus* are amongst the few registered.

Few amphibian species were registered in the fields' ecosystems, being restricted to two members of the Bufo genus (*B. ictericus and B. crucifer*)

Photo 4 - *Bufo ictericus*

Within the heterogeneous group under the herpetofauna classification, reptiles account for the region's largest number of species. In the open areas the main species to be found are snakes of the Bothrops genre, particularly *Bothrops jararaca*, the least demanding species of the genre.

Lizards such as *Tupinambis merianae*, *Tropidurus torquatus* and *Ameiva ameiva*, which adapt easily to existence alongside humans and *Hemidactylus mabouia*, which despite being an introduced specie is nevertheless very common throughout Brazil, particularly around buildings, are also to be found in the region. In addition to these species, others are also believed to exist within the AII and other open environments (Table II - attached).

b. Forest habitats (Forests and secondary growth areas)

The few sections of forest cover within the AII are found on the sides and tops of the region's hillocks and generally consist of secondary growth formations (Photo 5) at various stages of regeneration, or fragments of surviving forest the vast majority of which have undergone significant alterations to their original structure and composition attributable to grazing and anthropic action.

Photo 5 – Fragment of secondary vegetation in the Area of Indirect Influence with details of its outer section.

The presence of individual tree species such as *Anadenanthera peregrina* and *Piptadenia gonoacantha* in the upper canopy is common. The interior of these secondary growth areas is generally occupied by plants and trees such as *Luehea grandiflora, Sparattosperma leucanthum, Jacaranda macrantha*, *Pausandra morisiana, Guapira opposita*, *Matayba guianensis, Mabea fistulifera*, *Andira ormosioides*, *Ecclinusa ramiflora and Senefeldera verticillata,* which share the space with palm trees such as *Attalea humilis*, *Astrocaryum aculleatissimum* and *Desmoncus polyacanthos*. Herbaceous and ligneous creepers are abundant in these forests, making them dense in appearance (Figure 5).

In the better lit sub-forest areas *Guadua tagoara* can frequently be found, with its rapid growing branches and offshoots competing vigorously for the available light with the local plants and trees and younger trees which have not yet reached the canopy. Amongst the plants and grasses to be found on the lower strata of these forest areas are species such as: *Sorocea hilarii, Siparuna arianeae, Tetraplandra riedelii, Mollinedia* sp., *Clarisia ilicifolia, Miconia albicans, Miconia* cf. *lepidota, Clidemia bullosa, Clidemia hirta*, *Psychotria martiana*, *Faramea* sp., *Dorstenia arifolia* and *Ctenanthe glabra*.

Photo 6 – Interior of secondary forest within the AII

The forest edges frequently contain typical pioneer and secondary species. In these areas low tree species predominate (up to 5 - 7 meters in height), such as: *Cecropia lyratiloba, Cecropia hololeuca*, *Trema micrantha*, *Cupania emarginata*, *Aureliana fasciculata, Casearia sylvestris, Guarea guidonia*, *Guarea macrophylla* sp. *tuberculata, Allophylus* sp., *Trichilia casaretti, Gochnatia polymorpha, Xylopia sericea*, *Solanum leucodendron* and *Piptadenia gonoacantha*, occurring together with species of bush and grass such as: *Bactris* setosa, *Ananas bracteatus*, *Dichorisandra thyrsiflora Cordia taguahyensis, Clidemia hirta*, *Piper mollicomum* and *Guadua tagoara*.

This peripheral vegetation is generally marked by an absence of epiphytes and an abundance of bushes, climbers and lianas, such as: *Lygodium volubile, Gouania blanchetiana, Arrabidaea* sp., *Herreria salsaparilha, Serjania sp., Paullinia sp., Pereskia aculeata* and *Anemopaegma scandens*, amongst others.

Photo 7 – General view of peripheral forest area within the AII and details of *Ananas bracteatus,* a specie of bromeliad sometimes found in forest within the AII.

Epiphytes are uncommon and are mainly represented by bromeliads (Aechmea nudicaulis, Streptocalyx floribundus, Billbergia zebrina, Tillandsia stricta, Tillandsia

usneoides, Vriesea sp.) and cactii (Lepismium houlletianum, Rhipsalis sp.). Climbers are abundant, particularly on the periphery and altered forest sections. The following species are particularly abundant: bignoniacese, such as *Anemopaegma scandens, Adenocalymma sp*. and *Arrabidaea sp*.), smilacacese, such as *Smilax elastica*, dioscoriacese (*Dioscorea sp*.), nictaginacese (*Bougainvillea sp*.) and sapindacese (*Serjania sp, Paullinia sp*.), amongst other families.

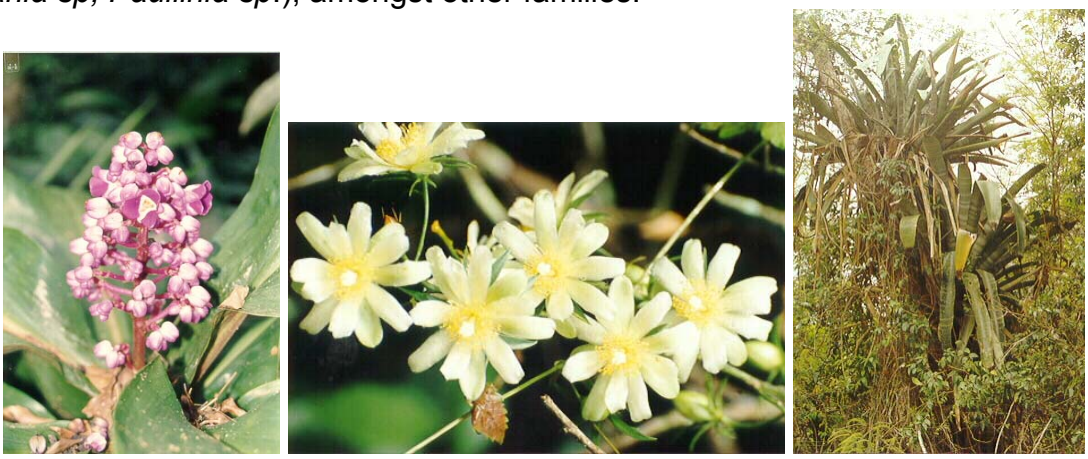


Photo 8 - *Dichorisandra thyrsiflora, Pereskia aculeata and Streptocalyx floribundus.*

Amongst the species of trees which occupy the canopy in some surviving areas on the hill slopes are some capable of reaching 20-25 meters in height, such as: *Schizolobium parahyba*, *Brosimum guianense* and *Anadenanthera peregrina*), the latter commonly observed in the region's forests.

In terms of fauna, the secondary formations inspected contained fauna little different to that found in the surrounding fields. The most common species were found to be: *Crotophaga ani* and *Guira guira*, *Sicalis flaveola*, *Furnarius rufus* and *Sporophila* spp. Species such as *Piaya cayana* and *Cyclarhis gujanensis* feature amongst the most frequently observed representatives of omnivores occupying the upper strata of this environment. In the case of carnivores, *Rupornis magnirostris* and *Milvago chimachima* are amongst the most frequently observed species in the upper reaches of peripheral forest areas. In the sub-forest area species such as *Micrastur ruficollis,* which preys on small birds amongst the branches is one of the few species characteristic of shaded environments. Generally speaking, the birds found in the surrounding fields also tend to be found in this environment, with the exception of sub-forest dependent species, such as *Chiroxiphia caudata*, *Saltator similis* and *Conopophaga melanops*. The list of species registered appears in Table III (attached.

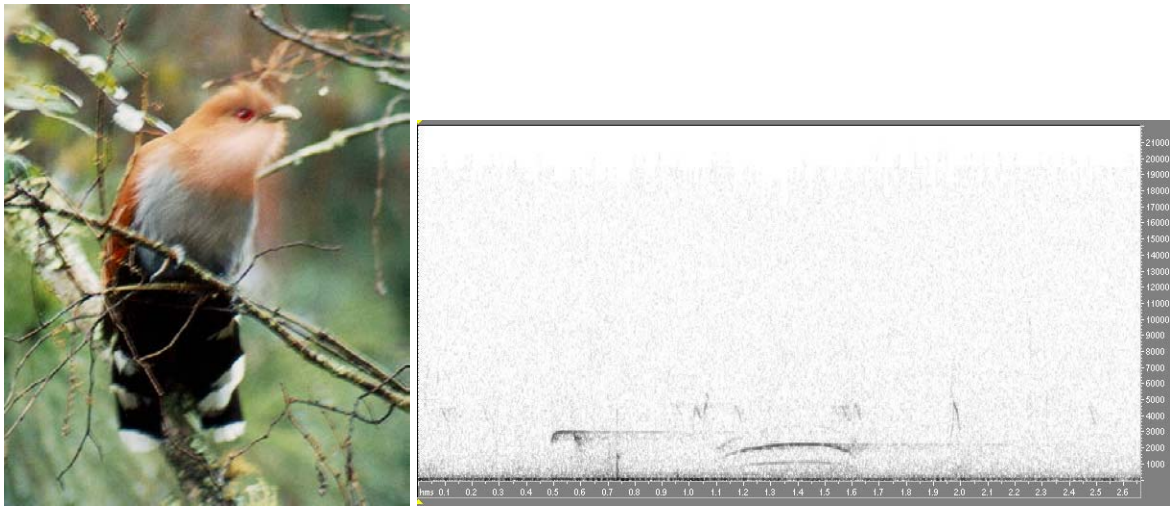


Photo 9 – Details of *Piaya cayana* and its respective sonogram

In the case of mastofauna, a pattern very similar to that recorded in the surrounding fields was observed. Having combined the results of field observations and interviews, species such as the following were recorded: *Cavea aperea*), *Didelphis aff. marsupialis* and *Sciurus aestuans*. Whilst not recorded directly, species such as *Nasua nasua, Euphractus sexcinctus* and *Dasypus navencinctus* were mentioned in various interviews.

Some areas within the limits considered were notable due to the presence of some largely unspoiled forest formations. These units should be considered as priority sectors for the implementation of conservation initiatives.

Parque de Atalaia (Atalaia Park), located on the section leading to Ouro creek, is a particularly valuable area.

Atalaia Municipal Park contains one of the municipality of Macaé's few remaining areas of characteristic dense sub-mountain ombrophyl forest. The fragmented and isolated nature of these pockets of forest is best illustrated by observations made in areas adjacent to the park, particularly those located in its meridian portion. These sections, currently with no tree cover, were once covered with typical vegetation whose main characteristics lay in its ability to spread over flat areas where the soil has been subject to little development and their high susceptibility to flooding caused by the rise in ground water level during periods of heavy rain. Exuberant lowland forests predominated, home to species of trees characteristic of periodic or permanently flooded environments, such *Symphonia globulifera* L., *Tabebuia umbellata*, *Calophyllum brasiliense* Camb., and *Tabebuia cassinoides* (Lam.) DC.), amongst various others.

As a rule, the state of the vegetation's conservation in the area covered by Atalaia Park varies is proportional to its height. As such, the majority of forest cover in easily accessible areas, usually those at lower altitudes which include the meridian portion, consists mainly of secondary forest growth at various stages of regeneration, created by

the clearing of land for agricultural and grazing purposes. In some sections still used as pasture, the following species predominate *Ageratum conyzoides*, *Sida rhombifolia*, *Urena lobata* and *Andropogon bicornis,* currently at the initial regeneration stage. In areas which have been abandoned longer, typical secondary vegetation can be found. In these areas a layer of scrub develops which is composed of *Baccharis*, *Vernonia* and *Eupatorium* genres, melatomataceous species such as *Clidemia bullosa* and *Clidemia hirta* and verbanaceous, such as *Lantana camara*, amongst other species.

At earlier stages to that described above, during the successive secondary growth stages, when an arboreal stratum has already been formed, species such Guarea guidonia, Cupania oblongifolia, *Zanthoxylum rhoifolium*, *Acnistus arborescens*, *Sapium glandulatum,* Casearia sylvestris, *Cecropia glaziovii, Cecropia hololeuca*, *Sparattosperma leucanthum*, *Trema micrantha* and *Astrocaryum aculeatissimum* commonly occur.

These forest's lower stratum is generally dense and notable for the abundance of bushes, where melastomataceous species are commonly found (*Miconia* spp., *Leandra* spp.), which share the available space with rubiaceous species such as *Psychotria* cf. *nuda* and *Psychotria spp.* Amongst the herbaceous and ligneous creepers commonly found in such an environment, the following are particularly prevalent: *Pithecoctenium crucigerum*, *Paullinia* spp., *Serjania* spp, *Mikania* sp. and A*rrabidaea selloi*.

During the secondary local forests' natural regeneration process, the proximity of the remaining pockets of well-preserved forest growth at higher levels is particularly important. These areas provide a propagation source for species characteristic of the more advanced succession stages, thereby increasing the potential for recovering these areas and allowing regeneration to include elements from these phases. In fact, its possible to see that various sections within these secondary growth areas are undergoing an intense regeneration process marked by the abundance of individual young trees characteristic of the upper stratum in better preserved areas, amongst which are various lauraceous species, such as *Ocotea* spp. and *Nectandra* spp.

The most preserved forest sections within the confines of Atalaia Park are restricted to its higher points where the vegetation was not subjected to clearance and where selective logging was carried out on a much smaller scale. This environment contains large trees, capable of reaching 20-30 meters in height, which form an almost continuous canopy, including species such as: *Cariniana legalis*, *Plathymenia foliolosa*, *Ficus gomelleira*, *Ficus insipida*, *Melanoxylon brauna*, *Gallesia sp.* and *Apuleia leiocarpa*. It is worth remembering that these native species were drastically reduced or even rendered extinct in various regions within the State of Rio de Janeiro due to selective cutting and extraction processes.

The upper stratum is diverse by nature. In addition to the species mentioned earlier, trees such as *Virola* cf. *oleifera*, *Cabralea canjerana*, *Sterculia chicha*), *Hyeronima alchorneoides*, *Cedrela fissilis* and *Alchornea triplinervia* are to be found, as well as various laurels, such as *Ocotea* spp. and *Nectandra* spp.

At those points were tree cover is continuous, the forest environment is somber and humid, while the thinner lower stratum facilitates penetration into the forest. This is marked by the diversity of bushes and small trees of the monimaceous species (*Siparuna* sp. e *Mollinedia* sp.), moraceous (*Sorocea guilleminiana, Sorocea hilarii),* mirtaceous (*Myrciaria tenella*) and rubiaceous (*Simira* sp., *Psychotria* spp.), with particular emphasis on ferns (*Cyathea* sp.) and species of palm such as *Euterpe edulis*, *Polyandrococos caudescens* and shadowpalms such as *Geonoma* sp.

The herbaceous and sub-arbustous stratum is represented in these forests by piperaceous species , such as *Piper* spp. and *Peperomia* spp. associated with begoniaceous *Begonia* spp.), marantaceous (*Calathea* sp., *Ctenanthe* sp.) and heliconiaceous (*Heliconia psittacorum*, *Heliconia* sp. Photo 10), amongst others.

Photo 10 – *Heliconia* sp. and *Quesnelia edmundoi* var. *rubrobracteata*,

Amongst the species dependent upon support that can be found in this forest environment, the large lianas are of particular relevance, in that they tend to attach themselves to large well-developed trees. These lianas house an abundant and varied epiphytic community in their trunks and branches, including innumerable pteridophytes, araceae, orchids and bromeliads, the latter represented by species of *Vriesea*, *Aechmea*, *Billbergia*, *Nidularium* and *Quesnelia*.

An area in the park's northern section, but situated outside its confines, contains a surviving section of well-preserved forest. This particular stretch of forest, a large portion of which is traversed by the Ouro creek, is notable for its vegetation, which, similarly to those within the park itself, includes various large trees such as the cedar, laurel, mimosa, apuleia and muskwood, amongst other trees characteristic of more advanced stages of succession.

The flora reflects the humid conditions brought by the creek, on whose banks hygrophylous species such as *Swartzia simplex* var. *grandiflora* and mimosas, also associated with mirtaceous species such as *Myrciaria* cf. *tenella,* can be found. Epiphytes are abundant in certain sections, particularly close to the creek banks, where many species of bromeliads are also evident, such as *Nidularium* sp. *Vriesea* cf. *incurvata* and *Billbergia euphemiae*, as well as cataceous species such as *Rhipsalis* sp., *Lepismium* sp. and various other epiphytic species.

Recent attempts by homesteaders to settle in the area have resulted in the de-characterization of vegetation at certain points due to forest clearance activities.

The bird life in Atalaia Park and the adjacent area associated with Ouro creek, is basically composed of elements from the original lowland forest, now degraded. There is therefore a lack of the major synergetic elements and animals dependent on larger forest areas. However, it was still possible to observe rare and endangered species which still live in the area, such *Amazona rodochorytha*.

These areas also contain elements characteristic of the Amazon rainforest. This section of the Atlantic Forest represents the southernmost limit for some of those elements.

The list of species registered during field studies appears in Table IV (attached). Some species are illustrated in Photo 11.

Photo 11- *Myarchus ferox and Euphonia clorotica*

Within the park confines, the fauna is composed of a mixture of species common to open systems, such as *Cerdocyon thous*, *Gallictis cuja* and various rodents, and others eminently suited to a forest environment. Amongst the latter are species such as *Alouata fusca* and *Leopardus tigrina*, which is on the endangered list.

A list of the fauna registered appears in Table V (attached). Some species and their sign appear in Photo 12.

Photo 12- *Carollia perspicillata, Delomys sublineatus* and *Alouata fusca feces*

Amongst the reptiles, we can stress the possible presence of *Lachesis muta* in Atalaia Park, as mentioned in various interviews, as well as *Bothrops bilineata*, a species at extreme risk of extinction, both of which, if detected, would serve as indicators of the forest's good state of conservation. We can also find tree-dwelling reptile species in this environment, including snakes such as *Pseustes sulphureus* and *Corallus hortulanus* and lizards of the *Anolis genus*.

Table VI (attached) contains a list of other species probably found in forest environments throughout the basin of the lower Macaé River basin.

The amphibian species recorded during field studies on watercourses associated with Atalaia park and Ouro creek are listed in Table VII (attached). Amongst the better-known species, the following deserve special mention: *Bufo ictericus, Scynax perpusilla*, *Phyllomedusa burmeisteri* and two frog species.

c. Coastal habitats

The coastal portion of the Macaé River basin contains two large vegetal formations, represented by mangrove and sandspit units. The mangroves will be dealt with in tandem with fluvial habitats.

Various vegetal communities can be recognized within the sandspit area. These communities are described below, in accordance with the classification proposed by ARAÚJO & HENRIQUES (1984):

- Halophilous vegetation
Species resistant to salinity and tidal influences occupy the sand strips along the beach's upper section. Characterized by a restricted number of species, this community is dominated by succulent halophyles, particularly *Blutaparon portulacoides* and *Alternanthera maritima*.

- Psamophylous vegetation
Occupies the first sandy ridge, in areas of loose sand not affected by wave action. The following species are particularly conspicuous: *Sporobolus virginicus, Ipomoea pes-caprae, Ipomoea imperati, Canavalia rosea* and *Mariscus pedunculatus.* The

leguminous *Sophora tomentosa* and some cactaceans are also frequently found in this formation.

- Low post-beach thicket
Occurs on the first sandy ridge, beginning at the point where the waves are unable to reach and ending approximately at the crest of this ridge. The vegetation is bushy and impenetrable and is shaped by the prevailing wind. Dominated by a few species, including *Bumelia obtisifolia, Jacquinia brasiliensis* and *Schinus terebinthifolius*.

-Myrtaceae Thicket
Characterized by the size of its dense, impenetrable growth. The Myrtacae species predominates, accompanied by various others such as *Protium heptaphyllum, Aspidosperma pyricollum, Esenbeckia rigida, Melanospidium nigrum. Erythroxylum ovalifolium, Garcinia brasiliensis, Tapirira guianensis, Schinus terebinthifolius*, *Byrsonima sericea and Capparis flexuosa*, amongst others. Creepers of the *Passiflora, Serjania, Adenocalymma, Anemopaegma* and *Arrabidaea* genres are also common.

- Palmae Scrub
Community found on sandy ridges both near to, and far from the water's edge. Characterized by its low height, growing up to 1.5 meters. *Allagoptera arenaria* is the predominant species.

-Clusia Scrub
This formation consists of discontinuous cover reaching up to 5 meters in height, composed of thickets interspersed with clearings and sparse herbaceous or sub-arbustive cover, where species such *Neoregelia cruenta, Aechmea nudicaulis* and *Allagoptera arenaria* are to be found. Other species commonly present in these thickets are *Byrsonima sericea*, *Garcinia brasiliensis, Manilkara subsericea* and *Opuntia vulgaris,* amongst others.

