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ENVIRONMENTAL ASSESSMENT FOR THE DOMINICAN REPUBLIC POWER SECTOR

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U.S. Agency for International Development
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February 1995

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ENVIRONMENTAL ASSESSMENT FOR THE DOMINICAN REPUBLIC POWER SECTOR

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ACRONYMS

Acronym	Definition
APHA	American Public Health Association
ASTM	American Society for Testing and Materials
BACT	Best Available Control Technology
BH	Baghouse
CAASD	Corporación de Aguas y Alcantarillado de Santo Domingo
CDE	Corporación Dominicana de Electricidad
CEM	Continuous Emissions Monitor
CFR	Code of Federal Regulations (USA)
CIBIMA	Centro de Investigación de Biología Marina
CNE	Consejo Nacional para la Energía
COENER	Comisión Nacional de Política Energética
CONATEF	Comisión Técnica Forestal
DECON	Deutsche Energie-consult Ingenieurgellschaft mbH
DIGENOR	Dirección General Normas y Sistemas de Calidad
DNP	Dirección Nacional de Parques
EA	Environmental Assessment
EIAS	Evaluación Impacto Ambiental y Social
EIS	Environmental Impact Statement
EPRI	Electric Power Research Institute
ESMAP	Energy Sector Management Assistance Programme
ESP	Electrostatic Precipitator
FEDOMASEC	Federación Dominicana de Asociaciones Ecologistas
GODR	Government of the Dominican Republic
HUD	U.S. Housing and Urban Development Agency
IDB	Inter-American Development Bank
INAPA	Instituto Nacional de Aguas Potables y Alcantarillado
INDRHI	Instituto Nacional de Recursos Hidráulicos
ISA	Instituto Superior de Agricultura
JUNTA	Asociación para el Desarrollo de San José de Ocoa, Inc.
LPG	Liquified Petroleum Gas
METALDOM	Complejo Metalúrgico Dominicano
MNHN	Museo Nacional de Historia Natural
NEPA	U.S. National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NGO	Non-Government Organization
NPDES	National Pollutant Discharge Elimination System
ONAPLAN	Oficina Nacional de Planificación
PGIR	Power Generation and Institutional Restructuring Project
PRONATURA	Fondo Integrado ProNaturaleza
RCRA	Resource Conservation and Recovery Act
SECTUR	Secretariat for Tourism
SURENA-SEA	Subsecretaría de Estado de Recursos Naturales
UNCED	United Nations Conference for Environment and Development
USAID	U. S. Agency for International Development
USEPA	U. S. Environmental Protection Agency
WB	World Bank
ZOODOM	Parque Zoológico Nacional

ABBREVIATIONS

Abbreviation	Definition
Btu	British Thermal Unit
MBtu	Million Btu
°C	Degrees Celsius
°F	Degrees Farenheit
K	Kelvin
$\mu g/m^3$	Micrograms per cubic meter
CO	Carbon Monoxide
DA	Daily Average
dBA	Decibels (Acoustic)
GWh	Gigawatt-hour
H_2S	Hydrogen Sulfide
Ldn	Day-Night/A-Weighted Sound Average
km	Kilometer
kV	Kilovolt
KW	Kilowatt
KWh	Kilowatt hour
lb	Pound
m	Meter
m/s	Meter per second
ft	Feet
ft/s	Feet per second
mg/l	Milligram per liter
mg/m^3	Milligram per cubic meter
MW	Megawatt
ng/J =	Nanogram/Joule = 0.00233 lb/million Btu
ng/m^3	Micrograms per Cubic meter
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
O_3	Ozone
PM_{10}	Particulate Matter less than 10 Microns
ppm	Parts per million
RD$	Dominican Republic Pesos
SO_2	Sulfur Dioxide
SO_X	Sulfur Oxides
toe/year	Tons oil equivalent per year
tpy	Tons per year
TSP	Total Suspended Particulates
wt% S	Percent weight of Sulfur

SUMMARY

PROJECT CONTEXT

The Consejo Nacional para la Energía (CNE) of the Dominican Republic is currently completing the Power Generation and Institutional Restructuring (PGIR) project. This project is needed to plan new power facilities economically and efficiently to serve the industrial, consumer, and tourist sectors; to site and control the operation of power plants in an environmentally responsible manner; and to provide a financially profitable basis for power generation in the Dominican Republic.

The key components of the PGIR project are the Power Sector Expansion Plan, which forecasts power demand to the year 2010 and designates potential sites for future power plant development; the Dominican Republic Energy Law (anticipated passage by the Congress in mid-1995), which provides the foundation for privatization of the power sector; and the construction of two private power plants with installed capacity of 125 MW each, to be financed by a loan of approximately $220 million guaranteed by the World Bank (WB) and the Inter-American Development Bank (IDB). The multilateral development banks require that an Environmental Assessment (EA) be prepared before loan approval can be granted.

The CNE has created the Equipo Técnico organization to serve as a bridge between the existing Corporación Dominicana de Electricidad (CDE) and the planned Superintendencia de Electricidad, the new agency which will regulate the power sector after the Energy Law is adopted. Congress is currently reviewing a proposed Environmental Law. This law provides the foundation for an environmental review system for all development projects in the country. At the present time, however, no legal mechanisms are in place for preparation, review, and approval of Environmental Impact Assessments (EIAs) in the country. Therefore, the Equipo Técnico is acting as the sponsor and approval body for the EA, together with the WB and the IDB.

PURPOSE OF THE ENVIRONMENTAL ASSESSMENT

The project on which this EA is based is the development of two new 125 MW power plants on any one of four priority locations: Boca Chica/Andrés, San Pedro de Macorís, Puerto Viejo de Azúa, and Itabo. It is assumed that the fuel source would be high sulfur coal or fuel oil. No other siting or design details are available at this stage.

This EA has three objectives:

1.) To provide sector-wide environmental guidelines and mitigation measures supporting the Power Sector Expansion Plan

2.) To identify the first steps for environmental agency strengthening in anticipation of the passage of the Energy Law and the Environmental Law

3.) To provide the necessary guidelines for environmental siting, design, and management requirements for the bid packages to be prepared for the two new plants to be financed with support from the WB/IDB

EA REQUIREMENTS

In the absence of Dominican Republic environmental assessment requirements, multilateral funding organization guidelines have been followed in this EA. The WB and the IDB have designated the EA as a Sectoral Category B and Category IV, respectively. Ordinarily, a Category IV is equivalent to a WB Category A. However, in this case, the IDB has agreed that a Category B is appropriate. Because the IDB and WB guidelines for EA preparation are similar, the IDB has agreed to have a single reference to WB guidelines in the EA.

In the absence of a completed Power Sector Expansion Plan, the EA does not contain the full evaluation of a long-range plan that is normally part of a sectoral EA scope. Instead, the intent is to incorporate the recommendations in this EA in the Power Sector Expansion Plan.

IMPLEMENTATION MECHANISMS

New institutional mechanisms will be required to implement the Energy Law and the Environmental Law, including a revision in countrywide agency charters and agency coordination procedures; institution of environmental evaluation and compliance procedures for all sectors, including the power sector; issuance of sector-specific regulations; and the setting of sector-specific standards.

CURRENT STATUS OF THE DOMINICAN REPUBLIC POWER SECTOR

The power sector of the Dominican Republic consists of fossil-fueled and hydroelectric generating facilities, a high-voltage transmission system, and a medium-voltage distribution system. The total installed capacity of the Dominican Republic is approximately 2,070 MW. The CDE controls almost 70 percent (1,425 MW) of the nationwide power generating capacity, as well as the high-voltage transmission system and medium-voltage distribution system.

Condition of the Power Sector

The EA team visited selected representative plants in March 1994. These plants represent a variety of power types (steam and gas-turbine, diesel, and hydro), fuel types, and geographic location. Reconnaissance at each plant, which consisted of visual observations and interviews with plant managers and operating personnel, confirmed the findings presented in previous studies conducted by USAID and the WB.

The reliability of the electric supply in the Dominican Republic has been steadily declining over the past decade. Blackouts and brownouts are a common occurrence. Many businesses are forced to install their own generating capabilities or suffer severe economic losses. The

low reliability of the power system can largely be attributed to inadequate or deferred maintenance and old or obsolete equipment.

USAID estimated in 1989 that based on the relationship between GDP growth and electricity generation, the interruptions of electrical service cost the Dominican economy US$218.4 million annually between 1984 and 1988. As power outages accelerated in the 1990s, it is estimated that the annual cost to the Dominican Republic economy has reached over US$500 million.

The Power Sector Expansion Plan

The primary objectives of the Dominican Republic Power Expansion Plan are to correct the power generation deficit by adding additional installed capacity and increasing the distribution efficiency by upgrading transmission lines and substations. An average demand growth of 5.1 percent per year, and retirement of the older, less efficient power plants now in operation during the period of this plan are assumed in plan preparation. New plant requirements by the year 2010 are nine new plants with a total capacity of 1,250 MW by the year 2010. The two new proposed 125 MW plants are included in this total.

ENVIRONMENTAL IMPACTS OF EXISTING FACILITIES

A representative sample of selected "worst case" power plants located throughout the Dominican Republic was evaluated. Emphasis was placed on identifying impacts in the key disciplines as follows: air quality, water quality, biology, and land use/social.

Air Quality

Maximum downwind concentrations for the existing power plants were calculated using the EPA model SCREEN 2 for a typical meteorological case, a high ventilation case, and the worst case meteorological conditions. Maximum pollutant concentrations were below the ambient standard (within acceptable levels) for all facilities except the 24-hour SO_2 standard at the Haina plant. This ambient standard would be exceeded downwind of the Haina plant under worst case stable meteorological conditions. It should be noted, however, that this condition rarely occurs in this region.

The existing operating rates of all the plants range from 20 percent of installed capacity to 75 percent. The Haina and Itabo plants are operating at a range of 40 to 50 percent of installed capacity. If all the plants in the system were to operate at 75 percent of capacity (a typical load capacity for plants in the U.S. is 80 percent), all the plants except for Haina and Falcon Ridge would be within acceptable levels for all pollutants. Haina would continue to exceed the 24-hour SO_2 standard and would also exceed the 3-hour SO_2 standard under the worst case stable meteorological conditions. This is considered to be a significant adverse impact. Falcon Ridge, which is now operating at 20 percent capacity, would emit 6,435 lbs/hr of SO_2 at 75 percent of installed capacity, which would exceed the 24-hour SO_2 standard but would not exceed the 3-hour standard. This is considered to be an adverse, but not significant, impact.

Water Quality

In the absence of data gathering and analysis or systematic documentation on the quality of power plant cooling water discharge or on relative volumes, flow rates, and sources of any liquid wastes, only a qualitative evaluation of the impacts can be made.

The general practice in the Dominican Republic is for cooling water to be discharged directly into the receiving waters. In the absence of any discharge point diffusers or cooling towers, there is most likely a significant rise in ambient water temperatures adjacent to the cooling water effluent. This plume may remain buoyant for a distance from the discharge point and remain stratified and unmixed. In calm water, the plume may remain unmixed for a considerable distance, but that distance can decrease with increased wind and currents causing turbulence and mixing.

For example, it is possible that significant thermal plumes are being created in the Iguamo River and in the ocean through discharges from the San Pedro de Macorís and Itabo plants, respectively. The cooling water effluent was observed to produce significant steaming and the air temperature at the outfall was noticeably warmer than the surrounding vicinity. The intake water temperature was 28.10°C and the discharge was 35.80°C.

According to the plant workers, the intake water temperature averages 31°C in the summer and 28° to 29°C in the winter. Cooling water discharge temperatures supposedly average 32°C throughout the year. However, it is not known if the temperatures observed and quoted are representative of other power plants in the Dominican Republic.

Solid Waste Disposal

Current ash disposal practices in the Dominican Republic power sector, as demonstrated at the Itabo disposal site, are directly impacting the natural environment by contaminating the soil and thus impacting vegetation growth cycles. Heavy metal concentrations may be leaching into the ground and surface waters, thus adversely affecting biological resources. For example, the uncontrolled drainage at the Itabo disposal site may be significantly impacting the coastline by contaminating the seawater and adversely affecting the biological resources there. The residents near the Itabo disposal site may be directly impacted as they are permitted to travel the road adjacent to the site and scavenge the site for food. They may be directly ingesting the ash.

In power plants using oil as the main fuel source, sludge is removed from on-site fuel storage tanks when the tanks are sporadically cleaned. The sludge material is placed in unmanaged, open pits or is pumped directly from the tanks into unlined underground storage pits. Asphaltic or sludge material is a mixture of heavier hydrocarbons, relatively small amounts of water, and inorganic material such as sand. The potential impacts of these current disposal practices to soil and ground surface waters depend on the quantity of sludge applied to the land and the soil type, its permeability, and attenuation capacity. Generally, many of the higher hydrocarbons present in the sludge material have a low water solubility and adhere strongly to the soil and are thus not readily mobile in it. It is possible, however, that

contaminants such as lead and vanadium leach into groundwater resources. The affected soil will not support any vegetation and surrounding vegetation may be destroyed where contaminants migrate. The affected soil will have an accumulation of metals such as chromium, copper, lead, zinc, and vanadium. At existing facilities, the large quantities of this material applied to the soil will result in larger accumulation and therefore increase migration of these contaminants to surrounding soil and groundwater and, eventually, to surface waters. For example, the unlined, open pit disposal areas at the Puerto Plata plant are located in an area with a natural slope to the sea. The site is also near residential units and a historic tourist attraction.

EXISTING REGULATORY FRAMEWORK

In the Dominican Republic, the responsibilities for environmental protection are distributed among numerous government organizations. Approximately 26 agencies or commissions are responsible for regulating environmental quality. There are no regulatory agencies for air quality or industrial waste management. Several organizations were created by Presidential Decree to study specific environmental issues. These agencies lack operating budgets and authority to regulate the resources/pollutants for which they are responsible.

No formal process currently exists for the screening, preparation, and review of EIAs for power plants or any other projects that may adversely impact the environment. In the absence of a cohesive environmental strategy, comprehensive environmental law, and environmental oversight responsibilities, power sector policies and development decisions have not incorporated environmental objectives.

There is no public involvement, and no mitigation measures are required to offset any adverse impacts. Further, since EIAs are not required for public or private projects, there is a substantial lack of data on baseline conditions for water quality, air quality, wetlands, biological resources, land uses, and other important resources.

A rational, consistent protocol for development of environmental standards and mechanisms for permitting and enforcement must be developed countrywide and for the power sector.

ENVIRONMENTAL IMPACTS OF PLANNED FACILITIES

The four locations selected for potential development of the two new power plants were identified by the Equipo Técnico as being the most feasible considering engineering criteria as well as preliminary environmental review. The impacts of developing the plants on any of the sites are described, with the proviso that site-specific EIAs to be prepared for the plants once preliminary designs are available, would present more detailed impact evaluations. At the same time, the impacts described in this EA can be generally applied to other sites in the Dominican Republic and thereby expanded, with their associated mitigation measures, for inclusion in the Expansion Plan for the Power Sector.

AIR QUALITY

Itabo

There are now two 125 MW units designed to fire coal or oil at the Itabo plant site. In order to calculate a worst case scenario of the impacts at the Itabo site, it is assumed that the existing units would be burning coal with the source sulfur content as is used at present (0.56 percent) while the two new units would be burning high sulfur oil (4.25 percent wt. sulfur). The impacts associated with two new 125 MW units at the Itabo plant site are determined by adding the emissions from the two new units to the existing facility emissions. It is also assumed that Itabo unit I (which is currently non-operational while being rehabilitated) will be in operation at the same time.

The maximum concentrations of sulfur dioxide when burning the high sulfur fuel oil would exceed the 3-hour SO_2 standard by approximately 20 percent and the 24-hour SO_2 standard by 270 percent. This is considered to be a significant adverse impact. However, if fuel with 2 percent wt. sulfur content is used in the new boilers, the ambient SO_2 standards would not be exceeded even under the worst case meteorological scenario.

San Pedro de Macorís

Emissions of sulfur dioxide from the existing plant at San Pedro de Macorís are slightly greater than the coal burning scenario for Itabo I and II plant. Therefore, if this site is selected for the two new units, the contribution of emissions from those units to the existing SO_2 concentrations would result in excess of the ambient standards. The impacts associated with developing the two units at this site, using the high sulfur fuel oil, under worst case meteorological conditions, exceed the 3-hour SO_2 standard by approximately 15 percent and the 24-hour standard by 200 percent. This impact to air quality at this site is considered to be a significant adverse impact. If a low sulfur fuel is used (less than 2 percent wt. sulfur), maximum pollutant concentrations would not exceed the ambient standards and significant impacts would be avoided.

Andrés/Boca Chica and Puerto Viejo de Azúa

The planned expansion at both of these priority sites would result in ambient air concentrations below air quality standards because there are no existing facilities at the same location that would add to these pollutant concentrations.

WATER QUALITY

The water quality impacts would be similar for all the sites, as follows:

- A significant rise may result in ambient water temperatures adjacent to the discharge of the cooling water effluent. This plume may remain buoyant for a distance from the discharge canal and remain stratified and unmixed. In calm water, the plume may

remain unmixed for a considerable distance, but that distance can decrease with increased wind and currents causing turbulence and mixing.

- The use of brackish to marine waters for cooling may lead to the fouling or clogging of supply pipelines, conduits, or tubing by the growth and eventual encrusting of marine algae and invertebrates on this equipment. A standard practice for removing this material is the use of some type of biocide such as hypochlorite or chlorine.

- Heavy metals may be leached from various sources at the facilities. Heavy metals may originate from corrosion of pipes caused by exposure to the marine water, leaching from improperly disposed fly ash, or even biocides that are copper-based.

- Surface water runoff from the sites will contribute concentrations of any of the chemicals used at the plants, as well as oils, grease, and suspended solids. Open drainage systems are likely to contribute additional sewer wastes such as waste oils, lubricants, solvents, and cleaners.

- At present the docks show evidence of oil spillage during fuel transfer operations. This is evidenced by a heavy coating of black oil residue on the dock. Any spillage goes uncollected and untreated into the surrounding waters and sediments, thereby contaminating them with various petroleum hydrocarbons.

- Coal piles completely open to the elements and not surrounded by any structures that would contain surface water runoff from the piled coal will result in dust being washed from the pile and transported to the surrounding surface waters or ocean.

- The ash disposal area is likely to be highly contaminated with various heavy metals from the ash and possibly organic compounds from the unknown waste.

- Excess water quality constituents such as temperature, pH, heavy metals, petroleum hydrocarbons, and organic compounds may result. The magnitude of these impacts will be a function of plant construction and operational methods and fuel source.

BIOLOGY

Andrés/Boca Chica

The terrestrial flora and fauna at the site are limited and disturbed. It does not appear that significant flora and fauna would be impacted by the project. The marine waters are very clear and turbidity/suspended solid levels are low. The project could significantly impact marine communities in this area if effluent streams and surface water runoff are uncontrolled.

San Pedro de Macorís

The clearance of trees and shrubs for construction would not result in an adverse impact at the site; however, there would be a loss of habitat for birds and mammals and added human

activity may disturb some sea birds such as terns. Because of the existence of numerous industries along the Iguamo River, it is likely that additional discharges from a power facility would have a cumulative adverse impact on the aquatic resources of the area.

Puerto Viejo de Azúa

The proposed site is currently undisturbed and would require extensive clearing. This may result in significant adverse impacts to birds and mammals that may reside in the scrub, shrubs, and trees. Because of the relatively undeveloped nature of the area the new facility could significantly impact the water quality of the bay by introducing anthropogenic compounds. This would adversely affect the fisheries resources.

Itabo

Because of the minimal vegetation around the site, there is not likely to be a significant adverse impact to terrestrial flora and fauna. Because of the existence of several industrial facilities, the offshore water quality is likely to already be degraded. Introduction of additional untreated effluent would have an adverse cumulative impact on marine biota.

SOLID WASTE DISPOSAL

If the power plant developed is coal-fired, coal ash would be the primary waste stream. Of the three basic types of ash, fly ash coming from electrostatic precipitators is the most likely to be created at the plant and would represent the bulk (i.e., weight) of the solid waste to be disposed. As discussed in Section 2.3, the impacts associated with unmanaged ash disposal can result in soil contamination and leaching of contaminants in toxic quantities into the ground- and surface waters, and cause serious direct and indirect impacts to the natural and human environments. Leachable quantities of lead, arsenic, barium, cadmium, chromium, mercury, silver, and selenium in potentially toxic quantities would be quite possible if ash is disposed of in unlined and unmanaged disposal sites.

If the proposed plant uses the Fuel No. 6, the primary waste stream would be a heavy asphaltic sludge material that would be removed when the storage tanks undergo cleaning. Although the exact chemical composition of this material is unavailable, it would be rich in asphaltic hydrocarbons, some of which have leachability potential in addition to potentially leachable quantities of lead and vanadium. The heavier hydrocarbons would adhere to the soil and eventually inhibit the ability of the soil to sustain vegetation.

Regardless of the fuel type used, if solid waste is not disposed of properly, extensive soil and groundwater contamination could occur, thus causing potential significant adverse impacts to human health.

LAND USE/SOCIAL

In the absence of adopted land use plans and zoning, land use impacts focus on the ability of the proposed sites to accommodate new power plants. Suitability of a site for certain land uses, such as residential, depends on many other impacts, such as noise, air emissions, solid waste disposal, and visual and historic resources.

Andrés/Boca Chica

Land use impacts of plant development on its immediate surroundings would be minimal. However, the Boca Chica area is a densely populated tourist center, for which preservation of aesthetic resources is critical. Transport of coal on major roadways would have adverse visual, traffic, dust, and noise impacts. Views of the stack from the beach would also adversely impact the recreational quality of the area. Beneficial social impacts would consist of additional employment opportunities for area residents and indirect economic benefits to merchants from additional spending.

San Pedro de Macorís

Because of the existence of a power plant on the site, the addition of a new facility would be compatible and therefore not adverse. Impacts to the adjacent residential settlement would be exacerbated however. Transport of coal would have adverse impacts similar to those described above.

Puerto Viejo de Azúa

Development in this area would not adversely impact a residential community. The plant would be compatible with the agricultural uses in the area. However, if endangered species are found on and around the site and it is designated a nature preserve, development could have adverse impacts.

Itabo

The site is part of a large heavy industry area containing much of the necessary infrastructure for power plant operation. Land uses in the surrounding area are also industrial. Therefore the facility would be compatible with existing uses. Several detached residential units nearby would be adversely affected and would have to be relocated. Beneficial impacts include new direct and indirect employment opportunities and improvements in the quality of life in the region.

MITIGATION MEASURES FOR PLANNED FACILITIES

Mitigation measures are recommended for the four priority sites selected for this EA, but they also apply to other power plant sites in the Dominican Republic. Most of the mitigations would also apply to the impacts of existing plants. These mitigation measures should serve as the basis for development of site-specific mitigations in the project-specific EIAs.

Air Quality

- The use of any fuel with 2 percent sulfur content or less would reduce the identified adverse impacts to insignificant levels.

- Maintenance procedures should be instituted to ensure that emission control equipment is functioning properly. Effective plant maintenance procedures should be established to achieve long periods of efficient operation and few outages or upsets.

- The operation of combustion control equipment of power plants should be monitored and controlled to maintain and increase the efficiency of operations, and thereby reduce the amount of pollutant emissions per KWh of electricity produced.

- Stacks in new plants should be designed to ensure that the stack height is sufficient to reduce the ground level concentrations at the downwind receptors.

Water Quality

The mitigation measures proposed to reduce impacts to water quality to insignificant levels are divided into two categories: construction and operational.

- Construction storm water runoff—surface water runoff, storm water runoff, and runoff from equipment wash-down areas should be collected into a silt trap or settling basin with an oil separator. The oils should be skimmed off and the solids allowed to settle out of suspension. The waste oils should be collected and disposed of off-site in an appropriate disposal area.

- Refueling—equipment refueling should take place off-site to minimize the possibility of fuel spills.

- Sewerage—any domestic sewage generated during construction should be collected in a portable collection system or impermeable sump and disposed of off-site.

- Start-up water—waters flushed through the new facility during start-up should be collected in a holding facility (such as a pond or sump) before discharge.

- Operational cooling water discharge—thermal plumes from the cooling water discharge can be minimized through the construction of a submerged, multiport diffuser. Other methods such as alternative heat dissipation design and methods for waste heat utilization should be considered during the plant design phase.

- Cooling water—cooling water should be monitored for pH, dissolved oxygen, and heavy metals. If concentrations are not within the guidelines the effluent should be treated to bring it within acceptable levels.

- Site drainage—surface water runoff from working and wash-down areas, chemical storage facilities, parking lots, and access lots, should drain into a single collector system and sump.

- Loading and transfer facilities—if oil is the fuel source, the entire loading and transfer area should be surrounded by oil booms in the water during unloading, augmented by absorbent material, available for deployment in the event of an oil spill.

- Ash disposal—ash resulting from a coal-burning facility should be disposed of at a designated ash disposal facility. The disposal facility should be designed to minimize surface water runoff from the site and to minimize waste leachates from entering surface or groundwater.

Biology

- Terrestrial biology—mitigation of impacts to terrestrial flora and fauna should be addressed through proper siting and design of the power plants. Vegetation and wildlife surveys should be conducted in all areas that would be affected, including the plant itself, fuel loading areas, construction staging areas, access roads, and any ancillary facilities required during construction.

- Aquatic biology—site-specific surveys should be conducted at each plant site including baseline surveys and post construction monitoring to determine the impacts at each site.

Solid Waste Disposal

The primary recommended mitigation measure for the environmentally responsible disposal of solid waste streams is to reduce them at the source by using high quality fuel or efficient fuel operating systems. Currently land disposal is the only viable option in the Dominican Republic. Land disposal should be conducted according to the best site selection and design standards as follows:

- Site selection—the site should not be near ground- and surface water resources and highly permeable soils. Sites near coastal, wetland, and mangrove areas should not be considered viable. The disposal site should be on low-lying and relatively flat land and residential settlements should be prohibited within a specified zone perimeter around the disposal site.

- Site preparation/design—if the primary waste stream is coal ash, and if there are toxic quantities of heavy metals in the ash leachate, the site should be lined. A liner consisting of a material mixture of fly ash, bottom ash, and cement compacted against the soil is an appropriate and inexpensive technique.