-Ericaceae Scrub
Occurs in depressions in sandy lowlands, formed by bush thickets interspersed by areas of herbaceous cover. Particularly prevalent within this community are species such as *Humiria balsamifera*, associated with other species such as *Leucothoe revoluta, Byrsonima sericea* and *Ocotea notata*. In the open sections between thickets sub-arbustive species such as *Marcetia taxifolia* and *Gaylussacia brasiliensis* are to be found.

In addition to these communities, and having adopted a wider definition for the term sandspit, ARAÚJO & HENRIQUES (1984) also referred to the existence of three forest formations in the region, Dry Forest, Periodically Flooded and Permanently Flooded Forest, as well as a herbaceous formation, Herbaceous Marshland, which they classified as belonging to this vegetation complex. We will now describe only the first of these formations. The remainder will be described in the section dealing with lentic habitats.

Dry Forest is found on older sandy ridges and is characterized by its tree cover, of between 10 and 15 meters in height. Its floristic composition is still relatively unknown, as few surviving pockets remain along the coast of the State of Rio de Janeiro.

The majority of the municipality of Macaé's sandspit vegetation lies within the Jurubatiba National Park. Created in 1998 and covering a total of 14,860 hectares, this unit represents the first National Park to actively protect sandspit areas. The park includes coastal systems with authentic sandspit areas, flooded forests, lagoons, coastal lakes and both salt and freshwater marshes. .

This region's importance is increased because it is the only one in the State of Rio de Janeiro containing surviving representatives of periodically and permanently flooded forests within its sandspit complex (ARAÚJO & HENRIQUES, 1984)

ARAÚJO (1999) registered the occurrence of 507 vegetal within Macaé's sandspit region. The families possessing the greatest diversity of species in the region are: Leguminosae (35 species), Myrtaceae (32 species), Rubiaceae (27 species) and Euphorbiaceae (20 specie).

Photo 13- Sandspit in the Macaé region.

In the case of fauna, the sandspit environment is characterized by the small number of endemisms (PORTO & TEIXEIRA, 1984), the majority of its fauna being common to the Atlantic Forest or other floristic types, such as the Cerrado. The only case of a bird apparently unique to the sandspit environment is that of *Mimus gilvus*. This particular bird is very commonly kept in captivity, due to it ability to imitate a wide range of sounds.

Existing bush and thicket formations within the study area can be characterized by the presence of: *Rupornis magnirostris*; *Columba cayennensis*; *Celeus flavescens*; *Picumnus cirratus*; *Tolmomyias flaviventris*; *Myiornis auricularis*; *Coereba flaveola* and *Euphonia chlorotica*.

The meadowland areas possess less interesting bird life in conservation terms, due to the fact that the species present are basically those common to many different environments and geographic locations. The meadowlands can be characterized by species such as *Bubulcus ibis*; *Heterospizias meridionalis*; *Vanelus chilensis*; *Colaptes campestris*; *Furnarius rufus*; *Machetornis rixosus*; *Phaeoprogne tapera*; *Mimus saturninus*; *Volatina jacarina* and *Emberizoides herbicola*.

The majority of these species benefit from the anthropic activity in the region. The heron settled in Brazil naturally (probably from the African continent) where it benefits from the region's ranching activities. Species such as *Nothura maculosa* and *Crypturellus parvirostris* can also benefit from various types of cultivation.

The survey conducted in the region by ALVES (1993) which listed the bird species to be found on the Santana archipelago and the adjacent coastline is an important work. In the latter case, it considers the Fort Marechal Hermes preserved coastal forest. This survey registered 52 species of bird life, as listed in Table VII (attached.

d. Fluvial habitats

The region's main fluvial system is the Macaé River basin, which covers some 1,765 km^2, partly bordered by the Macabu River basin (a tributary of Lagoa Feia) to the north, The São João river basin to the south, the Macacu River basin to the west and the Atlantic Ocean to the east.

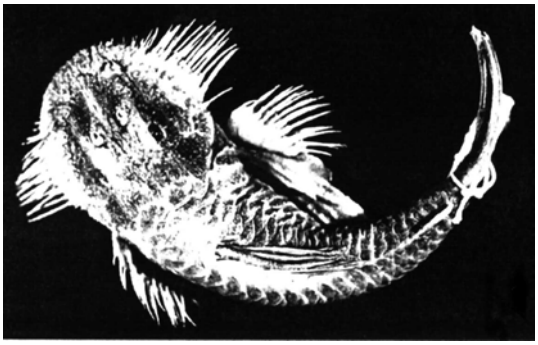
The basin covers the majority of the municipality of Macaé, as well as sections of the municipalities of Friburgo, where the rivers rise, Casimiro de Abreu, Rio das Ostras, Conceição de Macabu and Carapebus. Nearly 82 % of the basin's surface lies within the municipality of Macaé.

Formerly known as the Bagres River, the Macaé rises in the Macaé mountains near to Mount Tinguá (1,560m in height), in Nova Friburgo. The river runs for approximately 136 kilometers before reaching the Atlantic Ocean close to the city of Macaé. Its main tributaries on its right bank are the Bonito, Purgatório and Pedrinhas rivers; the Abacaxi and Carão creeks; the Teimoso river, the Roça Velha and Belarmino creeks and the Três Pontes river. Its main left bank tributaries are the Sana, Atalaia, São Domingos, Santa Bárbara, Ouro Macaé, São Pedro and Jurumirim rivers and the Genipapo, Guanandirana and Sabiá creeks.

The DNOS cleared a 25 kilometer section of the Macaé river's lower course as well as similar operations on the tributaries of the São Pedro river, amongst others. (SEMADS, 2000).

The data collated during field research and samples already obtained from the Macaé basin by other researchers led to the list of ichthyofauna which appears in Table VIII (attached).

Of the species listed, the presence of *Byrcon opalinus*, as registered during analysis of the material stored at the National Museum (MNRJ 13592) and *Hemipsilichthys garbei* (corroborative batch stored at the Rio de Janeiro National Museum - MNRJ 13592 - and the São Paulo Museum of Zoology - MZUSP 46967) are particularly significant as they both feature on the State of Rio de Janeiro endangered species list.



to 14- *Hemipsilichthys garbei* (Source: OLIVEIRA, 1996)

The section between the river's source and the 100 meter datum situated outside the AII contains very uniform ichthyofauna, characterized by the absolute predomination of species typical of environments possessing high hydrodynamic energy and a reduced variety of species.

Backwater areas between rocks and deeper pools display more characteristic formations, composed of schools of a particular species of minnow (*Astyanax* cf. *scabripinnis)*, which occupies the more open areas of this environment, and groups of *Corydoras barbatus* and *Phalloceros caudimaculatus* in the areas closest to the riverbank.

Rhamdioglanis frenatus is often found under stones and tree trunks, the Macaé river population representing the extreme northern limit for this specie. These environments also play host to certain catfish species, *Ancistrus* sp., *Neoplecostomus microps and Schizolecis guntheri* being the most common.

The lowland area which includes the section corresponding to the AII is home to a combination of species dominated by those whose ideal habitat consists of areas with little fluvial circulation where sedimentary deposits are most common.

In the backwaters some species may be sighted more frequently, which usually denotes a greater abundance. Amongst this category are species such as: *Phalloceros caudimaculatus*, *Geophagus brasiliensis, Cichlasoma facetum*, *Pimelodella lateristriga*, certain strains of *Hypostomus punctatus*); *Hoplias malabaricus*, *Oligosarcus hepsetus*, *Gymnotos carapo* and *Rhamdia quelen*).

Photo 15 - *Mimagoniates microlepis, Imparfinis minutus, Corydoras barbatus* from the Macaé River basin.

The depositing conditions existent in backwaters are attractive to bottom feeders such as ilyophagous fish of the *Hypostomus* and *Cyphocharax* genres. Bearing in mind that many of these groups represent a food source to the local population, these areas, particularly the Macaé River's main channel are particularly popular fishing sites.

The following species have also been observed: *Microglanis parahybae*, *Astyanax bimaculatus* and others, represented by the *Hyphessobrycon* genus, *Callichthys callichthys*, *Eigenmannia virescens*, *Parauchenipterus striatulus*, *Synbranchus marmoratus* and small members of the catfish family (*Parotocinclus maculicauda and Hisonotus notatus*.).

Marine species (namely *C. parallelus, A. lineatus, G. boleosoma and M. curema*) were observed until a short distance beyond the point at which the BR-101 highway crosses the Macaé River, as also occurred with the São Pedro River.

Another nearby basin is that of the Imboassica River, whose system displays eminently typical lowland fluvial characteristics, flowing between swamp and flatlands.

This system's fauna is extremely similar to that of other small rivers within this environmental macro-region. The species listed (as defined in Table IX - attached) reflect the system's general characteristics, with the ichthyofauna totally dominated by those species characteristic of lower river courses and backwater areas.

FONSECA (1995) synthesized the knowledge of the composition and distribution of the freshwater prawn (Atyidae and Palaemonidae) in the State of Rio de Janeiro's fluvial network. Based upon the author's survey and data obtained from samples taken along the Macaé's lower reaches, it can be concluded that the species listed in Table X (attached) will be present within the AII.

Trichodactylus sp. and *Atya* sp may also be added to the above list, having both been observed during field studies. The latter is of particular importance as it is currently under threat of extinction.

Atya sp. was observed in Ouro Creek, invariably hiding itself under rocks and other submerged objects.

Photo 16 - *Atya* sp.

Winged fauna extremely similar to that found in adjacent meadowland was observed on the banks of the rivers, the only significant factor being the greater prevalence of *Casmerodius albus* and *Egretta thula*, as well as *Leistes militaris, Dendrocygna viduata and Amazonetta brasiliensis*.

Hidrochaeris hidrochaerus, *Lutra longicaudis* and *Procyon* cancrivourus were also observed in the area.

Mangrove swamps have formed along the final section of the Macaé River, growing in silt sediment in areas subject to tidal influences. This vegetal community is under serious threat from the nearby urban area, particularly clandestine land clearance activity.

The area's flora consists of species characteristic of these formations, such as *Rhizophora mangle, Laguncularia racemosa and Avicennia schaueriana*, in association with lines of *Acrostichum danaefolium* and *Hibiscus* sp., which help to separate the fluvial pioneer formations from their fluvial-marine counterparts (mangroves) situated along the full length of the main channel of the majority of the region's rivers, sometimes even penetrating a long way into the interior.

Visiting marine groups may often be observed in the Macaé River's mangroves, including species such *Sula leucogaster*, *Fregata magnificens*, *Sterna hirundinacea, S. eurygnatha and S. maxima*). ALVES (1993) also reports sightings along bordering sections (i.e Macaé docks) of *Haematopus palliatus*, *Larus dominicanus* and occasional visits by *Catharacta skua*.

The other species registered consist of a mixture of marshland wildlife, of which *Phalacrocorax olivaceus* were particularly conspicuous, with groups appearing in both the rural and urban areas*. Pitangus sulphuratus*, *Fluvicola nengeta*, *Crotophaga na, Guira guira* and *Volatina jacarina* are particularly commonplace*.*

e. Lentic habitats

Two large categories of lentic environments occur in the AII. The first corresponds to small depressions capable of being flooded, which may or not be associated with forest units.

When these areas are associated with forest units the following features occur:

Periodically flooded forest
Located in damp depressions, characterized by arboreal cover normally with a poor variety of species therein. Predominant species found in this environment are *Symphonia globulifera* and *Calophyllum brasiliense*. Representatives of species such as *Bactris setosa, Garcinia brasiliensis, Sorocea hilarii and Tapirira guianensis* can also be found.

Permanently flooded forest
Originally found on the margins of lakes or damp depressions, characterized by arboreal vegetation up to 8 meters in height, with *Tabebuia cassinoides* the predominant species.

Herbaceous swamp units comprise herbaceous formations in soil susceptible to flooding and are characterized by predominantly graminoid vegetation. The most notable species encountered are cyperaceous and gramineous, especially those of the *Fimbristylis, Rhynchospora, Cyperus, Paspalum* and *Panicum* genres, amongst others. *Jamaican Cladium* has been observed in permanently flooded terrain, whilst *Typha angustifolia* predominates in areas where the water levels are deeper.

Photo 17- Detail of herbaceous swamp

The ichthyofauna of these systems is less rich when compared with the fluvial environments. The species sampled were those shown in Table XI attached.

Photo 18 - *Phalloceros caudimaculatus and Hyphessobrycon reticulatus*

The second category includes lakes and coastal lakes along the coastal strip, particularly Lakes Imboassica, Cabiúnas and Comprida

Lake Imboassica is the result of the damming of the small Imboassica River by a sandy ridge (LAMEGO, 1974). This lake's environment has undergone significant changes due to the fact that it receives large quantities of sediment in the form of organic waste, discharged by residences along the water's edge. Frequent interventions involving the artificial breaching of its sandbar also occur, in a process similar to those observed previously in other of the state's lakes (currently lagoons).

The ichthyofauna sampled in this environment by AGUIARO (1994) differs significantly from that collected from the Imboassica River (defined in the preceding table). The list of species obtained by the author appears in Table XII (attached).

The arrangement obtained is mainly composed of marine species, some of which have possibly been trapped inside the system following the closure of the sandbar after one of its periodic openings. This factor means that for many species the environment is not suitable for reproduction or growth, and as such their presence there is essentially accidental.

The most abundant species captured by AGUIARO (1994) using sweep nets were *Gerres aprion*, *Xenomelaniris brasiliensis, Geophagus brasiliensis, Platanichthys platana, Ciharichthys spilopterus, Mugil curema* and *Genidens genidens*.The most abundant captured in snare nets were *G. aprion, M. curema, G. genidens, G. brasiliensis, C. hippos, Strongylura timucu, Mugil* sp., *Lycengraulis grossidens, Gerres gula, Tilapia rendalli* and *Elops saurus*.

SAAD (1997) analyzed the effect upon the lake's fish stocks attributable to the breaching of its sandbar. The study took place between October 1993 and September 1994, during which the sandbar was opened twice (March 16 and April 26, 1994). Thirty-five species were collected and no alteration to the situation presented in the preceding table was observed.

AGUIARO (1994) studied Lakes Comprida and Cabiunas, with areas of 0.35km^2 and 0.11km^2 respectively. Field studies were conducted between July 1991 and January 1993, during which period 7 three-monthly samples were obtained.

Manual trawls and different gage nets were used to collect the samples. The list of species captured and their distribution in each of the lakes is illustrated in Table XII (attached).

In the case of Lake Cabiúnas, samples obtained using sweep nets normally consisted of young specimens, with *Gerres aprion and G. brasiliensis* the most abundant. Of the samples obtained by manual dragnet, *Hyphessobrycon bifasciatus, H. luetkeni* and *Poecilia vivipara* were the most representative. Samples obtained using series of snare nets showed *Cyphocharax gilbert* to be the most abundant, followed by *A. bimaculatus* (AGUIARO, 1994). January 1992 was the month when the most species were observed.

In Lake Comprida the only specie to be captured by sweep net was *G. brasiliensis*, whilst all other species observed in that environment were caught using dragnets. Of these, *H. bifasciatus* was the dominant specie.

H. malabaricus was abundant in the series of snare nets. This was the dominant specie in most of the samples taken, with the exception of April and June 1992, when *Centropomus undecimalis and G. brasiliensis* dominated their respective months.

***Photo* 19 - *Geophagus brasiliensis* in snare net.**

5.3.2.2 Direct Influence Area (AID)

a. Thermoelectric Plant construction site

The area directly affected by the project is covered by vegetation consisting almost entirely of anthropic fields (meadowland) essentially composed of gramineous species and invading plants. *Brachiaria sp* is the predominant specie, associated with diverse species such as *Panicum* spp., *Borreria* sp*., Cordia* sp*., Hyptis brevipes*, *Vernonia scorpioides*., *Cyperus* spp. and *Lantana camara,* as well as many other grasses and undershrub species commonly found in these environments.

In damp poorly drained lowland stretches *Mimosa bimucronata* is commonly found, as well as cyperaceous species (Scleria sp., Cyperus spp.), which form dense bushy

groups. Swampy areas frequently play host to species such as *Acrostichum danaeifolium* and *Typha angustifolia*.

The list of vegetable species observed in this sector appears in Table XIV (attached).

Terrestrial wildlife is the same as that described for the meadowland areas.

The ichthyofauna observed at a location close to the direct intervention site (i.e. at the Macaé River and BR-101 highway crossing point) is mostly similar to that listed for the Area of Indirect Influence, namely the lower reaches of the Macaé River. In fact, the species missing from Table XV (attached), namely *Hoplerythrinus unitaeniatus, Imparfinis minutus and Glanidium melanopterum* probably occur in the region and were not collected due to selectivity problems experienced with the sampling instruments used, and in the case of *Synbranchus marmoratus*, because of its burrowing nature, which makes its very difficult to catch.

Species such as *Mimagoniates microlepis* and *Rivulus janeiroensis* are more commonly found in swamps or small tributaries, which explains their absence from samples taken from the river's main channel.

As previously described, the presence of certain euryaline marine species such as *Centropomus parallelus*, *Achirus lineatus and Mugil curema* was observed in the AID. This denotes these species' movement in the space between the estuary and the area under scrutiny, possibly related to athropic and/or reproductive strategies

Photo 20 - *Achirus lineatus* and juvenile *Mugil curema*.

b. Gas pipeline area

The gas pipeline's direct influence area was considered to be the full extent of the project's proposed route, to which a further lateral strip 20 meters in width has been added.

In this area the dominant vegetation is almost all anthropic, essentially formed from gramineous species and invading plants. *Brachiaria* cf. *plantaginea* is the dominant specie, associated with various other species, such as *Panicum* spp., *Hyptis brevipes*, *Vernonia scorpioides*., *Cyperus* spp., *Lantana camara* and *Borreria* sp., as well as other grasses and underbush species commonly found in these environments.

At the base of tree-covered hillocks, the few pockets of native vegetation directly affected correspond to peripheral forest characterized by typically pioneering and secondary species. In these environments the predominant species are low arboreal varieties, such as *Guarea guidonia*, *Guarea macrophylla* subsp. *tuberculata, Casearia sylvestris, Cacropia hololeuca*, *Cecropia lyratiloba*, *Trema micrantha*, *Aureliana fasciculata, Trichilia casaretti, Cupania oblongifolia, Gochnatia polymorpha, Xylopia sericea*, *Solanum leucodendron* and *Piptadenia gonoacantha*, which share the available space with bush and underbush species such as *Cordia taguahyensis, Clidemia hirta*, *Piper mollicomum* and *Guadua tagoara*.

This peripheral vegetation is generally marked by an absence of epyphites and an abundance of climbers, such as *Gouania blanchetiana, Arrabidaea* sp., *Herreria salsaparilha, Serjania sp.* and *Anemopaegma scandens*, amongst other species.

On certain sections at the foot of these hills temporary creeks and streams favor the presence of species that are more demanding in terms of soil humidity, such as *Polygonum acre*, *Heliconia episcopalis*, *Dichorisandra thyrsiflora* and *Tripogandra* sp. The list of vegetable species registered along the full extent of the proposed route appears in Table XVI (attached).

The great majority of fauna observed in this sector was similar to that registered in the area of indirect influence, meadowland formations, forest peripheries and swamp systems.

No endemic disease or threat of extinction affecting either flora or fauna was registered in this sector.

The aquatic environments within the gas pipeline's area of direct influence are insignificant, mainly consisting of little more than culverts installed during sanitation initiatives on the Macaé River's lower reaches. They are occupied by small fish, notably *Hyphessobrycon bifasciatus, H. reticulatus* and *Geophagus brasiliensis*. Tables XVII and XVIII (attached) contain a list of fish and amphibians recorded in the region studied.

5.3.3 Conservation Units

The municipality of Macaé and the area of the Macaé basin contain Conservation Units. Due to their close proximity to the project, the units described below are particularly relevant:

- *Restinga de Jurubatiba National Park*

Created on 29/04/98, this park lies on the coastal region on land belonging to the municipalities of Carapebus, Macaé and Quissamã, in the State of Rio de Janeiro, occupying an area of approximately 14,860 hectares.

The park consists of a sandy quaternary plain 12 meters in height at its highest point. The ground is composed of sandy marine quartzes between hydromorphic podzoic layers. The large number of aquatic and amphibious environments existing within this system makes the region one of the most diverse of Brazil's coastal ecosystems.

The park is situated approximately 19 kilometers from the project as the crow flies.

Photo 21 –Aerial view of the Restinga de Jurubatiba Nation Park region.

- *Fazenda União Biological Reserve*

Created on April 22, 1998 with the objective of guaranteeing the protection, conservation and recovery of the remaining pockets of Atlantic Forest and its associated species, as well as the typical fauna which depends upon it for its survival, particularly the golden cebus monkey (*Leontopithecus rosalia*). Administered by IBAMA, the reserve occupies a total area of 3,126 hectares, 2/3 of which is covered by dense Atlantic Forest.