- Site operation—when coal ash is brought to the disposal site, the piles should be built in 6- to 12-inch layers and compacted by overriding the material with rubber tire

mobile equipment such as a roller or a front-end loader. The site should be guarded and patrolled, runoff or leakage collected on-site should be properly treated prior to disposal, and down-gradient groundwater wells should be installed and regularly monitored for contamination.

- Non-land disposal options—the industrial and commercial uses for coal ash such as asphalt pavement, concrete, blocks for buildings and structures, lightweight aggregate, structural fills for construction, and soil modification for agriculture should be explored in the Dominican Republic.

Land Use/Social

The primary mitigation to avoid or reduce adverse impacts at any future site is proper siting of the facility. The project-specific EIAs should include consideration of siting issues. The general mitigation measures listed below apply to the four sites.

Andrés/Boca Chica

To mitigate the spillage of coal ash, dust, noise, and the aesthetic impacts of plant related traffic, including the transport of waste materials such as coal ash:

- All trucks should be either enclosed or covered with a tarp to prevent spills or dispersion of ash

- Transportation corridor improvements, such as tree planting and landscaping, should be undertaken in populated residential and tourist/commercial areas.

- To mitigate the potential adverse visual impacts of stack and plume visibility to the Boca Chica area, the following should be implemented:

- Siting of the plant should reduce the view of the stack from Boca Chica Beach and the water.

- Screening devices, such as the use of paint and materials and lighting alternatives should be employed to minimize the visual intrusion of the stack.

San Pedro de Macorís

To mitigate the impacts of coal ash transportation, the mitigations recommended for Boca Chica should be implemented. Relocation of the nearby residential should be considered to mitigate land use impacts.

Puerto Viejo de Azúa

Special provisions should be made to ensure the continuation of recreational activities at the beach. If part of the area is designated as a natural preserve, the power plant and its intake and outfall canals should be sited at the appropriate distance from the preserve.

Itabo

To mitigate the impacts to nearly residential units, the residents should be relocated to an appropriate residential area.

ACTION PLAN

The action plan presents a strategy to facilitate construction of two new power plants totaling 250 MW by 1998. Because the WB and the Dominican Republic are committed to constructing these plants in keeping with the best available environmental practices, the Equipo Técnico should assume responsibility for the environmental supervision, review, and implementation steps which would normally be conducted by designated environmental agencies and dedicated branches of the CNE.

The action plan also contains recommendations for long term institutional strengthening in the Dominican Republic which should be undertaken after adoption of the new Energy Law and the Environmental Law.

Order of magnitude costs for action plan implementation apply only to short term activities for environmentally sound development of the two new power plants.

POWER SECTOR ENVIRONMENTAL COMPLIANCE PROCEDURES—INTERIM MEASURES

Interim measures include supervision and mitigation monitoring, and mitigation monitoring plan implementation.

EIA Supervision and Mitigation Monitoring

EIA supervision and mitigation monitoring includes developing of EIA guidelines, specifying EIA contents, implementing mitigation measures, involving the public, and reviewing and approving the final EIA.

EIA Guidelines

EIAs for new plants should be prepared following the WB Operational Directive (OD) 4.01 and the equivalent IDB Directive for Category A.

EIA Contents

All of the potential environmental impacts listed in this EA should be analyzed for the plant sites. The EIA would contain an evaluation of all beneficial and adverse environmental impacts likely to result from the construction and operation of the proposed power generation facility. The following is a list of some anticipated adverse impacts. The list is not comprehensive, and more precise impacts should be identified when site delineation, plant engineering parameters, design parameters, and preferred fuel source are identified.

- Air Quality
  - Short-term, localized impacts from construction activities such as grading, earth moving, and truck traffic
  - Substantial air emissions (SOx, NOx, CO, hydrocarbons, and particulate matter) from plant operation that result in the deterioration of ambient air quality, contribute to the degradation of global air quality, and substantially affect sensitive receptors
- Water Quality
  - Alteration of surface water quality including, but not limited to, temperature, dissolved oxygen, or turbidity resulting from the thermal and chemical discharges from plant outfall into surface waters
  - Substantial reduction in the amount of water otherwise available for public water supplies and use due to plant cooling and process water requirements
- Biology
  - Change in diversity of species or number of any species of marine or aquatic life resulting from the thermal and chemical discharges from plant outfall
  - Impacts to fish migratory corridors, coral reefs, fishing areas, and other aquatic biological resources from the disposal of dredge material if port dredging is necessary
  - Change in diversity of species or numbers of any species of plant life (including trees, shrubs, grass crops, and aquatic plants) resulting from plant construction and operation
- Solid Waste Disposal
  - Soil, ground water, and surface water quality contamination and potential public health hazards which pose a threat to people, animal, or plant populations in the affected area resulting from the disposal of waste streams such as coal ash or sludge material

- Land Use/Recreation
  - Inconsistency of power plant development with present or intended land uses in the affected area causing substantial alteration of the present or intended land use pattern
  - Economic and recreational opportunity losses resulting from the impact of power plant development on the viability and attractiveness of surrounding recreational resources and tourism attractions
  - Impact to surrounding land uses in the event of accident or upset including, but not limited to, fire, explosion, oil spill, or fuel spill
- Aesthetics
  - Obstruction or degradation of any scenic vista important to the recreational or tourism use in the area resulting from plant stack, smoke plume, associated waste disposal activities, or the plant itself
- Soil Erosion
  - Wind and water erosion of soils due to the construction of a power facility on a shoreline or river bank
  - Deposition erosion from plant construction and operation which may modify the river or stream channel, or the bed of the ocean, bay, or inlet
- Traffic
  - Pressure on existing road capacity including fuel and waste transportation corridors and plant access roads to accommodate additional traffic generated from plant construction and operation
- Noise
  - Increase in existing noise levels due to construction and plant operations
  - Exposure of nearby residents to severe noise levels from plant operations

Mitigation Measures

The mitigation plans contained in the EIAs should adapt the mitigation measures recommended in this EA to the new plant and site designs and the costs and schedule for their implementation should be included in the overall project cost. Mitigation measures should become covenants of the loan. This stipulation should be included in the bid request package to plant builders.

Public Involvement

Public scoping and public review of the Draft EIAs should be incorporated into the EIA preparation process.

EIA Review

The EIAs should be reviewed for completeness and adequacy according to WB and IDB criteria by environmental professionals specializing in EIA preparation. Approval of bids should not be issued until the EIAs are deemed to be adequate.

Implementation of Mitigation and Monitoring Plans

This component involves mitigation implementation, environmental oversight, interim enforcement, and ambient air monitoring.

Mitigation Implementation

As part of bid approval the plant builders should commit to designating an environmental coordinator (who may be the plant engineer) to be responsible for adherence to the agreed to mitigation measures during construction and plant operation. This assignment would involve scheduled official site visits during construction and operation and annual plant audits with responsibility for the following:

- Review of the mitigation monitoring plan during construction and operation
- Adherence to the WB and IDB Occupational Health and Safety Guidelines
- Recording and reporting of spills, occupational and environmental accidents, and emergencies
- Implementation of plant-wide emissions and discharge monitoring programs

Environmental Oversight

The CNE should oversee environmental compliance during plant construction and operation. This oversight activity would involve:

- Monitoring of the implementation of the mitigation plan
- Inspection of emissions/discharge monitoring program
- Evaluation and approval of periodic effluent and air emissions reports

Interim Enforcement

A mechanism for interim enforcement of loan covenants specific to project mitigation measures should be devised and become the responsibility of the CNE.

Ambient Air Monitoring

Preliminary investigation of appropriate locations for ambient air monitoring stations should be initiated by the CNE as a precursor to the promulgation of air quality standards, regulations, and enforcement procedures.

POWER SECTOR ENVIRONMENTAL MANAGEMENT CAPABILITY

Agency Authorization

When the Energy Law and the Environmental Law are adopted, agency responsibilities for the thermal and hydroelectric facilities should be clearly defined and delegated to one or two agencies to eliminate the existing confusion and overlap among agencies. Authority for commissioning, review, and approval of EIAs should also be clearly delegated, probably most logically to the Superintendencia.

Power Sector Environmental Guidelines

The Comisión Nacional de Energía should develop guidelines for compliance with these laws by the power sector. Guidelines should include the following components:

- Environmental training of agency staff
- EIA requirements and approval process
- Coordination of EIAs, "concesión definitiva" to discharge permits
- Monitoring and reporting requirements for power plants
- Sector-wide environmental conditions data collection and analysis
- Mitigation plan requirements
- Public environmental education/information

Site Selection Criteria

Upon completion and approval of the Power Sector Expansion Plan, the CNE should establish siting criteria for new power plants including environmental screening criteria. Site selection studies should be conducted by the CNE or the private power plant builders. Criteria should include the following environmental considerations:

- Air quality
- Meteorological conditions of the impact area
- Topography of the impact area
- Ambient air quality of the impact area
- Water
- Availability
- Quality (baseline conditions)
- Proximity to major groundwater recharge zones
- Aquifer characteristics
- Proximity to water bodies and wetlands
- Drainage problems (such as local ponding)
- Capacity of existing waste water treatment facilities
- Land use/socioeconomic
- Characteristics of immediately surrounding area and region
- Distance of plant from populated area
- Size and location of surrounding communities
- Culture and lifestyles of the area
- Ecology
- Proximity to sensitive plant communities
- Proximity to sensitive, rare, or endangered wildlife habitats
- Proximity to protected ecological area
- Type and extent of present and past human disturbance

Inter-Agency Coordination

Assuming that the Superintendencia is delegated with the authority for sponsorship of power sector EIAs as the "lead agency," an environmental unit should be established within the agency. To ensure broad multidisciplinary input and review of EIAs, other agencies must be identified for participation in the process, namely water resources, air resources, and land use planning agencies. Once the EIA Draft is completed, review should include the Comisión para el Medio Ambiente. The Comisión's recommendations should be incorporated in the Superintendencia and Comisión Nacional de Energía finally review prior to approval by the Office of the President.

Public Education/Information

The environmental unit of the Superintendencia should actively involve the general public in the EIA review process as well as the planning process, specifically in the site selection stage. During construction and plant operation the public can continue to be involved through a responsive education/information program.

Environmental Training

Superintendencia staff should be trained in EIA preparation and review, environmental compliance techniques, environmental impacts particular to the power sector, and commercial and industrial uses of coal ash.

Environmental Standards

Once the Environmental Law and the Energy Law are adopted and environmental standards for air quality, water quality and hazardous waste are established, these standards should be stipulated for all Comisión Nacional de Energía operations.

Development of country-specific standards should take place after baseline research on existing conditions such as ambient air quality and water quality in receiving waters is completed. Air quality source emission standards that are adopted should be based on an evaluation of existing conditions and designed for the climate regime of the region.

Country-wide designation of categories for receiving waters should take place before receiving water standards can be developed. Some effluent discharge standards have already been developed in the Dominican Republic. Existing effluent or discharge standards should be reviewed, modified if necessary, and adopted by the agency designated for their enforcement.

INSTITUTIONAL STRENGTHENING OF ENVIRONMENTAL MANAGEMENT CAPABILITY

In the long-run the success of environmental management in the power sector will depend on the formalization of strengthened institutions designated to manage environmental compliance country-wide, across sectors. Extensive institutional development and clear designation of non-conflicting authority is required in order to create a viable management system implementing the proposed Environmental Law and Energy Law.

A study of all the agencies that now have responsibility for planning and environmental review should result in the following:

- Redefinition of agency mission
- Redistribution of environmental compliance responsibilities
- Restructuring of agency operating guidelines to eliminate fragmentation and redundancy
- Reallocation of operating agency budgets
- Commitment of human resources

Environmental Guidelines

At the completion of the institutional study and subsequent formalization of agency roles and responsibilities, each agency should develop its own environmental guidelines interpreting the Environmental Law in the context of its own domain. The guidelines should prescribe the steps required in the EIA preparation process, the content of EIAs with relevance to the specific issues of concern to that agency, and the relationship of EIAs to the permitting process. Thus, INDRHI would prepare guidelines applying to forestry, agriculture, and fisheries and ONAPLAN would develop guidelines for comprehensive plans, master plans, and development projects.

A model outline of the topics to be included in agency environmental compliance guidelines follows.

I. Environmental Screening

   A. Determining projects subject to and excluded from compliance

   B. Determining appropriate level of detail in the EIAs

   C. Determining if proposed project should be evaluated with other (impacts of) similar projects

II. Preparing EIAs

A. Scope of the EIAs

1. Defining scope

2. Involving public and NGO participation in scoping

3. Involving concerned agency participation in scoping

B. Conducting EIAs

1. Defining the proposed action

2. Identifying the affected human and natural environment

3. Assessing environmental and social impacts of the project

4. Developing mitigation measures to offset adverse impacts

5. Preparing the EIAs document in the proper format

C. Notifying the Public

1. Identifying public review and comment period procedures for EIAs

2. Providing notice of availability of EIAs

III. Relationship of EIAs to Agency Permitting Processes

IV. Implementing and Monitoring Mitigation Measures

A. Preparation or review of a mitigation and monitoring plan detailing implementation and monitoring responsibilities for the mitigation measures defined and agreed upon during the EIAs process.

Additional environmental guidelines should also include the following:

- Planning for environmental facilities, (e.g., a water treatment plant)
- Baseline data collection requirements, such as analytical methods and chemical parameters
- Project-specific studies commonly required, such as air dispersion models, water quality models, or traffic studies

- Sector-specific required mitigation measures

- Monitoring and reporting requirements such as monitoring parameters and reporting frequency

Inter-Agency Coordination and Public Scoping

The agency sponsoring the project for which an EIA is being prepared should take the lead in the preparation, review, and approval of the document. Regular procedures should be established for co-ordination with other agencies in the EIA review and approval process. Mechanisms should be instituted to involve the general public in the EIA scoping process. Standard review periods should be specified for the Preliminary Draft EIA, the Draft EIA, and the Final EIA.

EIA Preparation and Approval Procedures

For the EIA preparation process to be applied consistently across sectors, EIA procedures should be adopted. These procedures would identify the steps for developing, evaluating, reviewing, and approving EIAs in all sectors, and ensuring integration of cross-sectoral issues and public concerns into project planning, design, and mitigation. Procedures would specify the timing for public scoping and public hearings and review and comment periods for EIA drafts.

Environmental Planning and Management

A comprehensive national resource assessment and monitoring strategy should be developed and a single agency should be designated to be responsible for any resource (e.g., water, air, flora and fauna, etc.) The planning and management strategy should include the following:

- A resource assessment program to gather basic data and to determine baseline conditions. After baseline data is assessed, this program would function as a continuous monitoring program

- A resource-specific monitoring program to function as part of an overall permitting system for facilities that release pollutants that affect the resource

The agency responsible for the resource should perform the following:

- Resource survey and mapping

- Resource classification

- Resource evaluation

- Resource planning

- Permitting
- Resource monitoring

At this time, assessment and monitoring programs are needed for at least the following resources: 1.) flora and fauna; 2.) coastal marine resources (mangroves, coastal wetlands, fisheries); 3.) surface waters and wetlands; 4.) forestry; 5.) land uses; 6.) air quality; and 7.) water quality.

ENVIRONMENTAL TRAINING AND PUBLIC EDUCATION

Training is needed on two levels: training of agency staffs on national and sectoral levels; and environmental education of the general population. Environmental assessment training should begin immediately. Environmental awareness programs should be devised for the general public, with a specific focus on schools.

1. INTRODUCTION

1.1 PURPOSE OF THE PROJECT

The Consejo Nacional para la Energía (CNE) of the Dominican Republic is presently completing the Power Generation and Institutional Restructuring Project (PGIR). This project is needed in order to plan new power facilities in an economical and efficient manner to serve industry, residents, and the tourist sector; to site and control the operation of power plants in an environmentally responsible manner; and to provide a financially profitable basis for power generation in the Dominican Republic.

The key components of the PGIR project are the Power Sector Expansion Plan, which projects demand for power to the year 2010 and designates potential sites for future power plant development; the Dominican Republic Energy Law, which provides a foundation for the privatization of the power sector; and the commissioning of two privately owned power plants with installed capacity of 125 MW each in the near term.

1.2 PROJECT CONTEXT

The Power Sector Expansion Plan is presently under preparation and the recommendations in this Environmental Assessment (EA) will be incorporated in the Plan. The Energy Law has been submitted to the Dominican Republic Congress and passage is anticipated in 1995. In the interim, the Equipo Técnico (Technical Group) has been appointed by the CNE as a transition agency to bridge the Corporación Dominicana de Electricidad (CDE) and the Superintendencía de Electricidad, which will regulate the power sector after the Energy Law is adopted. The World Bank (WB) and the Inter-American Development Bank (IDB) will provide a guarantee for a loan of approximately $220 million to finance the two new plants planned for the immediate future. Any loan by the multilateral development banks requires an environmental evaluation before loan approval can be granted.

1.3 PURPOSE OF THE ENVIRONMENTAL ASSESSMENT

The purpose of this EA is threefold:

- To provide environmental background data, a sector-specific environmental impact evaluation, and mitigation measures to function as environmental guidelines supporting the Power Sector Expansion Plan

- To identify the first steps for the strengthening of the environmental agency that will be required to implement the Energy Law

- To provide the necessary environmental design requirements for the bid packages to be prepared for the two new plants to be financed by the WB/IDB

The Dominican Republic has recently submitted the Ley de Protección y Calidad Ambiental (Environmental Law) to Congress. This law provides the foundation for a system of environmental review of all development projects in the country. At the present time, however, no legal requirements are in place for preparation of Environmental Impact Reports for new projects. The World Bank Guidelines for Sectoral Environmental Assessment in the Power Sector are, therefore, the basis for preparation of this EA. The IDB requirements are similar to the requirements of the WB and, therefore, are not cited separately.

1.4 ENVIRONMENTAL ASSESSMENT REQUIREMENTS

The proposed project has been designated Category B by the WB and the IDB. Accordingly, the focus of this EA is on recommending an Action Plan (mitigation strategy) that can be incorporated into the Power Sector Expansion Plan.

A Sectoral EA in Category B is similar in nature to a Programmatic EIS under the U.S. National Environmental Policy Act (NEPA). The EA covers the broader environmental impact matters that apply to an entire sector country-wide. Subsequent project-specific Environmental Impact Statements or Reports incorporate by reference the general discussions in the EA and are concentrated solely on the issues specific to the project. This process, called *tiering*, allows the agencies involved, in this case the Equipo Técnico, WB, and IDB, to focus on the issues that are ready for decision and to exclude from consideration those issues that are not yet ready.

1.5 DESCRIPTION OF THE PROJECT

The project has been defined as the construction of two 125 MW power plants on one or two of four priority development sites that have been identified by the Equipo Técnico. There is the understanding that recommendations made in the EA would be applicable to the power sector as a whole, including existing plants.

1.6 PROJECT SCHEDULE

The loan is anticipated to be executed near the end of 1995. Pre-qualification requests for private bids for the new power facilities where sent out in the summer of 1994. Construction is anticipated to begin by the end of 1995, and plant operation by 1998.

1.7 IMPLEMENTATION MECHANISMS

New institutional mechanisms will be required in order to implement the Energy Law and the Environmental Law. This will involve a revision in country-wide agency charters and agency coordination procedures; the institution of environmental evaluation and compliance procedures for all sectors, including the Power Sector; the issuance of sector-specific regulations; and the setting of sector-specific standards.

This EA provides interim recommendations to assist the Equipo Técnico in achieving environmental compliance by the two new plant owners, and to set the groundwork for a permanent environmental institutional framework for the Dominican Republic Power Sector.

2. CURRENT SITUATION OF THE DOMINICAN REPUBLIC POWER SECTOR

2.1 CURRENT STATUS OF THE POWER SECTOR

2.1.1 Overview

The power sector of the Dominican Republic consists of fossil-fueled and hydro-electric generating facilities, a high voltage transmission system, and a medium voltage distribution system. The total installed capacity of the Dominican Republic is approximately 2,070 MW.[1] The Corporación Dominicana de Electricidad (CDE) controls almost 70 percent (1,425 MW) of the nationwide power generating capacity, as well as the high voltage transmission system and medium voltage distribution system. The remaining 30 percent of the generating capacity (645 MW) is in the hands of the private sector. Only 145 MW of this private sector power is available to the CDE grid. Until 1994, the private sector could only install generating units for internal use, while the CDE could purchase available power produced by private generating facilities to fill gaps in the public sector service coverage.

A study by USAID in 1989[2] estimated that based on the relationship between GDP growth and electricity generation, the interruptions of electrical service cost the Dominican economy US$218.4 million annually between 1984 and 1988. As power outages accelerated in the 1990s, it is estimated that the annual cost to the Dominican Republic economy has reached over US$500 million.

To address these issues, the Government of the Dominican Republic (GODR) has begun a process of reorganizing the electric power sector. The May 1993 Decree No. 148-93 was signed to institute a strategy to reform, restructure, and expand the electric sector in a manner designed to promote private sector participation. The decree created the CNE, which is advised by the Technical Group.

As part of the privatization process, the GODR has authorized the development of two new privately owned power plants. The Technical Group has been charged with drafting a new energy law to be acted upon by the Dominican Congress. The energy law is intended to deregulate and codify the privatization of the electric generation subsector, as well as parts of the distribution system. The new law will create a regulatory agency called the Superintendencia de Electricidad (Superintendencia), which will replace CDE as the agency responsible for planning and implementation of all electric power projects.

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1 Project Paper Draft Outline, Energy Privatization Project (No. 517-0270), USAID/Dominican Republic, 1993.

2 Memorandum, G. Weynand to S. Schweitzer, et.al., Subject: Trip Report - Santo Domingo - Dominican Republic, July 22, 1993.

2.1.2 Description of the Current Dominican Republic Power Sector

Electric generation is provided by means of power plants located throughout the country, with fossil units located primarily near the coast and the hydro-electric plants located mostly inland. The fossil plants are located close to the principal load centers as can be seen in Exhibit 2-1. The sector uses a variety of prime movers: steam turbines, gas turbines, diesel engines, and hydraulic turbines. Steam generation uses two primary fuels: coal and residual fuel-oil (sometimes called No. 6 oil or "Bunker C"). Gas-turbines and diesel engines use gas-oil, also known as No. 2 oil.

The majority of these plants are owned and operated by CDE. Currently the CDE generation sector is composed of twelve steam turbine units (representing 52 percent of CDE's generating capacity), eight gas turbine units (21 percent), four diesel units (<1 percent) and fifteen hydro-electric units (26 percent) for a total installed capacity of about 1,425 MW. The remaining power plants in the Dominican Republic are privately owned and generate electricity for internal use by the owners. However, five of these privately owned stations sell up to 145 MW of their generating capacity to CDE for the national grid.

The high voltage transmission network of CDE consists of 138kV and 69kV transmission lines. The 138kV system interconnects the main generating regions and the corridor between Puerto Plata in the north and Santo Domingo in the south, as well as between Santo Domingo and San Pedro de Macorís to the east. It also connects the five largest hydro-electric units to the national grid. The 69kV network distributes power to the southwestern and northeastern regions. The 69kV system also connects the smaller hydro-electric plants to the national grid. Connection to the load centers is made via a 12.5kV medium voltage distribution system.

2.1.3 Characteristics of Existing Plants

Table 2-1 presents the generating capabilities of the CDE power plants now in operation in the Dominican Republic. The table shows the nominal installed capacity (nameplate rating) of the units as well as their current available capacity. The available capacity shown reflects the net capacity deliverable to the grid (net from internal use in the generating plant). Also, the capacity of some units is limited by extended outages, unavailable or undersized equipment, and performance inefficiencies. These conditions seriously limit CDE's ability to meet peak demands, not only during the high peak dry season, but also during other times of the year. Table 2-1 also shows the amount of net electric generation by each unit for the past four years. The net generation is the amount of electricity delivered to the grid. Table 2-2 shows similar information for the privately owned power plants that supply power to the CDE grid. The "Available Capacity" in this table represents that portion of the plant capacity available to CDE.

Table 2-1 Capacity and Net Generation of CDE Owned Power Plants, First Quarter 1994

Generation Unit	Capacity (MW)[1]		Net Generation (Gwh)[2]			
	Installed	Available	1990	1991	1992	1993
Steam Turbine Power Plants						
Itabo 1	125.0	0.0[3]	329.8	545.5	499.9	374.5
Itabo 2	125.0	125.0[3]	643.3	302.5	723.0	761.3
Haina 1	54.0	48.0[3]	22.7	0.0	0.0	212.0
Haina 2	54.0	0.0[3]	107.0	74.5	184.2	8.5
Haina 3	84.9	36.0[3]	319.5	216.7	259.8	217.2
Haina 4	84.9	52.0[3]	52.0	310.2	351.2	284.5
Haina 5	84.9	70.0[3]	166.1	0.0	0.0	233.2
Santo Domingo 5	12.7	8.5[3]	34.5	61.3	73.6	66.2
Santo Domingo 8	26.5	0.0[3]	137.7	123.2	126.8	46.4
Puerto Plata 1	27.6	19.0[3]	0.0	0.0	91.6	142.0
Puerto Plata 2	36.8	0.0[3]	94.0	140.4	39.1	0.0
San Pedro 1	33.0	30.0[3]	144.1	212.0	207.0	229.1
TOTAL	749.3	378.5	2,050.7	1,986.3	2,556.2	2,574.9
Gas Turbine Power Plants						
Los Mina 1	35.0	22.0[3]	0.0	0.0	63.2	122.5
Los Mina 2	35.0	23.0[3]	0.0	20.4	122.5	111.1
Los Mina 3	65.0	0.0[3]	0.0[4]	0.0[4]	110.8	67.5
Los Mina 4	65.0	0.0[3]	0.0[4]	11.5	213.0	203.6
Timbeque 1	21.1	15.0[3]	94.1	112.4	72.1	87.6
Timbeque 2	21.1	18.0[3]	85.3	111.6	68.5	79.6
San Pedro de Macorís	28.3	25.0[3]	0.0	0.0	0.0	31.2
Barahona	28.3	0.0[5]	0.0	0.0	0.0	0.0
TOTAL	298.8	103.0	179.4	255.9	650.1	703.1
Diesel Engine Driven Power Plants						
Constanza	2.6	0.0[6]	0.0	0.0	0.0	0.0
Sabana de la Mar	0.5	0.5[6]	0.7	0.7	0.0	0.0
Manzanillo	0.5	0.5[6]	0.3	0.4	0.2	0.1
Pedernales	1.7	1.7[6]	2.5	3.1	3.4	4.0
TOTAL	5.3	2.7	3.5	4.2	3.6	4.1
Hydro-electric Plants						
Tavera 1 & 2	96.0	48.0[7]	137.2	232.1	195.9	324.1
Valdesia 1 & 2	54.0	25.0[7]	51.7	58.9	41.4	135.0
Jigüey 1 & 2	98.0	72.0[7]	0.0[4]	0.0[4]	76.1	293.1
Aguacate 1 & 2	52.0	36.0[7]	0.0[4]	0.0[4]	58.1	275.9
Sabana Yegua	12.5	6.0[7]	32.9	78.5	55.0	83.7
Rincón	10.1	6.0[7]	14.3	20.6	20.4	32.8
Las Damas	7.5	2.0[7]	22.1	22.3	18.7	16.9
Sabaneta	6.0	4.0[7]	16.2	24.8	26.6	32.9
Jimenoa	8.0	6.0[7]	49.5	46.7	45.7	57.9
Hatillo	8.0	6.0[7]	52.1	50.7	37.9	47.2
Lopez-Angostura	18.0	8.0[7]	68.6	98.7	80.1	111.6
TOTAL	370.1	219.0	444.6	633.3	655.9	1,411.1
GRAND TOTAL	1,423.5	703.2	2,678.2	2879.7	3865.8	4693.2

[1] Available Capacity as of the 1st Quarter of 1994.
[2] Data provided by CDE Departamento de Planificación, March 1994.
[3] Data provided by CDE Departamento de Planificación, FAX dated April 20, 1994.
[4] Unit under construction at this time.
[5] Telephone conversation with Sra. Milagros Ramírez (Departamento de Planificación) May 10, 1994.
[6] DECON Interim Report, *Plan Nacional de Expansión de la Generación del Sistema Eléctrico de la República Dominicana*, March 1994.
[7] Telephone conversation with Sra. Milagros Ramírez (Departamento de Planificación) May 12, 1994.