The reserve is situated approximately 18 kilometers from the project as the crow flies.

Photo 22 – Golden cebus monkey in the Fazenda União Biological Reserve

- *Atalaia Municipal Park*

Created by Municipal Law No. 150098, dated 24-06-95, this park occupies an area of 235 hectares. The park's objective is to preserve surviving pockets of Atlantic Forest, including lowland or sub-mountain areas, the latter having almost disappeared from the region. The park is situated approximately 13 kms for the project site.

Photo 23 – Bromeliad in Atalaia Municipal Park

5.4 ANTHROPIC ENVIRONMENT

5.4.1 AREA COVERED

The municipality of Macaé, where the plant is to be implemented, is being treated as the area of influence from a socioeconomic viewpoint. The municipality currently has an expressive industrial and service sector catering mainly to the needs of the oil industry.

5.4.2 MACAÉ REGION – SOCIOECONOMIC EVOLUTION

The North Fluminense Region has undergone various periods of growth and economic stagnation since its inception in the 18th century, due either to an increase or lack of regional investment or changes in government policy.

The main economic factor responsible for triggering the region's development between the 18th and 19th centuries was sugar cane production. In 1819, São João da Barra and north Macaé had approximately 20 sugar mills between them.

A further impulse was brought about following the construction of the connecting canal between the municipalities of Campos dos Goitacazes and Macaé, necessary to address commercial demand over and above the capacity of the existing São João da Barra harbor facilities. This link provided direct contact between the sugar mills and plantations on the Paraiba do Sul plain and the port of Macaé. The port grew significantly in commercial stature due to the subsequent increase in business.

However, the advent of the rail link between Campos dos Goitacazes and Macaé in 1875, later followed by its extension through to Niterói rendered both canal and port obsolete.

This growth slowed down and eventually ground to a halt during the initial two decades of the following century. The position began to change from that point on, with significant growth in the 1960's still attributable to the sugar industry. Growth was further stimulated in 1975 following the implementation of new government incentives to use alcohol rather than petrol as a fuel source, an initiative known as the PROALCOOL Program.

As a result, sugar cane cultivation underwent a process of modernization, spreading to areas previously given over to cattle ranching. These factors, combined with the availability of salaried employment, contributed to the increased migration to Campos dos Goytacazes and Macaé, the region's main urban centers.

However, the lack of investment in the modernization of production technology and the slow-down of the PROALCOOL program triggered another period of economic decline and led to a return to cattle ranching and diversification of the region's agricultural activities. The latter formed the base of the region's emerging industrialization process, essentially dedicated to the production of agricultural goods and foodstuffs.

The Brazilian oil industry began a period of rapid growth in 1979, following the discovery of new oil reserves in the Campos Basin. Current indicators show that this field's production alone is almost on a par with that of some of the major oil exporting countries, such as Libya and Indonesia, and exceeds that of other traditional exporters such as Angola and Oman. Production in the Campos Basin is expected to increase by 9.4% per annum.

This growth brought about another change to the region's socioeconomic organization due to the new demands created in the municipalities by activities directly or indirectly related to the oil industry. These demands triggered another urban exodus in search of salaried employment.

These changes had a marked effect upon the region's fishing industry, of great importance to the North Fluminense coastal communities up to that time. From that point on the industry has progressively declined, despite the significant number of people still engaged in fishing activities in some municipalities.

The municipalities affected are currently seeking to establish a new development trend, with many directing their efforts to the consolidation of the region's tourist potential to add new impetus to its commercial and service sectors.

The government policy of expanding its energy generating capacity, a sector currently dominated by hydraulic energy and oil, has brought new development opportunities to the region, due to the implementation of thermoelectric generating plants fuelled by natural gas. This fuel source produces a cleaner, less intrusive energy product from an environmental viewpoint, as is the case with the Macaé Merchant Thermoelectric Facility.

5.4.3 MUNICIPALITY OF MACAÉ - DESCRIPTION

The Municipality of Macaé is situated in the North Fluminense Region of the State of Rio de Janeiro, adjoining the municipalities of Conceição de Macabu, Carapebus, Rio das Ostras, Casimiro de Abreu, Nova Friburgo and Trajano de Morais. Originally part of Cabo Frio and Campos dos Goytacazes, it was politically and administratively emancipated on 25/01/1814 and currently occupies an area of 1,218.8 km^2. According to its municipal planning secretary, its population currently stands at 113,042. (1998).

The first municipal Development Plan was produced in 1979 with the objective of managing the city's growth following the implementation of the PETROBRÀS Cabiúnas Terminal two years previously. This Plan included legal instruments governing the occupation and use of urban land to support the area's expansion, both from a demographic perspective and in relation to economic activities linked to oil exploration and production.

Three further plans were proposed and reviewed between 1980 and 1989. These plans dealt with zoning, definition of urban perimeters, the Land Allocation Law and regional

impact studies intended to control the previously unregulated urban expansion. This ever-increasing urban migration was responsible for serious alterations to the region's natural and urban environment. Although these plans were not approved, they formed the basis of the 1990 Municipality of Macaé Director Plan, the sole planning instrument currently used by the municipality.

5.4.3.1 Economic Activity

For many years sugar cane was the backbone of the Macaé economy. Following the implementation of the PETROBRÁS' terminal in the municipality and its associated oil exploration and production activities, the city's economy came to concentrate on the industrial, commercial and service sectors.

The expansion of oil-related activities created approximately 7,200 direct and 14,000 indirect job opportunities. Tax revenue and royalties provided a further boost to the local economy. According to data provided by the Macaé Treasury Secretary, the municipality's ICMS revenue exceeded the 100% mark between 1995 and 1999.

According to family income data obtained from the Getúlio Vargas Foundation, the Norte Fluminense region has one of the State of Rio de Janeiro's lowest average incomes, at 1.2 Minimum Monthly Salaries (SMM), with the municipality of Macaé topping the regional tables at 2.1 Minimum Monthly Salaries.

It is expected that private companies will invest approximately R$ 10 billion in the municipality over the next five years. These investments will result in an increased diversification in the demand for services and equipment and the creation of new economic activities in the region, particularly in the tertiary sector, i.e: accommodation, catering, drilling, industrial assembly, heavy machinery workshops, offshore transport and supply services and small service providers.

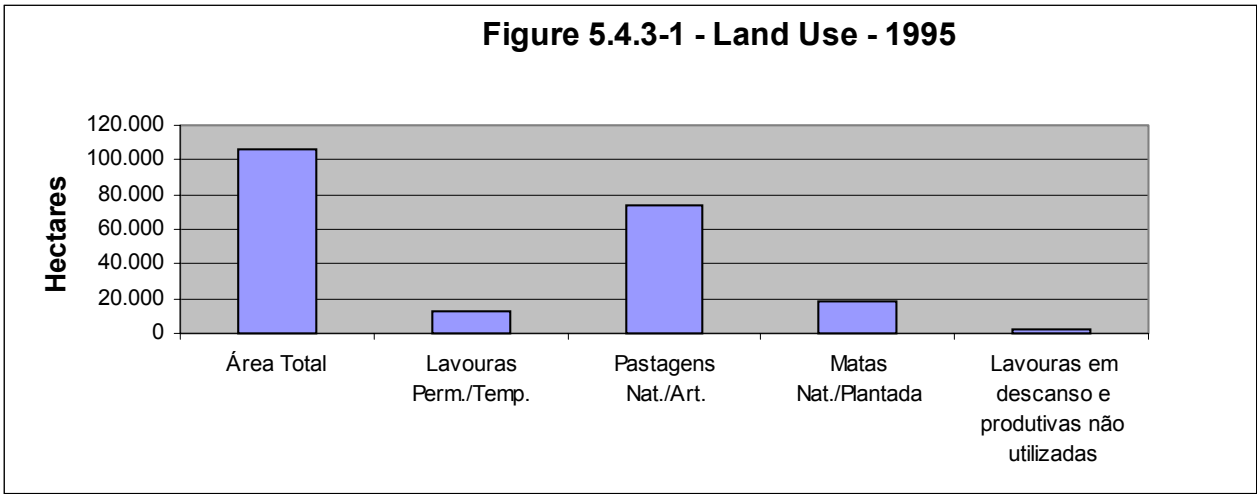
These changes are already being felt by the tertiary sector, which currently employs almost 41% of the municipality's labor force, with the secondary sector accounting for only 8% and the primary 4%.

If on the one hand the primary sector makes a fairly insignificant contribution when compared to the municipality's current industrial activities, its performance is nevertheless important in relation to the State of Rio. Forty percent of the municipality is given over to cattle ranching, and it figures amongst the State of Rio's three leading cattle producers.

In 1995, out of the area given over to agricultural or livestock production, 13% was used for cultivation and a further 79% was occupied by natural or planted grazing land. Despite the transformations currently affecting the municipal economy, sugar cane production is still an important activity, accounting for approximately 78% of its cultivated area in 1995. Banana production is another permanent activity within the region worthy of mention. Within the primary sector, the trend is to invest in fruit-growing

enterprises throughout the North Fluminense Region, but despite this investment in the Macaé economy has predominantly been in oil and gas exploration activities in the Campos Basin. Figure 5.4.3-1 and Tables 5.4.3-1 and 5.4.3-2 below illustrate these situations.

Figure 5.4.3-1 - Land Use - 1995



Total Area Perm./Temp. Crops Pastures Nat./Art. Forest Nat./Planted Fallow land or productive but not used

Source: IBGE census

TABLE 5.4.3-1 – MUNICIPALITY OF MACAÉ – AGRICULTURAL PRODUCTION

TEMPORARY CULTIVATION

Product	1994				1995			
	Planted area (ha)	Area harvested (ha)	Production (t)	State Production %	Planted area (ha)	Area harvested (ha)	Production (t)	State Production %
Rice (husk)	1,5000	1.500	6,138	9.60	1,600	1,330	5,320	12.00
Sugar cane	10,300	9,600	480,000	7.00	9,600	9,600	480,000	6.60
Beans (grain)	317	317	273	3.00	1,072	1,072	1,259	15.50
Manioc	90	90	1980	0.80	98	98	2,156	0.90
Corn (grain)	425	425	918	1.70	400	400	880	3.00
Tomato	-	-	-	-	1	1	35	0.02

TABLE 5.4.3-2 - MUNICIPALITY OF MACAÉ – AGRICULTURAL PRODUCTION

PERMANENT CULTIVATION

Product	1994				1995			
	Planted area (ha)	Harvested area (ha)	Production (t)	State Production %	Planted area (ha)	Harvested area (ha)	Production (t)	State Production %
Banana	2,600	2,600	2,860	9.30	2,200	2,200	2,090	7.70
Coconut	6	6	60	0.80	6	6	60	0.50
Orange	15	15	960	0.07	15	15	960	0.10
Passionfruit	2	2	160	0.50	2	2	160	0.40

The municipality is responsible for 12% of the State of Rio's fishing activities. Approximately 3,700 tons of fish is landed at its ports, making it the state's fourth largest fish producer.

According to Macaé's Agriculture and Environment Secretary, the municipality has some 1,500 fishermen. It is one of the few coastal municipalities in Brazil to have a fishermen's organization in the form of the Z-3 Fishing Colony and the Macaé Mixed Fishermen's Cooperative. The former has 1,600 associate members and provides medical and dental services to fishermen and their families through an agreement with SUS (Brazilian Public Health Service). The latter has 30 associate members who sell fish on the Rio de Janeiro market, keeping 30% of the profits.

The municipalities' commerce and services sectors have kept pace with the urban expansion of the last two decades. Although the region's natural and scenic assets give it great tourist potential, this sector does not yet make any significant contribution to its economy.

5.4.3.2 Infrastructure

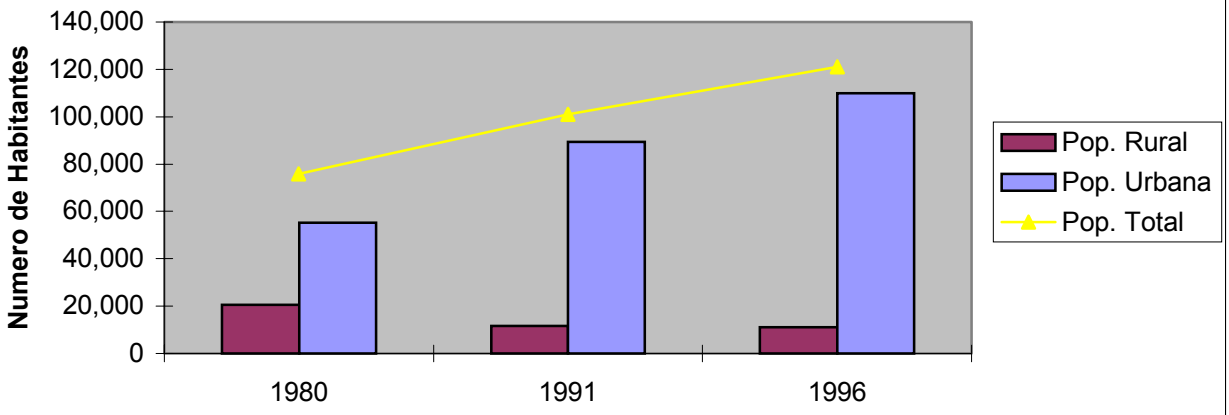
The Municipality of Macaé has undergone many major transformations over the last two decades. Many of its peripheral areas, many of which contain mangrove and sandspit formations, have been occupied by low-income migrant job-seekers.

If on the one hand the population has benefited from the growth brought about by the implementation of the region's new enterprises, which have increased the offer of goods, employment, services and income, on the other, the city has grown in a disorganized fashion, without providing the basic public service infrastructure necessary to address the new demands.

5.4.3.3 Demographic Aspects

The changes in the municipality's basic economy illustrated in item V-4.3.1 are significantly reflected in the growth in the rate of urbanization recorded between 1980 and 1996, as depicted by Figure 5.4.3-2 below.

Figure 5.4.3-2 - Population Growth for Macaé - 1980 to 1996



Source: FIBGE

From the mid-1980's on, the city of Macaé registered one of the highest demographic growth rates amongst the state's municipalities, although the growth rate for the state itself was in decline. The creation of thousands of new job opportunities resulted in an intense migratory process. This meant that the city's population rose from 59,397 in 1980 to 93,657 in 1991, 113,042 in 1996 and 121,047 in 1998 (Source: CIDE).

According to IBGE statistics, while the state's population grew at a rate of 1.15% per annum between 1980 and 1991, Macaé's population was growing at a rate of 2.63% per annum. During the subsequent 1991-1996 period the state's growth rate fell back to 0.92%, while the municipality's continued to rise to 3.73% per annum.

CIDE (The State of Rio de Janeiro Statistics Annual) excluded population data relating to the newly-formed municipalities of Quissamã and Carapebus from its historical series in order to accurately assess Macaé's current growth rate. By so doing, it was able to ascertain the population increase for the 1980-1991 period, which corresponded to 4.23% per annum, a figure much higher than the figures for Quissamã and Carapebus. This growth rate was sustained during the subsequent period, while the North Fluminense Region as a whole posted growth figures below 1.6% per annum.

Macaé's expressive population growth is due to the number of migrants who moved into the municipality seeking work, transferees and accompanying family members. In 1980 some 9,600 people from other Brazilian states or municipalities in the state of Rio de Janeiro had lived in the municipality for less than ten years (12.7% of the total population). In 1991 this figure had risen to 21,731, representing 21,5% of its

population. The migrant population growth rate for the 1980-1991 period was 7.7% per annum.

The last survey conducted by the IBGE in Macaé in 1999 showed the migrant percentage to be 32.66%, demonstrating that the municipality continues to attract migrants, basically because of improvements to the local economy associated with the oil industry.

5.4.3.4 Population – Social Organization

The most expressive organizations in the municipality of Macaé are residents associations and organizations representing the working classes, these being a reflex to the high population growth rate and the area's urbanization. The Federal University of Rio de Janeiro and several NGOs, particularly those dealing with environmental matters are also extremely active in the municipality.

Neighborhood associations have representatives in almost every district and are a way for local residents to participate in the local public policymaking process. The associations meet fortnightly with the Municipal Social Promotion Secretary to discuss the city's problems and submit demands relating to their respective districts. The Secretary, in conjunction with the Social Action Foundation (to which he is answerable), is responsible for developing important alternative employment and income initiatives for the municipality's low-income population. These initiatives are developed in close cooperation with the residents associations and **Environmental Education Centers**.

The **Macaé Environmental Education Centers** were created recently (89/99), the product of the "The Nature of the Landscape" program, an initiative introduced by the Municipal Secretary for Agriculture and the Environment in partnership with CIMA (Culture, Information and Environmental Center), a Non-Governmental Organization – NGO, supported by the Caixa Economica Federal. Five such centers already exist, responsible for the city's environmental management, principally in matters relating to garbage, the planting of seedlings and sanitary drainage:

- **Lagoa de Imboassica Environmental Education Center – NEASSICA**, active in the districts of Imboassica, São Marcos, da Glória, Cavaleiros, Novo Cavaleiros, Cancela Preta, Duque de Caxias, Jardim dos Cavaleiros, Granja dos Cavaleiros, Vale Encantado, Bosque dos Cavaleiros, Parque de Tubos, Mirante da Lagoa and Morada das Graças. Develops initiatives with the community, mainly with the objective of restoring and revitalizing Lake Imboacica;
- **Verde Environmental Education Center – NEAVERDE,** active in the districts of Aroeira, Nova Aroeira, Nova Macaé, Jardim Santo Antônio, Morro de Santana, Morro de São Jorge, Botafogo, Malvinas, Virgem Santa and Horácio. Some of Macaé's most needy areas are located in these districts. Involved in efforts to encourage the planting of seedlings by organizing planting "bees" and selective trash collection;

- **Parque Aeroporto Environmental Education Center – NEA AEROPORTO,** active within the Parque Aeroporto community, which with its more than 40,000 inhabitants is Macaé's most populated district. This district has significant concentrations of low-income families;
- **Jurubatiba Environmental Education Center – NEA JURUBATIBA**, active in the districts of Balneário Lagomar, Barreto, Engenho da Praia, Cabiúnas and Lagomar;
- **Grupo Educacional Visconde de Araújo Environmental Education Center– NEA GEVA**, active in the districts of Visconde de Araújo, Novo Visconde, Maringá, Miramar and Bela Vista.

In addition to the Environmental Education Centers, other institutions also exist doing excellent work in the environmental protection field. The Rio de Janeiro State Secretary for the Environment and Sustainable Development – SEMADS/RJ initiative in sub-dividing the state into 7 Environmental Macro-Regions – MRAs, to serve as planning units for the definition of public environmental policies and sustainable development in a state-wide context under the terms of Decree No. 26.058 is particularly worthy of mention.

The region under scrutiny for the purpose of this study lies in **Environmental Macro-Region 5 (MRA-5)**, managed by the **Inter-municipal Hydrographic Basin Management Consortium for the Macaé, Macabu and São João Rivers and Lake Feia.** The Consortium has the following objectives:

- Represent its members in environmental issues of common interest in its dealings with public and private entities, both Brazilian and international;
- Prepare, adopt and execute plans, programs and projects intended to promote and accelerate sustainable development and environmental conservation;
- Promote projects and / or measures intended to recover and preserve the environment, paying special attention to the soil, mountain ranges, lowlands, lakes, rivers, streams, reservoirs, Atlantic rainforest, sandspits, micro-bays, beaches, inlets and the coastal zone;
- Promote preventive or corrective measures intended to preserve the environment and clean up rivers, reservoirs, lakes, lagoons and beaches;
- Manage financial and technical resources obtained from public agencies, financial institutions and the private sector intended to promote the region's sustained development;
- Provide technical support for the State System for Water Resource Management, the Lakes, Lagoons and Reservoirs Management Councils and the Basin Committees to be formed by the State Government to carry out the plans and programs defined by these bodies.

The municipality of Macaé also enjoys the support of the Federal University of Rio de Janeiro (UFRJ) on environmental issues, through the efforts of the Macaé Center for Ecological Research – NUPEM, which in partnership with the municipal authorities and PETROBRÁS is involved in the Lake Project (Projeto Lagos), a program intended to recover the coastal lakes and study the ecosystems in Restinga de Jurubatiba National Park. NUPEM is involved in research and preservation activities relating to sandspits, coastal lakes, mangrove swamps, water resources and the Macaé Atlantic Rainforest.

The work carried out in the region by the following Non-Governmental Organizations - NGOs is also worthy of mention:

- **Macaense Environmental Defense Association – AMDA:** concentrates mainly on the preservation and recovery of the Macaé river basin. Closely involved in questions relating to the municipality of Macaé's urban and industrial growth. This is the region's most structured NGO. Publishes "Environment" magazine every two months.
- **SOS Praia do Pecado:** concentrates on the conservation of Pecado beach and assists IBAMA in the rescue of dolphins, whales, penguins and other stranded animals;
- **Amigos do Parque de Jurubatiba (Friends of Jurubatiba Park):** fought to establish the park and currently involved in its conservation;
- **Environmental Information and Action Network – RAIA –** active in Macaé's mountain region. Involved in the preservation of creek environments and the environmental education of tourists frequenting the Sana river basin.