Table 2-2 Capacity and Net Generation of Privately Owned Power Plants Selling Power to CDE, First Quarter 1994

Generation Unit	Capacity (MW)[1]		Net Generation (Gwh)[2]			
	Available	Purchased	1990	1991	1992	1993
Purchased Power						
Santiago	12.0	10.0[2]	35.6	39.1	64.8	82.1
Falcon Bridge	40.0	40.0[3]	289.7	307.3	332.2	297.6
Wärtsilä Domingo	40.0	40.0[2]	153.3	218.6	249.3	252.6
Wärtsilä Puerto Plata	18.0	0.0[2]	0.0[2]	51.8	116.8	109.6
Metaldom	35.0	35.0[2]	0.0	0.0	0.0	0.0
TOTAL	145.0	125.0	478.6	616.8	763.1	741.9

[1] Available Capacity as of the 1st Quarter of 1994.
[2] Data provided by CDE Departamento de Planificación, FAX dated April 20, 1994.
[3] Data provided by CDE Departamento de Planificación, FAX dated May 8, 1994.

Source: *Plan Nacional de Expansión de la Generación del Sistema Eléctrico de la República Dominicana*, DECON Interim Report, March, 1994; CDE Departamento de Planificación, 1994.

Annex A provides further detailed information on specific characteristics of the thermal power plants in the Dominican Republic, including number of units, status, age, boiler characteristics, and fuel data.

2.1.4 Condition of the Power Sector

The reliability of the electric supply in the Dominican Republic has been steadily declining over the past decade. Blackouts and brownouts are a common occurrence. Many businesses are forced to install their own generating capabilities or suffer severe economic losses. The EA team visited selected representative plants in March 1994. These plants represent a variety of power types (steam and gas-turbine, diesel, and hydro), fuel types, and geographic location (see Table 2-3). Reconnaissance at each plant consisted of visual observations and interviews with plant managers and operating personnel, which confirmed the findings presented in previous studies conducted by DECON[3] and The World Bank.[4] The low reliability of the power system can largely be attributed to inadequate or deferred maintenance and old or obsolete equipment. As Table 2-1 and Table 2-2 show, the country's available capacity has been reduced to about 848 MW (703 MW from CDE and 145 MW purchased). With an expected peak demand of 1,097 MW[5] in 1994, CDE has a capacity deficit of almost 250 MW at present.

[3] *La Situación Energética y Proyectos Principales*, DECON Report, December 1993 and *Plan Nacional de Expansión de la Generación del Sistema Eléctrico de la República Dominicana*, DECON Interim Report, March 1994.
[4] UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) Strategy and Programs Division report *Dominican Republic - Issues and Options in the Energy Sector*, May 1991.
[5] DECON Interim Report, *Plan Nacional de Expansión de la Generación del Sistema Eléctrico de la República Dominicana*, March 1994.

Table 2-3 List of Plants Visited During In-Country Survey March, 1994

PLANT NAME	PLANT LOCATION	PLANT TYPE	NUMBER OF OPERATING UNITS AND AVAILABLE CAPACITY	FUEL TYPE	POLLUTION CONTROL
Itabo	Santo Domingo	Steam Turbine	Unit 1 - 0 MW Unit 2 - 125 MW	Fuel Oil #6 or Coal	Cyclone Chamber for Oil burning); ESP (for coal burning); pulse jet baghouse in discharge from ESP and cyclone
Haina	Santo Domingo	Steam Turbine	Unit 1 - 48 MW Unit 2 - 0 MW Unit 3 - 36 MW Unit 4 - 52 MW Unit 5 - 70 MW	Fuel Oil #6	None
Santo Domingo	Santo Domingo	Steam Turbine	Unit 5 - 8.5 MW Unit 8 - 0 MW	Fuel Oil #6	None
Puerto Plata	Puerto Plata	Steam Turbine	Unit 1 - 19.0 MW Unit 2 - 0 MW	Fuel Oil #6	None
San Pedro de Macorís	San Pedro de Macorís	Steam Turbine	Unit 1 - 30.0 MW	Fuel Oil #6	Unit 1 - Cyclone Chamber
Los Mina	Santo Domingo	Gas Turbine	Unit 1 - 22.0 MW Unit 2 - 23.0 MW Unit 3 - 0 MW Unit 4 - 0 MW	Fuel Oil #2	None
Timbeque	Santo Domingo	Gas Turbine	Unit 1 - 15.0 MW Unit 2 - 18.0 MW	Fuel Oil #2	None
Wärtsilä	Santo Domingo	Diesel Engine	Unit 1 - 5.71 MW Unit 2 - 5.71 MW Unit 3 - 5.71 MW Unit 4 - 5.71 MW Unit 5 - 5.71 MW Unit 6 - 5.71 MW Unit 7 - 5.71 MW	Fuel Oil #6 - Diluted by Fuel Oil #2	None
Valdesia	Valdesia	Hydroelectric	Unit 1 - 27.0 MW Unit 2 - 27.0 MW	Not Applicable	Not Applicable

A program of preventive maintenance does not exist, and necessary repairs have not been carried out for extended periods. The low system availability prevents CDE from being able to take any plants out of service for normal maintenance except for very short periods. These outages are generally of an emergency nature and repairs are usually limited to those needed to return the unit to service. CDE's weak financial situation limits the amount of money available for maintenance. Currently, with seven plants out of service for refurbishment, CDE is forced to delay major maintenance on operating plants, thus raising the risk of more frequent breakdowns.

The poor condition of the transmission and distribution systems also contributes significantly to the poor delivery of electric service. Lack of protective devices, overloaded circuits, and undersized equipment lead to frequent breakdowns. Total losses in the transmission and

distribution system have risen from over 32 percent in 1990 to almost 39 percent in 1993[6]. These transmission system losses require CDE to have a higher available capacity than would be required for an adequately designed and maintained transmission and distribution network.

2.1.5 Power Needs of the Dominican Republic

During 1993, the total Dominican Republic's power sector energy supply was approximately 5,434 Gigawatt-hours (GWh).[7] For the same year, the total energy demand was approximately 6,523 GWh. The total energy deficit for the year 1993 was approximately 1,089 GWh.

The forecasted power demand for the years 1993 through 2015 is shown in Exhibit 2-2. Historically, CDE has been unable to satisfy its system demand. In view of this situation, the GODR has taken the necessary steps to increase the available capacity and availability in the near term and the long term.

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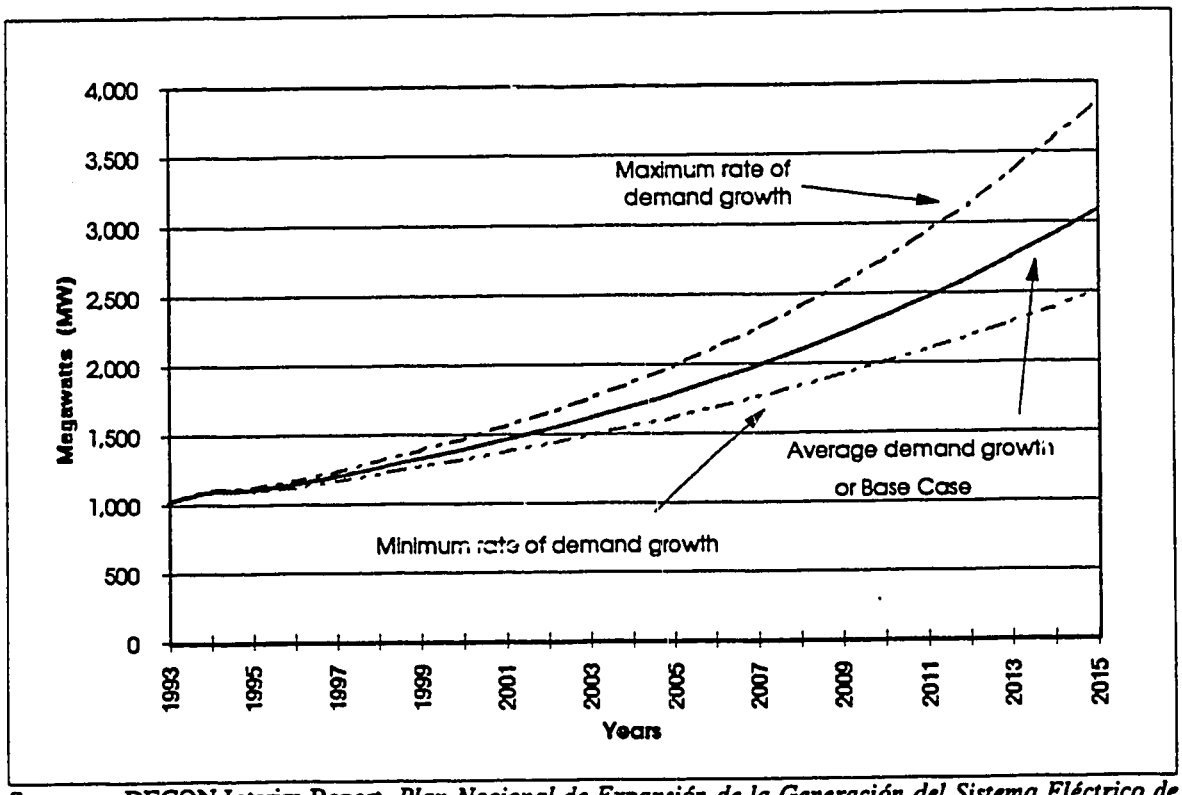
[6] La Situación Energética y Proyectos Principales. DECON Report, December, 1993.

[7] Ibid.

Exhibit 2-2 Forecasted Peak Power Demand



Source: DECON Interim Report, *Plan Nacional de Expansión de la Generación del Sistema Eléctrico de la República Dominicana,* March 1994.

2.1.5.1 Near Term Program

To improve the ability of the system to meet the near term demands of the system, CDE has planned to add 744.5 MW of available capacity during 1995.[8] 397.5 MW will be returned to the system as a result of the rehabilitation of seven steam and gas-turbine power plants (Itabo 1, Haina 2, Santo Domingo 8, Puerto Plata 2, Los Mina 3 & 4, and Barahona). CDE will purchase an additional 275 MW from three private companies: 185 MW from Smith Co-generation International, 50 MW from Compañía de Electricidad de Puerto Plata at their expanded plant at Wärtsilä, and approximately 40 to 50 MW from the Complejo Metalúrgico Dominicano (METALDOM). Finally, the completion of the 42 MW steam station at Barahona and the 30 MW hydro-electric plant at Río Blanco will add an additional 72 MW. If this ambitious program is executed as planned, the power supply would exceed the

8 La Situación Energética y *Proyectos Principales.* DECON Report, December, 1993.

projected demands for the years 1995 and 1996 and eliminate the deficit that CDE has faced during the past decade.

To provide sufficient system reserve, power supplies for the future and needed backup in case the planned rehabilitation program is delayed in coming on-line, the WB and IDB are providing a loan package to the Dominican Republic to cover the cost of two additional 125 MW power plants. Four priority sites have been identified for the location of these plants (see Exhibit 2-3).

At the same time that CDE is engaged in bringing more capacity onto the power generation system, it has begun a program to rehabilitate the distribution networks and substations in Santo Domingo, Santiago and 10 other principal cities. This program is expected to cost nearly US$104 million for the construction of new transmission lines and substations.

2.1.5.2 The Power Sector Expansion Plan

CDE has initiated the preparation of the Power Sector Expansion Plan for the Dominican Republic. The primary objectives of the Dominican Republic Power Expansion Plan are to correct the power generation deficit by adding additional installed capacity and increasing the distribution efficiency by upgrading transmission lines and substations. At the time of preparation of this EA, only the Interim Report[9] of the plan was available. An average demand growth of 5.1 percent per year, and retirement of the older, less efficient power plants now in operation during the period of this plan are assumed. The Plan calls for new plant additions by the year 2010 on the basis of these assumptions, as shown in Table 2-4.

Table 2-4 Planned Power Plant Capacity for 2010, Dominican Republic

Year	Number and Capacity of Units
1996*	2 x 125 MW
1998	2 x 125 MW
2000	1 x 250 MW
2003	1 x 250 MW
2005	1 x 250 MW
2010	2 x 250 MW
TOTAL	9 for 1,250 MW

Source: *Plan Nacional de Expansión de la Generación del Sistema Eléctrico de la República Dominicana*, DECON Interim Report, March 1994.

*The Interim Report states that the two new plants would be operational by 1996. With construction start anticipated for late-1995, actual operation is more likely in 1998 unless a fully built plant is brought on-site sooner.

9 Plan Nacional de Expansión de la Generación del Sistema Eléctrico de la República Dominicana, DECON Interim Report, March, 1994.

The Interim Report does not describe the additions to the supporting infrastructure that will have to be added for these new plants. The capacity of the transmission and distribution system will have to be increased in proportion to the increase in system power capacity. Such factors as the development of fuel and waste transport systems will also have to be included in the Expansion Plan. Plant operating and maintenance personnel and managers will have to be hired and trained. The availability and need for in-country repair and maintenance facilities have to be investigated.

2.2 EXISTING ENVIRONMENTAL IMPACT NORMS

Environmental Impact Norms or Standards are promulgated for two primary reasons:

- To provide a means of measuring existing environmental quality
- To provide the basis for measuring and controlling environmental impact

Impact norms have been published by the following types of organizations:

- International organizations such as The World Bank and the World Health Organization
- National U.S. organizations such as the USEPA

Environmental impact norms are presented for the following media:

- Water quality norms
- Solid waste management norms
- Air quality norms

Environmental impact norms are usually applied by an agency charged with the regulation of a certain environmental sector. The environmental quality of an area or region can be measured by comparing field measurements of specific pollutant concentrations at representative spots in the region with the corresponding environmental norms. If the measurements yield values approaching or higher than the standard, then the environmental quality of the region is considered threatened or poor. In the case where standards do not exist, during the early stages of a new environmental management program, goals, policies, and appropriate management practices can be adopted to achieve environmental objectives in the interim. Progress is then measured by acceptance and implementation of the recommended goals and practices.

Many nations have adopted environmental impact norms based on recommendations developed by the United Nations World Health Organization, The World Bank, and the U.S. Environmental Protection Agency (USEPA). Of these, the USEPA norms are the most comprehensive, with a strong scientific foundation based solidly on research,

experimentation, and field measurements. The World Bank has also published industry specific environmental guidance for development projects.[10]

2.2.1 Air Quality Impact Norms

Air quality related norms or standards are of two types: emission and ambient. Emission standards apply to allowable limits of specific pollutants emitted from a stack or vent, and ambient standards pertain to allowed concentrations of pollutants in the ambient air to protect public health and welfare. All World Bank projects require that for new plants, specified ambient air quality concentrations downwind of these plants must not be exceeded. Also, the USEPA has set ambient air standards based on health effects to humans and on environmental effects on plants and materials.

The ambient air quality standards that will be used to assess the impacts of existing and future power plant projects are defined below.

Table 2-5 Ambient Air Quality Standards (Concentration in $\mu g/m^3$)

Pollutant	Time Avg.	World Bank	USEPA
SO_2	3 hr. 24 hr. annual	- 250 100	1300
NO_2	annual	100	100
PM_{10}	24 hr. annual	-	150 50
CO	1 hr. 8 hr.	-	40,000 10,000

2.2.2 Water Quality Impact Norms

Water pollution control is typically not one of the major components in power plant design and planning. However, water quality considerations are important in the following specific areas:

- Water availability, use, and recycle
- Facility water and waste water treatment systems design
- Water quality of the receiving body of water
- Impact of thermal discharges on aquatic and marine biology

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10 Environmental Guidelines. The World Bank, Office of Environmental Affairs, Washington D.C., USA (July 1984).

- Impact on human health and the environment from the discharge of untreated sanitary wastes

Environmental impact norms applied to liquid wastes take two general forms:

- Receiving water standards applicable to fresh and marine water bodies

- Discharge limits that are pollutant-specific and are attainable only by pre-treatment of the waste stream. Included in with the full range of chemical pollutants are restrictions on the temperature difference between the waste stream and the receiving water at the point of discharge.

Apart from discharges of sanitary waste, other liquid effluents from industrial plants consist principally of cooling water and waste by-products from the process or other sources which may contain dissolved or suspended constituents. Process cooling is an integral part of the power plant operations. This water is maintained at specific pH and quality levels as required by equipment specifications. It generally is not in contact with any of the waste-generating operations within the plant, but the surfaces with which it comes in contact may be coated with corrosion-inhibiting and anti-fouling compounds. These compounds may contain chromates, tins, and copper which can wash into the cooling water. The resulting effluent therefore can contain these metals as well as being elevated in temperature.

As a general guideline for World Bank projects (World Bank, 1984), effluent temperatures should not be more than 3 °C higher than that of the receiving waters. Where the receiving water temperatures are at 28 °C or less, the effluent temperature may be a maximum of 5 °C above that of the receiving waters. In cases where maintaining these differentials cause excessive increases in project costs or is determined to cause undue harm to fisheries or other aquatic life, the maximum allowable temperature may be determined from the following equation (World Bank, 1984):

$$T_{max} = OT + \frac{URLT-OT}{3}$$

Where: T_{max} = Maximum allowable stream temperature after mixing
OT = Optimum temperature for species affected
URLT = Ultimate recipient lethal temperature for species affected

It is assumed that the maximum allowable temperature would be protective of the most sensitive species or appropriate target species or life stage.

2.2.3 Solid Waste Management Norms

Solid waste impact norms generally take the form of recommended waste management practices intended to reduce or eliminate the migration of harmful substances from waste disposal areas to the environment. Contaminant migration from a waste site occurs directly via the air pathway as windborne dust, or indirectly by leaching of chemicals into the surrounding soil and ground water, and by chemical reaction within the waste mass that

results in the production of secondary gaseous and liquid pollutants that have the potential to migrate offsite.

Solid wastes are divided into four major categories:

- Hazardous wastes
- Non-hazardous wastes
- Radioactive wastes
- Mixed wastes

Each category of solid waste has its own rules and regulations for handling, transport, and disposal. Hazardous and non-hazardous solid wastes are considered herein. World Bank recommended solid waste management practices are presented below. USEPA solid waste management guidelines, which are more comprehensive than those of The World Bank, are also presented below.

Proper location and operation of disposal sites are the principal factors in handling solid wastes. Improperly operated disposal areas can result in noxious odors caused by decomposing material; increase in disease carriers (e.g., bacteria, rats, and flies); increased litter, truck traffic and noise; and possible dust movement. Dust can create a problem at dump sites that are completely dry. These sites should be routinely watered, kept to a minimum, or eliminated, depending upon their composition and the environment surrounding the disposal site.

Solid wastes from industry often pose special problems such as non-degradability (plastics) and toxicity (chemical residues). In establishing disposal methods, solid wastes should be classified and rated as to their effects, such as human toxicity; ground water contamination; biodegradability; and mobility. Chemical, physical, and biological methods are normally used to analyze air and water effluents from solid waste disposal areas.

The siting, construction, and operation of a solid waste disposal site are specific to the anticipated waste stream. The type of waste (e.g., hazardous, non-hazardous), handling technology, and disposal site limitations (e.g., size, proximity to other uses) are used to determine the way in which the site would be managed. Sites should be designed and operated to prevent or minimize air emissions, such as methane, and liquid emissions, such as contaminated surface runoff and leachate. Soil gas collection systems, runoff collectors, and leachate collection systems can be incorporated into the design phase to assure that contaminant migration does not occur offsite. Additionally, compaction of the wastes and daily cover with materials such as clay or bentonite also aid in sequestering contaminants.

Facilities must remedy releases that threaten human health and the environment (called "corrective action"). Corrective action may be required through the permitting process or through an enforcement order.

The extensive literature available from the USEPA provides comprehensive guidance on the management, treatment, and disposal of various forms of solid waste.

2.3 ENVIRONMENTAL IMPACTS OF EXISTING POWER PLANTS

The following sections present the environmental impacts of the power sector in accordance with World Bank Operational Directive 4.01. In keeping with these assessment guidelines, this section focuses on the environmental problems specific to the power sector. The assessment is based on a representative sample of selected worst case power plants located throughout the Dominican Republic where field visits and interviews were conducted. A list of the selected facilities is shown in Table 2-3 and descriptions of plant specifications are included in Annex A.

Consistent with the focus of the Power Sector Expansion Plan, currently under preparation, the main focus of this EA is on power generation from thermoelectric power plants. However, because 26 percent of the power generation in the Dominican Republic is produced by hydroelectric facilities, a hydroelectric plant, Valdesia I and II, was visited by the EA team. The following impacts generally result from the construction and operation of hydroelectric plants:

- Water Quality. The most pervasive adverse impacts of hydroelectric plants are associated with water quality. Water quality can be affected by increased sedimentation resulting from induced erosion remains in the bed of water course and elsewhere in the watershed area, due to road building and clearance of vegetation; logging, and cultivation by people who have moved into the watershed areas as a result of the construction of the dam project. Water quality may also be adversely impacted by salt accumulation, eutrophication from weeds and biomass decay, increased turbidity, and pollution from agricultural, industrial, and human wastes.

- Biology. Aquatic biology, such as fisheries, is adversely affected by degraded water quality. Terrestrial biology is adversely impacted by clearing and inundation of trees and vegetation necessary for project construction. Hydroelectric facilities can also result in the reduction of biological diversity and destruction of endangered species.

- Land Use/Social. The adverse impacts associated with the change in land use directly or indirectly caused by the presence of hydroelectric facilities include the reduction of recreation and fishing opportunities, population influx, and linked social effects, including health, security, and impact on local culture. Health impacts often include water-related diseases such as schistosomiasis, onchocerciasis, encephalitis, and malaria.

- Air Quality. Adverse air pollution impacts attributed to fugitive dust emissions occur only during facility construction. Because the construction period can last for several years, this is a persistent impact which can adversely affect sensitive receptors. However, there are typically no adverse air quality impacts during plant operation.

The Valdesia I and II Plant, which was operating in 1993 at less than 50 percent of installed capacity, is constrained by the arid conditions in the Dominican Republic in the past five years. The reservoir is very low and the river bed below the dam is dry for a long stretch.[11]

Other conditions observed or reported by CDE officials at the plant were a significant amount of erosion at the river banks, loss of vegetation, and a significant amount of silt accumulation in the river.[12] The lack of water tends to exacerbate the potential impacts of hydroplant operation. For example, the effects of siltation on overall water quality in the river are more severe when the total amount of water is reduced. This impact in turn adversely affects the habitat necessary for the survival of fish.

When responsibilities for gathering base data, planning, and monitoring impacts of hydroelectric plants are re-affirmed or modified, a country-wide program should be implemented by the agency entrusted with this charge. Any recommendations for mitigating existing impacts (e.g., re-vegetation) would require site-specific studies to identify the impacts and design the mitigation programs.

2.3.1 Air Quality

The impact on air quality is determined by evaluating the relationship of maximum concentrations at ground level to ambient air quality standards.

This section presents an assessment of the air quality impacts from the operation of existing fossil-fueled power generation facilities in the Dominican Republic. These power plants differ widely in age, type, and physical condition. Maintenance practices are generally deficient and the plants visited do not appear to be efficiently run. The newer plants, such as Wärtsilä in Puerto Plata, Los Mina, and Itabo are in better condition than the older facilities, but these plants also exhibit signs of neglect and low maintenance.

The only pollution controls on the existing facilities are cyclones and electrostatic precipitators (ESPs) on the coal burning plants to reduce particulate matter emissions (except for Itabo, which has a baghouse). There is no control of sulfur dioxide emissions at these facilities. The sulfur content of the coal is about 1 percent by weight, and for oil, the average sulfur content is less than 3 percent; but the No. 6 heavy oil, which is also used, can be as high as 4.25 percent. Light oils burned in turbines contain less than 1 percent sulfur.

In the absence of quantitative air quality measurements, visual observations indicate that air quality in the Dominican Republic appears to be good. Generally the high ventilation rates characteristic of the Caribbean trade wind regime dilute air pollutants and carry them out to sea. However, particulate matter emissions from plants firing coal have occasionally resulted

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11 Because data and studies on current conditions onsite and in areas affected by hydroelectric facilities were not provided by INDRHI, specifics on conditions are not presented.