Professional class organizations – representative of segments of civil society according to profession: Macaé's most representative body is the **North Fluminense Oil Industry Workers Union**. This union is well represented due to the large number of workers involved in PETROBRÁS' activities and has the Jornal Nascente newspaper as its communication vehicle. The following unions are also established in Macaé, although their influence is not as significant: **Electrician's Union, Railroad Union** and **Commercial Employees Union**.

The Macaé Industrial and Commercial Association – ACIM: founded in 1916, the association has almost 600 associate members, mainly small businessmen. It has considerable influence and plays a leading role in the city's politics.

Macaé Regional Engineering and Architecture Council – CREA: plays an extremely expressive role due to the large number of associated professionals (1,200) in relation to the size of the local population. It is worth emphasizing that CREA/RJ (due to the regional office policies) is involved in a program entitled "Movement of the Waters", intended to settle the question of territorial management of water resources. This initiative, which has far-reaching implications for the Macaé regional office, has resulted in CREA/RJ promoting informative events in the region, in keeping with the current policies pursued by the Macaé Municipal Authorities, in its effort. to create an inter-municipal entity to manage the Macaé river resources.

6. APPRAISAL OF POTENTIAL ENVIRONMENTAL ASPECTS

6 APPRAISAL OF POTENTIAL ENVIRONMENTAL IMPACTS

6.1 METHODOLOGY ADOPTED

The appraisal of potential environmental impacts presented in this study is structured in accordance with the principles of the current environmental licensing system, and consists of a preliminary instrument to assist both the developer and the public agencies involved in the licensing process in reaching a decision as to the implementation and operation of a certain project.

This stage will therefore be drawn up on the basis of the standards and limits already established by the environmental legislation.

It should be noted that the appraisal of impacts and the mitigating measures presented take into consideration the Thermo-electric plant-Gas pipeline system under normal operating conditions. Risk situations or accidental events are considered in the plant and gas pipeline risk analyses, which also deal with aspects of the Emergency Action Plans.

For purposes of a general understanding of the topics to be considered in this chapter, definitions of the terms used in this appraisal are provided below.

- **Environmental Impact**

Any adverse or beneficial change in the environment resulting wholly or partially from the activities, products or services of an organization.

- **Definition of Environmental Impact - CONAMA Resolution 01/86**

Any alteration in the physical, chemical and biological properties of the environment, caused by any type of matter or energy resulting from human activities that directly or indirectly affect the health, safety and well-being of the population, social and economic activities, the biota, the aesthetic and sanitary conditions of the environment and the quality of environmental resources.

- **Classification of environmental impacts**

- Nature: positive or negative;
- Type of effect: direct or indirect;
- Extent: local or regional
- Term: short, medium or long term;
- Time frame: temporary, cyclical or permanent;
- Reversibility: reversible, partially reversible or irreversible;
- Mitigability: mitigable, partially mitigable or unmitigable;
- Significance: high, medium or little;

- Scale: large, medium or small.

- **Acceptable Impacts**

- Those that can be mitigated and/or compensated for;
- Those that are in accordance with applicable environmental quality standards;
- Those that generate benefits for society (positive impacts).

In this context, the technical team for this environmental impact study performed the above-mentioned analyses to assess changes that might be generated in the various environmental parameters as a result of the activity to be carried out by the venture.

This set of appraisals encompasses technical and scientific methods (namely evaluations of a quantitative nature) and empirical methods of appreciation of the facts (expressed by means of qualitative evaluations). The evaluations, normally taken together with the experience of experts in studies of this nature, were made in the light of interdisciplinary technical meetings and visits to the area, with a view to the full development of the environmental impact evaluation process by those involved.

The results were therefore arranged and organized so as to permit a logical chain of presentation of the basic premises guiding the appraisal of potential environmental impact.

The overall approach of this chapter will be organized in such a way as to permit the construction of a mitigation program, considering the preventive, corrective and compensatory nature of the measures, as well as the development of the environmental monitoring program.

General comments on the planning stage of the project, followed by environmental evaluations of the parameters of the physical, biotic and anthropic environment for the installation and operational stages respectively are set forth below.

6.2 DESCRIPTION AND CLASSIFICATION OF POTENTIAL ENVIRONMENTAL IMPACTS

6.2.1 PLANNING STAGE OF THE PROJECT

The potential environmental impacts at the planning stage described below in general terms are linked to the disclosure of the project and information to the community.

6.2.1.1 Potential Impacts on the Social and Economic Environment

- **Social expectations and mobilization of the community generated by the construction of the thermo-electric plant with the disclosure and information to the local and regional community.**

– Description:

This stage may give rise to social expectations, due to the possibility that jobs will be generated. Thus, considering the high rate of unemployment in Brazil, the preventive measures to control in advance the social expectation generated by the construction of the plant should be restricted to responsible disclosure of the real requirements at this time (number of jobs, specializations required, etc.). This disclosure should preferably be made in a planned manner, by the developer itself together with the official organizations responsible for placing and training labor (SESI-SENAI, FIRJAN/Macaé, ACIM – the Macaé Commercial and Industrial Association, and the Municipal Office.).

Another potential impact at this stage are the expectations generated in the public mind with regard to the inclusion of a new project/user of the water resources available in the Macaé River hydrographic basin, source of the main water supply of the Macaé municipal district.

– Classification:

In this specific case, bearing in mind the local mobilization in relation to the theme and the lack of public information as to the basin's water resources, the impact can be evaluated as potentially negative, diffused, of high to moderate magnitude and highly significant, since it involves public opinion in the region of the project, although there is a strong possibility of mitigation, through the disclosure of information to the public of studies carried out, and discussion in the sphere of the MRA-5.

- **Social expectations and community mobilization generated by the construction of the Gas pipeline with disclosure and information to the local and regional community.**

– Description:

Disclosure renders public the intention to install the gas pipeline. As from that point, expectations will be generated among owners of properties in the surrounding areas as to possible interference generated by the work in the region.

Similar expectations may also arise from the contracting of the topographic and registration studies of accesses and areas, when the fieldwork begins.

In order to conduct these studies, the developer's public relations teams should enter into contact with populations that live or own properties in the areas to be affected, collecting registration information. This will set in motion a process of direct disclosure of the project, which should be conducted in a responsible manner, providing consistent information to reduce the expectations generated by the lack of information.

– Classification:

Indirect, potentially negative impact, local, short-term, temporary, reversible, small scale, partially mitigable and of little significance.

6.2.2 IMPLEMENTATION STAGE

6.2.2.1 Impacts on the physical environment

- **Compromising of environmental quality in terms of noise pollution due to earth-moving work and assembly of equipment**

– Description:

The impact of risks to the environmental quality caused by the implementation stage of the project will depend largely on the noise levels and the distances of the receivers in relation to the sources on noise in the area in question.

At the implementation stage of the Macaé Merchant plant in the Severina area, the noise production will be temporary, and is likely to result from earth-moving operations, truck traffic, and operations with heavy tractors, rock crushers, compressors and the assembly of equipment.

– Classification:

Negative impact, direct effect, local scope, medium term, temporary, reversible, mitigable, of little significance and consequence.

- **Alteration of the original relief as a result of earth-moving work for the plant and to excavation and recovery of land for the implementation of the gas pipeline**

– Description:

The objective of the earth-moving work is to level the land at the 20 meter level, in order to create an area large enough to accommodate the installations of the Macaé Merchant plant. Linear excavation will be necessary, also for the implementation of the gas pipeline, along the 25 km alignment.

– Classification:

Negative environmental impact, direct effect, local, immediate, permanent, irreversible, (in the case of the plant area, and reversible along the gas pipeline, through the closure of the trench and reconstruction of the contours that will mark the conclusion of the work), unmitigable, of little significance and scope.

- **Changes in levels of turbidity and transporting of solids to the natural drainage system, compromising the water quality, due to the earth-moving work and interference at the edges of the bodies of water, increasing the local potential for erosion and silting up.**

– Description:

A small amount of localized interference will be required for the implementation of the water impounding system and discharge of effluents in the Macaé river, and for the passage of the gas pipeline through the Macaé River and some lesser bodies of water.

With regard to the earth moving, construction and assembly work, there is a significant stretch of grassy vegetation between the installation point and the Macaé river, which will serve as a natural barrier for any sediments that might filter from upstream as a result of the earth moving.

If the earth is exposed for a lengthy period, the risk of erosion will increase, including linear erosion, that is, a concentrated drainage of water over the surface of the land, causing furrows and ravines.

– Classification:

Impact of a negative nature, direct, of local scope and diffused downstream of the Macaé River, immediate, temporary, reversible, mitigable, reduced significance and scale.

6.2.2.2 Impacts on the Biotic Environment

Changes in the natural habitats are direct effects arising from the *opening of accesses and of the right of way of the gas pipeline, installation of work sites and earth-moving work and dump areas.* The magnitude of this effect is closely related to the degree of conservation of the ecosystems situated in the area directly affected.

This impact will not be felt on the Macaé Merchant plant land, due to the eminently rural nature of the area.

The final stretch of the gas pipeline crosses a patch of residual forest, situated between the borders of the Pau-Ferro and Santa Rita Farms, following the line of the right of way formed by the line of the PETROBRAS water supply line (see Figure 6.2-1 below). This fragment, clearly secondary, is of bio-conservationist value, as it represents one of the few remaining wooded areas.

Figure 6.2.2-1 – Line of the Petrobrás water supply lines, passing through remnants of woodland. The figure clearly shows the alignment of the supply lines across the picture.

As noted in the field study, the edge of the woodlands effectively dominates the system, which has a reduced nucleus in the greater part of the area. This disposition clearly shows the considerable capacity of the pastoral vegetation to penetrate to the interior of the fragment and suggests that new interference will tend to reduce rapidly the few remaining core areas. The existence of a clearing caused by deforestation in the southwestern part of the fragment should be noted, as a fragility factor (Figure 6.2-2).

Figure 6.2.2-2 – Details of remnants of woodland and recent deforestation

In the particular case of the impact on fauna caused by the noise produced during the construction phase, this will be limited to the duration of the works, and will therefore be a short-term interference.

- **Elimination or burial of grassy plant cover and isolated organisms caused by the earth-moving work for implementation of road access, equipment, infrastructure installations; structuring the land to receive the plant and opening the trench to lay the gas pipeline.**

– Description:

Operations involving earthworks and installation of support areas, even when technical and environmental criteria have been established in this respect, result in the elimination of the plant cover, or at the least, deprive the original formation of its characteristics. In the specific case of the area directly affected, the vegetation is largely grassy, with a few bushes and small trees scattered around the area (see Figure 6.2-3).

Figure 6.2.2-3 – General aspect of the implementation area of the Macaé Merchant plant, with predominantly low grassy vegetation.

In this respect, the impact generated by the activity includes aspects of an adverse nature for the plant cover in the area in which the premises are to be installed. In this specific case, the vegetation is made up of pastoral grassy formations that dominate the area. The elimination of isolated organisms will only affect the area intended for the equipment mentioned above.

Although the existing plant cover will be eliminated, it should be emphasized that this is not native vegetation, nor does it have notable ecological value. It consists of exotic species that currently support the fauna which has adjusted to them.

Classification:

Negative environmental impact, of direct effect, local scope, immediate, permanent, unmitigable, reversible, reduced significance and scale.

- **Driving out of wildlife populations due to noise produced and movement of personnel, machines, equipment and vehicles**

– Description:

Preparation of the land for the implementation of the thermo-electric plant and the gas pipeline will involve the movement of vehicles and heavy machinery, representing sources of noise. These operations will tend to drive out wildlife in the area directly affected and its immediate surroundings.

As it is typically a rural environment, although with an anthropic influence (proximity to the BR-101 highway), the wildlife populations, made up of hemerophilous species, are likely to move naturally to similar environments, very common in the AID and AII, which will reduce the scale of the impact.

– Classification:

Impact of direct effect, negative, local scope, short-term, permanent, irreversible, unmitigable, of reduced significance and scale.

- **Destruction of the vegetation and reduction in the habitat area suitable for the fauna due to the installation of the work site and dump areas for the Gas pipeline**

– Description:

Although installed in a belt changed by existing linear work, the construction of the gas pipeline will temporarily result in an extension of the altered strip, due to the need to establish a working area some 15 meters wide along the alignment.

The vegetation will be removed as a result of preparation of the land and the installation of work sites and dump areas, with a negative effect on wildlife populations in the area, by reducing the space available for their settlement and survival. The greater part of the fauna will avoid the strip during the works, due to the human activity.

– Classification:

Impact of direct effect, negative, local scope, certain to occur in the case of land clearance and may occur in the case of work sites and dump areas, short-term, permanent, reversible, small scale, partially mitigable, with residual impact of little significance.

- **Interference with phytobenthos and zoobenthos communities and disturbance of ichthyofauna.**

– Description:

The alignment of the gas pipeline will involve crossing around 14 small drainage channels, as well as the Macaé River. These passages will be by means of underground constructions, crossing below the bed of the watercourses, and thus any interference with these watercourses will be eliminated once they have been installation.

During the placing of these crossings, however, trenches will be excavated across the watercourses, causing temporary impacts of changes in the beds, churning up of the bottom, and may affect the ichthyofauna**,** phytoplankton and zooplankton by increasing the turbidity of the water and a resulting decrease in the penetration of sunlight. The ichthyofauna, however, will avoid and stay away from the affected area.

The phytobenthic and zoobenthic communities existing around these areas will suffer the same effects of the increase in particles in suspension and diminished penetration of sunlight, but are likely to be more affected, due to closeness to the substratum of the channel beds. It should be taken into consideration, however, that it is normal for a large amount of particles in suspension to be found in these channels and in the Macaé River itself.

– Classification:

Impact of direct effect, negative, local scope, short-term, temporary, reversible, of average scale, unmitigable, with residual impact of average significance.

- **Increased hunting**

The opening of new paths or improvements to existing access paths to fairly inaccessible areas caused by work on implementation of the gas pipeline could facilitate the entry of hunters and the search for game birds and small and medium-sized mammals, causing a negative pressure on management of wildlife stocks.

Another aggravating factor is the actual mobilization of personnel for the work, which could result in an increase in the number of people in the habit of hunting. It is to be noted that, in the specific case of certain types of reptiles, disinformation and the generalized fear de ophidians might lead to the indiscriminate killing of organisms that play an important role as biological controllers.

This panorama is significant only with regard to the impact on changes in woodland habitats, as described above. Thus it refers to the fragment of woodland in which a

notable depletion of the fauna was noted, in the course of the field studies, possibly as a result of the interaction of hunting with the actual degeneration of the integrity of the system. It is therefore a stretch in which new impacts could have a significant dimension.

Considering that the team will remain in the area for a very short time and bearing in mind the possibility de mitigation of the impact by following simple measures, such as informing and restraining the workforce and guarding service areas, the pressure of hunting will have little impact and importance.

– Classification:

This impact is considered negative, direct, short-term, temporary, reversible, local, mitigable, low scale and of little consequence.

- **Formation of environments favorable to development of vectors.**

The accumulation of garbage in work site areas can serve to attract sinanthropic species, including rodents that act as vectors for etiological agents of various diseases, an impact that, although localized, should be reduced and controlled.

– Classification:

This impact is considered negative, direct, temporary, reversible, local, low scale and of little consequence.

- **Interference in the drainage network along the gas pipeline**

The drainage channels, consisting of an eminently man-made system, currently support a limited variety of fauna. Although the interference with the aquatic systems along the alignment will not have a significant impact in the context of the region, it could intensify locally the silting up of these systems, changing the characteristics of the drainage complex of the former marshy areas.

Similarly, the establishment of work sites implies the existence of new sources of sewage, which could compromise the chemical qualities of the waters of the adjacent aquatic systems.

The sum of the impacts felt on these systems will be reflected, in a different fashion, in the composition of the various species in the channels, causing the fauna to move to less altered sectors, thereby changing the normal distribution pattern in the area. An increase could occur in small watercourses and swamps in the mortality rate of some

less tolerant groups, or those with a lower capacity to disperse, found in the areas directly affected.

– Classification:

This impact is negative, direct, temporary, reversible, local, partially mitigable, low scale and of little consequence.

6.2.2.3 Impacts on the Anthropic Environment

- **Generation of jobs arising from implementation of the project**

– Description:

The implementation of the thermo-electric plant will call for the hiring of labor in the civil, mechanical and electrical fields. These demands will vary, during the construction period, in terms of intensity, duration and distribution over the areas, peaking at around 500 employees. Construction of the Macaé Merchant plant will take one year.

The implementation stage of the gas pipeline includes the period in which the work will be carried out, expected to last for two months. Due to the accelerated work schedule, it is estimated that 100 qualified and unqualified workers will be hired.

The region offers a variety of companies providing construction and assembly services, employing local labor, which will be given preference in putting the project into effect. This being the case, this appraisal does not anticipate a marked mobilization of groups from outside the region, thus minimizing the impacts on local urban infrastructure and equipment. Furthermore, local hirings, even on a temporary basis, provide new work opportunities for unemployed labor in the region. No accommodation will be constructed for personnel on the plant and gas pipeline work sites, for the reasons mentioned above.

There will be a demand for highly specialized labor for the electro-mechanical assemblies of the plant, and this will be hired in other parts of the country or even abroad.

In view of the social and economic profile of the region, especially Macaé, the demands generated by the implementation of the Macaé Merchant plant will have a positive impact, as they will link up with the existing industrial estate and services. This procedure directly contributes to increase the offer of employment for local labor. It should be noted that the venture would also create additional indirect employment.

– Classification:

Positive impact, of direct/indirect effect, local and regional scope, short-term, temporary, reversible, and of major significance and scale, which could be reinforced, depending on the policy adopted by the company.

- **Changes in the landscape caused by the earth-moving work and implementation of the structures of the plant and connection of the transmission lines**

– Description:

The land chosen for implementation of the plant is situated in a rural zone. The area located on land with altitudes in the region of 50 meters, the lowlands of the Macaé River in this region being mainly around 5 meters. The earth-moving work will alter the current contours of the landscape, reducing the height of the land to 20 meters, and introducing an element of industrial architecture into a predominantly rural area. This effect could, however, be reasonably diminished by an adequate landscaping and replanting project.

Similarly, the connection of the Macaé Merchant plant with the FURNAS transmission line will cause visual congestion through the accumulation of lines in the landscape, since there are plans for connections of the North Fluminense thermo-electric plant with the same transmission line, relatively close by.

– Classification:

Negative impact, direct effect, local, immediate/short-term, permanent, irreversible, partially mitigable, reduced significance and small scale (if properly alleviated).

- **Establishment of right of way for connection of the Macaé Merchant plant with the existing transmission line**

– Description:

The Macaé Merchant plant will be linked to the electricity system by connection with the existing 345 kV FURNAS transmission line, which passes approximately 150 meters from the site of the project, on the eastern side. A small right of way will be required to make the connections, which will involve negotiations for the expropriation of this strip with the owner(s). Use of the land in the right of way should be restricted, both in respect of buildings and with regard to the cultivation of species of vegetation.

– Classification:

Negative impact, direct effect, local, immediate/short-term, permanent, irreversible, unmitigable, of reduced significance and small scale.

- **Improvements to and appreciation of local areas, as a result of the actual implementation of the thermo-electric plant.**

– Description

The implementation of a large-scale industry may result in the appreciation of neighboring areas, in view of the improvements in urbanization and civil services that could be prompted in the Severina area by the existence of the venture.

This appreciation will assist in strengthening the local economy, with the attraction of new projects to the area, generating local and regional commercial and tax effects.

– Classification:

Positive impact, direct effect, local scope, medium term, permanent, irreversible, average significance and scale.

- **Generation of businesses and income for local commercial and service** operations **during the implementation of the project**

– Description:

In addition to the direct demand for the local construction and assembly sectors that may be generated by the venture, there is also the likelihood that business and income will be generated for local commerce and services. Such prospects are associated to

the demand for food, sales of materials, the hotel trade, transport, etc, representing a boosting of local economic activity.

Consequently, positive effects on a small scale are anticipated on the municipal income and tax revenues.

– Classification:

Positive impact, direct effect, local and regional scope, medium term, temporary, reversible, average significance and scale.

- **Demobilization of labor**

– Description:

Implementation of the Macaé Merchant plant will take one year, and will call, in the peak period, for 500 employees.

Implementation of the gas pipeline will take approximately two months, and will call, in the peak period, for 50 employees.