12 Discussion with plant manager and Eduardo Martínez, CDE, March 11, 1994.

in nuisance reports of fly ash and fugitive dust in the local communities (see Exhibit 2-4). Because of the lack of air quality monitoring data for the island, dispersion modeling is carried out to assess the impacts of existing facilities. This impact analysis is described in the following sections.

2.3.1.1 Impact Assessment Methodology

The impacts of emissions from existing and future fossil fuel power plants on local air quality are determined by quantifying emissions from the plants based on reported operating characteristics, and calculating ambient air concentrations through the use of atmospheric dispersion models. To quantify the impacts, the following methodology is used:

1.) Emission rates for a given plant are calculated using USEPA emission factors reported in the document AP-42 (EPA, 1985), multiplied by the operating rate. The emission factors in AP-42 are based on emission measurements made on a large number of plants operating throughout the U.S. In the calculation, actual operating rates are used and are expressed in grams per second as input to dispersion models. Detailed plant operating characteristics and emission estimates are given in Annex B.

2.) In order to identify the plants representing the worst case air quality impacts, the emissions from all the fossil-fueled power plants in the Dominican Republic were estimated via calculation. The 1993 emissions from these plants are summarized in Table 2-6, expressed in pounds of pollutant per hour. Table 2-6 shows that two plants, Itabo and Haina, have much greater emissions than the others. Since these two plants represent the worst case air quality impacts, they were selected for dispersion modeling and subsequent impact analysis.

3.) Maximum one-hour average ground-level concentrations of SO_2, NO_x, and PM_{10} are calculated using the EPA atmospheric dispersion model SCREEN 2 (Version 92245). To obtain multi-hour averages, the one hour concentrations are multiplied by wind meander factors recommended by EPA. The Itabo and the Haina plants are modeled separately, since they are separated by several miles with little opportunity for plume overlap, under the given wind regime.

4.) It should be noted that emissions of carbon monoxide (CO) were not included in the modeling or analysis, since levels are extremely low as compared with the other pollutants and would not cause significant impacts.

5.) Three meteorological scenarios are considered in the modeling analysis, assuming worst case stable conditions, moderate, and high ventilation scenarios. However, the worst case is highly unlikely due to the typical trade wind regime.

6.) The total ambient air concentration is determined by adding the calculated maximum downwind concentration to a background pollutant concentration. In the absence of ambient air quality data in the Dominican Republic, the background levels are based on 1991 monitoring data for San Juan, Puerto Rico.

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7.) This total ambient air concentration is tested for significance by comparing it to the USEPA ambient air quality standards presented in Section 2.2.1.

Table 2-6 Estimated 1993 Emissions from Fossil-Fueled Power Plants (lbs./hr.)

PLANT	SO_2	NO_x	PM_{10}
Itabo (oil)	3774	586	249
(coal)	954	1524	582
Haina	7578	1176	500
Santo Domingo	364	56	24
Puerto Plata	711	110	47
San Pedro de Macorís	1005	156	66
Los Mina	761	100	10
Timbeque 1	580	77	8
Los Mina	761	100	10
Timbeque 2	580	77	8
San Pedro de Macorís	422	56	6
Santiago	148	20	2
Falcon Bridge	1716	206	110
Wärtsilä	1098	54	5

2.3.1.2 Impacts of Existing Facilities

Maximum downwind concentrations for the existing power plants were calculated using the EPA model SCREEN 2 for a typical meteorological case, a high ventilation case, and for worst case meteorological conditions. Maximum pollutant concentrations were below the ambient standard (within acceptable levels) for all facilities except the 24-hr SO_2 standard at the Haina plant. This ambient standard would be exceeded downwind of the Haina plant under worst case stable meteorological conditions. It should be noted, however, that this condition rarely occurs in this region.

The existing operating rates of all the plants range from 20 percent of installed capacity to 75 percent. The Haina and Itabo plants are operating at a range of 40 to 50 percent of installed capacity. If all the plants in the system were to operate at 75 percent of capacity (a typical load capacity for plants in the U.S. is 80 percent), all the plants except for Haina and Falcon Ridge would be within acceptable levels for all pollutants. (See Table 2-7 for Itabo plant.) Haina would continue to exceed the SO_2 24-hr standard and would also exceed the SO_2 3-hour standard under the worst case stable meteorological conditions. (See Table 2-8 for Haina Plant.) This is considered to be a significant adverse impact. Falcon Ridge, which is now operating at 20 percent capacity, would emit 6435 lbs./hr. of SO_2 at 75 percent of

Table 2-7 Air Emission Concentrations at the Itabo Plant ($\mu g/m^3$)

FUEL TYPE	COAL												FUEL OIL											
Meteorological Condition	Typical				High Ventilation				Worst Case				Typical				High Ventilation				Worst Case			
Pollutant	SO_2		NO_x[1]	PM_{10}[1]	SO_2		NO_x	PM_{10}	SO_2		NO_x	PM_{10}	SO_2		NO_x	PM_{10}	SO_2		NO_x	PM_{10}	SO_2		NO_x	PM_{10}
	3 hr	24 hr	annual	24 hr.	3 hr	24 hr	annual	24 hr.	3 hr	24 hr	annual	24 hr.	3 hr	24 hr	annual	24 hr.	3 hr	24 hr	annual	24 hr.	3 hr	24 hr	annual	24 hr.
Background[2]	8	8	35	5	8	8	5	35	8	8	5	35	8	8	5	35	8	8	5	35	8	8	5	35
Max. Total Concentration	48	26	7	46	39	22	6	44	116	60	21	66	164	77	8	40	122	59	7	39	467	212	26	51
Ambient Standard[3]	1300	250	100	150	1300	250	100	150	1300	250	100	150	1300	250	100	150	1300	250	100	150	1300	250	100	150

(1) Because emission levels are below levels of significance for NO_x and PM_{10}, only 24-hour and annual levels are shown.
(2) Background levels are based on 1991 monitoring data for San Juan, Puerto Rico, *National Air Quality and Emissions Trends Report, USEPA, 450-R-001*, Oct. 1992.
(3) Based on USEPA standards, except 24 hour SO_2 World Bank standard.

installed capacity, which would exceed the SO_2 24-hr standard, but would not exceed the 3-hour standard. This is considered to be an adverse but not significant impact.

Mitigation measures described in Section 6.1.1 would have to be implemented to reduce the impacts to insignificant levels.

Table 2-8 Air Emission Concentrations at the Haina Plant ($\mu g/m^3$)

FUEL TYPE	FUEL OIL											
Meteorological Condition	Typical				High Ventilation				Worst Case			
Pollutant	SO_2		NO_x	PM_{10}	SO_2		NO_x	PM_{10}	SO_2		NO_x	PM_{10}
	3hr	24 hr	annual	24hr	3hr	24 hr	annual	24hr	3hr	24hr	annual	24hr
Background (1)	8	8	5	35	8	8	5	35	8	8	5	35
Maximum Total Concentration	322	143	10	44	253	117	9	42	929	417	21	62
Ambient Standard (2)	1300	250	100	150	1300	250	100	150	1300	250	100	150

(1) Assumes Worst Case Meteorology and 4.25 wt % sulfur fuel
(2) Based on USEPA standards, except for the 24-hr. SO_2 World Bank standard

2.3.2 Water Quality and Biology

2.3.2.1 Water Quality

The impact on water quality is determined by evaluating the degree to which liquid and thermal discharges from the plant facilities affect baseline (existing) levels of selected chemical constituents and water temperature and directly impact biological resources.

Industrial discharges in the Dominican Republic are not regulated to any great extent and are not subject to rigorous review against regulatory guidelines. In interviews with engineers from CDE, it is apparent that only drinking water supplies are monitored on a regular basis. It appears that monitoring at industrial facilities, such as at the existing power plants, is conducted to ensure that the cooling water is within operational guidelines for the plant itself, but not to determine compliance with environmental or other regulatory standards.

There is, therefore, no apparent documentation on the quality of the cooling water discharge or any of the other discharges that are released from the existing power plants. In addition, relative volumes, flow rates, and sources of any other liquid wastes from the plants is

difficult to determine. With these shortcomings taken into consideration, no quantifiable impacts to water quality can be determined; only qualitative assessments can be made.

It is possible that significant thermal plumes are being created in the Iguamo River and in the ocean through discharges from the San Pedro de Macorís and Itabo plant, respectively. During the site visits in February 1994 by the EA team, it was observed that the cooling water effluent was steaming significantly and the air temperature at the outfall was noticeably warmer than the surrounding vicinity. During an April 1994 visit to San Pedro de Macorís, the intake water temperature was 28.1 °C and the discharge was 35.8 °C. According to the plant workers, the intake water temperature averages 31 °C in the summer and 28 to 29 °C in the winter. Cooling water discharge temperatures supposedly average 32 °C throughout the year. It is not known, however, if the temperatures observed and quoted are representative of other power plants in the Dominican Republic.

The general practice in the Dominican Republic is for cooling water to be discharged directly into the receiving waters. In the absence of any discharge point diffusers or cooling towers, there is most likely a significant rise in ambient water temperatures adjacent to the cooling water effluent. This plume may remain buoyant for a distance from the discharge point and remain stratified and unmixed. In calm water, the plume may remain unmixed for a considerable distance, but that distance can decrease with increased wind and currents causing turbulence and mixing.

The use of brackish to marine waters for cooling may lead to the fouling or clogging of supply pipelines, conduits, or tubing by the growth and eventual encrusting of marine algae and invertebrates on this equipment. A standard practice for removing this material is the use of some type of biocide, such as hypochlorite or chlorine. It is possible that these compounds are being used at the existing facilities and then being discharged into the receiving waters without pre-treatment to neutralize the chlorine.

Heavy metals may be leaching from various sources at the existing facilities. Heavy metals may originate from corrosion of pipes caused by exposure to the marine water, leaching from improperly disposed fly ash, or even biocides that are copper-based. The specific constituents and concentrations in the effluent and receiving water are unknown.

Surface water runoff from the existing sites apparently is collected in some type of drainage system and discharged directly to the receiving waters. This runoff would originate from any of the paved areas (parking lots, loading areas, storage sites) and unvegetated vacant land around the sites, thereby possibly contributing concentrations of any of the chemicals used at the plants, such as oils, grease, and suspended solids. It does not appear that there are any settling basins, grease traps, or monitoring locations associated with the discharge lines. Because the drainage system is open, it is likely that any sewer wastes such as waste oils, lubricants, solvents, and cleaners are disposed into the system. Storage areas for sodium hydroxide and sulfuric acid are not segregated from the rest of the plant and thus any spillage of these chemicals most likely also flows into these drains.

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The dock at the San Pedro de Macorís site shows evidence of oil spillage during fuel transfer operations (see Exhibit 2-5). This is evidenced by a heavy coating of black oil residue on the dock. According to the plant workers, it does not appear that there are oil spill prevention or contingency plans in place during fuel handling. Any spillage then goes uncollected and untreated into the Iguamo River, thereby contaminating the surrounding waters and sediments with various petroleum hydrocarbons.

The coal pile at the Itabo site is completely open to the elements and not surrounded by any structures that would contain surface water runoff from the pile. There are no apparent drainage systems serving the coal pile. It is most likely that in heavy rains, coal dust is washed from the pile and transported to the surrounding surface waters or ocean.

The ash disposal area at Itabo, as described in Section 2.3.3 "Solid Waste Disposal," is inadequately designed to handle this type of waste. Due to the slope of the site and unrestricted disposal of unknown wastes and ash from the power plant, the surface water runoff from the disposal area is likely to be highly contaminated with various heavy metals from the ash and possibly organic compounds from the unknown waste, as shown in Exhibit 2-5.

2.3.2.2 Biology

Terrestrial Biology. Because guidelines for the protection of biological resources are still in the development stage within the Dominican Republic, existing power facilities were completed without consideration of the impacts to terrestrial flora and fauna. Therefore, it is not known whether the existing plants were built in significant habitats of any sensitive or special status plants or animals.

The only impact to terrestrial biology that is apparent from a visual observation is associated with ash disposal at the Itabo site (see Exhibit 2-5). The disposal areas have not been cleared of native vegetation and they accept not only ash but a mixture of other solid waste materials as well. The vegetation remaining on the site does not appear to be healthy and is steadily being covered by the waste. Leaching of contaminants from the ash and other waste occurs with subsequent uptake by the vegetation both on and off site. This may lead to the bioaccumulation of contaminants such as heavy metals in roots, stems, leaves, and seeds, all of which can be eaten by the local fauna. Ingestion of the contaminated vegetation can lead to biomagnification of these chemicals in higher trophic levels, which could eventually lead to adverse population and community effects in, for example, local birds and mammals. These effects can include reproductive failure, reduced viability of young, deformities, and eventual loss of the more sensitive species.

Aquatic Biology. As with the terrestrial biological resources, environmental regulations concerning the protection of aquatic resources have not been adopted. In addition, no surveys have been conducted in the intake/receiving water around any of the existing power facilities. With this lack of information, it is difficult to determine the type and magnitude of impacts due to the existing plants. It can be assumed, however, that with the degraded water quality

being discharged from the facilities, the resources of the receiving waters are being adversely impacted.

It appears that there may be a significant thermal load from the cooling water effluent discharged into the receiving waters. Without monitoring, however, it cannot be determined whether this has significant biological effect. Some fisheries agencies in other countries, such as the island of Cyprus in the Mediterranean Sea, allow for a discharge to be up to 10 °C above ambient temperatures. It is not known whether this temperature differential above the ambient level is within the tolerance ranges of the fishes present in the waters surrounding the Dominican Republic. There is, however, anecdotal evidence from the plant workers at San Pedro de Macorís that local fishermen are very successful at catching fish near the thermal plume caused by the cooling water effluent discharge.

In addition to the impacts to aquatic resources caused by contaminants in the water column, it is likely that various fishes are being impinged or caught up against the intake screens. Other fishes may be sucked through the screens and become entrained in the intake system. If intake structures are located in important fisheries habitats, this may be having a deleterious effect on fish populations in the localized area.

2.3.3 Solid Waste Disposal

Solid waste disposal impacts are determined by evaluating the extent to which disposal methods adversely affect soil, ground, and surface water quality, and create a potential public health hazard which poses a threat to people, animal, or plant populations in the affected area.

The solid waste disposal practices in the Dominican Republic power sector follow no specific regulations or technical guidelines. The two primary solid waste streams produced from power generation at existing plants are coal ash and sludge material cleaned from fuel storage tanks. As demonstrated at the Itabo disposal site in Exhibit 2-6, wastes are indiscriminately discharged on land with little attention to siting criteria and subsequent environmental impacts to both the natural and human environment. There are both direct and indirect adverse environmental impacts resulting from the current disposal practices. The direct impacts are contamination of soil surface and groundwaters, which may be succeeded by contamination of the food chain, and contamination of present and future drinking water supplies.

The lack of control over solid waste streams is the largest cause of impacts related to improper solid waste disposal in the power sector and is exacerbated by the absence of data regarding waste quantities and their chemical compositions. No on-site chemical analyses are conducted on solid wastes and the specific chemical composition is indefinite. Since the quantity of wastes generated in the power sector is not systematically recorded on a plant-by-plant basis, the total disposed quantity is also unknown. In the absence of analytical data and public health studies, it is uncertain to what degree these haphazard disposal practices have already impacted the natural environment and subsequently human health. Further, this lack of quantification makes the effects on the human and natural environment

greatly unpredictable. A potential problem, therefore, may not be noticed until it becomes a serious threat to the environment and human health. As the country develops its power sector and other sectors, these existing effects will only intensify as waste streams increase and diversify.

Despite the deficit of quantified data, some general impact conclusions can be drawn for each of the potential solid waste streams.

2.3.3.1 Coal Ash

The composition of ash from the coal-fired plants in the Dominican Republic is dependent upon type of feed coal, boiler configuration, and, firing temperature. Particle size is determined by firing conditions and pollution control efficiency. The primary coal source for existing coal-fired plants is Colombian coal which is of medium quality. A higher quality of coal would generate a lower quantity of ash. There are three basic types of ash: bottom ash/slag, mechanical hopper ash, and fly ash. Fly ash captured by electrostatic precipitators (ESPs) is the most common in the power sector. Although chemical compositions vary, heavy metals are always present in the fly ash.

Although coal ash is generally considered non-hazardous in the U.S. when properly disposed, it contains substances that are leachable in potentially toxic quantities. Since no chemical analyses have been conducted on the ash disposed on land sites throughout the country, it is unknown whether the ash should be considered hazardous. The toxicity characteristics of the ash leachates are, therefore, also unknown. The levels of elemental concentrations in ash leachate vary considerably in U.S. studies and leaching patterns are different for the elements depending on the solubility properties of the constituents. Studies in the U.S. have demonstrated the leaching potential of metals such as lead, arsenic, barium, cadmium, chromium, mercury, silver, and selenium in toxic quantities.[13]

Current ash disposal practices in the Dominican Republic power sector, as demonstrated at the Itabo disposal site, are directly impacting the natural environment by contaminating the soil and thus impacting vegetation growth cycles (see Exhibit 2-5). Heavy metal concentrations may be leaching into the ground and surface waters, adversely affecting biological resources. Further, the uncontrolled drainage at the Itabo disposal site may be significantly impacting the coastline by contaminating the seawater and adversely affecting the biological resources there. The residents near the Itabo disposal site may be directly impacted as they are permitted to travel the road adjacent to the site and scavenge the site for food. They may be directly ingesting the ash.

Secondary or indirect impacts may also result from ash disposal practices. Present and future drinking water supplies may be contaminated by metal concentrations leaching first into ground water resources and eventually migrating to surface waters. As observed at the Itabo disposal site, animals such as pigs, goats, cows, and chicken wander this area in search of

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13 EPRI, 1983; Tripodi, et.al., 1980.

food and are likely ingesting the ash directly. In addition, due to the probability of the uptake of heavy metals by plants, the animals are likely contaminated by this route as well. As the metals bioaccumulate up the food chain, these animals, which are sources of food and milk for nearby residents, are contaminated with these potentially hazardous metals such as lead, vanadium, and chromium.

2.3.3.2 Sludge

In power plants using oil as the primary or secondary fuel source, an asphaltic material is removed from on-site fuel storage tanks when the tanks are sporadically cleaned. The sludge material is indiscriminately placed in open pits (see Exhibit 2-6) or is pumped directly from the tanks into unlined underground storage pits. The unmanaged open pit disposal areas observed at the Puerto Plata plant are located next to the storage tanks on a hill with a natural slope towards the sea. This disposal site is in close proximity to residential settlements and a historic building, which is reportedly a tourist attraction. At the Los Mina plant, the sludge is pumped directly from the tanks into unlined underground pits where it is free to contaminate the surrounding soil and ground water resources.

This asphaltic or sludge material is a mixture of the heavier hydrocarbons, relatively small amounts of water, and inorganic material such as sand. The potential impacts of these current disposal practices to soil and ground surface waters depend on the quantity of sludge applied to the land and the soil type, its permeability, and attenuation capacity. Generally, many of the higher hydrocarbons present in the sludge material have a low water solubility and adhere strongly to the soil and are thus not readily mobile in it. It is possible, however, that contaminants such as lead and vanadium leach into groundwater resources. The affected soil will not support any vegetation and surrounding vegetation may be destroyed where contaminants migrate. The affected soil will have an accumulation of metals such as chromium, copper, lead, zinc, and vanadium. At existing facilities, the large quantities of this material applied to the soil will result in larger accumulation and therefore increase migration of these contaminants to surrounding soil and ground and, eventually, surface waters.

2.3.4 Land Use/Social

Land use/social impacts are determined by evaluating the compatibility with surrounding uses; the ability of the site to accommodate the power plant in terms of traffic, noise, and visual impacts; the effects on aesthetic resources vital to areas with intensive tourist and recreational uses; and the availability of necessary infrastructure such as access roads and ports. Social impacts are determined by the relocation of existing residential and commercial establishments, disruption of established communities, the hazards to public health, and the effects on quality of life and changes to employment.

There are no land use management guidelines or procedures in the Dominican Republic, and in their absence, non-industrial uses are permitted adjacent to the power generation facilities. The two uses most seriously affected by these land use practices are residential and recreational/tourism.

2.3.4.1 Residential

Although many plants are in primarily industrial areas and are dedicated sites, sporadic residential settlements such as shacks or run-down detached homes occur along the facility perimeter fence line. For example, at Timbeque, shacks are located up against the fence line, approximately 8 meters away from 2 gas-turbine generators (see Exhibit 2-7); at the Santo Domingo plant, the immediate area is industrial in nature, yet residential units surround the plant and residents are permitted to use the plant access road; at San Pedro de Macorís, residential settlements are located just over the fence line approximately 500 meters away from the plant. Residential uses are also permitted next to disposal sites as observed at both the Itabo ash disposal site and the Puerto Plata open pit disposal area, which is located in close proximity to residential settlements.

2.3.4.2 Recreation/Tourism

The aesthetic quality critical to the economic value of recreation and tourist areas is adversely affected by the improper siting of plants in proximity to these areas. The most striking example of this adverse impact is the Puerto Plata plant located in an area of substantial tourism (see Exhibit 2-7). Fuerte San Felipe, a historic building of touristic value, is located only 15 meters away from the plant boundaries, fuel oil storage tanks and large open sludge pits. The plant is located approximately 500 meters south of the Malecón road running along the rocky shoreline and 200 meters west of the center of a town that is a point of interest and shopping center for many visitors. Plant emissions blow directly over the town and the high stack and brownish plume of the Puerto Plata plant, located atop a hill, are also visible from many tourist locations such as the hotels along the Costamber and several historic buildings.

Although the extent to which tourism is directly impacted by poor land use management exemplified by the Puerto Plata plant is difficult to quantify in monetary terms without extensive studies, it is clear that the lack of land use management practices compromises the value of recreational resources.

2.3.4.3 Social

The direct adverse impacts to residential settlements are, depending on their severity, either nuisance impacts affecting the quality of life or serious impacts to public health. The residential settlements are exposed to nuisances such as low-level noise from generators, industrial traffic, and plant operations; dust from industrial traffic; poor air quality surrounding the plant; and aesthetic concerns such as stack plume, poor plant maintenance, disposal of scrap metal, minor oil spills, and coal dust. Aggregated, these nuisances adversely impact the quality of life at these locations.

These nuisances, however, in more severe quantities may also significantly impact public health. Although studies evaluating such health impacts have not been conducted, and noise, air, and water quality have not been monitored, qualitative conclusions can be drawn regarding the potential health impacts to the nearby residents. Residents' health is adversely

affected by continuous noise levels greater than 65 Ldn[14] (HUD, 1992) exemplified at the Timbeque plant. The careless handling of fly ash at the plant at San Pedro de Macorís has resulted in undetermined amounts of ash spilling into the storm gutters and onto the vegetated area of the proposed site where animals are free to graze and drink from stillwater ponds. The type and extent of these existing and other impacts such as noise and air quality on the residents living approximately 500 meters southwest of the plant is unknown. However, during field research, a plant employee indicated that he knew of residents with respiratory problems apparently caused by intake of the ash. In addition, living in close proximity to power plants subjects residents to the potential serious consequences of plant accidents such as fire, explosions, fuel oil spills and power line and power station accidents. However, the single greatest impact resulting from these land use practices is the effects of unmanaged disposal and handling of waste materials, in particular fly ash, on human health as described in detail in Section 2.3.3, "Solid Waste Disposal."

2.4 ENVIRONMENTAL COMPLIANCE CONSTRAINTS

Several factors contribute to the lack of compliance in the Dominican Republic power sector with internationally accepted environmental standards such as those outlined in Section 2.2, "Existing Environmental Impact Norms." These constraints, consisting of economic, maintenance, and reporting/monitoring factors, severely limit the capability of the Dominican Republic to develop and operate facilities in an environmentally responsible manner.

Economic constraints are the primary factors inhibiting environmental compliance in the power sector. The following problems result from a lack of properly applied funding and contribute to the environmental degradation in the Dominican Republic:

- Inadequate retrofit with modern pollution control equipment (direct cost of additional units, but also the cost of fitting it into existing operations)
- Inadequate number of qualified personnel and training of less qualified employees to operate and maintain existing plants at maximum efficiency to achieve substantial air quality benefits
- Inability to use higher quality fuels (coal and higher quality petroleum distillate) in order to reduce the volume of plant emissions
- Lack of maintenance of non-essential equipment and systems, resulting in low efficiency operation and compensation for equipment defects, and equipment repair only when plant operations are threatened (see Exhibit 2-8)

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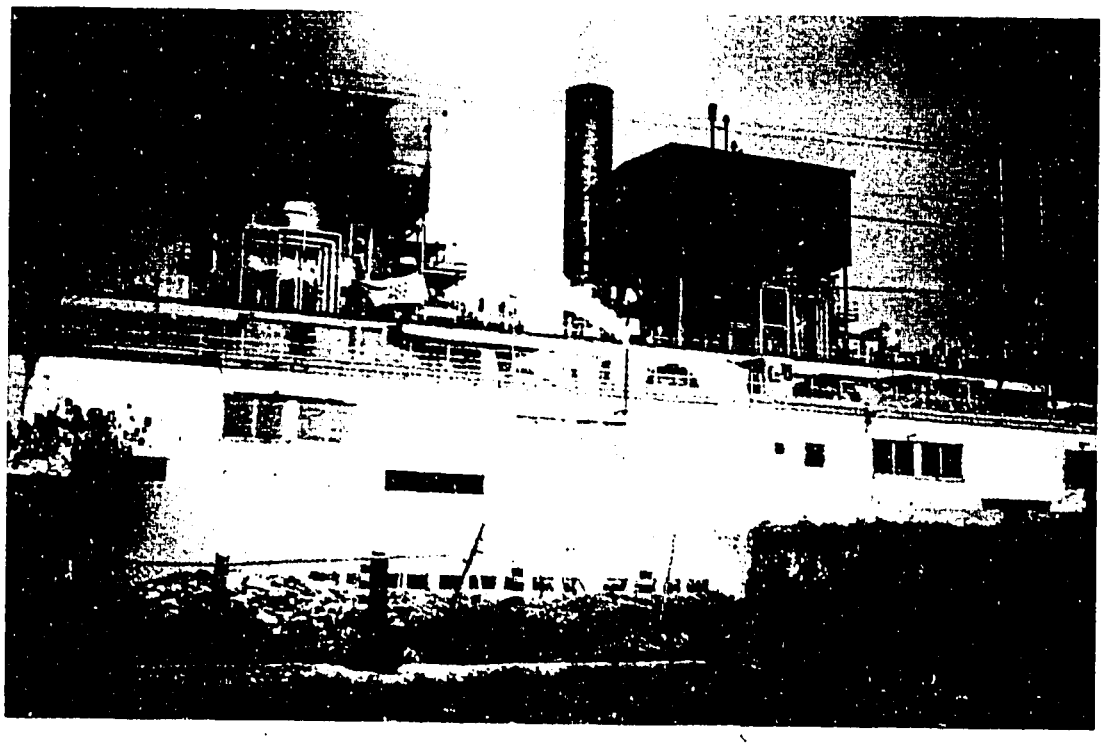
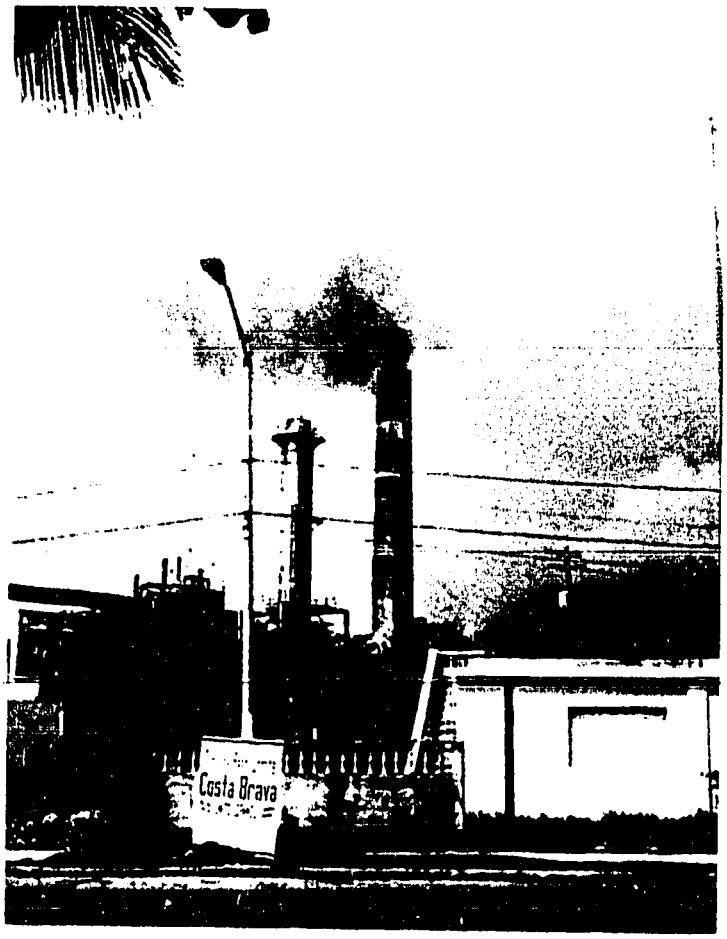
14 Ldn is the 24-hour average sound level, in decibels, obtained from the accumulation of all events with the addition of 10 decibels to sound levels in the night from 10 p.m. to 7 a.m. The weighing of nighttime events accounts for the usual increased interfering effects of noise during the night, when ambient levels are lower, and people are trying to sleep.

Poor maintenance results from insufficient funds to maintain plant efficiency and to adequately compensate employees so that care is taken not to dispose of scrap metal, equipment, building materials, and trash on the plant site.

An equally important factor contributing to the lack of environmental compliance in the Dominican Republic is the absence of a coherent environmental institutional structure to effectively promulgate and enforce environmental standards. There is no system in place that requires the power sector to monitor or report environmentally significant information such as the quantity and quality of air quality emissions and solid waste streams. Therefore, there is no incentive or reason to collect information that is not perceived by plant management to be essential to plant functioning. The limitations of the environmental institutional framework are further described in Section 3, "The Dominican Republic Environmental Institutional Framework."



Stacks at Haina Plant

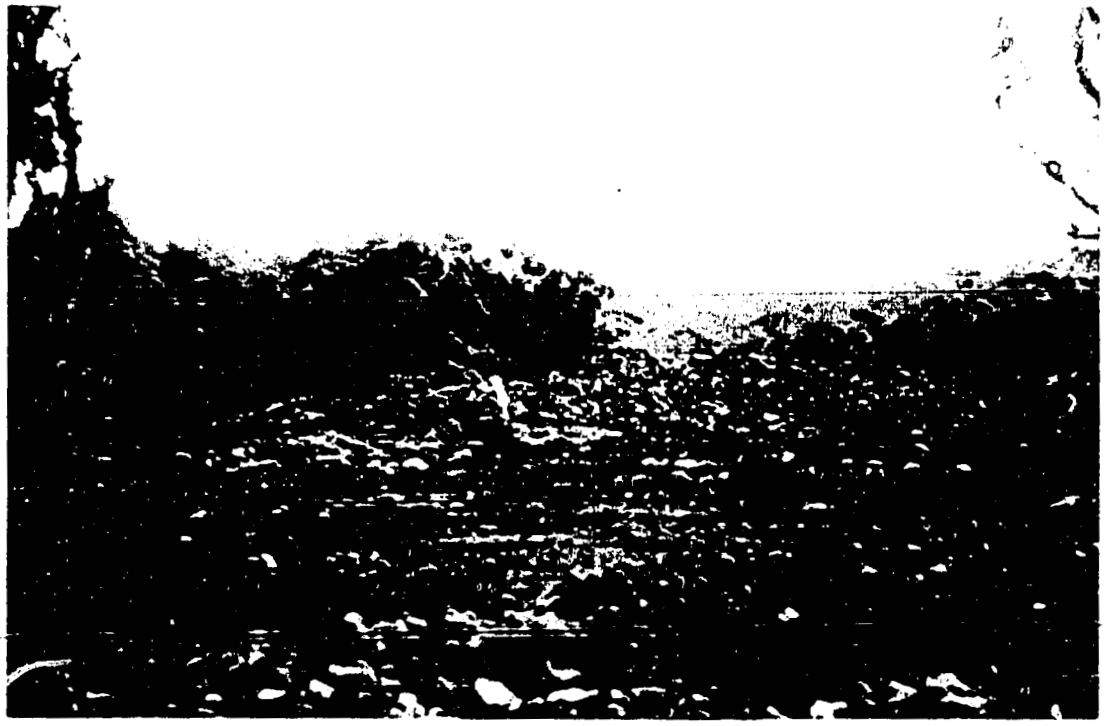


Stack at Puerto Plata Plant

Exhibit 2-4

Air Quality Effects

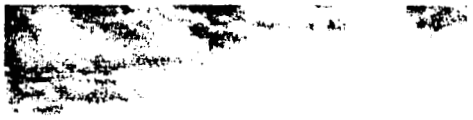
Oil spillage at San Pedro de Macorís



Disposal site at Itabo

Exhibit 2-5
Water Quality/Biology Effects

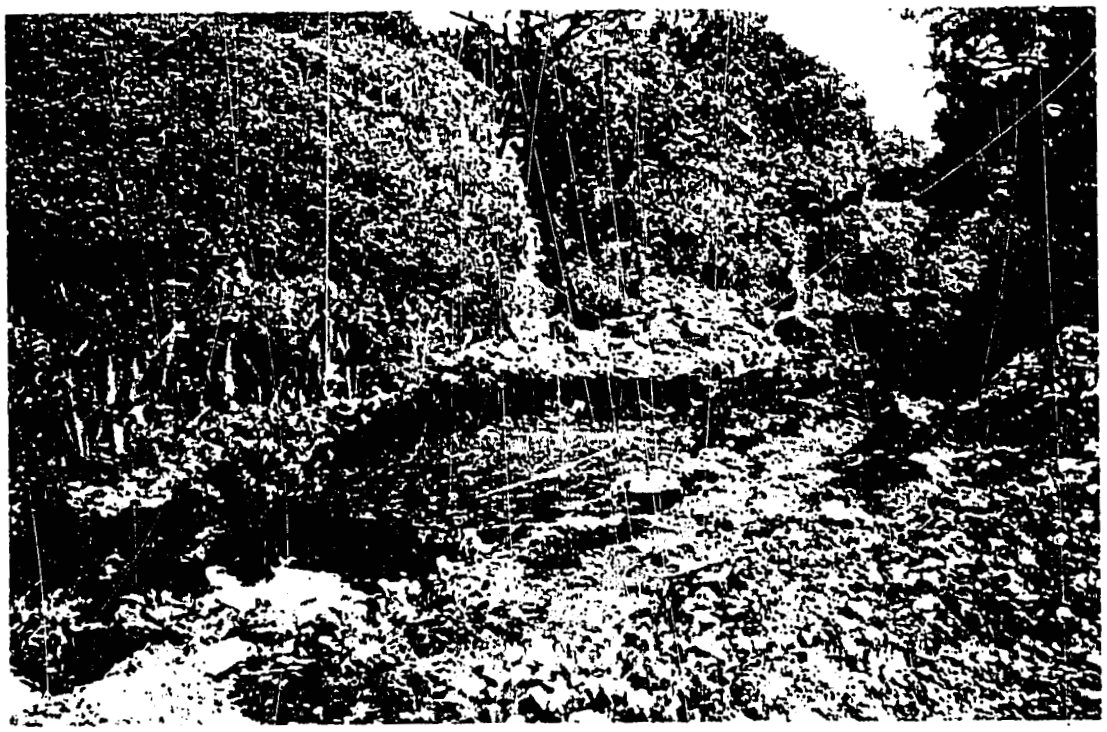
Itabo coal ash disposal site



Coal ash spillage at
San Pedro de Macorís

Exhibit 2-6

Solid Waste Disposal Practices

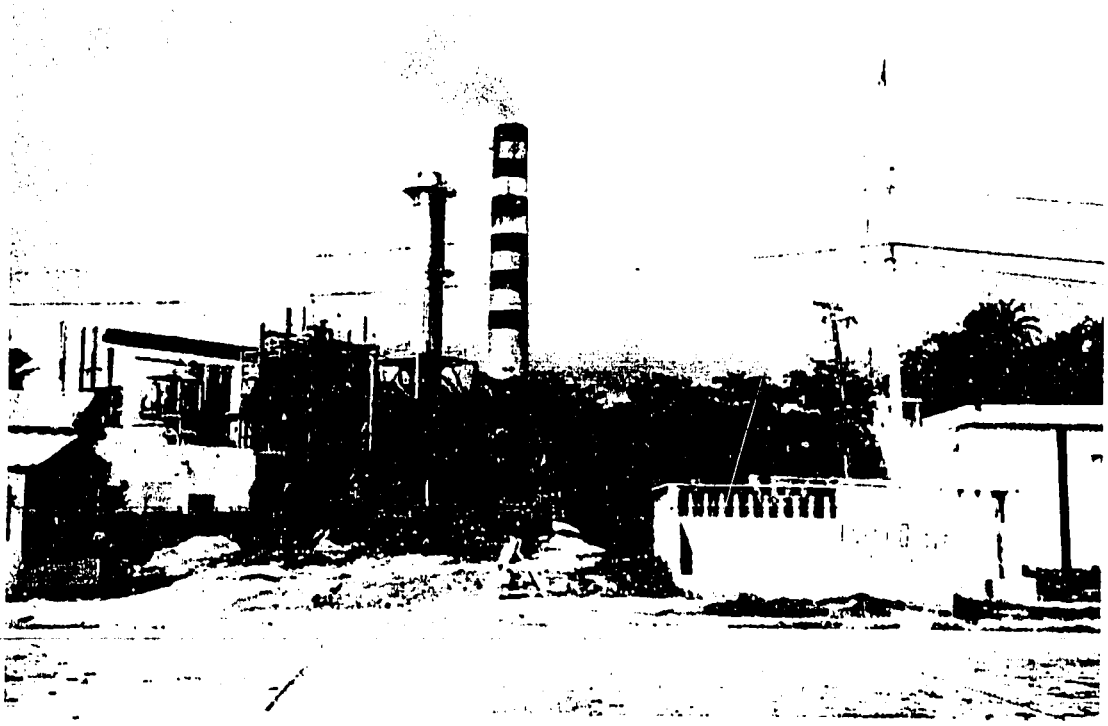


Open pit sludge disposal at Puerto Plata Plant

Exhibit 2-6 (Cont'd)

Solid Waste Disposal Practices

Shacks along the fence at the Timbeque Plant



View from the Malecón of the stack at the Puerto Plata Plant

Exhibit 2-7
Land Use/Social Effects

Exhibit 2-8
Plant Maintenance Activities

3. THE DOMINICAN REPUBLIC ENVIRONMENTAL INSTITUTIONAL FRAMEWORK

Environmentally sustainable development of power sector projects in the Dominican Republic will depend on the integration of an environmental management capability into the country's institutional and regulatory framework. This section presents an overview of the current legal and regulatory situation in the country. A detailed review of all laws, regulations, and environmental agencies is beyond the scope of this EA. Therefore, the analysis in this section is based on a review of previously completed reports and studies, and interviews of the EA Team in March and April, 1994 with agency staffs and key environmental committee members in-country (see Section 9, "Organizations and Persons Consulted").

3.1 POLICY AND LEGAL FRAMEWORK

A clear, national environmental policy based in law is essential to incorporating environmental concerns into planning and development and to ensuring appropriate environmental protection and management.

3.1.1 Existing Environmental Policy and Laws

The first policy initiative to integrate environmental management into the Dominican Republic governmental framework was formulated in the 1992 United Nations Conference for Environment and Development (UNCED) report. In that initiative, GODR supported the concept of sustainable development, elaborating on critical environmental problems such as deforestation, unregulated industrial pollution, and the declining quality of life, including health and education. The UNCED country report presented a cohesive environmental strategy addressing land use, sustainable natural resource development, institutional and human resource development, and financing of environmental programs and projects. Consequently, the preparation of several plans was undertaken with support from the international donor community: the Tropical Forestry Action Plan; the National Tourism Development Plan; the Water Resource National Plan; the National Health Plan; and the National Potable Water and Waste Water Plan. The status of these plans is unknown at this time.

At present, there is no comprehensive environmental law in place, but some existing laws and resolutions contain policy statements or isolated standards pertaining to various aspects of the environmental quality. The Public Health Law (1956) regulates all aspects related to public health, such as contamination of potable water, solid waste disposal, and water and food contamination. Law 128 (1988) prohibits the import of certain types of solid wastes into the Dominican Republic. Law 217 (1991), to be administered and enforced by the State Agriculture Secretariat, prohibits the import or commercial use of certain pesticides and other potentially dangerous chemicals.

There is also enabling legislation for agencies and commissions charging them with responsibility for a particular aspect of environmental quality. This legislation does not generally contain a structural governmental framework for execution of these responsibilities. Annex C lists these agencies and their enabling legislation.

Discussions with agency staffs and key environmental committee members[1] indicate that there is growing environmental awareness and concern among the Dominican public. Individuals from these staffs and others have been identified as being qualified to participate and perform as part of the new institutional and regulatory framework resulting from the passage of the proposed environmental law.

3.1.2 Proposed Environmental Policy and Law

The comprehensive environmental law, "Ley de Proteción y Calidad Ambiental," which sets forth national environmental policy, has been drafted and is currently awaiting Presidential approval before being submitted for Congressional approval.

3.1.2.1 Purpose of the Law

The fundamental purpose of the environmental law is to protect, defend, preserve, and restore the environmental quality of all natural resources. The law addresses all aspects of environmental quality; designates La Comisión Nacional para el Medio Ambiente as the environmental oversight agency; and stipulates enforcement provisions and penalties for violations of environmental norms. The law emphasizes the rational use of resources and directly prohibits any public or private actions that would contribute to the degradation of air, water, and land-based resources. The law does not set forth practical guidelines for policy implementation. Provisions such as specific agency responsibilities and protocols for agency coordination, review, monitoring, and enforcement have not yet been drafted.

3.1.2.2 Scope of the Law

The water quality provisions in the proposed law require permits to use national waters; direct the establishment of water quality protection zones for water bodies already seriously degraded; prohibit industrial and other contaminating discharges into national waters; and, in the absence of municipal capacity, obligate all industries and major developments (including hotels) to be responsible for providing their own adequate wastewater disposal systems. To address air quality, the law identifies particular emission types and their potential sources to be regulated to avoid deterioration and degradation of air quality. The law identifies the preservation of biodiversity as a goal and the protection of specific ecosystems as a national priority. Native flora and fauna are also afforded protection. Flora and fauna species of national interest and protection are cataloged. Land use and solid waste disposal are also regulated in the proposed law. The Comisión Nacional para el Medio Ambiente is required to develop a national zoning plan. Also required is a solid waste disposal plan which coordinates collection with communities and requires disposal in areas with minimal permeability in order to prevent leaching.

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1 Hector Guiliani Cury of Equipo Técnico on March 7, 1994: Eleuterio Martínez of ONAPLAN on March 11, 1994: Dr. Antonio Thomen of Comisión Nacional para el Medio Ambiente on March 13, 1994.

3.1.2.3 Responsible Agencies

The proposed law endows the Comisión Nacional para el Medio Ambiente with all aspects of environmental oversight and sets forth its responsibilities. Most importantly, the Comisión Nacional para el Medio Ambiente will be responsible for setting environmental norms, rules, and regulations; reviewing environmental and social impact statements; and, in general, coordinating all government and private sector actions related to environmental quality. Its organizational structure will incorporate the relevant existing agencies so that, in theory, it will have administrative oversight of these agencies. Specific responsibilities of existing or new agencies still have to be defined. Agency coordination guidelines for compliance activities such as permit review procedures must still be identified.

3.1.2.4 Guidelines and Procedures

Environmental norms, to be developed by the Comisión Nacional para el Medio Ambiente, include such standards as air quality emission limits, effluent discharge types and limits, noise levels specific to land use, and conservation standards for ecosystem preservation. An Evaluación de Impacto Ambiental y Social (EIAS) will be required before a license is granted to execute a project that may have a potentially adverse impact on the environment. The law identifies some of the types of projects and activities that will require impact statements, such as airports, ports, power plants, and other major projects. It also outlines required sections for EIASs, such as detailed project description, description of the area of impact, identification of project alternatives, and prediction of impacts. The law also makes extensive provisions for public review of the EIAS.

3.1.2.5 Compliance and Enforcement

Although the law is specific regarding legal sanctions for noncompliance with its provisions, individual compliance and enforcement responsibilities of the agencies are still to be identified.

3.2 EXISTING REGULATORY FRAMEWORK

3.2.1 Current Responsible Agencies

Currently in the Dominican Republic, the responsibilities for environmental protection are distributed among numerous government organizations. As shown in Annex C, approximately 26 agencies or commissions are responsible for regulating some aspect of environmental quality. There is no designated agency for air quality or industrial waste management. Several organizations were created by Presidential Decree to study specific environmental issues. These agencies lack operating budgets and authority to regulate the problem for which they are responsible. There are also a number of agencies responsible for planning, development, and protection of natural resources, such as the Subsecretaria de Estado de Recursos Naturales (SURNEA-SEA), the Dirección General Forestal (DGF), the Instituto Nacional de Recursos Hidráulicos (INDRHI), and the Dirección Nacional de Parque (DNP).

These organizations have overlapping missions and responsibilities, and the institutional relationship between organizations remains legally and administratively undefined. For example, it is the joint responsibility of several organizations to formulate environmental policy and strategies, and several are also involved in the parallel development of environmental standards and norms. The regulation of industrial effluents is a conspicuous example of agency duplication and redundancy, with Instituto Nacional de Aguas Potables y Alcantarillados (INAPA) in charge of planning and construction of potable water systems and Corporacíon de Aguas y Alcantarillado de Santo Domingo (CAASD) responsible for the administration and development of potable water systems in Santo Domingo. Both agencies, along with INDRHI, have responsibilities for regulating industrial discharges as well as management of potable water supply. The apparent lack of coordination and information-sharing between the existing organizations indicates a need for an effective method for assigning responsibilities among agencies.

The responsibilities for national environmental management and planning are also distributed among several organizations. A brief description of the organizations that are directly charged with the task of environmental management follows:

- **Oficina Nacional de Planificación (ONAPLAN).** The Environmental Department of ONAPLAN, the national planning agency established in 1967, is in the process of formulating national environmental policy and plans, including the Territory Master Plan, the Ozama River Clean Up Plan, and Environmental Protection Standards.

- **La Comisión Cumbre de Tierra.** Following the United Nations Earth Summit in 1992, this Comisión was formed by Presidential Decree 340 to carry out Agenda 21 and the resolution of the UNCED conference. The president of the Comisión is the Vice President of the Dominican Republic, and the Comisión executive director is the director of ONAPLAN. According to Agenda 21, the Comisión is responsible for developing the nation's environmental strategy by coordinating all of the Dominican Republic's agencies and commissions. The Comisión is also preparing to develop national environmental standards.

- **La Comisión Tecníca Ecológica.** Created by Presidential Decree 226 in 1990, the Comisión Tecníca is responsible for policing the pollution of water quality resources caused by solid waste, chemical, and industrial pollution. In the absence of a legal regulatory framework or monitoring system, the Comisión Tecníca has acted as environmental police, collecting RD$20 million in fines from polluting industries. The Comisión Tecníca is preparing to develop technical standards and environmental norms.

- **La Comisión Nacional para el Medio Ambiente.** La Comisión Nacional para el Medio Ambiente, created in 1987 by Presidential Decree 157, is the agency whose mission most resembles that of an environmental oversight agency. The Comisión is currently responsible for the control, reduction, and elimination of activities that are harmful to human health and the ecosystem.

3.2.2 Current Guidelines and Regulations

Currently in the Dominican Republic, a process for the screening, preparation, and review of EIAS does not exist for power plants or any other projects that may adversely impact the environment. This means that environmental and social considerations are not included in power project development. There is no public involvement, and no mitigation measures are required to offset any adverse impacts. Further, since EIASs are not required for public or private projects, there is a substantial lack of data on baseline conditions for water quality, air quality, wetlands, biological resources, land uses, and other important resources.

Environmental regulations are scattered among separate agencies and are reported to be both redundant and technically inconsistent. Consequently, environmental permitting processes for water quality discharges, air emissions, and other relevant impacts associated with power plant operation and development do not exist. There are no air quality emission limits or ambient air quality standards, nor are there any provisions directly regulating the disposal of potentially hazardous wastes, such as coal ash and sludge material. There are water quality standards and industrial discharge standards which have been developed. NORDOM 436 establishes a set of physical and chemical norms for industrial effluents with which responsible industries should comply. NORDOM 1 establishes the required potable water quality norms. These existing water quality standards and regulations are detailed in the report "Red Nacional de Monitoreo de Calidad de Aguas para la República Dominicana."[2] In the absence of permitting processes, it is unclear how these existing water quality standards for human drinking water, industrial effluent standards, and the provisions for potable water quality established in the Public Health Law (1956) are implemented, if at all, by responsible agencies.

3.2.3 Current Compliance and Enforcement

In general, compliance with the few existing environmental laws, regulations, and standards is reported to be weak and highly inconsistent. The absence of an administrative process to both inform potential industrial applicants of the standards in place and to ensure compliance via a permitting process severely inhibits compliance with any promulgated standards. Some existing power plants do conduct monitoring of discharges. For example, the San Pedro de Macorís plant monitors temperature of the plant outfall to the receiving body of water. However, these results are not systematically recorded, nor are they reported because there are no compliance requirements or enforcement mechanisms.

3.3 ISSUES IN THE ENVIRONMENTAL LEGAL AND REGULATORY FRAMEWORK

The extent of the existing institutional constraints to environmental management in the Dominican Republic has been described in several studies and reports such as The Country Environmental Profile (USAID, 1981); Dominican Republic Issues and Options in the Energy Sector (ESMAP, 1991); Dominican Republic National Report (prepared for the UNCED

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2 INDRHI, Informe No. 63, (April, 1993).

Conference, 1991) Dominican Republic; and Environmental Issues Paper (World Bank, 1993, an unpublished report).

The current institutional capacity of the Dominican Republic is weak due to unclear and undefined national environmental policy, limited human and financial resources, and severely fragmented organizational structure. The lack of a financially and legally sanctioned environmental policy-making body has resulted in ad hoc national environmental polices and management. The current implementation of environmental law and policy in the Dominican Republic does not facilitate the incorporation of environmental or social objectives in economic development, planning, budgeting, and decision-making. The commitment to a clear national environmental policy has only recently begun.

Environmental laws and standards regarding resource use, resource protection, environmental quality, pollutant discharge, waste disposal, and facility siting are weak or nonexistent. Further, there is an absence of regulation to implement the few existing laws, which makes compliance unrealistic. The absence of an environmental assessment process results in projects which do not incorporate interdisciplinary environmental issues or community participation. Institutional functioning is also constrained by inadequate operating budgets and lack of environmental training and management at the agency level.

The environmental agencies appear to be isolated and not integrated into the economic development planning and decision-making for projects in all sectors. Thus, existing agencies have little opportunity and incentive to share information and coordinate and integrate responsibilities, which compounds the problem of redundancy and conflict. Further, it is difficult to discern which law is in effect and which agency is in charge. It is also difficult to distinguish between those regulations and agencies that may be effective in protecting some aspect of environmental quality and those that are extraneous. Overall, the institutional structure in the Dominican Republic lacks the capacity to ensure compliance and enforcement of standards.

The weak institutional capabilities discussed above at once contribute to and are exacerbated by a lack of information regarding existing environmental problems. Potentially significant environmental problems are not noticed until they become a serious threat involving irreversible change. This information gap is caused by the absence of monitoring systems, public awareness, an effective environmental management system, and enforced technical standards. Preventative action intended by the proposed environmental law and management system recommended in this document will be difficult with this serious lack of data. Identification of the existing environmental problems and environmental baseline data will be important to environmental protection during the development of the environmental management capacity.

The regulatory and institutional framework proposed by the environmental law is, clearly, a much needed first step to achieving a comprehensive approach to sustainable development of natural resources and environmental protection. The next task will be implementation of the proposed law by installing an organizational structure to support its requirements and developing measures to achieve significant institutional improvements.