As explained above, the implementation is likely to favor local labor, largely mobilized by service companies established in the region. Given the current business dynamics in Macaé, with numerous oil companies and other industrial segments starting operations in the region, the demobilization of work on the plant is not expected to result in a significant availability of labor, in view of the growing demands in the area.

– Classification:

Negative impact, direct effect, local scope, medium term, permanent, irreversible, mitigable, average significance and small scale.

- **Highway crossings**

– Description:

Although the gas pipeline is located in the right of way of another gas pipeline and subsequently in that of the existing water supply line, there will be interference caused by the opening of the access road and of the trench in which it will be installed. Crossing the RJ-25 and two other roads in the vicinity, and the proximity to the existing gas pipeline and water supply line are likely to be the major interference caused by the gas pipeline. No urban areas will be crossed. Due to these road crossings, the work of installing the gas pipeline could cause short-term disruption to local traffic.

– Classification:

Negative impact, direct effect, local scope, likely to occur, short-term, temporary, reversible, small scale, mitigable, with residual impact of little significance.

- **Increase in heavy traffic on regional and local roads.**

– Description:

While the work is being carried out, materials will be transported, especially pipe sections. As these classify as heavy, high-volume products, they may cause periodical disruption to the flow of vehicles on the BR-101, the RJ-168 and on other access roads to the works, as well as wear and tear to the roads. The increase in the traffic of large vehicles on local and regional roads could lead to an increase in the number of road accidents.

– Classification:

Negative impact, direct effect, local/regional scope, certain to occur, short/medium term, temporary, reversible, average scale, mitigable, of little significance.

6.2.3 OPERATIONAL STAGE

6.2.3.1 Physical environment

- **Compromising of air quality by atmospheric emissions**

– Description:

During the operation, the plant will emit combustion gases containing atmospheric pollutants such as SO_2, NO_x, MP, HC and CO.

In order to evaluate the change in air quality that might occur as a result of these emissions, an atmospheric dispersion study was carried out, and is presented as an attachment to this EIA.

As a result of these studies, it was noted that the concentration of all the pollutants mentioned produced by the operation of the Macaé Merchant plant would be well below the maximum standards permissible for air quality.

To illustrate, the results of the Nox modeling are shown below, taking into consideration only the operation of the Macaé Merchant plant (Figure 6.2.3-1).

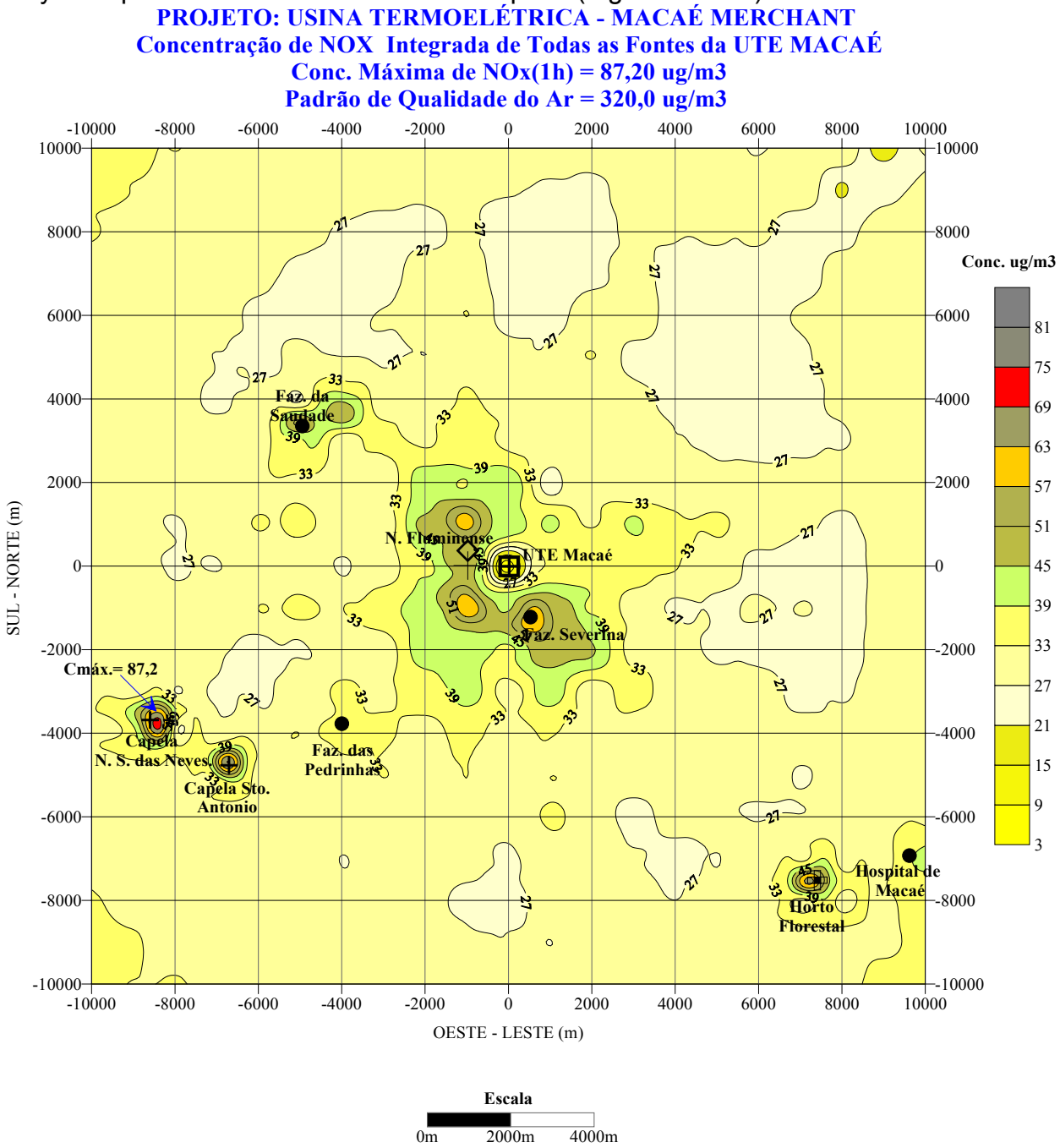


Figure 6.2.3-1 – Map of isoconcentrations (1h) of Nitrogen Oxides, NOx, resulting from the integrated emissions from the Macaé-Merchant source, on the influence area.

The air quality in the region is good, with low concentrations of the pollutants evaluated, so that the overall quality of the air in the influence area of the venture is not compromised, guaranteeing conditions of well-being and health for the inhabitants in the vicinity, and the integrity of the flora, fauna and materials.

The studies carried out also considered the potential cumulative effect of the emissions of the Macaé Merchant plant and the emissions expected from the similar venture (North Fluminense thermo-electric plant), scheduled for installation on land neighboring on the present project.

The results obtained in the modeling, integrating the emissions of both plants, although the indicate higher levels in the final concentration of the pollutants analyzed, show that even so, the results obtained, at any point of the area studied, are within the limits permitted under Brazilian legislation and international standards.

The results of the Nox modeling, considering the concurrent operation of the Macaé Merchant plant and the North Fluminense thermo-electric plant, can be seen in Figure 6.2.3-2, below.

– Classification:

Negative impact, direct effect, local scope, likely to occur, short-term, permanent, reversible, small scale, partially mitigable, with residual impact of little significance.

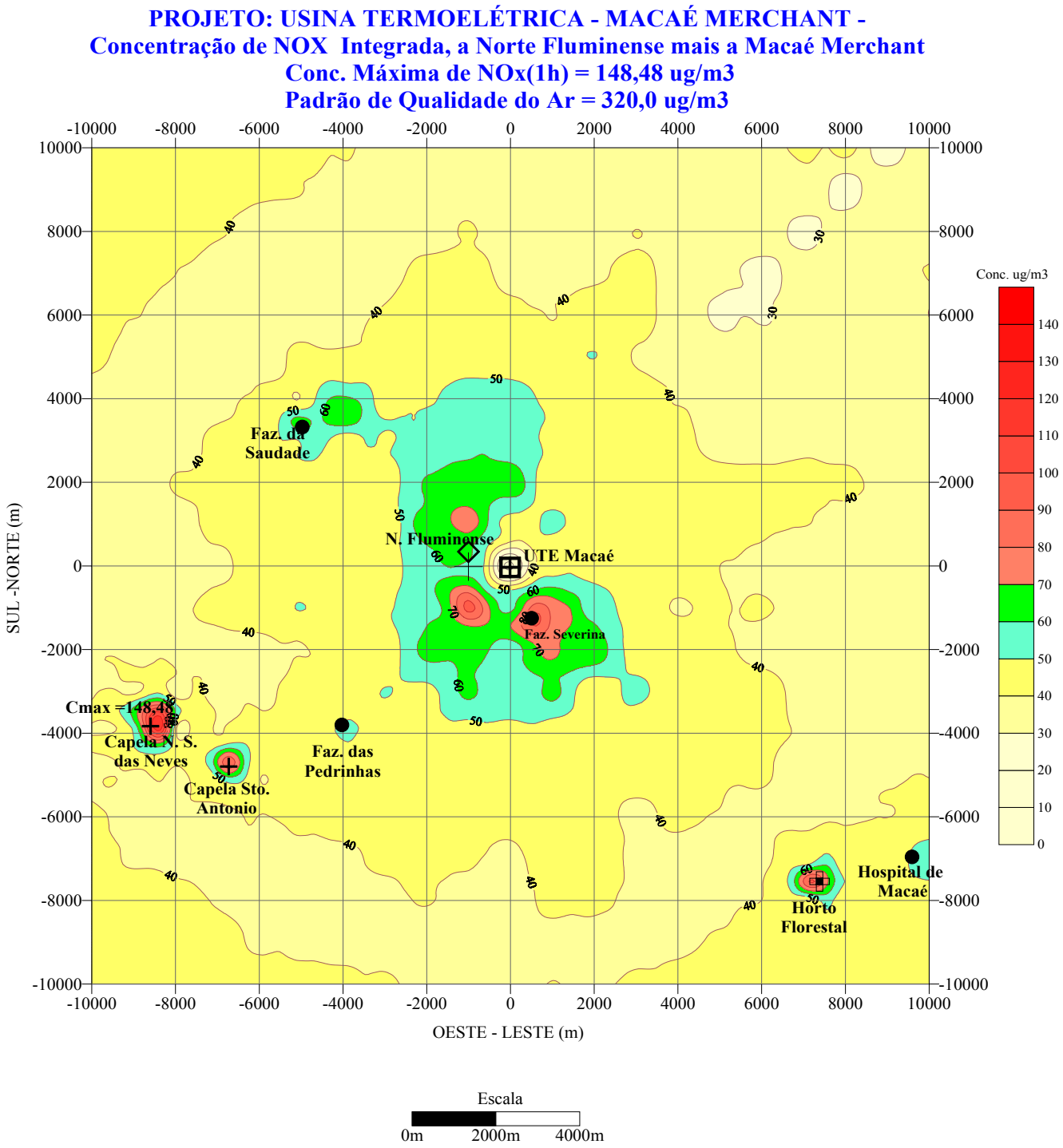


Figure 6.2.3-2 – Map of isoconcentrations (1h) of Nitrogen Oxides, NOx, resulting from the integrated emissions from the Macaé Merchant and the North Fluminense sources on the influence area.

- **Compromising of environmental quality in terms of noise pollution, due to the operation of the thermo-electric plant.**

– Description:

Noise level simulation studies were carried out, considering the Macaé Merchant plant generation with 16 turbines, each generating noise levels of 85 dB(A) at one meter from the sources of noise. The noise generation of the equipment was associated to the background noise in the region, and measured during the stage of diagnosis of the region.

The environmental noise levels in the region arising from the operation of the Macaé Merchant plant can be visualized in Figure 6.2.3-3.

Another simulation was made, incorporating in the model the turbines of the North Fluminense thermo-electric plant, located on land adjoining the Macaé Merchant plant. The association of the noise levels generated by the two projects, operating concurrently, is shown in Figure 6.2.3-4.

An analysis of the figures mentioned above will show that the noise level generated by the operation of the Macaé Merchant plant in the region to the west of the plant (where there are five houses), will be some 15 dB(A) higher than the pre-existing background noise (around 45 dB(A)). This situation is aggravated when compared with the situation with both plants in operation, resulting in a noise level of close to 70 dB(A) in this region.

The change in noise levels expected on the site of the project and in the immediate surroundings is significant, and it could be claimed that a receiver located outside the area of the PLANT, in the surrounded areas mapped, could be inconvenienced by the noise generated by operation of the plants.

In view of the results of the modeling study, El Paso will be adding to the acoustic devices already foreseen in the selection of equipment, the planning and installation of additional protection to reduce the noise levels to the levels laid down by the federal and state legislation governing this matter.

– Classification:

Negative impact, direct effect, local scope, immediate, permanent, reversible, mitigable, average significance and scale.

PROJECT: MACAÉ MERCHANT THERMO-ELECTRIC PLANT
ANALYSIS OF NOISE LEVELS

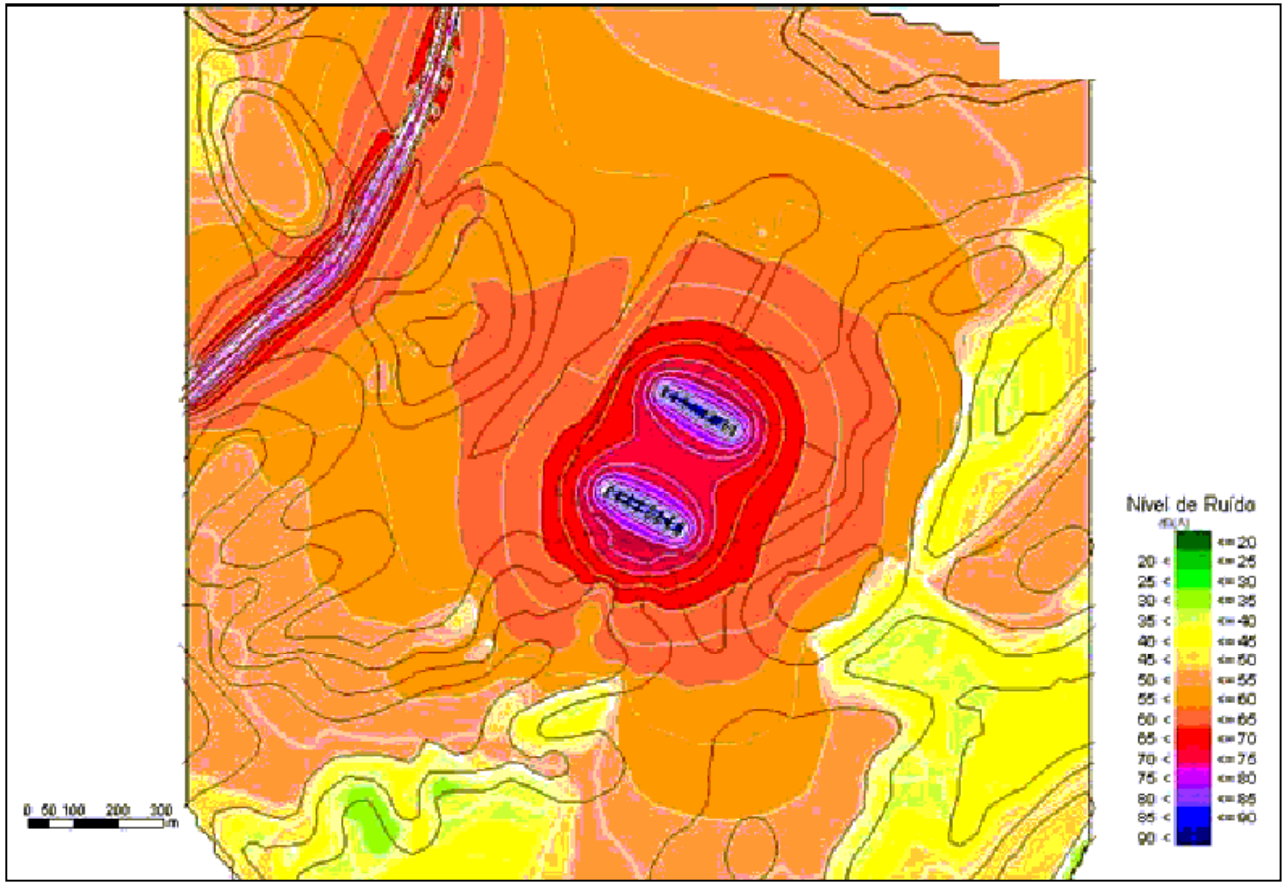


FIGURE 6.2.3-3 – NOISE LEVELS, CONSIDERING THE OPERATION OF THE MACAÉ MERCHANT PLANT TOGETHER WITH THE NOISE OF THE BR-101 HIGHWAY

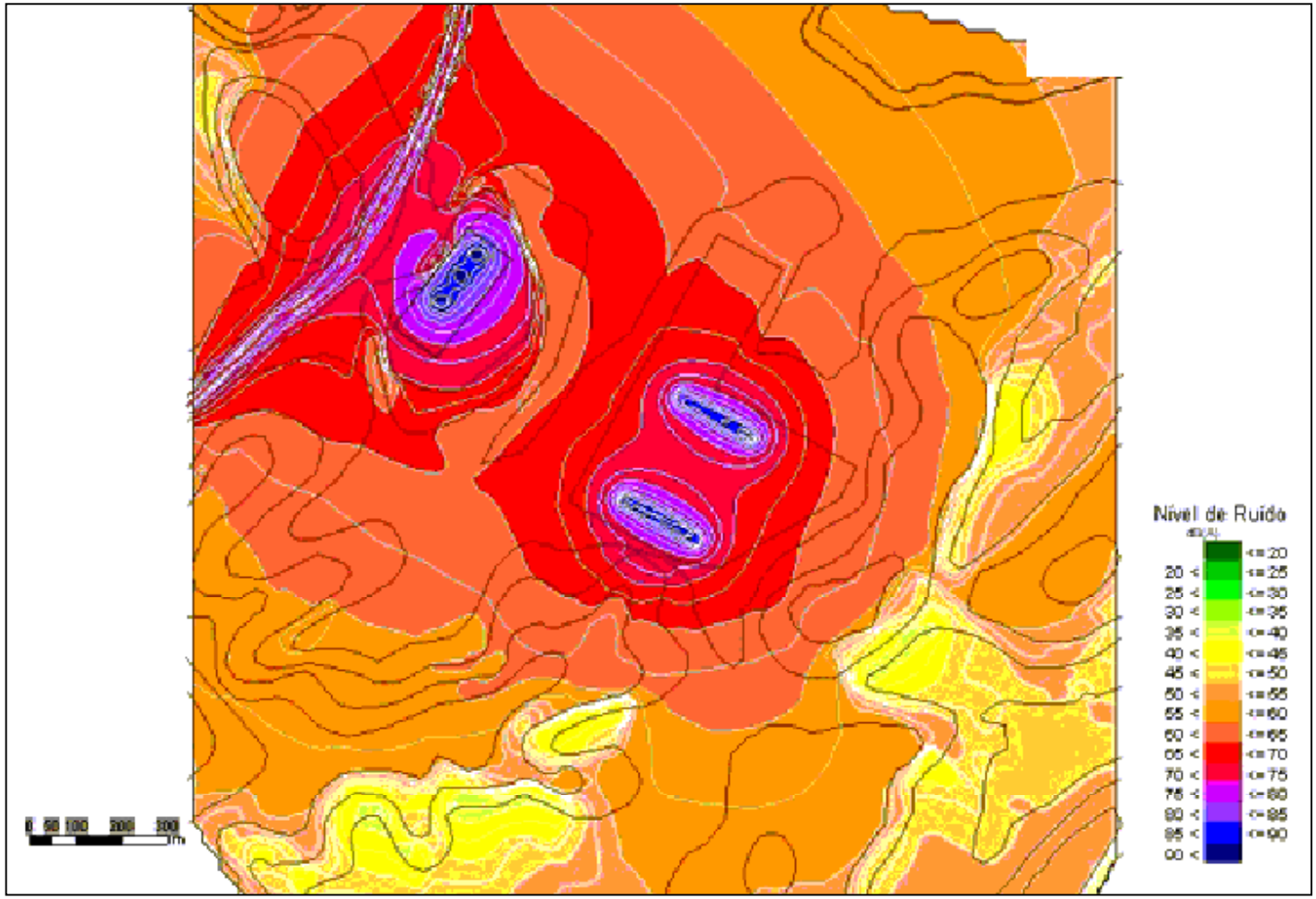


FIGURE 6.2.3-4. – NOISE LEVELS, CONSIDERING THE OPERATION OF THE MACAÉ MERCHANT PLANT (16 TURBINES) AND THE NORTH FLUMINENSE THERMO-ELECTRIC PLANT (3 TURBINES) TOGETHER WITH THE NOISE OF THE BR-101 HIGHWAY

- **Reduction in the available water in the Macaé River, downstream from site of the impounding as a result of water intake.**

– Description:

There are known to be users of water resources in the Macaé River basin, such as CEDAE, which draws off 600 l/s of water to supply the public in Macaé, Rio das Ostras and Barra de São João, downstream from the site chosen for implementation of the plant.