4. REVIEW OF THE POWER SECTOR REGULATORY FRAMEWORK

4.1 INSTITUTIONAL FRAMEWORK OF THE ENERGY SECTOR

The agencies that participate in energy policy formulation and planning in the Dominican Republic are the Consejo Nacional para la Energía (CNE) and the Comisión Nacional de Política Energética (COENER), which advise the Office of the President on energy policy matters. Until now, the operational responsibilities for national power generation, transmission, and distribution have been met by the Corporación Dominicana de Electricidad (CDE). The Technical Group provides technical assistance to CNE in the current transition to a privatized power sector. ONAPLAN also has energy planning functions as part of its national economic planning responsibilities. Recently, in order to facilitate and promote private sector participation in electricity generation, the Directorate for Development and Regulation of the Electrical Energy Industry was created.

4.2 CURRENT POWER FACILITY ENVIRONMENTAL PERMITTING PROCEDURES

In the absence of a cohesive environmental strategy, comprehensive Environmental Law, and an inclusive environmental oversight agency, power sector policies do not consistently integrate environmental aspects. For example, considerations of air and water quality and solid waste disposal are not incorporated into power sector project planning and site selection. There are neither emission standards for power-related pollution nor environmental permitting procedures for plant operations. Currently, there is no government mechanism to ensure compliance should standards be developed on a case-by-case basis.

4.3 PROPOSED ENERGY REGULATORY AND INSTITUTIONAL FRAMEWORK

An integral component in the Dominican power sector reform is the proposed "Ley General de Electricidad" (Energy Law), which is currently under review by the Congress. This law establishes comprehensive reform of all aspects of production, transmission, distribution, and commercialization of electricity. It also revises the organizational functions of the State toward accomplishing efficient policy development and implementation.

4.3.1 Purpose and Scope of the Law

The fundamental purpose of the law is to ensure effective energy development with the optimal use of resources; promote private sector participation in the development of the energy sector; integrate the consideration of environmental aspects in energy development; promote fair competition in energy sector development; regulate prices to reflect a competitive market; prohibit monopolistic practices which inhibit competition into the production and commercialization of energy; and redefine the essential function of the State to be the promoter, regulator, and facilitator of effective energy production.

4.3.2 Responsible Agencies and Environmental Review Protocol

According to the proposed Energy Law, the organizations responsible for regulating the electricity subsector will be the Comisión Nacional de Energía and La Superintendencia de Electricidad, both new organizations created by the law. The Comisión Nacional de Energía, reporting to the Office of the President, will be responsible for energy policy development and oversight of the entire energy sector to ensure its proper functioning within the goals and objectives of this law. The Superintendencia will make recommendations to the Comisión Nacional de Energía and will be responsible for all aspects of implementation of energy sector development policy. Among its many functions, the Superintendencia will analyze and supervise electricity prices and tariffs; supervise the fulfillment of technical norms and standards of electricity production, transmission, and distribution; and apply fines and penalties for infractions of regulations and norms.

An application for a "concesión definitiva" (an authority to construct or operate an electric works) would be submitted to the Superintendencia for review and evaluation. The application, plus the Superintendencia's recommendations for approval or rejection of the project, would be forwarded to the Comisión Nacional de Energía. If approved by the Comisión Nacional de Energía, the application is forwarded to the Office of the President for final authorization. If approved by the Office of the President, the applicant would be granted certain rights usually restricted to the public domain and authorized to construct and operate an electricity works subject to the provisions of Energy Law.

4.3.3 Environmental Guidelines and Procedures

Included in the application for authority to construct and operate submitted to the Superintendencia, there must be a study assessing the environmental impacts of the proposed installation and the applicant's proposed methods to mitigate these impacts. The law requires that these mitigation measures comply with provisions and norms set forth by "the appropriate organization." For example, air emissions abatement measures must be in accordance with air quality emission limits, and mitigation of water quality impacts must adhere to the water quality standards. Since this environmental assessment is part of the application package, environmental considerations are, theoretically, incorporated into the project evaluation process. The law, however, does not indicate that the applicant would have to reevaluate the findings and proposed mitigation of the assessment if certain impacts have not been identified or if proposed mitigation measures are determined to be inadequate to offset adverse impacts.

Although there is no specific environmental permitting process set forth in this legislation, the law includes a general requirement that the Comisión Nacional de Energía "dictate norms to protect environment and ecology under which all energy enterprises will be subject to compliance." However, the law does not indicate what environmental resources (air, water, land use) these norms will address or how they might be developed. For example, the law does not mention coordination with any of the four existing environmental organizations, or the potential role of the Comisión Nacional para el Medio Ambiente.

4.3.4 Environmental Compliance and Enforcement

The law requires companies who are granted the authority to construct and operate plants to comply with all environmental norms and regulations. The Superintendencia is given the authority to enforce technical norms dictated by the Comisión Nacional de Energía and oversee compliance with these norms. The law does not specify implementation provisions for the Superintendencia's required compliance oversight functions, such as an environmental permitting and review process. The law also does not address enforcement mechanisms such as monitoring and inspection of mitigation measures identified in an approved permit to operate. Although the assessment of environmental impacts and mitigation measures is included in the application for authority to construct and operate a plant, the law does not obligate the Superintendencia or the Comisión Nacional de Energía to reject applications that do not mitigate environmental impacts to the proscribed standards. In addition, the law does not elaborate on how the Superintendencia might integrate its oversight and review responsibilities with other organizations listed in Annex C.

4.4 ENVIRONMENTAL ISSUES IN THE POWER SECTOR REGULATORY FRAMEWORK

Weaknesses in the energy sector institutional framework resemble the institutional fragmentation in countrywide environmental management functions. Currently, the institutional responsibilities in the power sector are inadequately defined, which results in lack of coordination and follow-up and overlap of agencies. Policies and programs are inadequately prepared and coordinated within appropriate agencies, and projects are selected without proper environmental considerations. Given the current institutional and regulatory framework, special interim measures will have to be undertaken to ensure that the mitigation measures proposed in this Sectoral EA will be effectively implemented and enforced.

The incorporation of environmental considerations into energy development policy and the requirement of an environmental assessment prior to the granting of authority to construct and operate a power plant by the Energy Law is encouraging. However, if the responsibilities of the Comisión Nacional de Energía and the Superintendencia to develop and enforce norms to protect environmental quality go undefined and uncoordinated with other relevant agencies, the current problems of technical and administrative duplication and conflict will be exacerbated. Close coordination between the implementation procedures for the Energy Law and the Environmental Law will be extremely important in realizing genuine environmental benefits. The Comisión Nacional de Energía and the Superintendencia must develop a rational, consistent protocol for the development of environmental standards and a mechanism for permitting and enforcement.

In addition to the challenges of developing effective institutional arrangements, there are potentially problematic issues in the application review process as defined by the Energy Law. First, the inclusion of an environmental assessment and mitigation plan in the application does not guarantee an environmentally sound evaluation by the Superintendencia or the Comisión Nacional de Energía before a recommendation and final authorization is granted to construct and operate a plant. Second, even though the application review process theoretically provides for the integration of environmental criteria into the project selection process, it is not an adequate

substitution for enforcement. Third, the incentive to adequately weigh environmental implications in energy policy planning and specific project planning has not yet been provided. Issues such as the degree to which proposed mitigation measures adhere to established standards and how environmental costs are weighed against the benefits of electricity production will be critical in achieving environmentally sound project development.

Since the Comisión Nacional de Energía and the Superintendencia are the agencies responsible for energy policy development, implementation, and environmental assessments, it is extremely important that objectivity be maintained in the accomplishment of these two tasks. In order to facilitate objective review and approval of the environmental assessment, the Superintendencia, in its review of the "concesión definitiva," should not be solely responsible both for the environmental evaluation and the appraisal of the project from an energy development perspective. An additional detailed environmental review process should take place using outside agencies.

5. ENVIRONMENTAL IMPACTS OF PLANNED FACILITIES AND ALTERNATIVES

5.1 DESCRIPTION OF PLANNED FACILITIES

The Dominican Republic Power Expansion Plan is currently in the process of being prepared. This EA will be input to the plan. In order to prepare this EA, four locations were identified as priority sites for the development of two 125 MW generation units. It is assumed that the two 125 MW units may be developed on any one or two of the four potential sites: Andrés/Boca Chica, San Pedro de Macorís, Puerto Viejo de Azúa, and Itabo.

These locations (see Exhibit 2-3) were identified by the Equipo Tecníco as being the most feasible according to physical and operational development criteria such as port access, water availability, ground transportation, and other infrastructure access. The four sites are used to analyze and describe potential environmental impacts of new facilities and to recommend mitigation measures to be incorporated into future power plant projects. These impact descriptions, as well as mitigation measures recommended in Section 6, can be generalized to other sites with similar characteristics. A description of each of the priority sites is provided below.

5.1.1 Andrés/Boca Chica

This proposed site is located in Andrés along a scenic ocean shoreline on the western side of an existing sea port (see Exhibit 5-1). Although no exact site boundaries have been determined, two possibilities for plant location exist at the Andrés site: a land-based site located along the rocky shoreline and a floating plant site, approximately 0.2 to 0.5 kilometers from the shoreline. The port and its immediate vicinity is industrial in nature with a sugar refinery, water treatment plant, and undedicated garbage dump located in the area. Boca Chica, a densely developed, popular tourist and local recreation area is located approximately 3 kilometers to the east of the priority site at Andrés.

5.1.2 San Pedro de Macorís

The priority site in San Pedro de Macorís is a site neighboring an existing power plant. The site is located along an existing port of the Iguamo River (see Exhibit 5-2). The port and land area surrounding the site is industrialized with a cement factory located directly across from the existing plant. There are some residential uses nearby to the proposed site. The site itself has scattered vegetation, short trees, and grasses, and is currently used as grazing for animals such as goats and pigs, which are sources of food and milk for the nearby residents.

5.1.3 Puerto Viejo de Azúa

The priority site in Puerto Viejo de Azúais in an undeveloped natural area on the coast (see Exhibit 5-3). The only development nearby is an LPG plant. Vegetation is sparse and views inland are of flat land and somewhat elevated hills. The site does not appear to have a major potential for residential or tourist development.

5.1.4 Itabo

Although the exact site delineation is unknown, the priority site at Itabo would be located adjacent to the existing Itabo plants containing two 125 MW coal fired units (see Exhibit 5-4). The area surrounding Itabo is industrial in nature with a petroleum refinery and sugar refinery nearby, and no residential development in the immediate vicinity. Due to the close proximity of the existing power generation facilities (Itabo I and II), the necessary industrial infrastructure such as a fuel handling port, transport corridors, coal piles, and conveyor belts is already in place.

5.2 ENVIRONMENTAL IMPACTS OF PLANNED FACILITIES

5.2.1 Air Quality

The proposed new power plants, consisting of two 125 MW units, developed at four potential locations (Itabo, Andrés/Boca Chica, Puerto Viejo de Azúa, and San Pedro de Macorís), are evaluated by comparing the estimated air emissions of these units with ambient standards as defined in Section 2.2.1. It is assumed that the proposed units will incorporate pollution control equipment similar to existing facilities in the Dominican Republic. These controls include electrostatic precipitators for particulate control, but no equipment to control SO_2 emissions.

The potential impacts resulting from locating two 125 MW units at each of the four locations are presented below.

Itabo. There are now two 125 MW units designed to fire coal or oil at the Itabo plant site. In order to calculate a worst case scenario of the impacts at the Itabo site, it is assumed that the existing units would be burning coal with the source sulfur content as is used at present (.56 percent) while the two new units would be burning high sulfur oil (4.25 percent wt. sulfur). The impacts associated with two new 125 MW units at the Itabo plant site are determined by adding the emissions from the two new units to the existing facility emissions. It is also assumed that Itabo Unit I (which is currently nonoperational while being rehabilitated) will be in operation at the same time. The predicted maximum concentrations for all the pollutants under a worst case meteorological scenario are shown in Table 5-1. The table shows that maximum concentrations of sulfur dioxide when burning the high sulfur fuel oil would exceed the 3-hour SO_2 standard by approximately 20 percent and the 24-hour SO_2 standard by 270 percent. This is considered to be a significant adverse impact. However, if fuel with 2 percent wt. sulfur content is used in the new boilers, the ambient SO_2 standards would not be exceeded even under the worst case meteorological scenario. Table 5-1 also shows that the predicted levels for the other pollutants are under the ambient air quality standards.

Table 5-1 Air Emission Levels of Planned Facilities at Itabo[1]

	SO_2 3 hr.	SO_2 24 hr.	NO_x annual	PM_{10} 24 hr.
Background	8	8	5	35
Existing Facilities	116	60	16	31
2 new 125 MW units[2]	1551	694	40	122
Ambient Standards[3]	1300	250	100	150

(1) Assumes Worst Case Meteorology and 4.25 wt,% sulfur fuel.
(2) Unit II is presently in operation and Unit I is under rehabilitation. It is assumed that by the time the new plants are built, Unit I would also be in operation. It is also assumed that the new units would operate at 75% capacity.
(3) Based on USEPA standards, except for the 24-hr SO_2 World Bank standard.

San Pedro de Macorís. Emissions of sulfur dioxide from the existing plant at San Pedro de Macorís are slightly greater than the coal burning scenario for Itabo I and II plant. Therefore, if this site is selected for the two new units, the contribution of emissions from those units to the existing SO_2 concentrations would exceed ambient standards. The impacts associated with developing the two units at this site, using the high sulfur fuel oil, under worst case meteorological conditions, exceed the 3-hour SO_2 standard by approximately 15 percent and the 24-hour standard by 200 percent. This impact to air quality at this site is considered to be a significant adverse impact. If a low sulfur fuel is used (less than 2 percent wt. sulfur), maximum pollutant concentrations would not exceed the ambient standards and significant impacts would be avoided.

Andrés/Boca Chica and Puerto Viejo de Azúa. The planned expansion at both of these priority sites would result in ambient air concentrations below ambient air quality standards because there are no existing facilities at the same location that would add to these pollutant concentrations.

5.2.1.1 Carbon Dioxide Emissions

Emissions of carbon dioxide are of concern because of their potential to contribute to climate change through radiative feedback in the troposphere. The proposed power sector expansion would be expected to increase CO_2 emissions by about two million tons per year, as compared with existing emissions from power plants in the Dominican Republic of approximately nine million tons. The estimated worldwide emission of CO_2 is about 3 gigatons per year ($3x10^{12}$ Tons). The relative increase in CO_2 emissions resulting from the development of the proposed units would be modest. Improved energy efficiency and conservation would minimize increases of CO_2 emissions.

5.2.2 Water Quality/Biology

5.2.2.1 Water Quality

The potential water quality impacts at any of the four proposed power plant locations are essentially similar for each of the sites. If the proposed facilities are built in the same fashion as the existing facilities, there will likely be the following significant water quality impacts of the same type and magnitude as described in Section 2.3.2:

- A significant rise in ambient water temperatures adjacent to the discharge of the cooling water effluent. This plume may remain buoyant for a distance from the discharge canal and remain stratified and unmixed. In calm water, the plume may remain unmixed for a considerable distance, but that distance can decrease with increased wind and currents causing turbulence and mixing.

- The use of brackish to marine waters for cooling may lead to the fouling or clogging of supply pipelines, conduits, or tubing by the growth and eventual encrusting of marine algae and invertebrates on this equipment. A standard practice for removing this material is the use of some type of biocide such as hypochlorite or chlorine. It is possible that these compounds are being used at the existing facilities and then being discharged into the receiving waters without pre-treatment to neutralize the chlorine.

- Heavy metals may be leached from various sources at the facilities. Heavy metals may originate from corrosion of pipes caused by exposure to the marine water, leaching from improperly disposed fly ash, or even biocides that are copper-based.

- Surface water runoff from the sites will contribute concentrations of any of the chemicals used at the plants, as well as oils, grease, and suspended solids. Open drainage systems are likely to contribute additional sewer wastes such as waste oils, lubricants, solvents, and cleaners.

- Docks show evidence of oil spillage during fuel transfer operations. This is evidenced by a heavy coating of black oil residue on the dock. Any spillage goes uncollected and untreated into the surrounding waters and sediments, thereby contaminating them with various petroleum hydrocarbons.

- Coal piles completely open to the elements and not surrounded by any structures that would contain surface water runoff from the piled coal will result in dust being washed from the pile and transported to the surrounding surface waters or ocean.

- The ash disposal area is likely to be highly contaminated with various heavy metals from the ash and possibly organic compounds from the unknown waste.

- Excess water quality constituents such as temperature, pH, heavy metals, petroleum hydrocarbons, and organic compounds may result. The magnitude of these impacts will be a function of plant construction and operational methods and fuel source.

5.2.2.2 Biology

The identification of potential impacts to biological resources, both terrestrial and aquatic, must necessarily be qualitative in nature due to the lack of information on baseline biological conditions in any of the proposed sites. Without data concerning species composition, diversity, presence, or absence at these sites, the determination of the significance of the impacts cannot be made as well. Therefore, only general categories of biological impacts are presented in the following discussion. Identification of site-specific resources and subsequent impacts should be performed in the subsequent project-specific EIASs.

Terrestrial Biology

Andrés/Boca Chica. The terrestrial flora and fauna at the site are limited and disturbed. Much of the area proposed for development is currently being used as a disposal site and as a result does not support any vegetation. It is difficult to determine which species of mammals and birds use the area without performing site surveys and transects. Based on the very limited observations from the site visits, it does not appear that significant flora and fauna would be impacted during construction and operation of power plant at this site.

San Pedro de Macorís. There is a stand of trees and shrubs that would be cleared and removed during construction. These types of trees and shrubs appear to be common in the area and their loss may not be significant in total acreage. There would be, however, loss of habitat for birds and mammals that may use this small grove for shelter and nesting. In addition, the added human activity in the area may disturb some of the sea birds such as terns.

Puerto Viejo de Azúa. The proposed site is currently undisturbed and would require extensive clearing of xeric scrub, shrubs, and trees. Disturbing this somewhat pristine area may result in significant impacts to birds and mammals that may reside in this vegetation and use it for cover, shelter, nesting, and resting.

Itabo. The terrestrial biota of the area proposed for the new facility is limited, and appears to be somewhat disturbed. The site is characterized by grasses and creeping groundcover, and appears to have recently been planted with small palm trees. Very few other trees or shrubs that would provide habitat and cover for terrestrial biota are in the immediate area, except those directly adjacent to the dwellings across the roadway. Construction and operation of a power facility in this area most likely would not result in a significant loss of flora or fauna because this area is already subject to human activity and may have been previously cleared and disturbed.

Aquatic Biology

Andrés/Boca Chica. The marine waters offshore are very clear and turbidity/suspended solids levels are low. Numerous algae, encrusting corals, and sea urchins were apparent in the intertidal to subtidal zone. Based on these limited observations, it appears that the construction and operation of a plant at this site could significantly impact the marine communities in the area. The various effluent streams as well as uncontrolled surface water runoff would degrade the water quality and as a result would alter, possibly adversely, the marine community structure of this area.

San Pedro de Macorís. Due to the turbidity of the water, no observations were made of the intertidal or subtidal areas. Because of the numerous industries already located along the Iguamo River, it is assumed that the water quality has already been impacted, and as a result the aquatic communities in the area have been altered over the years. It is likely that additional discharges from a new power facility will have a cumulative adverse impact on the aquatic resources of the area.

Puerto Viejo de Azúa. At the site there are no industrial discharges and the bay is relatively pristine. The only major development in the area is a loading dock for LPG that is pumped to a storage facility. The dock appears to be kept relatively clean and there are no major discharges into the bay. There are no apparent oily sheens on the water and visibility is good, which is indicative of low levels of suspended solids and turbidity. Local workers indicated that local residents catch fish, shrimp, and red lobster in the bay. It is apparent that an industrial facility such as a power plant, with its attendant loading docks and discharge pipes, could significantly impact the water quality of this bay through the introduction of anthropogenic compounds and subsequently adversely affect the fisheries resources utilized by the local fishermen.

Itabo. The waters offshore of the proposed Itabo facility are the source of intake water for the existing plant as well as receiving effluent from that plant. Apparently, fishing is limited in the nearshore area and the few local fishermen who do utilize the area must fish in deeper waters off the shelf that rings the island. (Martínez, personal communication, 1994). As with the San Pedro de Macorís site, there are a number of industrial discharges surrounding the proposed facility, which most likely have already contributed to water quality degradation, and subsequently adversely impacted the marine biota. Additional discharges from a new facility could have a cumulative adverse impact to the marine communities in the vicinity of the facility. However, without detailed modeling, the extent to which the communities are impacted cannot be determined.

5.2.3 Solid Waste Disposal

The environmental impacts resulting from the disposal of solid waste generated from the proposed plants located at any of the four priority sites (Boca Chica, San Pedro de Macorís, Puerto Viejo de Azúa, and Itabo) will primarily depend on the propriety of waste disposal methods. If the planned facilities employ the current disposal practices, many of the impacts, also described in Section 2.3, would result.

Such disposal practices could result in extensive soil and ground water contamination and adverse impacts to human health, as described in Section 2.3. A sound siting methodology, site preparation, and operation guidelines, if implemented, would avoid many of these egregious environmental impacts caused by improper disposal methods.

Environmental impacts caused by chemical contamination result from two variables: fuel type and characteristics; and characteristics of the disposal site. Since these variables are yet undefined, it is not possible to predict the specific impacts and their extent at this time. However, it is assumed that the proposed plants will generate either coal ash or sludge from fuel oil storage tanks as the primary waste material.

If the power plant developed is coal-fired, coal ash would be the primary waste stream. Of the three basic types of ash, fly ash coming from electrostatic precipitators, is the most likely to be created at the plant and would represent the bulk (i.e. weight) of the solid waste to be disposed. As discussed in Section 2.3, the impacts associated with unmanaged ash disposal can result in soil contamination and leaching of contaminants in toxic quantities into the ground and surface waters, and cause serious direct and indirect impacts to the natural and human environments. Leachable quantities of lead, arsenic, barium, cadmium, chromium, mercury, silver, and selenium in potentially toxic quantities would be quite possible if ash is disposed of in unlined and unmanaged disposal sites.

If the proposed plant uses the Fuel No. 6, the primary waste stream would be a heavy asphaltic sludge material that would be removed when the storage tanks undergo cleaning. Although the exact chemical composition of this material is unavailable, it would be rich in asphaltic hydrocarbons, some of which have leachability potential in addition to potentially leachable quantities of lead and vanadium. The heavier hydrocarbons would adhere to the soil and eventually inhibit the ability of the soil to sustain vegetation.

Regardless of the chosen fuel source, associated waste stream, and its disposal quantity, guidelines for the siting, preparation, and operation of the disposal site discussed in Section 6.3 should be implemented to avoid potentially harmful environmental impacts resulting from soil, grou and surface water contamination.

5.2. Land Use/Social

The potential land use impacts resulting from power plant development at any of the four priority sites are assessed in the absence of adopted land use plans and development policies. In the absence of such documents, the land use impact assessment focuses on the ability of the proposed site to accommodate a power generation facility. These evaluations necessarily include a range of impacts such as noise, plant emissions, and the impact on visual and scenic quality of the area surrounding the four priority sites. Although site specific social surveys were not conducted, the types of social impacts that may be anticipated at the four sites and at other sites countrywide are considered. These evaluations are divided into two geographic areas: impacts to the area immediately surrounding the site and the impacts in a larger radius.

5.2.4.1 Andrés/Boca Chica

The Andrés site is located along a scenic ocean shoreline on the western side of an existing sea port. Industrial uses surround the existing port. These uses include a sugar refinery and a water treatment plant. The water treatment plant immediately adjacent to the site is unobtrusive in design and operation and is visually shielded by abundant vegetation. The sugar refinery is the most prominent use in the immediate vicinity with its relatively large land area, tall stack emitting brownish smoke, unmanaged waste materials, and bagasse piles on-site. Adjacent to the shoreline site is an unofficial garbage dumping area accommodating waste from a nearby residential development.

From a land use consistency perspective, the impacts of plant development to the immediately surrounding area at the Andrés would be minimal. Although engineering and site design criteria should be used to reduce disturbances to air and water quality and land-based resources, the industrial uses would not be adversely impacted by plant-related impacts such as noise, traffic, air emissions, and visual intrusion to the viewshed in the immediate vicinity. The road serving the site also serves the port and surrounding industrial uses and would be, with improvements, appropriate for industrial traffic associated with power plant development. The scenic quality of the coastal area immediately surrounding the site vicinity has been seriously degraded by the presence and operations of the sugar refinery.

From a land use perspective, the Andrés site has some potential limitations. The land-based site, although boundaries are undefined, is quite small and may require that the plant be placed directly up against the shoreline without appropriate setback. A floating site, just outside the shipping lanes, may conflict with the existing port traffic.

The larger area of influence includes Boca Chica, a densely developed popular tourist and local recreation area located approximately 3 kilometers to the east of the site at Andrés. It borders the corridor which would serve the plant's supplies and waste disposal transportation route. Impacts to the residential uses along the transportation corridor would be primarily attributed to the fuel and waste transport activities. If coal is used as the fuel source and proper measures are not taken to control the dispersion of these materials, the coal and the ash wastes may spill along the corridor. Since tourism is the primary focus of Boca Chica, potential impacts to the aesthetic quality of this area would adversely effect its value as a tourism and local recreational resource.

There would be potentially significant land use impacts should a plant be developed at the Andrés/Boca Chica site. However, there would be no adverse social impacts in the immediate vicinity. In the larger area of influence, the quality of life for the residents along the transportation corridor to the plant would be adversely impacted due to increased dust, traffic, and noise. Coal ash spillage in particular, because of its potentially leachable constituents, would be considered an adverse impact to public health. Beneficial social impacts would include increased employment opportunities in the Andrés/Boca Chica area during construction and plant operation. Based on an assumed 3-year construction period, approximately 210 construction jobs would be created. Approximately 100 permanent full-time jobs would be created for the two plants. Improvements in power supply, which would be system-wide, would result in direct

beneficial quality of life impacts and indirect beneficial economic impacts resulting from increased economic activity countrywide.