However, the scale of the planned water intake (86 l/s) to supply the Macaé Merchant plant has little effect on the availability of water downstream. The water intake represents around 1.7% of the minimum local availability, considering the minimum flow noted at Severina ($Q_{7,10}$ - 4,87m^3/s). It should also be born in mind that some 14% of the water taken out is returned to the Macaé River after due treatment. Accordingly, the water intake for the plant in this region should not have a significant effect on the availability of water in the Macaé River.

– Classification:

Negative impact, direct effect, local scope, long-term, permanent, reversible, unmitigable and small scale.

- **Variation in the water quality downstream of the point at which effluents from the Macaé Merchant plant are discharged**

– Description:

The water will be taken from the Macaé River and the effluents will be discharged into the same river, upstream from the water intake, as recommended in the State Constitution of Rio de Janeiro (art. 261, paragraph 4).

The discharge of effluents anticipated for the plant is equivalent to 12 l/s (consumption index of 86%), meaning that of the amount taken in, 86% of the volume is used or lost in the process, and does not return directly to the bodies of water.

Also, as the minimum flow of the Macaé River ($Q_{7,10}$) is considered to be 4.87 m^3/s, the effluents discharged into the water correspond to around 0.2% of its flow.

The implementation of an effluents treatment system, together with the operation of the thermo-electric plant and monitoring of the quality of the discharge, will mean that the final plant effluent that will return to the Macaé River will comply with the criteria laid down by the environmental legislation in force. The waste returned to the Macaé river might alter to an insignificant degree the water quality of this stretch of the river.

– Classification:

Negative impact, direct effect, local scope, short-term, permanent, reversible, mitigable, of little significance and low scale.

- **Alteration of the quality of surface waters by maintenance work on the gas pipeline**

– Description:

As at the implementation stage, the performance of maintenance work on crossings and the right of way of the gas pipeline may affect the quality of surface waters through the increase in particles in suspension. However, this will occur infrequently.

– Classification:

Direct impact, negative, local, medium and long-term, temporary, reversible, small scale, partially mitigable and of little significance.

- **Generation and Disposal of Solid Waste arising from Operation of the Macaé Merchant plant Water Treatment Station**

The Macaé Merchant plant Water Treatment Station is scheduled to operate in treating up to 308 m^3/h of water for refrigeration of the system and other uses. The operation of a water treatment station (ETA) generates solid residues, known as station sludge, classified by the ABNT as Class II waste (non-inert residues), which must be adequately disposed of in licensed Class II dumps. Around 3 m^3/day of residues will be generated by the water treatment.

Adequate disposal of this waste will avoid the effects of contamination of water and land (normally associated with the inadequate disposal of the residues), that would be caused to the region if previously accepted practices, such as the return to the river of these solids, were to be adopted.

– Classification:

Impact direct, negative, local, medium and long-term, permanent, irreversible, average scale, mitigable and of average significance.

6.2.3.2 Biotic environment

- **Impacts on vegetation of the emission of atmospheric pollutants**

– Description:

The effect of gaseous pollutants on plants depends on a number of biotic and abiotic factors. The most important are: species, and even genotypes of a species, life form, age, stage of development, stage of activity and general vigor of the plant, climatic and edaphic conditions, concentration and chemical nature of the pollutant, length of exposure and the time of day at which it occurred. In several cases, the effects of the pollutant are proportional to the multiplication of the "concentration" and "time of exposure" factors, namely, of the quantity of pollutant, although it is not always a linear relationship. The long-term influence of relatively low concentrations is the main reason for chronic injuries noted to forest ecosystems, reflecting the negative effects on the metabolic processes and the slow accumulation of toxic agents in vegetable tissues. High concentrations of pollutants, in turn, can cause acute and visible damage to the vegetation, even when exposed for a short period.

Among the most important pollutants, at present, are sulfur dioxide (SO_2), nitrogen oxides (NO_x), ozone (O_3) and peroxyacetyl nitrates (PAN).

The venture operates exclusively on natural gas. The operation of the plant generates atmospheric pollutant emissions that may contain NO_x, SO_x, CO, CO_2 and MP, among other air pollutants.

However, in view of the composition of the gas supplied by PETROBRAS in Cabiúnas, which will supply the plant, and which has low levels of H_2S, measurable concentrations of SO_2 are expected in the emissions of the plant. With regard to the other parameters, the concentrations calculated by means of studies made of the dispersion of atmospheric pollutants are well below the levels established by law to protect the flora, fauna, and health and well-being of the population, and adverse effects are consequently not expected on the flora of the AID.

The fact that the Macaé Merchant plant is located in an area predominantly made up of fields and pastures, and moderately distant from the patches of Atlantic Rainforest in the region, should also be taken into consideration.

– Classification:

Negative impact, indirect effect, regional extent, medium term, permanent, reversible, mitigable and of little significance.

- **Impacts on Avifauna caused by emissions of atmospheric pollutants from the plant**

In addition to the indirect impacts caused to the avifauna by changes in the vegetation, the pollutants discharged into the atmosphere can also directly affect birds. Studies carried out in temperate areas of Europe show that acid rain (resulting from the contact of SO_2 and NO_x with atmospheric water vapor, forming sulfuric and nitric acid) can indirectly affect birds' eggs, thereby leading to a reduction in successful reproduction and thus to the number of specimens (Graveland et al. 1994).

In view of the low concentrations of atmospheric pollutants generated by the Macaé Merchant plant as mentioned in previous points, no adverse effects are expected on the avifauna of the AID.

– Classification:

Negative impact, indirect effect, local scope, long-term, permanent, reversible, mitigable and of reduced scale and significance.

- **Prevention of the regrowth of vegetation along the gas pipeline**

– Description:

Maintenance operations on the gas pipeline will automatically prevent the regrowth of tree vegetation on the right of way. On a stretch close to where the gas pipeline reaches the site of the plant, it crosses a fragment of woodland. However, in the case of the Macaé Merchant plant dedicated gas pipeline, this will be installed in a corridor already occupied by the water supply line and the PETROBRAS gas pipeline, thus reducing the need to create a new treeless strip in the stretch where the line crosses this remnant of vegetation.

– Classification:

Direct impact, negative, local, medium and long-term, permanent (useful life of the venture), reversible (after decommissioning), small scale, unmitigable and of little significance.

6.2.3.3 Anthropic Environment

Impacts relating to social and economic aspects are set forth below.

- **Generation of jobs by operation of the thermo-electric plant**

– Description:

Operation of the plant should absorb a total of 50 people on a permanent basis. Accordingly, due to the small proportion of direct permanent jobs, the impact from a social and demographic viewpoint at the operational stage will be limited.

– Classification:

Positive, direct and indirect effect, local scope, immediate, permanent, reversible, reduced significance and scale.

- **Boosting of the economy by energy generation**

– Description:

Firstly, it is important to consider that, in general, the implementation of the plant meets the requirement to increase power supply capacity in the light of the deficiencies of the electricity system in the Southeastern Region.

The State of Rio de Janeiro will gain in terms of flexibility and autonomy of power, stimulating new investments by the production sectors, with various social and economic effects.
In particular, as the Macaé Merchant plant will be installed in the North Fluminense region, and although it will be integrated to the interconnected S/SE/CO system, it will also be capable of having an impact on energy on a local scale. This bearing in mind the currently unfavorable situation for the North Fluminense region, the south of the State of Espírito Santo, and notably for the municipality of Macaé, in the context of the configuration of the interconnected system (only one supply source, basically imported from outside the region).

Due to its location, the implementation of the Macaé Merchant plant will therefore have a differentiated impact on power for the region in which it will be established, in the form of the introduction of differentiated energy benefits, an unusual occurrence in generation work within an interconnected system.

The most widespread impact, therefore, is the venture's potential, in economic terms, to assist in attracting new industrial, commercial and services ventures to the State. However, this may or may not occur.

– Classification:

Positive impact, indirect effect, local and regional scope, short to medium term, permanent, reversible, highly significant and large scale.

- **Restriction of land use in the right of way of the Gas pipeline and the Transmission line**

– Description:

Use of the land in the right of way should be restricted, with no buildings or any intensive use being permitted. As already emphasized, however, the dedicated gas pipeline will not require the opening up of new rights of way, as it will be installed along existing strips.

– Classification:

Negative, direct, local, immediate, permanent, reversible, partially mitigable, of reduced significance and scale.

6.2.4 DECOMMISSIONING OF THE MACAÉ MERCHANT PLANT AND THE DEDICATED GAS PIPELINE

6.2.4.1 Physical environment

- **Change in the quality of surface water.**

– Description:

Termination of maintenance of the gas pipeline area could lead to the formation de erosive processes capable of changing the quality of surface water through an increase in the quantity of particles in suspension, and silting up of the watercourses.

– Classification:

Direct impact, negative, local, long-term, temporary, reversible, small scale, totally mitigable and not significant.

6.2.4.2 Biotic environment

- **Regrowth of natural vegetation on the track.**

– Description:

On the termination of the useful life of the gas pipeline there will not longer be any reason to keep the right of way open, and the shrubby or arborous vegetation will this be able to re-establish itself automatically. The regrowth of the vegetation is a positive effect of decommissioning, and could be encouraged and speeded up by replanting the area with suitable vegetation.

It should be noted, however, that the right of way is shared with other lines, belonging to PETROBRAS, that may not be decommissioned, which would impede this impact.

– Classification:

Direct impact, positive, local, long-term, permanent, with residual impact on a small scale and of reduced significance.

- **Disturbance of the ichthyofauna.**

– Description:

Termination of maintenance of the gas pipeline area could lead to the formation de erosive processes capable of changing the quality of surface water through an increase in the quantity of particles in suspension. This could affect the ichthyofauna, although on a small scale.

– Classification:

Direct impact, negative, local, long-term, temporary, reversible, small scale, totally mitigable.

6.2.4.3 Social and economic Environment

- **Extension of the Possibilities for Use and Occupation of the Right of Way of the Gas pipeline.**

– Description:

When the gas pipeline is decommissioned, activities carried out in the right of way may continue, while others, previously restricted, may be introduced. However, heavy machinery such as tractors may not be used on the land, nor may foundations be laid for buildings.

– Classification:

Direct impact, positive, local, long-term, permanent, reversible, small scale, with residual impact of average significance.

6.3 TABLES SUMMARIZING POTENTIAL ENVIRONMENTAL IMPACTS

Tables 6.3-1 to 6.3-4 below summarize the impacts identified for the planning, implementation, operation and decommissioning stages of the venture.

(see Tables 6.3-1.a 6.3-4.pdf)

Quadro 6.3 -1 - Síntese dos Impactos Ambientais

Fase de Planejamento

Aspecto	Impacto Ambiental	Fator Potencialmente Gerador de Impacto	Natureza	Forma de Incidência	Abrangência	Prazo de Ocorrência	Temporalidade	Reversibilidade	Mitigabilidade	Magnitude	Relevância
Socioeconomia	Expectativa Social e Mobilização Comunitária - Geração de Empregos	Divulgação da Implantação da UTE	N	I	L	CP	T	R	PM	M	A
	Mobilização Comunitária - Desapropriação e Interferências com a Faixa de Servidão	Divulgação da Implantação do Gasoduto	N	I	L	CP	T	R	PM	P	B

Natureza: Positivo - P
Negativo - N

Forma de Incidência: Direto - D
Indireto - I

Abrangência: Local - L
Regional - R

Prazo de Ocorrência: Imediato - I
Curto Prazo - CP
Médio Prazo - MP
Longo Prazo - LP

Temporalidade: Temporários - T
Cíclicos - C
Permanentes - P

Reversibilidade: Reversíveis - R
Parcialmente Reversíveis - PR
Irreversíveis - I

Mitigabilidade: Mitigáveis - M
Parcialmente Mitigáveis - PM
Não Mitigáveis - NM

Magnitude: Pequena - P
Média - M
Grande - G

Grau de resolução: Baixo - B
Médio - M
Alto - A

Relevância: Alta - A
Média - M
Baixa - B

Quadro 6.3-2 - Síntese dos Impactos Ambientais

Fase de Implantação

Aspecto	Impacto Ambiental	Fator Potencialmente Gerador de Impacto	Natureza	Forma de Incidênc	Abrangência	Prazo de Ocorrênc	Temporalidade	Reversibilidade	Mitigabilidade	Magnitude	Relevância
Ruído	Comprometimento da qualidade ambiental em termos de poluição sonora	Obras de Terraplanagem e montagem de equipamentos	N	D	L	MP	T	R	M	P	B
Geomorfologia	alteração do relevo original	Obras de Terraplanagem e Escavação para Implantação do Gasoduto	N	D	L	I	P	I/R	NM	P	B
Recursos Hídricos	Alterações nos níveis de turbidez carreamento de sólidos para os ri	Obras de Terraplanagem e intervenções nas drenagens	N	D	L	I	T	R	M	P	B
Cobertura Vegetal/Fauna	Supressão ou soterramento da cobertura vegetal graminóide e indivíduos isolados	Obras de Terraplanagem	N	D	L	I	P	R	NM	P	B
	Afugentamento de povoamentos faunísticos	Emissão de ruídos	N	D	L	CP	P	I	NM	P	B
	Redução no habitat da fauna	Instalação de Infra-estrutura para obra	N	D	L	CP	P	R	PM	P	B
	Interferências nas comunidades aquáticas	Instalação de Infra-estrutura para obra e movimentação na área	N	D	L	CP	T	R	NM	M	M
	Aumento da caça	Abertura de caminhos durante obra do gasoduto	N	D	L	CP	T	R	M	P	B
	Formação de ambientes propícios ao desenvolvimento de	Acúmulo de lixo nos canteiros de obra	N	D	L	CP	T	R	M	P	B
	Intervenção na rede de drenagem ao longo do gasoduto	Implantação do Gasoduto	N	D	L	CP	T	R	PM	P	B
Sócio economia	Geração de empregos	Implantação do Empreendimento	P	D/I	L/R	CP	T	R	-	G	A
	Alteração na paisagem	Implantação do Empreendimento	N	D	L	I/CP	P	I	PM	P	B
	Estabelecimento de Faixa de Servidão para Conexão à LT existente	Conexão da UTE à LT	N	D	L	I/CP	P	I	NM	P	B
	Melhoria e Valorização de Áreas	Implantação da UTE	P	D	L	MP	P	I	-	M	M
	Geração de negócios e renda	Implantação da UTE	P	D	L/R	MP	T	R	-	M	M
	Desmobilização da Mão-de-obra	Implantação da UTE	N	D	L	MP	P	I	M	P	M
	Interferências com vias	Implantação do Gasoduto/ escavação	N	D	L	CP	P	I	M	P	B
	Aumento do Tráfego nas vias	Implantação do Gasoduto	N	D	L/R	C/MP	T	R	M	M	B

Quadro 6.3-3 - Síntese dos Impactos Ambientais

Fase de Operação

Aspecto	Impacto Ambiental	Fator Potencialmente Gerador de Impacto	Natureza	Forma de Incidência	Abrangência	Prazo de Ocorrência	Temporalidade	Reversibilidade	Mitigabilidade	Magnitude	Relevância
Qualidade do Ar	Comprometimento da qualidade do ar	Emissões atmosféricas	N	D	L	CP	P	R	PM	P	B
Ruído	Comprometimento da qualidade ambiental em termos de poluição sonora	Operação da termelétrica	N	D	L	I	P	R	M	M	M
Recursos Hídricos	Diminuição da oferta hídrica no rio Macaé	Captações hídricas	N	D	L	LP	P	R	NM	P	B
	Variação da qualidade da água a jusante do ponto de lançamento dos efluentes da UTE no rio Macaé	Retorno de vazões da ETE da usina	N	D	L	CP	P	R	M	P	B
	Alteração na qualidade da água	Manutenção do Gasoduto	N	D	L	M/LP	T	R	PM	P	B
Solos/Água	Disposição de Resíduos Sólidos	Operação da Estação de Tratamento de Água da UTE	N	D	L	M/LP	P	I	M	P	B
Vegetação/Fauna	Injúrias na cobertura vegetal	Emissão de poluentes atmosféricos	N	I	R	MP	P	R	M	P	B
	Impactos na avifauna	Emissão de poluentes atmosféricos	N	I	L	LP	P	R	M	P	B
	Impedimento de restabelecimento da vegetação	Implantação do Gasoduto	N	D	L	M/LP	P	R	NM	P	B
Sócio Economia	Geração de empregos	Operação da termelétrica (a)	P	D/I	L	I	P	R		P	B
	Dinamização da economia	Geração de energia	P	I	L/R	C/MP	P	R		G	A
	Restrição do uso do solo na faixa de servidão do gasoduto e da linha de transmissão	Operação da linha de transmissão	N	D	L	I	P	R	PM	P	B

Quadro 6.3-4 - Síntese dos Impactos Ambientais
Fase de Desativação

Aspecto	Impacto Ambiental	Fator Potencialmente Gerador de Impacto	Natureza	Forma de Incidência	Abrangência	Prazo de Ocorrência	Temporalidade	Reversibilidade	Mitigabilidade	Magnitude	Relevância
Recursos Hídricos	Alteração na qualidade das águas superficiais	Erosão na faixa de servidão - fim da manutenção	N	D	L	LP	T	R	M	P	B
Vegetação / Fauna	Recuperação da vegetação na faixa	Fim da manutenção na faixa de servidão do gasoduto	P	D	L	LP	P			P	B
	Perturbação da icitofauna	Erosão na faixa de servidão - fim da manutenção	N	D	L	LP	T	R	M	P	B
Sócioeconômico	alteração do uso e ocupação da faixa de	Desativação do Gasoduto	P	D	L	LP	P	R	M	P	M

6.4 ENVIRONMENTAL QUALITY FORECASTS FOR THE INFLUENCE AREA

6.4.1 WITHOUT THE VENTURE

Agricultural and cattle raising activity in the region is showing a trend towards moderate growth, principally in relation to the main traditional crops, and pasture.
There is no tendency towards greater dynamization or agricultural technological specialization in the region. The likely scenario is expected to be a moderate expansion of crops and pastures into wooded areas on hillsides.

6.4.2 WITH THE VENTURE

The environmental quality prognosis with the inclusion of the Macaé Merchant Thermo-electric plant indicates a dynamization of the municipal economy, and an increase in municipal revenues (tax receipts). Taking all the points mentioned above, and considering construction of the Macaé Merchant Thermo-electric plant, the overall trend is for positive changes**,** compared with the expectations in the event that construction of the project does not go ahead.

The generation of employment during construction of the venture, favoring the utilization of local labor for construction and assembly services, should have a positive impact for the municipality. In addition to these positive effects attributed to the implementation of the Macaé Merchant plant, it is to be expected that this will also produce synergetical effects of local dynamization, as it will take place concurrently with the implementation of other thermo-electric generation projects in the region.

The limited negative impacts on the physical and biotic environment resulting from the location chosen for implementation and the existing environmental conditions are also positive factors in respect of maintenance of environmental quality.

Thus one may conclude that the boosting effects are to be expected as from the construction of the project, and the percentage appreciation of positive economic values is apparently greater than the degree to which this venture, in particular, will lead to a reduction in the current local environmental quality .

7. MITIGATING MEASURES

- **Control Systems for Atmospheric Emissions (production system and dimensioning the smokestacks)**

One of the ways of reducing the emission of NO_x is to use of liquid fuel with a low nitrogen content. Another way is to modify combustion conditions in order to produce less NO_x, which is the option used in this project. The decrease in NO_x will be achieved by a system of water injection. This measure, since it constitutes a concept and technology selection aspect, is a mitigating measure incorporated into the plant design.

Another aspect of fundamental influence on environmental performance of atmospheric emissions is the size of the smokestacks, especially height and diameter, and the consequent exit speed of the gases.

The height and diameter of the Macaé Merchant Plant smokestacks were determined based on the results of an atmospheric dispersion model, based on simulations with different geometries, making it possible to verify that concentration standards at ground level were according to Brazilian legislation, regarding levels of emission accepted by the World Bank. This is therefore a mitigating measure incorporated into the concept of the project.

In this way, the procedures necessary for reducing the impacts on air quality are incorporated to the original basic design of the Macaé Merchant Plant.

7.2 IMPLEMENTATION PHASE OF THE PROJECT

This group of procedures basically deals with the supervision of various activities comprising the implementation phase of the project.

- **Labor Hiring and Demobilization Plan**

Since construction of the project will involve an expressive number of contracted workers, we suggest the adoption of a Contracting and Demobilization Plan in order to reduce the impact of concentrated mobilization of human resources, even by outsourced firms, to work on construction of the project.