5.2.4.2 San Pedro de Macorís

The lot selected for the site in San Pedro de Macorís neighbors an existing power plant. The site is located along an existing port of the Iguamo River. Across from the port is a cement factory which encompasses a rather large land area. A residential settlement is located approximately 500 meters to the southwest. The proposed site has scattered vegetation, short trees and grasses, and is used as grazing for animals such as goats and pigs, which are probably sources of food and milk for the nearby residents.

A power plant on this site would be compatible with the existing industrial uses in the immediate vicinity, thus land use impacts to the immediately surrounding uses would be minimal. The industrial uses of the area immediately surrounding the site would not be adversely affected by plant-related impacts such as noise, traffic, air emissions, and visual intrusion to the viewshed in the immediate vicinity. The road running into the site serves the existing plant and is well-suited to accommodate additional industrial traffic associated with power plant development. The port, already serving the existing power plant and the cement factory, is convenient for fuel transport activities necessary for plant development at this site. However, a special coal handling facility would have to be constructed.

Depending on the specific positioning of the new plant on the site, the nearby residents may have to be relocated. This would cause disruption to individual households as well as disruption to the neighborhood. These are considered to be significant adverse impacts.

The area of influence of the proposed site is rather isolated and highly vegetated with tall tropical foliage. The area surrounding the site is undeveloped with scattered human settlements. Impacts to these residential uses would be primarily attributed to the fuel and waste transport activities along transportation corridors. If coal is used as the fuel source and proper measures are not taken to control the dispersion of these materials, the coal and the ash wastes may spill along the route. The ash spillage in particular, because of its potentially leachable constituents, would be considered an adverse impact to the health of the residents along the transportation corridors. Both direct (plant construction and operation) and indirect (increased spending and production of good services) beneficial regional impacts would result from the additional employment. Countrywide beneficial impacts would result from system wide energy improvements and concomitant growth in economic activity.

5.2.4.3 Puerto Viejo de Azúa

The priority site in Puerto Viejo de Azúa is undeveloped except for the nearby LPG plant. A small town 2 km from the site houses approximately 2,000 residents. The residents use the beaches and the bay for recreation and fishing.

The site is on the coast at the tip of a large agricultural area. This is expected to flourish with the implementation of the JSURA irrigation project, which will bring water to the entire Puerto

Viejo de Azúa area. Because of the sparse terrestrial vegetation and the rocky character of the Caracoles beach, the area has not been considered to have major potential for tourism. Because of the reported abundance of marine vegetation, the presence of wetlands with mangroves, flamingos, and a coral reef, Eleuterio Martinez of ONAPLAN[1] has recommended that the area be designated a "natural resource" (presumably with some restrictions on development), but this plan has not yet been adopted.

Because of the lack of significant residential development in the area and the unlikelihood that such development would be planned in the future, locating a power plant in this area would not adversely impact a community. The plant would also not be incompatible with greater agricultural development of the area. However, if the site is shown to have endangered species of vegetation and wildlife with potential for designation as a natural preserve, the siting of a power plant with the concomitant coal handling facility would result in potentially significant adverse impacts.

Because of the distance of the residential units from the site, the only adverse effects on quality of life would be the introduction of an industrial use to the recreational beach and fishing activities. Plant development would provide employment opportunities, which are considered a beneficial impact. Countrywide beneficial impacts would be the same as for the other plants.

5.2.4.4 Itabo

The priority site at Itabo is immediately surrounded by the heavy industrial uses of the Itabo I and II plants and supporting infrastructure such as a coal pile and conveyor belts and fuel storage tanks. The land uses in a larger area (approximately 1 kilometer from the site) are also industrial in nature with the petroleum refinery and sugar refinery located nearby.

The proposed site at Itabo is compatible with the existing industrial uses in the immediate vicinity and a 1 km radius of the site. The industrial uses of both the immediate and general areas surrounding the Itabo site would not be adversely impacted by plant-related impacts such as noise, traffic, air emissions, and visual intrusion to the viewshed. However, several detached residential units located directly across from the existing plants would be adversely impacted by activities related to the new plant. The road serving the site serves the existing industrial uses associated with Itabo and is well-suited to accommodate additional industrial traffic associated with power plant development. The Haina port, already serving the existing power plants, is convenient for the fuel transport activities necessary for plant development at this site. From a land use perspective, due to uniform industrial uses and the limited residential development in the area, additional plant development at the Itabo site would not have adverse land use impacts.

The only adverse social impacts resulting from the plant construction would be the required relocation of several residential units abutting the site. Beneficial impacts to the region would include new direct and indirect employment opportunities and countrywide improvements in quality of life and economic growth.

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[1] Meeting, March 11, 1994.

5.3 THE NO-PROJECT ALTERNATIVE

The No-Project Alternative is defined as the decision by the Dominican Republic not to seek funding for and not to proceed with the construction of the two new 125 MW power plants.

Under the No-Project Alternative, there would be no international loan money for the plants that would be built by 1997-1998. Assuming the rest of CDE's expansion plan was to go forward as planned, the failure to build these two units would contribute a deficit of available power in the years from 1995 to 2006, reaching a maximum deficit of 200 MW by the year 2002. This is considered to be a significant adverse impact.

If a power deficit continues to prevail in the Dominican Republic, this would result in countrywide adverse social and economic impacts due to reduced economic development and reduced quality of services. A continued power deficit would also result in continued limitation on the quality of life of the population.

If the loan does not go forward, there would also not be an opportunity to mitigate the ongoing adverse environmental impacts of existing facilities in the power sector. This means that air quality, water quality/biology, solid waste, land use, and social impacts that are now associated with existing plants would continued unabated.

The No-Project Alternative would also remove the opportunity for the Dominican Republic to proceed with the first interim phase of power sector institutional strengthening activities that would be connected with this loan. These activities would consist of setting up a procedure for preparing project-specific EIASs, incorporating mitigation measures for identified impacts in the project design as a condition of the permit, and implementing a continuous environmental compliance system to monitor and enforce adherence to established standards and agreed-upon mitigation measures. Other activities which could not be undertaken without the loan include training in environmental evaluation and enforcement for the staff of the Superintendencia, the purchase of monitoring and other equipment, and public education about environmental issues related to the power sector.

5.4 POTENTIAL ENVIRONMENTAL IMPACTS OF TRANSMISSION LINES

Because this EA was based only on a limited set of assumptions for four new power plants on four alternative locations (size in MW and fuel type) a specific route for associated transmission lines was not available for the environmental evaluation. Certain potential impacts of transmission lines should be considered at this stage, however, before any of the proposed sites is selected for power plant development. At the time that site-specific EIASs are prepared for the new plants, the environmental impact assessment should include an environmental impact evaluation of the transmission lines associated with each plant.

Electric transmission lines can have the following adverse impacts during operation: land use, biology (flora and fauna), soils and geology, cultural resources (archeological and historic), visual resources, electro-magnetic fields, and socio-economic impacts. Some of these impacts

may be more severe during construction. Other adverse impacts that may occur during construction include air quality (dust), traffic, and noise.

Land Use

Impacts are completely dependent on the existing land use in and adjacent to the transmission line route. Impacts will result if the construction or operation of the line would cause: (1) a permanent or temporary cessation, disruption or modification of existing land uses; (2) a short-term or long-term reduction in the value of the visual setting for visually sensitive land uses (recreation or tourism); or (3) a substantial modification of future planning and development planning opportunities.

Biology

a. Vegetation — transmission towers and their associated uses such as pulling stations, construction yards and new access roads can result in trampling and crushing or removal of vegetation. Some vegetation will grow back after construction, but if new access roads are involved, some vegetation would be removed for the life of the project. The significance of the impacts is completely dependent on the value of the habitat to be disturbed (e.g., the presence of rare or endangered species).

b. Wildlife — impacts result from disturbance of habitat of unique or sensitive wildlife species which can occur when previously pristine areas are encroached by construction, particularly of new access roads. Impacts on predatory animals are less significant, because these animals can move to other areas to find suitable habitat.

Soils and Geology

Effects are caused by survey operations, construction, and exposure of soil to water, wind erosion, compaction, and potential for soil collapse after transmission line abandonment. Soil loss through wind erosion can cause an increase in sediment yield. New water runoff patterns resulting from construction create new drainage patterns, causing soil erosion. These effects are magnified by soil compaction. However, these impacts are short-term, and, therefore, usually not significant. Geological conditions along the route can seriously impact the transmission line. Potential effects include slope failure near mountains and hills, shrink and swell potential in areas of expansive soils, and instability in fault and seismic activity areas. Areas subject to flooding can also result in adverse impacts on the transmission system.

Cultural Resources

Adverse impacts can occur during ground disturbing activities associated with project construction. Additional impacts can occur during the operation and maintenance state and at abandonment. Cultural resource impacts are directly proportional to the amount of new ground surface disturbance occurring.

Visual Resources

Temporary impacts exist during construction as a result of the presence of heavy equipment, dust, and the views of construction yards. Permanent impacts include the potential intrusion of towers and lines, construction and maintenance roads, and substations into surrounding areas. Visual impacts depend on the distance from the observation point and the proximity of the

transmission lines to the main roads. Impacts are considered significant when scenic views critical to recreation or tourism activities are adversely affected.

Electro-Magnetic Fields (EMF)
These fields result when alternating current flows through a conductor. EMF levels increase with higher voltage, greater current, and proximity to the source. Although there is considerable concern about EMF impacts of transmission lines to nearby land uses, scientific research has not yet been developed to determine that exposure to a given EMF level is hazardous to human health. A prudent approach to mitigation of this potential impact is to avoid location of a transmission line adjacent to residential or recreational and educational facilities. Design measures can also be undertaken to reduce EMF levels, and monitoring studies after construction can keep the public informed about potential effects and line safety.

Socio-Economic Impacts
These include the potential availability of construction jobs, and influx of workers to the area during construction, economic growth in the area as a result of improved energy delivery. Most of these impacts would be beneficial and not considered to be significant, because they would be either temporary or permanent, but indirect.

The potential impacts described above and any additional site-specific impacts that may apply should be considered in the preparation of the project-specific EIASs for the new power plants. In addition, the need for new transmission lines and preliminary descriptions of the line routes, structures, conductors, and insulators, access roads and construction plans should be provided in the EIASs.

5.5 OTHER SOURCES OF POWER GENERATION AND ITS EFFECTIVENESS

The Power Sector Expansion Plan will focus on thermal power generation. However, other sources of power generation either already exist in the Dominican Republic or have been tried elsewhere and may be applicable to the Dominican Republic. Those sources which can be considered alternatives or supplementary means of meeting energy requirements are described in this section. Consideration of the beneficial and adverse environmental impacts and relative costs of alternative energy sources provides a perspective for the analysis of the thermal facilities.

5.5.1 Hydroelectricity

In comparison to thermal electricity generation, some beneficial environmental impacts of utilizing hydroelectric resources are the avoidance of adverse impacts to local and global air resources, and the avoidance of water and soils effects of residual waste materials such as coal ash. Adverse impacts of hydroelectric facilities include, primarily, large scale deforestation; soil erosion; degraded water quality; damaged fisheries; threats to species of flora and fauna; and population displacement and relocation. In addition, fugitive dust emissions can be significant during the construction period.

The Dominican Republic currently has 15 operating hydroelectric units with an installed capacity of 370 MW. The country contains approximately 2,000 MW of untapped hydroelectric potential. The average capacity factor for existing hydroelectric units is under 30 percent.[2] Major investment in the Dominican Republic hydroelectric facilities would be constrained[3], because the output of hydroelectric units would be severely restricted during the dry season (the Dominican geography which does not permit large storage reservoirs). These same geographic features also limit the size of the units to generally under 100 MW on any given site. This would require the construction of at least three separate hydroelectric facilities to produce the equivalent power of two 125 MW fossil units. The economic comparison between fossil-fueled power plants and hydroelectric facilities should be conducted as part of the Expansion Plan for the Power Sector.

5.5.2 Biomass

Municipal solid waste, agricultural waste (sugarcane, cotton, and wheat), and sewage sludge represent viable energy sources supplementing conventional energy sources, such as coal or fuel oil typically used for power generation. In comparison to thermoelectric power generation, the use of biomass materials has some beneficial environmental impacts relating primarily to the reduction of these waste streams and avoiding conventional disposal methods such as land filling and open burning. The air quality impacts associated with the use of biomass as a fuel source are comparable to those associated with fossil-fueled power plants. The sulfur content of these alternative energy sources is relatively low, typically less than 0.5 wt. percent Sulfur and, SO_X emissions are similar to power plants using low sulfur coal. When applying modern combustion methods such as low NO_X burners at fossil fuel power plants, NO_X emissions are also comparable.

Agricultural waste such as bagasse, a residual from sugar refining activities, is abundant in the Dominican Republic in the order of 2.5 million tpy of which 90 percent is reused at sugar refineries to produce steam and electricity.[4] The use of bagasse is, therefore, not a viable option in the Dominican Republic.

At a future stage in the economic development of the Dominican Republic the viability of using municipal solid waste and sewage sludge as an energy alternative should be examined. In order for municipal solid waste to be considered a supplemental energy source, an efficient solid waste collection system must be in place to assure steady supply. It is also important that municipal solid waste and industrial wastes are not mixed, so that potentially hazardous industrial wastes are not incorporated into the combustion process and dangerous toxins are not released to the

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2 DECON Interim Report, Plan Nacional de Expansión de la Generación del Sistema Eléctrico de la República Dominicana, March, 1994.

3 *Project Paper Draft Outline, Energy Privatization Project* (NO. 517-0270), USAID/Dominican Republic, 1993.

4 Dominican Republic: Issues and Options in The Energy Sector, Energy Sector Management Assistance Programme, (ESMAP), Industry and Energy Department, Washington, D.C.

atmosphere. The typical heat content of raw municipal solid waste is approximately 3,500 to 5,500 Btu/lb, comparable to that of low rank lignite coal. To increase the heating value, the waste should be concentrated into organic rich fractions prior to feeding it into the combustor. When sludge is considered for power generation, it has to be dewatered prior to introducing it into the combustor to boost its heat content. As a result of the need for all of these processes, the total capital investment cost for power generating facilities using municipal waste or sewage sludge is approximately US$5,207/KW[5] (including necessary treatment processes), considerably higher than fossil fuel power plants. The operating and maintenance costs for a comparable 250 MW facility are also considerably larger than the those of a fossil fuel plant. Therefore, this alternative is not practical at this time.

5.5.3 Wind

Wind-generated energy is a non-polluting source of electricity and, compared to alternative energy sources, beneficial impacts are incurred by avoiding the range of adverse environmental impacts associated with thermal, hydroelectric, and refuse-generated electricity.

The applicability of wind energy as an alternative energy source primarily depends on the local atmospheric energy flux and land area availability for erecting windmills. Wind turbine technology has improved over the last few years to effectively manage voltage control problems. In addition, the recent design of wind turbines for variable-speed operation captures more of the available energy while maintaining a constant-frequency electrical output. Although the large network of windmills required would occupy a large land area, the turbine foundations use only 1 percent of the total occupied land. Thus, windplants may co-exist with ranching and agricultural uses and can provide a long-term source of income for ranchers and farmers who typically receive 2-5 percent of the gross electricity revenues. The capital investment cost is US$1,106/KW[6] and the operating cost is US$10/KW.[7] Wind energy, as the California experience shows, can be a viable option for producing electricity. The feasibility of applying this technology in the Dominican Republic should be studied as part of a comprehensive energy resources program.

5.5.4 Energy Conservation

Low and distorted prices of energy for extended periods have thwarted efficiency drives in the Dominican Republic. In addition, energy efficiency measures have been constrained by the lack of awareness among energy users about available energy saving technologies, reluctance to assume the cost and risk of introducing new technologies, and lack of financing for efficiency measures. Energy substitution, using coal instead of fuel oil as a primary energy source, has the potential to lower fuel costs.

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5 EPRI, Technical *Assessment Guide: Volume 1: Electricity Supply – 1989 (Revision 6)*, Updated 1993.

6 *Ibid.*

7 *Ibid.*

Based on the experience in other countries, it can be assumed that an energy savings potential of at least 20 percent exists through low-cost housekeeping measures alone, equivalent to about 0.24 million toe/year (US$31.5 million at an international petroleum price of US$18/B). Housekeeping measures implemented in public buildings such as cleaning filters, preventing warm air infiltration, and replacing incandescent lights with florescent tubes can result in large efficiency gains. It is possible that an additional 15-20 percent of energy savings could be realized though major investments such as retrofits. Energy conservation can also be achieved through increased efficiency in energy conversion. Low fuel efficiency and technical and administrative losses in the electricity generation at the existing thermal power plants currently result in an amount to an estimated 30 percent loss.[8]

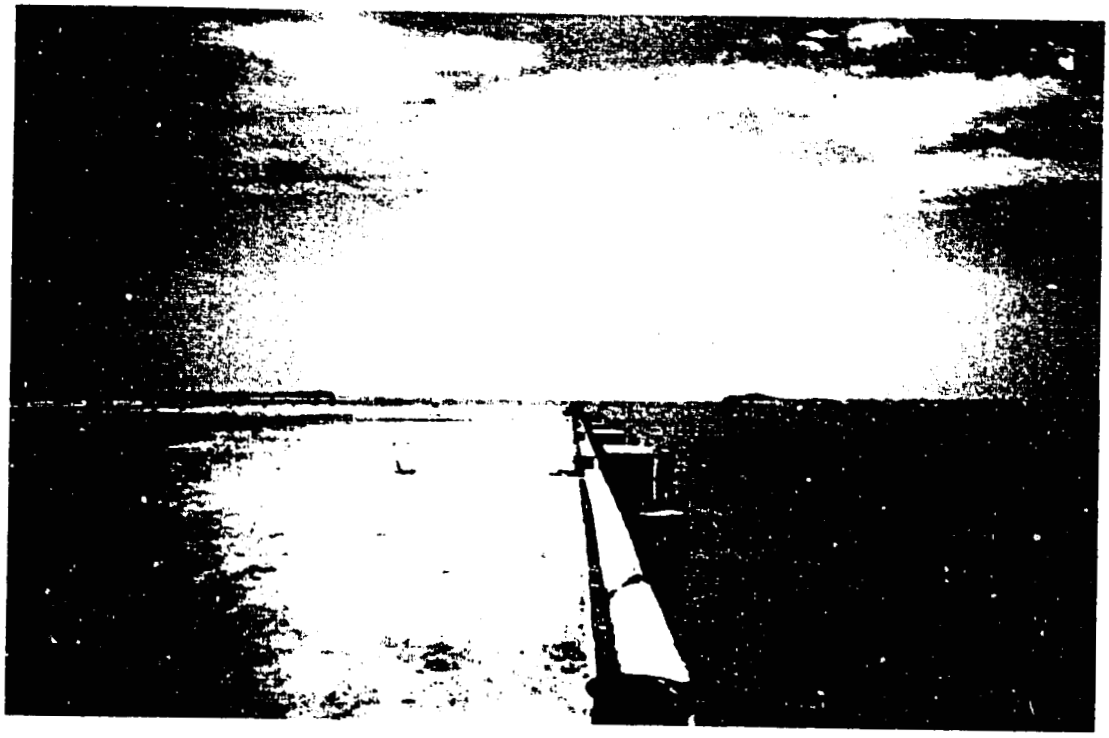
Once the Superintendencia is in place, management methods such as Demand Side Management (DSM) and Integrated Resource Planning (IRP) should be employed. DSM consists of the identification and implementation of initiatives that improve the use of energy-supply capacity by altering the characteristics of the demand for energy. This is accomplished by a mix of pricing, load management, and conservation strategies designed to increase the incentives for a more efficient use of energy. IRP consists of an evaluation of available demand and supply-side options to provide energy services and to determine an optimal energy service strategy, given economic and environmental factors. The costs of all the different energy supply and end-use technologies, processes, and programs that might be used to provide energy services are ranked, and the lowest-cost opportunities are implemented according to the cost ranking.

8 Dominican Republic: Issues and Options in The Energy Sector, Energy Sector Management Assistance Programme (ESMAP), Industry and Energy Department, Washington, D.C.

Exhibit 5-1
Proposed Site at Andres

Exhibit 5-2

Proposed Site at San Pedro de Macorís



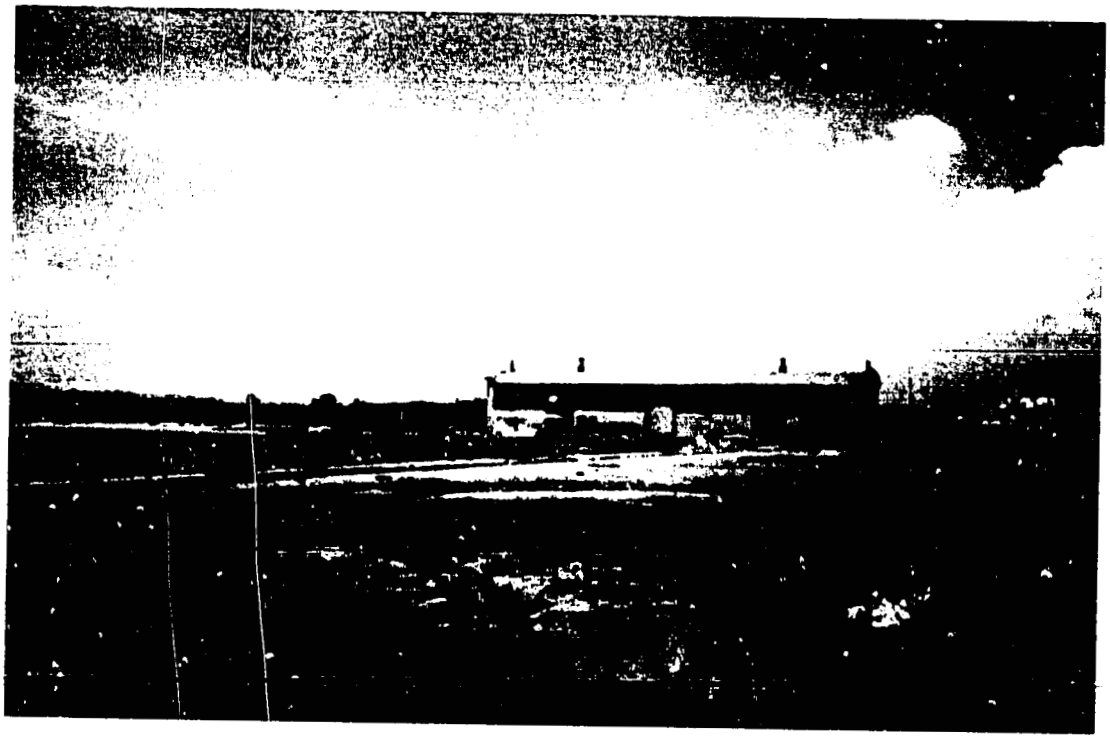


Exhibit 5-3

Proposed Site at Puerto Viejo de Azua

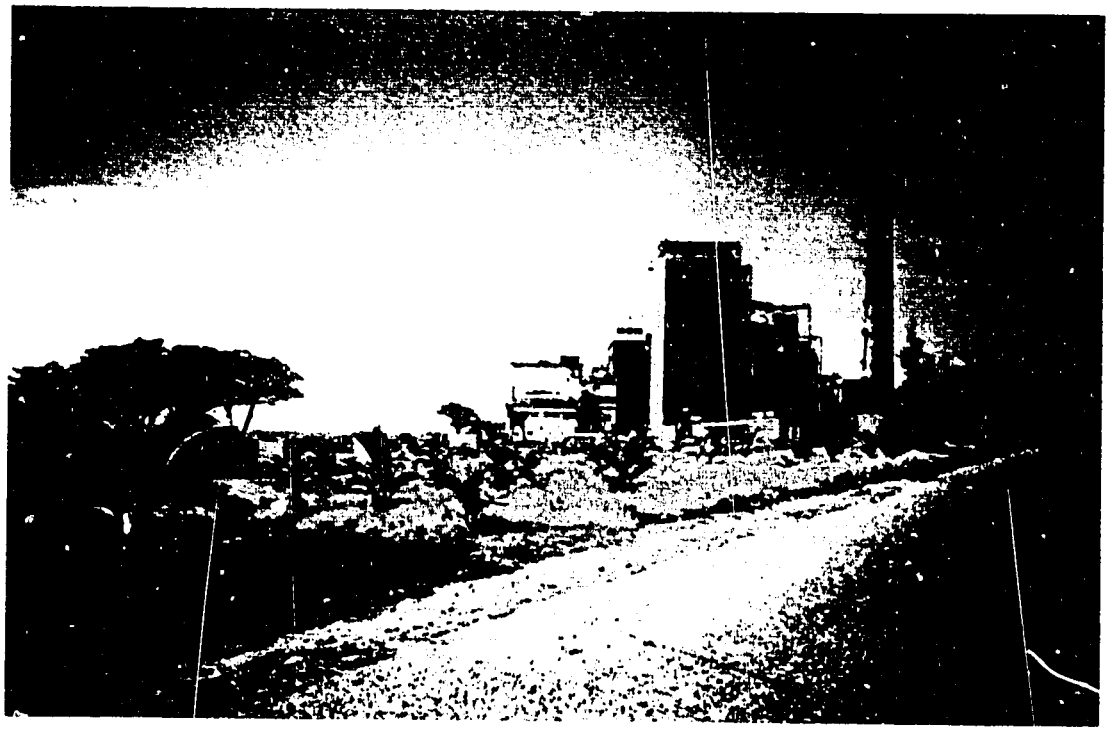


Exhibit 5-4
Proposed Site at Itabo

6. MITIGATION MEASURES FOR PLANNED FACILITIES

The mitigation measures recommended in this section are designed for the environmental impacts at the four priority sites described in Section 5.2, "Environmental Impacts of Planned Facilities," but they would be applicable to future power sector expansion at any designated site throughout the Dominican Republic. These mitigation measures should serve as the basis for site-specific mitigation measures particular to site and plant design to be developed in the project-specific EIASs.

6.1 AIR QUALITY

6.1.1 Mitigation Measures

The mitigation measures recommended below apply to both existing power plants and new plants.

1.) The use of any fuel (oil or coal) with 2 percent sulfur content or less would reduce the identified adverse impacts to insignificant levels. Low sulfur coal and low sulfur fuel oil are available on the market, but the costs will vary depending on the timing of the purchase. At the time of EIAS preparation for the planned facilities, a comparison between the cost of low sulfur fuel and the cost of installing pollution control equipment in the new plants, such as scrubbers, should be conducted. Installation of scrubbers would require major plant overhaul that could cost $10 million per unit. Also, the use of scrubbers would result in the production of Flue Gas Desulfurization Waste, which is considered to be toxic and is difficult to dispose.