This plan should clarify the economic opportunities of the project to local government, asking those with headquarters close to the project to collaborate with the contractors to recruit labor to be used in the construction phase of the project. The plan should orientate contractors to give preference to workers living in the county of Macaé.

- **Appropriate Disposal of Solid Residues**

The solid residues generated during construction of the project must be disposed of in appropriate licensed locations. The correct disposal of residues is an efficient way of reducing environments that could become breeding grounds for vectors, and also to avoid contaminating water flows.

- **Appropriate Disposal of Sewage**

To avoid interference of the works with the drainage system, the sewage from the work site should be disposed of in cesspits, installed at a secure distance from the water flows and supply wells.

- **Regular Maintenance of Vehicles**

All vehicles and machinery used in construction work should undergo regular maintenance, especially certifying that the necessary adjustments are made to minimize the emission of pollutant gases to the atmosphere.

- **Landscaping Design**

In order to minimize the impacts on the landscape caused by the presence of the thermoelectric plant in the rural scenery, a landscaping design (replacement of vegetation), will be drawn up and incorporated to the construction design of the plant. This project will be implemented after the end of construction.

The Landscaping Design should contemplate not only the esthetic aspect, but also the integration/harmony of the project in relation to the local landscape. This will be achieved using a vegetation barrier around the project, giving priority to the use of native regional species, with evergreen foliage, ornamental characteristics and which will attract birds and animals (floriferous and fructiferous).

- **Construction of Acoustic Barriers or Encasing the Equipment**

The Macaé Merchant Plant design already incorporates in its concept a device for isolating and reducing the individual noise level for each turbine-generator unit, capable of reducing the level of sound at a distance of 1 meter from the source to a maximum of 85 dB(A).

However, the studies and models of sound levels in the environment performed for the EIA show that in an operational situation with 16 turbines, the plant could produce sound levels 20 dB(A) above the existing background noise in places situated around the perimeter of the plant site. Since there are 5 homes near the south part of the plant site, an acoustic barrier should be designed and implemented, dimensioned in such a way as to guarantee sufficient sound dilution to avoid significantly altering the background noise which already exists near the homes.

Another alternative could be the increase of the insulation level of the equipment. The best solution will be defined when drawing up the final design of the Macaé Merchant Plant.

- **Adapting the Beginning of Gas pipeline Construction Work to Rainfall**

To avoid the impact caused by constructing the gas pipeline on the quality of the water and the soils of the region, the works should be executed preferably in the dry season. If this is not possible, special measures should be taken to control wash out of soil and action taken against erosion processes during construction.

- **Adequate Location of Work Sites**

Aiming to minimize any alteration to the forest habitats, the work sites and dumping areas should not be located in areas covered by forest vegetation, not only for the thermoelectric works, but also the gas pipeline, decreasing the impact on the vegetation cover and avoiding a reduction in habitat areas for the various species of fauna.

- **Control on Access to Forest Areas near the Gas pipeline**

Aiming to avoid an increase of hunting in the forest fragment cut by the gas pipeline, the entry of workers to these areas should be controlled and not stimulated.

- **Vegetation Replacement and Stabilization of the Gas pipeline Strip**

The reinstatement or vegetation replacement after the end of gas pipeline construction on the strips cleared for the work site along the gas pipeline alignment with native species of gramineous and other types of vegetation, according to the original profile of the area, will eliminate the impacts caused by removal of vegetation during the construction phase, and avoid the formation of erosion processes and consequent alteration of the quality of surface water.

- **Environmental Education**

Develop an environmental educational program for the workers at the work sites, to induce correct attitudes and habits towards environmental preservation, including to avoid dumping residues, such as litter and sewage anywhere. Ensure, using objective guidance, that hunting and predatory fishing is avoided, as well as the unnecessary cutting down of trees.

7.3 OPERATIONAL PHASE

The original concept of the Macaé Merchant Plant design already incorporates procedures developed to minimize the typical impacts of the operational phase in this kind of project. This constitutes mitigation incorporated to the design concept to guarantee better environmental performance during operation. This mitigation generally consists of technological aspects, the performance of which is accompanied by monitoring systems that will function throughout the entire life of the project and are described in the programs shown in Chapter 8 of this document.

The other aspects of mitigation associated with the operational phase are basically environmental administration procedures that require routine execution, presented as follows:

- **Control on the Discharge of Liquid Effluents**

The liquid effluents generated in the plant will be treated and discharged into the Macaé River, upstream from the plant intake. The quality of the effluents will be guaranteed by adequate operation of the treatment unit and controlled by monitoring, to ensure that they are in conformity with the criteria established by the State (NT-202 FEEMA) and Federal (Res. CONAMA 20/86 - art.21) legislation in effect.

- **Appropriate Storage and Handling of Materials**

The design will incorporate storage systems for liquid and solid products with adequate containment and drainage basins. Therefore routines and procedures should be established for handling these products, with adequate use of the systems.

- **Adequate Disposal of Residues**

The solid domestic residues originating from the mess hall, bathrooms and/or offices will be disposed in the Macaé landfill, transported by the company's own trucks or contracted vehicles.
Solid industrial residues that can be recycled (paper, plastic, aluminum, scrap iron) will be forwarded to companies that work with the separation and sale of recyclable material.
The water treatment plant sludge, after drying, will be temporary kept in an adequate manner according to the norms for Class II residues and sent to a company licensed by FEEMA for final disposal. All management of the residues will be carried out according to the norms and procedures established and approved by FEEMA.

- **Priority in Contracting Local Workers**

Aiming to bring welfare to the region, we suggest that part of the labor needed for the operation phase of the project be contracted in the area itself.

The execution of a training program will be arranged through agreements with local institutions, such as SESI/SENAI-Macaé, when possible giving priority to local workers.

- **Adaptation of Gas pipeline Maintenance Work to Rainfall**

To avoid the impacts caused by maintenance works on the quality of water and soil in the region, maintenance should be preferably performed during dry months, or if this is not possible, control procedures should be implemented as a priority during these works.

- **Signposting of the Gas pipeline**

Provide a clear system of signs in the gas pipeline right of way areas, including those inside properties, in such a way as to avoid damage or accidents caused by uninformed third parties, who could operate heavy equipment or excavate near the pipeline.

7.4 DEMOBILIZATION PHASE

- **Orientation to Owners about Land Use after the Gas Pipeline has been Deactivated**

The owners along the right-of-way strip will be informed as to which activities can be performed in the gas pipeline right-of-way strip after deactivation. Crops that require greater soil handling may be introduced and those already developed may be maintained in the strip after deactivation. The replacement of vegetation in the right-of-way strip after deactivation of the gas pipeline will also act to minimize the impacts on the exposed soils, which associated with heavy rains, could affect the quality of the water bodies.

7. MITIGATING MEASURES

7.1 PLANNING PHASE

Measures taken related with impacts that can be minimized through environmental planning and management of interventions are classified in this group, which should therefore be implemented based on more detailed studies of the factors affected and structured in specific projects.

- **Social Communication Campaigns**

To avoid negative social expectations, the developer should provide all information regarding the project and its relationship with the local community, including aspects regarding the hiring of labor, for the following reasons:

- Assure objective communications with the population directly affected, to explain the nature of the project and how the community will be affected. In the case of the natural gas supply line and electricity connection, it should also include information on the level of interference with rural properties owned by third parties and crossed by the rights-of-way used by PETROBRÁS and will also be used by the Macaé Merchant Plant dedicated pipeline;

- Establish agreements with the property owners, to plan actions that ensure a minimum of interference with properties, to avoid affecting the life of the residents and existing production. In cases where it is necessary to alter land use, even if only temporary for installation of a work site or right of way, cooperate with the owner or occupant of the land in order to find the best possible alternative, to avoid losses or decreases in resources. If this is not possible, the owners should be properly compensated.

- **Agreement on Land Use with Landowners along the Gas Pipeline Right-of-Way Strip**

During the gas pipeline design phase, agents in charge of agreeing conditions for the use of the right-of way strip should make agreements with landowners as to the means and restrictions on use of the land, to be observed during operation and maintenance of the gas pipeline.

8. ENVIRONMENTAL PROGRAMS

8 ENVIRONMENTAL PROGRAMS

The methodology utilized when assessing environmental impacts recognizes the necessity of establishing monitoring programs which permit expected impacts likely to be of major relevance to be monitored, as well as those intended to mitigate any subsequent impacts.

Consequently, the guidelines for programs intended to address the environmental aspects of any impacts attributable to the project appear below, even though in some cases the expected impacts are fairly insignificant:

- Social Communication Program
- Noise Levels and Emission Monitoring Program
- Atmospheric Emission Monitoring Program
- Air Quality Monitoring Program
- Water Quality and Effluent Monitoring Program
- Landscape Recovery Program
- Recovery Methods Monitoring and Supervision Program
- Regional Insertion and Environmental Compensation Program

Details of the environmental programs will be submitted to the environmental agencies following preparation of the Basic Environmental Project. A comprehensive report containing all data obtained during the environmental monitoring programs will be submitted to FEEMA on a twice-yearly basis.

8.1 SOCIAL COMMUNICATION PROGRAM

The social communication program is intended to provide adequate answers to questions put forward by the population as a whole and both private and public agencies, whether directly or indirectly involved, on the significance of the project and its impacts.

Its basic guidelines should include the establishment of a channel of communication with the representatives of the local community and the preparation and distribution of informative material for the pre-implementation phase for the local population and the press, amongst other initiatives. This program should begin immediately in order to avoid the impacts expected during the planning and construction phases.

8.2 NOISE LEVELS AND EMISSION MONITORING PROGRAM

The following noise level measurements should be obtained during the operation for two main reasons:

- to ensure that noise emissions comply with federal and state legislation, remaining below 85 dB(A) at 1 meter's distance from the noise source. This can be treated as an environmental performance monitoring exercise; and
- to ensure that noise levels at the facility's limits comply with federal regulations.

These measurements should be obtained annually using noise measurement instrumentation both during the day and at night.

8.3 ATMOSPHERIC EMISSIONS MONITORING PROGRAM

Measurements of NO_x, O_2 and CO emissions should be obtained at the chimneys for the purpose of monitoring environmental performance and the combustion process itself. The continuous measurement of atmospheric pollutant emission levels and the periodic submission of the results obtained will ensure compliance with both the facility's corporate environmental management system and FEEMA's self-monitoring system. This program should begin in conjunction with the start of electricity generating tests and should continue throughout the facility's useful working life.

8.4 AIR QUALITY MONITORING PROGRAM

Although the region's air quality and atmospheric dispersion conditions are considered to be good, no systemic air quality measurements for the area exist to illustrate the situation prior to the implementation of industrial projects or subsidize the monitoring of their long-term effects upon the environment. It is therefore intended to implement the air quality monitoring program within the area influenced by the plant in order to study and classify air quality before and during its operation.

Air quality parameters should be monitored regularly, considering readings obtained from two sampling stations situated at locations yet to be defined and based upon an aerial dispersion model. Four three-monthly campaigns should be conducted, with each campaign running for a period of ten days.

A background campaign should be conducted prior to the start of the project's implementation to establish a reference basis for the future assessment of monitoring results.
Having considered the emissions of a thermoelectric facility, as well as the air quality standards required by current Brazilian legislation, it is suggested that the following parameters be monitored:

- NO_x;
- SO_x;
- O_3;
- MP.

8.5 WATER QUALITY AND EFFLUENT MONITORING PROGRAM

The Water Quality and Effluent Monitoring Program is justified by the need to monitor effluents to ensure that they comply with existing legal standards. This can be achieved by checking their performance in terms of alterations in water quality at effluent discharge points.

As no water quality monitoring program currently exists for the Macaé River, this program could also provide medium-term support for the regional environmental management system associated with the Macaé River basin.

Sampling campaigns on the Macaé River will be conducted from two stations, one upstream and one downstream from the facility's effluent discharge point. These campaigns will be conducted during periods of both flood and drought. Quality parameters will be determined and measurements obtained at the two monitoring stations in order to also determine the Macaé's rate of flow.

Samples of the facility's effluent (obtained from the demineralization system, sanitary system, refrigeration tower blowdown and combined liquid effluent) will also be obtained to ensure that conditions comply with the limits established by law and are compatible with the water conditions recorded upstream of the discharge point.

Initially the following parameters should be determined at the Macaé monitoring stations: turbidity, color, pH, temperature, electrical conductivity, total filterable residues, non-filterable residuals, dissolved oxygen, DBO, DQO, carbonate, chlorate, sulfate, nitrate, ammonia, nitrogen Kjeldahl, silica, total phosphate, calcium, magnesium, sodium, potassium, lead, cyanide, copper, mercury, phenols, oil, grease and fecal coliforms. The above list is strongly based upon parameters previously analyzed by the region's environmental agency, with the addition of relevant parameters for the operational control of brute water for use in the plant.

Adjustments may be made to the above list during the course of the program whenever the parameters measured fail to show any significant change and remain within the limits established by CONAMA Resolution 20/86 for Class 2 waters.

In the case of effluent samples the parameters listed in article 21 of CONAMA Resolution No. 20/86 and FEEMA NT-202 which interface with the predominant characteristics of the body of water and with the use and treatment to which the plant's water is subjected will be analyzed. The parameters which will be analyzed are: pH, temperature, sedimentary materials, OD, DBO, DQO, conductivity, ammonia, phosphorus, oil, grease, phenols, cyanide, copper, mercury and lead. Effluent discharge should be monitored constantly.

Details of the water quality and effluent monitoring program will be submitted with the Basic Environmental Project.

8.6 LANDSCAPE RECOVERY PROGRAM

Grading operations prior to implementation of the thermoelectric facility and the actual implementation of an industrial unit in a rural area has an impact upon the landscape. It is intended to implement a landscape recovery program for the area occupied by the Macaé Merchant Thermoelectric Facility to protect the soil and assist in the recovery of the local environs.

Furthermore, the implementation of a landscaping project represents an improvement in environmental quality in relation to the vegetation which exists in the area today whilst also incrementing the intervention area's ecological equilibrium.

The following guidelines will be adopted for this project:

- Preservation of the remaining pockets of vegetation in the project's direct intervention area;
- Execution of planting programs in any area not occupied by buildings or required for access, parking, etc.;
- Use of native species of regional flora, especially those attractive to local fauna;
- Planting of hedges with the objective of improving the visual aspect, concealing the installations and reducing noise pollution (acoustic barrier);
- Constant maintenance of species planted after the project's implementation.

The project will be detailed in conjunction with the plant construction project.

8.7 REHABILITATION METHODS MONITORING AND SUPERVISION PROGRAM

This program is intended to monitor and supervise recovery initiatives in areas degraded by construction operations, thus ensuring the success of the measures implemented. These measures encompass the following situations:

- planting initiatives to recover areas degraded by construction work such as: loan areas, dumping grounds, building sites, provisional access routes, etc.;
- compensatory re-vegetation measures (concentration or richening) along the right-of-way and in permanent preservation areas.

A monitoring process will be introduced once the soil and vegetation recovery measures have been implemented. This monitoring will concentrate on the efficiency of the physical, re-vegetation and soil recovery measures adopted. The areas will be monitored throughout the project's implementation.

8.8 REGIONAL INSERTION AND ENVIRONMENTAL COMPENSATION PROGRAM

El Paso will enter into agreements with the environmental authorities involved and the local affected communities for the purpose of identifying environmental compensation or regional insertion lines of public interest pertinent to the project throughout the preparation of its Basic Environmental Plan.

9. CONCLUSION

9 CONCLUSIONS

This EIA sought to emphasize the environmental aspects involved in the implementation and operation of the Macaé Merchant Thermoelectric Plant as well as assessing this natural gas-powered thermoelectric generating project's environmental suitability, particularly at this moment in time when both the country's and the North Fluminense Region's need for new electricity generating sources have become paramount.

Some of the most important points identified by the team responsible for preparing the EIA in relation to the domestic energy situation, technology and local proposals concerning the Macaé Merchant project are presented below, in topical form:

- Hydraulic generation accounts for more than 90% of the country's energy capacity. Given the location of the major hydroelectric installations, far from consumer centers, it could be argued that while on the one hand they provide cheap energy, on the other they are heavily dependent upon hydraulic resources and a costly energy transportation system;
- The consumption of electrical energy has grown quicker than the economy and current generating capacity is very close to current demand, a situation which indicates the need for new generating sources in the immediate future;
- Having analyzed the options available, the government decided that natural gas powered thermoelectric generating operations using large thermoelectric plants located near to the points of greatest demand would be the best solution in terms of time, cost and environmental viability;
- The vast domestic natural gas reserves and the recent operational launch of the Brazil-Bolivia Gas Pipeline guarantee the supply of this fuel source for the thermoelectric plants, which should be implemented throughout the country in the near future;
- Natural gas is a fossil fuel that is widely used throughout the world (corresponding to 23% of the world's energy), due to its: (a) technical characteristics and high calorific power; (b) vast worldwide reserves; (c) low pollutant content (i.e – sulfur compounds, material in particle form, no-methane hydrocarbons); and (d) ability to be transported and used in safety;
- Rio de Janeiro produces natural gas in the Campos Basin and is a large electrical energy importer, thus making it a strong candidate to play host to the new natural gas powered thermoelectric generating plants;
- Having analyzed various alternative locations and generating capacities, the Macaé Merchant project decided to implement a 700 MW facility at Severina in the municipality of Macaé. A site of some 100 hectares was acquired for this purpose, consisting almost entirely of grazing land. The land acquired adjoins the site soon to be occupied by the Norte Fluminense Thermoelectric Plant, currently at the environmental licensing stage;
- The chosen area lies some 700 meter from the BR-101 highway and 1000 meters from the Macaé River, the water course to be used to supply the plant. The energy generated by the Macaé Merchant plant will be dispatched using the connection to the

FURNAS 345 kV transmission line which passes approximately 300 meters from the site's boundary;

- The natural gas will be supplied by PETROBRÁS using a dedicated pipeline some 20 kilometers in length, running from the Cabiúnas Station. At one point, the gas pipeline to be laid for the purpose of supplying the Macaé Merchant plant will use the right-of-way occupied by existing PETROBRÁS pipelines. At another point, it will occupy the right-of-way utilized by the PETROBRÁS pipeline carrying water between the Macaé River and Cabiúnas Station. Therefore there will be no interference with land or properties along the route;
- The Macaé Merchant facility will operate on a standard cycle utilizing 16 gas turbines;
- The Macaé Merchant gas turbines individually generate noise levels of 85 dB(A) at one meter from source. Generated noise level simulations involving the operation of all 16 gas turbines, in association with the operation of 3 of the neighboring Norte Fluminense's turbines showed that environmental noise levels could rise by up to 20 dB(A) over the pre-existing background noise (approx. 45 dB(A)) in the region to the west of the facility (where 5 homesteads currently exist). These expected alterations to noise levels on the project site and its immediate environs are quite significant, as a receiver located outside the plant's confines but within the mapped area would feel discomfort from the noise produced by the two plants. In view of this fact, El Paso is adopting all the measures necessary to reduce final noise levels to standards acceptable under the applicable legislation.
- The turbines are fitted with a water injection system for the purpose of reducing NO_X in emission gases, which when associated with the properties of natural gas can ensure that the system produces low levels of pollutant atmospheric emissions;
- The chosen location's air quality and atmospheric pollutant dispersion capacity indicate that the area is capable of coping with the plant's emissions and its joint operation with the Norte Fluminense plant in such a way that any resulting changes in air quality will be insufficient to cause any damage to the local community, flora or fauna;
- Macaé Merchant will use a closed cooling system, supplied by water drawn from the Macaé River, whose water quality and quantity is suitable to address all the plant's requirements without adversely affecting consumers downstream;
- The measures incorporated into the project such as: emission controls, effluent treatment, adequate disposition of residues, noise control, etc, are sufficient to adequately counter the project's environmental impact;
- From a socioeconomic viewpoint, the project will only create positive impacts associated with the creation of new direct and indirect job opportunities, a significant increase in tax revenue for the municipality and the possibility of attracting further new ventures;
- The monitoring measures proposed in this study are adequate to identify any undesirable environmental changes caused by the project;
- The risk analysis studies showed that social risk levels fall within internationally accepted standards and those established by FEEMA.

The technical team responsible for preparing this Environmental Impact Report is therefore of the opinion that the project is environmentally viable. The State of Rio de Janeiro's environmental control agencies are ultimately responsible for the decision to issue the project's environmental license.

10. TECHNICAL TEAM

10 TECHNICAL TEAM

10.1 PERSONNEL

Name	Profession	Professional Certification	IBAMA Federal Technical Register
Edson Cruz de Sá	Civil Engineer	CREA-RJ - 31001/D	4111098
Cláudia P. B.de Almeida e Silva	Civil Engineer	RJ-47911/D	4111/98
Carlos R. S. Fontenelle Bizerril	Biologist	CRB-RJ 12118/02-D	3/33/1999/000076-1
Cláudia Dias da Silva	Chemist	CRQ-03211-326	3/33/1999/000234-9
Claudia Magalhães Vieira	Biologist	CRB n. 12620702	02022-007784/0037
Dayse Maria Pereira Simplicio	Chemical Engineer	CREA/RJ 95-1-21123-5	3/33/1999/000264-0
Ernesto Getulio M. Vieira	Geographer		3/33/1999/000090-7
Jane Cortes Tavares	Civil Engineer	CREA-RJ 43.195-D	02022.007844/00-87
Renato Balesteros Pineschi	Biologist	CRB-RJ 07275/2	3/33/2000/000296-1
Sílvio de Oliveira	Environmental Meteorologist	CREA/SP 94.850 / D	02027/003561/00-61
Virginia Martins Machado	Civil Engineer	CREA-RJ 52-720/D	NR – 3/33/2000/000054-3

10.2 POSITIONS HELD

Name	Position Held	Signature
Edson Cruz de Sá	General Coordinator	
Cláudia P. B.de Almeida e Silva	General Coordinator	
Carlos R. S. Fontenelle Bizerril	Biotic Studies	
Cláudia Dias da Silva	Water Quality	
Claudia Magalhães Vieira	Biotic Studies	
Dayse Maria Pereira Simplicio	Risk Analysis	
Ernesto Getulio M. Vieira	Geology and Geomorphology	
Jane Cortes Tavares	Water Resources	
Renato Balesteros Pineschi	Vegetation Cover	
Sílvio de Oliveira	Environmental Meteorologist	
Virginia Martins Machado	Socioeconomics	

10.3 TECHNICAL TEAM – PROFESSIONAL BACKGROUND

CLÁUDIA PROVENZANO BARROS DE ALMEIDA E SILVA

Civil Engineering graduate: Rio de Janeiro State University – 1978; M.Sc. in Environmental Impact Assessment at the University of Wales (UK) 1991/1992. Fellow of the International Research and Major Project Management Center, Montreal, Canada.

Professional experience includes three years as Assistant Engineering Superintendent during construction of Baghdad- Al-Qaim – Akashat Railroad in Iraq and a further ten with Geotécnica S.A., as Operations and Environmental Superintendent. During this period she was responsible for the management of many engineering and environmental studies and projects, such as: engineering projects and environmental studies on the Brígida irrigation project, in the State of Pernambuco; similar activities on the Brumado project in the State of Bahia; technical coordination of the environmental management components of IBAMA's Institutional Strengthening Program; environmental assessment of the Jequitinhonha and Pardo Rivers Water Resource Management Plan and the Environmental and Indigenous Communities Protection Plan for Areas affected by the National Rural Routes Program in Paraguay.

Since her appointment as a director with ECOLOGUS in 1995, she has been responsible for coordinating environmental studies and the institutional development of public organizations (including environmental authorities and the energy and water sectors), in addition to regional and environmental development plans. She has also coordinated projects such as: environmental sensitivity and licensing studies in the Campos Basin on behalf of various oil companies and the Norte Fluminense Thermoelectric Facility's Environmental Impact Study and Report, in connection with oil and telecommunications projects; the environmental component of the Bay of Sepetiba Basin's Management and Sanitation Macro Plan and the Sustainable Development Plan for the Area affected by the BR-174 highway, as well as Regional Environmental Assessment Studies and Directives for the Integrated Planning of the Fortaleza Metropolitan Region's Hydrographic Basins.

EDSON CRUZ DE SÁ

Civil Engineer specialized in Hydraulics and Sanitation. Graduated from Rio de Janeiro Federal University's National Engineering College in 1974. Experience includes acting as general coordinator or technical superintendent on countless plans, projects and studies involving Regional Development, Water Resources and Environmental Sanitation, such as: Jequitinhonha and Pardo Valleys Water Resource Management Plan; the Curitiba Metropolitan Region's Water, Drainage and Environmental Sanitation Management Plans, involving the 14 metropolitan municipalities, for the purpose of implementing the Alto Iguaçú Integrated Management System; Northeast Region Valley

Hierarchy Study for the Development of Private Irrigation; Jequitaí River Irrigation Project; the Sepetibal Bay Basin Management and Sanitation Macro Plan, involving twelve municipalities within the State of Rio de Janeiro, Environmental Impact Study and Report on the Norte Fluminense Thermoelectric Facility's Gas Feeder Pipeline; and the Water Resources Development Plan for the Mearim River Basin and its Tributaries. Also distinguished himself as Coordinator, in Mozambique, of the regional development of hydro-agricultural, agro-industrial and infrastructure projects involving the necessity for extensive generation of primary data and complex logistical conditions for the Brazilian team on the ground.

As an Ecologus director, he is responsible for the company's environmental engineering division. His duties include: coordinating preparation of various projects; regional planning and environmental management, particularly those components relating to water supply and sanitation infrastructure, such as: Sepetiba Basin Environmental Management and Sanitation Macro Plan; studies on the use of water resources on the São Francisco River; Sustainable Environmental Development Plan for Areas affected by the BR-174 highway in Roraíma and the Environmental Impact Study on the implementation of the Coroa Grande Multimode Terminal. Also responsible for providing technical support to developers in their dealings with the environmental authorities during the environmental licensing process related with implementation of offshore oil and hydroelectric generating activities.

CARLOS ROBERTO SILVEIRA FONTENELLE BIZERRIL

Biological Sciences graduate: Santa Ursula University, holder of a masters in Biological Sciences (Zoology), having completed a post-graduate course with the Rio de Janeiro National Museum/UFRJ. Currently engaged on Post-Graduate doctorate studies in physical geography at the Federal University of Rio de Janeiro (UFRJ).

Acts as consultant to various public and private companies, particularly in matters relating to:

- Environmental impact studies on marine and estuarine ichthyofauna in the Campos Basin;
- Ichthyofauna inventory and management plan for the Paraiba do Sul River basin;
- Definition of priority areas for the monitoring of aquatic and terrestrial ecosystems associated with federal highways;
- Studies on existing fluvial and marshland ecosystems in the Quissamã Marshes (RJ), as part of the Quissamã Marshes Agro-Ecological Zoning Project.
- Preparation of quantitative impact assessment methodology relating to aquatic and terrestrial ecosystems for the identification and selection of suitable sites during hydrographic basin hydroelectric inventory studies.

- Environmental impact studies relating to the implementation of thermoelectric units; implementation of Petrobrás' ORLOM and ORFOZ pipeline; duplication of various sections of state and federal highways; expansion of port facilities; implementation of the Brazil-Bolivia Gas Pipeline; implementation of projects relating to the use of hydroelectric resources and implementation of the Air Cargo Terminal at Rio de Janeiro International Airport.
- Assessment of the condition of mangrove swamps on Cambembe Island, Guanabara Bay, Rio de Janeiro.
- Ichthyofauna studies relating to the drainage of the Paranapenema River within the areas affected by the Canoas I and II hydroelectric facilities (SP).
- Diagnosis of existing fauna throughout the preliminary domain of the GASBEL Gas Pipeline linking Belo Horizonte to Rio de Janeiro.
- Survey of flora and ichthyofauna on the section of the Cubatão River (Santa Catarina) between the Cubatão Hydroelectric Plant's dam and powerhouse.
- Preparation of management plan for the exploration of sand deposits adjacent to the Tavares River's mangrove swamps and the monitoring of subsequent physical, chemical and biotic analyses; monitoring of ichthyofauna in the Doce River (Minas Gerais) in areas affected by CENIBRA S.A. activities.
- Monitoring of ichthyofauna in the region affected by the activities at the Angra I Nuclear Plant, Rio de Janeiro.

Many of his works have been presented at national and international congresses and many of his articles featured in scientific publications.

CLÁUDIA DIAS DA SILVA

Senior chemist and holder of a Master's degree in her specialist field of Environmental Science and Technology at the International Institute for Hydraulic and Environmental Engineering, Holland and post-graduate in Environmental and Sanitary Engineering at UERJ (Rio de Janeiro State University). Has more than ten years experience with various companies in the preparation of various Environmental Studies, of which the following are particularly relevant: Project Environmental Impact Assessments; Environmental Restoration and Degradation Control Programs, as well as preparation of Environmental Impact Assessments and Reports for environmental quality monitoring programs and the assessment of basic sanitation projects. The following projects are particularly worthy of mention:

At Ecologus Engenharia Consultiva:

- Water quality studies relating to the Sustainable Environmental Development Plan for the Area Affected by the BR-174 highway, in the State of Roraíma which involved: survey of secondary data in cooperation with local and regional

institutions; field inspections and preparation of a cause and effect report on contamination of a domestic or agricultural origin; assessment of the pollution potential represented by the increase in traffic volume, particularly when involving the transportation of toxic loads. 06/98 to 09/98

- Participation in the environmental diagnosis of the coastal environs of the Fortaleza metropolitan region, emphasizing the classification of pollution factors associated with port and industrial activities within the Pecém complex, in view of the proposed increase of both rail and highway transportation of raw materials to the industrial complex. 09/98 to 12/98
- Preparation of studies and water quality model for the Sepetiba Bay Basin Environmental Sanitation and Management Macro Plan.
- Coordination of Environmental Impact Study on the Indigenous Communities and Environmental Protection Study in the area affected by the Santo Corpus, San Pedro-Gral, Aquino, Villarrica and San José projects forming part of the Paraguayan Ministry of Works' National Rural Routes Program. Paraguay, 1995.

Participation in the preparation of the RioGEn, Eletrobolt and Norte Fluminense Thermoelectric Plant Environmental Impact Studies/Environmental Impact Reports.

CLÁUDIA MAGALHÃES VIEIRA

Biologist / Botanist with a Bachelor's Degree in Ecology from the Federal University of Rio de Janeiro's (UFRJ) Biological Sciences Faculty. Has professional experience in the following activities:

- Scientific consultancy and assessorial activities on conservation projects, floristic and/or phytosociological surveys on natural or degraded areas, reforestation, environmental management plans, environmental Impact studies / environmental impact reports and other associated areas;
- Liaison with both public institutions and private companies, providing scientific botanic support on matters of a phytological, chemical, pharmaceutical or agricultural nature, amongst others;
- Technical-scientific assessorial services to private companies specializing in bromeliads, orchids and other ornamental plants;
- Executor of the Floristic and Phytological Project / Atlantic Rainforest Program for the Rio de Janeiro Botanical Gardens / Brazilian Environmental Study and Research;
- Botanical consultancy services during the survey of flora at Fazenda Ouro Verde, Nova Friburgo, Macaé da Cima, RJ;
- Biological consultancy services to Carvalho Hosken S.A. in partnership with Luiz Carlos Gurken to identify species of vegetation and prepare the report entitled "RIO 2 – Ecological Adaptation Plan ".

- Participation in the PHC Pirapetinga Environmental Impact Study, in Bom Jesus do Itabapoana, RJ – Physiognomic classification of vegetation and the collection, identification and listing of vegetable species. Period: 1999.
- Participation in the BR-101 highway extension program's Environmental Impact Study in Santa Catarina – identification and listing of vascular plants. Period: 1999.
- Participation in the Environmental Impact Studies on various projects, including: Araucária Thermoelectric Plant, in Curitiba, Paraná – Identification and listing of vascular plants (1999); extension operations at Porto do Forno, in Arraial do Cabo, RJ – Physiognomic and floristic classification (April and May 2000); gas pipeline installation operations at Macaé, RJ. Period (April 2000); Rio das Antas Hydroelectric Plant, RS – Physiognomic and floristic classification (July and August 2000); Castro Alves, 14 de Julho and Monte Claro Hydroelectric Plants, Rio das Antas, RS – Physiognomic and floristic classification. Period: July and August 2000.

Many of her scientific research papers have been presented at national and international congresses and many of her articles featured in scientific publications.

DAYSE MARIA PEREIRA SIMPLICIO

Graduated in 1987, with a degree in Chemical Engineering from the Federal University of Rio de Janeiro (UFRJ) – Specialized in Occupational Safety (CEFET), Sanitary and Environmental Engineering at Rio de Janeiro State University (UERJ).
A director with EIDOS do Brasil, she has been involved in the preparation of a wide range of projects for various clients, involving: Risk Analysis, Emergency Action Plans and Risk Management Plans for thermoelectric plants, offshore drilling units, gas pipelines, natural gas processing units, oil terminals and the transportation and storage of chemical products. The following projects are of particular relevance: studies prepared for Petrobrás relating to the GASDUC and GASCABO gas pipelines; the Cabiúnas oil pipeline and the Campos Basin's undersea oil production pipelines. Currently engaged in the preparation of a risk study on the Corumbá-Petrobrás Thermoelectric Facility in Mato Grosso do Sul.

ERNESTO GETÚLIO MICHIELIN VIEIRA

Geographer, graduated from the Federal University of Rio Grande do Sul, in December 1981. His professional experience includes a wide range of projects relating to urban and regional planning, monitoring of natural vegetation and silviculture, soil use and occupation; environmental impact analyses on hydroelectric, transmission line, gas pipeline, highway, irrigation and drainage projects. Also involved in areas such as demography, climatology, geomorphology and soil use (urban and rural). Has extensive experience in the use of geoprocessing and remote sensor applications, from aerial photography through radar and satellite imaging, including digital image processing.

Has experience in a wide number of companies / institutions, such as: EMBRAPA – Brazilian Agricultural and Livestock Research Company (July 1996 to June 1998) as researcher / CNPq/RHAE scholarship holder (Industrial and Technological Development Category); Coletivo Interdisciplinar de Consultores Ltda as partner / project coordinator (1994/1996). Held the post of consultant with GEROE (Executive Group for the Restoration of Emergency Works; 1995); Cep/Geotécnica (1994/1995); Imagem Sensoriamento Remoto S/C Ltda (1995); United Nations Development Program (1994); Coletivo Interdisciplinar de Consultores Ltda (1993/1994); Engevix Engenharia S.A (1993); Prospec S.A. - Prospecções e Aerolevantamentos (1992/1993); CDN Consultoria e Planejamento LTDA (1988); PROJETO RONDON (1987); INPE – Space Research Institute (1986);UFRGS - Rio Grande do Sul Federal University (1981)

Many of his works have been presented at national and international congresses.

JANE CÔRTES TAVARES

Civil Engineer. Graduated from Rio de Janeiro State University's Engineering Faculty in 1978. Water Resources Post-graduate at Rio de Janeiro Federal University's Post-Graduate Engineering Program (COPPE/UFRJ) 1980/1981. In recent years has occupied the post of hydrology engineer with Companhia de Pesquisa de Recursos Minerais - CPRM – R.J.

Her professional experience in the following activities are particularly relevant::

- With ECP: Hydraulic / Sanitary Project for the Juiz de Fora (MG) Sports Complex; Project for the definition of the Saquarema (RJ) Lake System Protective Strip and Complementary Studies; Lagoa Santa (MG) Basic Sanitary Drainage System Project; Project for the Water Supply Systems for the cities of Parintins and Itacoatiara-AM.
- With Engevix: Research for the development and implementation of computational models relating to hydrology and hydraulics; hydrological and hydrodynamic studies on tidal influences upon the Tocantins River following closure of the Tucuruí Hydroelectric Plant sluice gates (PA); review of hydrological studies relating to the Apiacás and Tucuruí Hydroelectric Projects (MT); studies relating to the Rio de Janeiro Metropolitan Region's Water Supply Management Plan, involving diagnosis of existing systems in the Municipalities of Rio de Janeiro and Baixada Fluminense; Proposed Solutions for the City of Petrópolis Water Supply System (RJ) and Proposed Solutions for the Water Supplies of the other Municipalities within the Rio de Janeiro Metropolitan Region. Implementation of flow model for the Paranaíba River basin as far as the Itumbiara Hydroelectric Plant (GO); implementation of flow model for the Paraíba do Sul River basin(RJ), involving: Basic Sanitation at the Campo Belo project - Angra dos Reis - RJ.

- With Hidrologia Ltda, directly attached to CPRM: directives for preparation of Fluviometric Consistency Studies for the national hydrometeorological network - DNAEE/CPRM; monitoring and analysis of reports on hydrometric data studies prepared by CPRM's Regional Divisions; training of personnel at CPRM's Recife Division to conduct fluviometric data consistency studies; preparation and implementation of a course on Hydrometeorological – Fluviometric Techniques for mid-level technicians based at CPRM's Regional Headquarters;

RENATO BALESTEROS PINESCHI

Currently reading for his Ph.D. in animal biology at the Rio de Janeiro Federal Rural University – 1999.

Main professional –technical activities:

- avifauna survey relating to the project and assessment of possible impacts arising from implementation of the Cachoeira Porteira Hydroelectric Facility, on the Trombetas River and Foz do Bezerra Hydroelectric Facility on the Paraná River - ENGE-RIO - Engenharia e Consultoria S. A.;
- Fauna survey and diagnosis in various areas affected by the implementation of hydroelectric, thermoelectric and PCH facilities and highway construction projects on behalf of a variety of client companies.
- Preparation of basic project, liaising between sponsor/IEF/NGO, project operational administration and execution of primary data surveys necessary for the unit's management – Desengano State Park- Agreement between IEF-RJ and PRÓ-NATURA
- Instituto Biodomus
- Environmental Impact Assessment / Environmental Impact Report on the South Recôncavo Oil Pipeline -ORSUB – Survey on vertebrates within project area and assessment of possible impacts attributable to its implementation.
- Urban Tree Planting and Municipal Nursery, Monitoring and Protection of Remaining Forest Areas and a Birdseed Collection and Production System; Serrinha do Alambari and Fumaça National Parks – on behalf of the Rezende Municipal Authorities.
- Implementation and management of Scientific and Commercial Nurseries.

SILVIO DE OLIVEIRA

Meteorologist. Graduated from the Federal University of Rio de Janeiro. Obtained a Masters in Space Science (MSc) at INPE (Space Research Institute). Currently

completing Ph.D. studies in Atmospheric Science at the University of São Paulo and Specializing in Environmental Engineering at Texas A & M University; Training in Atmospheric Turbulence at Centre de Recherches em Physique de L'Environnement, D'Etudes des Telecomunications - Paris, France. Participated in various specialist courses with CETESB - Companhia de Tecnologia de Saneamento Ambiental (Environmental Sanitation Technology Company) and other national and international entities. Attended CETESB courses on climate and both air and water pollution.

Has held the post of director of Empresa SECA - Sistema de Estudos Climáticos e Ambientais S/C Ltda (Environmental and Climatic Studies S/C Ltda) 1995 to present day; manager of CETESB (SP) Environmental Quality Department (1976 – 1995) and director of the National Meteorology Institute (INMET) – Ministry of Agriculture 1986 to 1990. Lecturer at various institutes of further education and company-run courses on topics relating to the use of meteorology in pollution control and the application of atmospheric dispersion mathematical models.

Responsible for more than 100 published works, including scientific articles, study projects and both national and international technical reports relating to environmental control. Has participated in various national and international congresses and seminars.

His professional experience includes countless works relating to the assessment of air quality and meteorological conditions for a variety of companies. Recently developed air and climate quality assessment studies for the RioGen (RJ) Thermoelectric Facility's Environmental Impact Study.

VIRGINIA MARTINS MACHADO

Civil Engineer. Graduated from Pontifícia Universidade Católica do Rio de Janeiro – PUC/RJ, in 1980, with specialist and post-graduate studies in Systems Analysis (PUC/RJ), Financial Administration (FGV) and Environmental Management (UFRJ).

Worked as a programmer and systems analyst for a period of ten years in engineering firms, developing computerized systems, technical support and training for users of information technology and preparing economic-financial viability studies for concessions. During the last three years has provided technical assessorial services involving preparation and consolidation of environmental projects developed by Ecologus. Participated in the Sepetiba Bay Basin Sanitation and Environmental Management Macro Plan as assistant coordinator of socioeconomic works; on the structuring of the geo-referential database and the consolidation of reports; on the Sustainable Environmental Development Plan for the BR-174 highway, in the State of Roraíma, in the completion of reports and Plan consolidation; as technical assistant in the consolidation and review of Environmental Control Reports relating to the licensing of oil exploration and production activities and for Environmental Impact

Studies and the respective Environmental Impact Reports for the implementation of Gas-powered Thermoelectric Generating Plants.

11. BIBLIOGRAPHY

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APPENDIX 1

RISK ANALYSIS STUDY FOR THE PROJECT

APPENDIX 2

ATMOSPHERIC DISPERSION STUDY

APPENDIX 3

SPECIES OF FAUNA AND FLORA OCCURING IN THE STUDIED AREA

APPENDIX 4

MODELING OF NOISE

APPENDIX 5

REQUEST FOR LICENSE FROM SERLA

APPENDIX 6

SPECIFICATIONS OF MAIN EQUIPMENTS & SYSTEMS

APPENDIX 7

TOPOGRAPHIC OF AREA

APPENDIX 8
PLANT LAYOUT