2.) Maintenance procedures should be instituted to ensure that emission control equipment, either presently installed or in new plants, is functioning properly. Increases in the operating efficiency of electrostatic precipitators (ESPs) can result in improvements in particulate removal from 99 percent to 99.5 percent, and reduction in the plume opacity levels to below 20 percent. Effective plant maintenance procedures should be established to achieve long periods of efficient operation and few outages or upsets. Procedures should include improved general housekeeping, routine inspection and repair of essential plant systems, and instrument calibration and repair.

3.) The operation of the combustion control equipment of power plants should be monitored and controlled to maintain and increase the efficiency of operations, and thereby reduce the amount of pollutant emissions per KWh of electricity produced.

4.) Stacks in new plants should be designed to ensure that the stack height is sufficient to reduce the ground level concentrations at the downwind receptors.

It should be noted that the coal handling facilities currently in place at the Itabo facility and at the Haina Port are presently under study. Recommendations for improvements in the coal handling and ash transportation and disposal procedures from that study will be incorporated in the final EA. It is anticipated that these recommendations will result in a reduction of fugitive dust emissions of coal dust from the coal handling system.

6.1.2 Perceived Value of Air Emission Reduction

Traditional analysis of power supply options has focused on the out-of-pocket costs of power production, such as capital investment, fuel cost, and operation and maintenance expenses. Environmental impacts have generally been external to economic analysis and, for that reason, are often referred to as "externalities." The limitation of that approach is that either environmental benefits are not considered at all, or that they are only considered indirectly through the use of design criteria to meet a set of regulations. There is no mechanism to allocate limited capital resources to the environmental control that will provide the greatest benefit.

In future economic evaluations, a reasonable approach will take the view that any investment for emission control equipment should be prioritized on an overall economic basis, including emission cost, so as to assure that limited capital is used in the most effective way. This approach is increasingly used in the United States and elsewhere, for evaluating power supply options with differing emission characteristics.

In this analysis, a range of emission values was reviewed. As an initial point of reference, the State of California levels that have been used as a model for other States were reviewed. These levels are presented as "high" (see Table 6-1). These were assumed to be the highest values that could reasonably be assigned to Dominican Republic. "Low" values were established to be 10 percent of those used in California. Although these values are characterized as "low," they are significantly higher than assigning no value at all, as is done in traditional economic analysis.

Table 6-1 Power Emission Values[1]$/Ton (1989 Dollars)

Emissions	High Values	Low Values
Nitrogen Oxide	$750	$75
Sulfur Oxides	$1,500	$150
PM_{10}	$1,280	$128

[1] California Energy Commission, *"Electricity Report,"* January 1993

At this time, it is not possible to estimate the reduction in tons of each pollutant that would result from the implementation of the mitigation measures recommended herein. When these amounts are known, at the completion of engineering and definitive determination of the fuel type to be used, assuming a 16-hour power plant operating day, and using the power emission values above, the benefits in dollars of reduced emissions per ton of pollutant can be estimated. For example, if a low sulfur fuel is introduced in a power plant that currently emits 64 tons of SO_2 per operating day (8,000 lbs. per hour), and emissions are reduced by approximately 75%, the value of the benefit for SO_2 in dollars would be within the range of $7,200 to $72,000 per day. This would amount to $262,800 to $2,628,000 per year.

6.2 WATER QUALITY/BIOLOGY

6.2.1 Water Quality

The mitigation measures proposed to reduce impacts to water quality to insignificant levels can be divided into two categories: construction and operational. The mitigation measures are applicable to any of the proposed plant sites and are also applicable to any type of fuel that may be used.

6.2.1.1 Construction Storm Water Runoff

Surface water runoff, storm water runoff (generally), and runoff from equipment washdown areas should be collected into a silt trap or settling basin with an oil separator. The oils should then be skimmed off and the solids allowed to settle out of suspension. The waste oils and solids should then be collected and disposed offsite in an appropriate waste disposal area.

6.2.1.2 Refueling

Equipment refueling should take place offsite to minimize the possibility of fuel spills. If this is not possible, fueling areas and fuel storage areas should be located on impervious surfaces, and fuel tanks should be located behind berms. Drainage from this area should be collected and disposed offsite.

6.2.1.3 Sewerage

Any domestic sewage generated during construction should be collected in a portable collection system or impermeable sump and disposed offsite. This assumes that there will not be any existing facilities that could be used by construction workers during working hours.

6.2.1.4 Start-up Water

Waters flushed through the new facility during start-up should be collected in a holding facility (such as a pond or sump) before discharge. Parameters such as pH, temperature, and heavy metals' concentrations should be measured at this point. If the effluent is found not to conform to existing applicable effluent discharge standards (e.g., NORDOM 436), the appropriate measures should be undertaken to bring the water quality within the regulatory limits. These methods may include neutralizing, cooling, precipitating, or removing heavy metals through adsorption on colloidal materials.

6.2.1.5 Operational Cooling Water Discharge

Thermal plumes from the cooling water discharge can be minimized through the construction of a submerged, multi-port diffuser. Discharge volumes and diffuser design (such as depth of diffuser, number and orientation of ports, and port discharge velocity) would be determined through temperature and flow modeling. However, this method of reducing thermal effects

(construction of a diffuser) is costly and may not be feasible under the financing package. If this is the case, cooling ponds or towers could be constructed. If the construction and operation costs are still too high, exceptions to water quality standards may have to be promulgated for this type of industry. Additional engineering methods to minimize the magnitude of thermal discharges such as alternative heat dissipation design (e.g., closed cycle cooling) and methods for waste heat utilization should be considered during the plant design phase.

If the power plant cooling system requires the frequent use of chlorine or other biocides to eliminate the growth of biofouling organisms, the effluent should be monitored to determine the residual levels of these chemicals before discharge. If high chlorine levels are detected, one method of reducing these concentrations may be the addition of sulfur dioxide before final discharge.

The cooling water effluent should also be monitored for a number of other constituents, including pH, dissolved oxygen, and heavy metals. As in the construction phase, if these parameters are not within acceptable water quality limits, appropriate methods should be applied to bring the effluent within regulatory guidelines. For pH, this may require neutralization or acidification. If dissolved oxygen levels are too low, increased aeration through the increase in the rate of discharge may be necessary. Adjustment of heavy metal concentrations may be more difficult and may require a rigorous investigative effort to determine the source of the particular metal (e.g., leaching from the condenser tubing) and to determine the proper operational or engineering solution, such as replacing the tubing with a more inert material.

6.2.1.6 Site Drainage

Site drainage, which includes surface water runoff from working and washdown areas, chemical storage facilities, parking lots, and access roads, should drain into a single collector system and sump. The runoff quantities for the collector system should be calculated using the Rational Method[1] and be based on an appropriate storm frequency. A runoff coefficient of 0.9 should be used for roads, pavements, and roofs; a coefficient of 0.5 should be used for all other areas. The minimum time of concentration should be five minutes. Such a design should prevent overflows during normal rainfall events. The sump should include oil skimmers or interceptors so that oils and grease can be removed before the runoff is discharged.

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1 The Rational Method is a design equation for small basins defined by $q_p = CiA$, where q_p is in acre-inches per hour, i is average rainfall intensity in inches per hour for a duration equal to the time of concentration of the basin, and A is area in acres (Linsley et al., 1958).

6.2.1.7 Loading and Transfer Facilities

If oil is the source of fuel for the proposed power plant(s), the entire loading and transfer area should be surrounded by oil booms in the water during unloading, augmented by absorbent material, available for deployment in the event of an oil spill. The absorbent material, once used, should be stored in 55 gallon drums specifically designated for collection of oily waste and disposed of in an appropriate waste disposal facility offsite. Once the fuel transfer is completed, the booms should be removed from the area, cleaned, and stored for later use.

If coal is the primary source of fuel, the storage piles should be covered, compacted, and sprayed with water to reduce dust. The storage area should be enclosed or bermed to prevent runoff from flowing offsite or into other locations within the operating facility. The area should be serviced by a drainage system that collects any localized runoff into a sump area where the solids can be removed, and possibly recovered for reuse, before discharge.

6.2.1.8 Ash Disposal

The ash resulting from a coal-burning facility should be disposed of at a designated ash disposal facility. As described in Section 6.3, "Solid Waste Disposal," the disposal facility should be designed in such a way as to minimize surface water runoff from the site as well as minimize waste leachates from entering either surface or groundwater in order to protect water quality.

6.2.2 Biology

6.2.2.1 Terrestrial Biology

Siting and Design. Mitigation of impacts to terrestrial flora and fauna would be addressed through the proper siting and design of the proposed power plant(s). Vegetation and wildlife surveys should be conducted in all areas that would be affected, including the plant site itself, fuel loading areas, construction staging areas, access roads, and any ancillary facilities required during the construction phase. If a potential development area, either the power plant or waste disposal facility, contains particularly sensitive habitat or species as defined by the proposed environmental law (Chapter 6), alternative designs or sites should be considered to avoid any potential conflicts.

Impacts could further be reduced if the proposed facility is located at an already disturbed site. With the biological diversity already reduced in industrial areas such as Itabo and San Pedro de Macorís, construction of a new plant would entail fewer impacts to flora and fauna than construction and development in an undeveloped area such as the Puerto Viejo de Azúa site.

6.2.2.2 Aquatic Biology

Water Quality Standards. In general, impacts to the aquatic environment at any of the proposed power facilities would be reduced through the implementation of water quality mitigation measures. Existing water quality standards or those to be promulgated as a result of the implementation of the proposed environmental law should be protective of sensitive aquatic resources such as invertebrates and fish. It will be important, however, to determine and quantify site-specific impacts to these aquatic resources within the project-specific EIAS.

Site-Specific Surveys. Because each of the proposed sites is different with respect to orientation and exposure to the marine environment, site-specific surveys will need to be conducted through baseline and post-construction monitoring to ascertain the level of impact at any of the facilities. These surveys should quantify the aquatic communities that would be potentially within the zone of influence of both the intake system as well as the outfalls. Siting of these structures should be within areas that would impact the fewest resources. For example, the intake structures should not be located in known spawning and nursery areas for commercially or recreationally important fish species. If there are significant fish or invertebrate resources within the proposed intake structures, velocities at the intake screens should be low enough to allow fish to escape and not become impinged or entrained into the cooling system.

6.3 SOLID WASTE DISPOSAL

The primary recommended mitigation measure for the environmentally responsible disposal of solid waste streams resulting from power sector expansion is to reduce them at the source by using a high quality fuel or efficient fuel operations systems. However, regardless of fuel and system types, some quantity of waste will be generated. In the Dominican Republic, land disposal is currently the primary disposal option due to the availability and accessibility of land and current lack of technology to support alternative methods such as economic reclamation and intense industrial and commercial use of coal ash. However, land disposal of solid wastes can tie up large tracts and will not always be practical where land is at a premium and environmental concerns are paramount. As the Dominican Republic industrializes and waste streams increase and diversify, non-land disposal techniques should be relied upon as viable disposal methods. Options such as economic reclamation and intense industrial and commercial use of coal ash should be initiated as soon as practical.

6.3.1 Land Disposal

Until these disposal options are viable, the land disposal of power-related solid waste streams should follow the proposed guidelines for disposal location siting; site design and preparation; and operation and management of the site. These recommendations should be implemented in order to effectively mitigate potential adverse impacts to the natural and human environments resulting from expansion of the power sector.

6.3.1.1 Site Selection

The siting of new disposal facilities for any power plant development, regardless of the primary waste stream, should follow a sound siting rationale. In general, the disposal site should be located in an area in which offsite migration of material is minimized. The site should have minimal proximity to ground and surface water resources and low soil permeability. In order to avoid adverse direct impacts to ground and surface water quality and marine and terrestrial biological resources, sites in or very near to coastal, wetland, and mangrove areas should not be considered as viable disposal locations.

The disposal site should be on low-lying and relatively flat land with no natural slopes toward sensitive resources such as human settlements, grazing areas, water resources, or sensitive biological areas. Areas with close proximity to any of these resources should be carefully avoided and any residential settlements should be prohibited within a specified zone perimeter around the disposal site. Future land use considerations should also be included in the site selection process so that when the disposal site becomes inactive, appropriate land uses may flourish on the former site. For example, land reclamation of former disposal sites may afford future land use options for agricultural uses.

If the Itabo site is selected for the development of one or two 125 MW units, the existing disposal site, serving Itabo I and II, should not be considered a viable disposal location. The Itabo disposal site does not conform to any of the siting criteria presented in this section and it would be environmentally unwise to exacerbate the existing problems already identified in Section 2.3. The Itabo disposal site would not be able to accommodate the estimated quantity of coal ash generated from the operation of the new unit(s).

6.3.1.2 Site Preparation/Design

The type of waste (coal ash or sludge) and its hazard and toxicity characteristics are the primary considerations in developing disposal site design criteria. These parameters are unknown because no chemical analyses have been conducted on existing power-related waste streams and any assumptions in this regard would be misleading. Although the disposal site design should be selected when more information is available, general recommendations for land disposal site preparation and design can be made.

If the primary waste stream is coal ash, and particularly if preliminary chemical analyses indicate toxic quantities of heavy metals in the ash leachate, the disposal site should be lined. Synthetic and geotextile lining and installed leachate collection systems are expensive and likely afford unnecessary precautions against leaching constituents. A liner consisting of a material mixture of fly ash, bottom ash, and cement compacted against the soil is an appropriate lining technique. Before the liner is laid and compacted, the site should first be excavated in a bowl shape from end to end so that water drains into a settling pond. The runoff water in the pond should be monitored for water levels and analyzed for pH and appropriate chemical parameters, principally heavy metals. In the future, after the site is inactive, it can be reclaimed. For example, by adding a significant layer of topsoil, the site can be reclaimed for agricultural purposes.

If the primary waste stream is sludge material, the land disposal site must be adequately lined to prevent contaminants from reaching the soil and leaching potentially toxic materials into the groundwater. A properly laid synthetic liner, which can accommodate the heavy rains in the region, may adequately protect against soil contamination and leaching compounds. In addition, a leachate collection system should be installed and leachate monitored for heavy metal concentrations.

6.3.2 Site Operation

When coal ash is brought to the disposal site, the piles should be built in 6 to 12 inch layers and compacted by overriding the material with rubber tire mobile equipment such as a roller or a front end loader. Many of the detrimental environmental effects of current disposal practices described in previous sections can be avoided in future power sector development by dedicating the selected disposal site. The site should be adequately guarded and regularly patrolled, thereby preventing the presence of animals and unauthorized persons, and the disposal of other wastes. The runoff or leachate collected on-site should be properly treated prior to disposal. Down-gradient groundwater wells should be installed and regularly monitored for contamination.

6.3.3 Non-Land Disposal Options

The industrial and commercial use of coal ash has been the subject of worldwide interest and study. Uses for coal ash such as asphalt pavement, concrete, blocks for buildings and structures, lightweight aggregate, structural fills for construction, and soil modification for agriculture are proven applications and their use has increased dramatically in the past decade. A program to initiate interest and generate demand for coal ash as a viable industrial material should be initiated immediately. Coal ash currently generated from the Itabo site should be used to instigate a program for marketing and commercialization of this material. A license or fee should be charged to interested parties hauling coal ash from the Itabo disposal sites; currently, unauthorized persons are taking the ash offsite. The fee revenue should be used for further research and public sector marketing efforts for the industrial applications of coal ash. Commercializing the ash at the Itabo disposal site accomplishes a short-term environmental benefit by reducing ash quantities on-site. A long-term environmental benefit is also fostered by encouraging and accelerating demand for ash so that in the future, ash generated from the proposed plants has a useful industrial and commercial application.

If the primary waste stream is asphaltic sludge material, alternative disposal methods for sludge (such as incineration, chemical treatment, or chemical fixation) should be addressed in the project-specific EIAS.

6.4 LAND USE/SOCIAL

The primary mitigation to avoid or reduce adverse or potentially significant land use/social impacts at any future site is proper siting of the proposed power facility. Since land use plans and guidelines do not exist for any of the proposed sites, preliminary siting decisions

regarding appropriate adjacent uses have not been made. Therefore, informed decisions regarding the appropriateness of the development of a power generation facility at the priority sites or any future site need to be made.

The project-specific EIAS would be the most appropriate and timely vehicle for addressing the project-specific siting issues and the potentially significant impacts identified in Section 5.2. The mitigation measures proposed below would apply to many sites with such similar conditions as proximity to residential, recreational, and tourism areas. However, for clarity, mitigation measures are listed for each of the four priority sites.

Andrés/Boca Chica. To mitigate the spillage of coal ash, dust, noise, and the aesthetic impacts of plant-related traffic, including the transport of waste materials such as coal ash, the following mitigation measures should be implemented:

- All trucks should be either enclosed or covered with a tarp to prevent spills or dispersion of ash.
- Transportation corridor improvements, such as tree planting and landscaping, should be undertaken in populated residential and tourist/commercial areas, especially Boca Chica.

To mitigate the potential visual impacts of stack and plume visibility to the Boca Chica area, the following mitigation should be implemented:

- The plant should be sited and positioned to reduce the view of the stack from Boca Chica Beach and the water.
- Screening devices, such as the use of paint and materials, lighting alternatives, and other means should be employed to minimize the visual intrusion of the stack.

San Pedro de Macorís. To mitigate the impacts of coal ash transportation, the mitigation discussed previously should be implemented. To mitigate the potential impacts to the nearby residential settlement, relocation of residents to a suitable location for residential use should be considered.

Puerto Viejo de Azúa. If the new units are located at Azúa, special provisions should be made to ensure the continuation of recreational activities at the beach. If part of the area is designated as a natural preserve, the power plant and associated intake and outfall canals should be sited at an appropriate distance from the preserve.

Itabo. To mitigate the impacts to nearby residential units, the residents should be relocated to a more appropriate residential area.

7. ACTION PLAN

The intent of the Action Plan is to introduce a strategy to strengthen the environmental management capacity of the power sector. In particular, the strategy is focused on ensuring that the two new power plants are built using the required mitigation measures, and that there is a governmental structure, even if temporary, to ensure that these mitigations are implemented during plant construction and operation. Because a national environmental management system is not presently in existence, recommendations are made in Section 7.1 for such a system. Recommendations for environmental management within the power sector are presented in Sections 7.2 through 7.5. Section 7.6 contains interim measures addressing environmental problems in the power sector and guidelines for project-specific environmental reports. Estimated costs of Action Plan implementation are presented in Section 7.7.

7.1 INSTITUTIONAL DEVELOPMENT OF ENVIRONMENTAL MANAGEMENT CAPABILITY

Ensuring that projects across many sectors are developed in an environmentally sound manner is dependent on the capability of the institutions in the Dominican Republic to produce and review an adequate environmental impact assessment; translate findings into design criteria; implement mitigation measures and environmental permits; and enforce environmental standards. Extensive institutional improvements, both on the national and sectoral levels, are required in order to install such an environmental management system.

An approach for a national environmental management framework is presented in this section on the assumption that the proposed Environmental Law will be passed. In light of the need for significant institutional strengthening, the preliminary recommendations made throughout Section 7.1 are numerous and will involve substantial development, commensurate technical assistance, and funding resources at the national level.

Institution of a national environmental management system will require the following: 1.) redefinition and clarification of agency mission and goals; 2.) redistribution of environmental management responsibilities; 3.) agency restructuring guidelines to eliminate fragmentation and redundancy; 4.) reallocation of agency operating budgets; and 5.) commitment of human resources. Before recommendations on these issues can be made, a detailed inventory and subsequent analysis of the institutional capacity of relevant agencies should be prepared. The World Bank guidance on this subject with respect to data collection techniques, analytical processes, and methods should be followed. The study would assess the strengths and weaknesses of the following organizational components of relevant agencies:

- Agency mission, goals, and range of responsibility
- Agency functions
- Legal basis for agency existence, authority, and function
- Agency organizational structure

- Formal and informal agency coordination protocol
- Allocated and actual operating budgets
- Equipment and supplies
- Human resources currently utilized in terms of staffing levels, level of expertise, agency educational requirements, and salary structure
- Human resources available outside the public sector, such as university, NGOs, and private sector business
- Formal and informal NGO and public involvement protocol
- National and international training opportunities

In order to provide a logical context for the recommendations concerning environmental management in the power sector, this section outlines the types of changes which would have to take place countrywide, with respect to the following activities: 1.) cross-sector environmental guidelines; 2.) inter-agency coordination; 3.) EIAS preparation and approval procedures; 4.) environmental planning, studies, and monitoring programs; 5.) training and public education; 6.) public consultation and NGO involvement.

7.1.1 Environmental Guidelines

Chapter 21 (Article 221) of the Environmental Law requires an Evaluación de Impacto Ambiental y Social (EIAS) for a wide range of major projects from power facilities, airports, and transportation projects, to programs and plans for national parks and agriculture. Chapter 21 (Article 223) of the Environmental Law also lists specific mandatory components for inclusion in the EIAS, such as descriptions of the project, affected impact area, environmental and social impacts, and mitigation measures.

The purpose for preparation of environmental guidelines to implement the law is to ensure that potential environmental and social consequences are integrated into the planning and decision-making processes used by public agencies and projects proposed by private industry. When environmental guidelines are developed specific to a particular agency, the focus on a particular resource or facility type renders the evaluation process more effective and efficient. The guidelines should consist of systematic practices regarding the preparation, review, and implementation of the EIAS for projects under that agency's jurisdiction. The guidelines would also describe the relationship of the EIAS to project permitting processes so that a logical and coherent record of compliance with applicable environmental permits and norms is established.

For example, INDRHI might prepare guidelines that emphasize resources such as forestry, agriculture, and fisheries that are commonly affected by the development of hydroelectric projects, and focus on mitigation for watershed management such as afforestation, land use changes, and construction of structural controls that might be required. Because the law requires

that environmental and social considerations be incorporated into plans as well as proposed projects, environmental guidelines should be developed within trustee agencies such as Subsecretariat for Natural Resources (SURENA) and the Directorate for National Parks (DNP) and agencies with planning responsibilities such as The National Planning Office (ONAPLAN) and the Secretariat for Tourism (SECTUR). The environmental guidelines developed by all agencies should be reviewed and approved by the Comisión Nacional para el Medio Ambiente before they are applied.

A model outline of the topics to be included in agency environmental compliance guidelines follows.

I. Environmental Screening

A. Determining projects subject to and excluded from compliance
B. Determining appropriate level of detail in the EIAS
C. Determining if proposed project should be evaluated with other (impacts of) similar projects

II. Preparing Evaluaciones de Impacto Ambiental y Social

A. Scope of the EIAS

— Defining the EIAS scope
— Involving public and NGO participation in scoping
— Involving concerned agency participation in scoping

B. Conducting EIASs

— Defining the proposed action
— Identifying the affected human and natural environment
— Assessing environmental and social impacts of the project
— Developing mitigation measures to offset adverse impacts
— Preparing the EIAS document in the proper format

C. Notifying the Public

— Identifying public review and comment period procedures for EIAS
— Providing notice of availability of EIAS

III. Relationship of EIAS to Agency Permitting Processes

IV. Implementing and Monitoring Mitigation Measures

A. Preparation or review of a mitigation and monitoring plan detailing implementation and monitoring responsibilities for the mitigation measures defined and agreed upon during the EIAS process.

Additional environmental guidelines should also include the following:

- Planning for environmental facilities, (e.g., a water treatment plant)
- Baseline data collection requirements, such as analytical methods and chemical parameters
- Project-specific studies commonly required, such as air dispersion models, water quality models, or traffic studies
- Sector-specific required mitigation measures
- Monitoring and reporting requirements such as monitoring parameters and reporting frequency

7.1.2 Inter-Agency Coordination

The coordination of relevant public agencies in the EIAS process is important in facilitating a multi-disciplinary and objective evaluation of potential environmental consequences of a proposed project. Building this capacity for agency coordination in the Dominican Republic is also important in bridging the information gap. However, only one agency should be responsible for preparing an EIAS within any sector. To avoid overlap, the public agency primarily responsible for carrying out or approving a project should be designated as the "lead" agency. It is this agency that should be responsible for preparing the EIAS, implementing its findings, and monitoring the mitigation measures incorporated into the project. Where several agencies might be involved in proposed project funding, approvals, or permits, the one with the majority of approval or permit responsibilities or the most governmental power should carry out the EIAS. Interested agencies are also those that are in charge of resources potentially affected by the proposed project. These recommendations follow the U.S. procedures for Federal EIS under NEPA, which have been proven successful since 1969.

7.1.3 EIAS Preparation and Approval Procedures

In order for the EIAS process to be applied consistently across all sectors, the Comisión para el Medio Ambiente should develop EIAS procedures. These procedures would identify the steps for developing, evaluating, reviewing, and approving EIASs in all sectors, and ensuring the integration of cross-sectoral issues and public concerns into project planning, design, and development of mitigation measures. Procedures developed by the Comisión para el Medio Ambiente might include the following:

- Public Scoping. After the decision to prepare an EIAS has been made and the concerned agencies identified, the scope of the EIAS should be developed with interested agencies, affected public parties, NGOs, and community groups. Public consultation during scoping often solves potential problems that may surface later in the EIAS process.

- EIAS Preparation and Review. The EIAS should be prepared and reviewed in consultation with the interested agencies and should be conducted in tandem with planning, review, and project approval processes. The draft EIAS may be prepared either by the staff of the lead agency, by contracting with a private consultant, or by accepting a draft prepared by the applicant or the applicant's consultant. Because the lead agency should be solely responsible for the EIAS's adequacy and objectivity, it should carefully review any draft prepared by an outside party. A review and comment period should be established affording ample time for comments. The lead agency should evaluate comments and provide timely written responses to be included in the final EIAS.

7.1.4 Environmental Planning, Studies, and Monitoring Programs

One of the obstacles to effective environmental management in the Dominican Republic is the present lack of basic data on the location and condition of natural resources and the impact of human and industrial activities on these resources. Basic data gathering and resource mapping are not normally part of the environmental compliance process, but the present absence of such data will render any proposed permits processes and monitoring programs ineffective. Environmental documents, such as permits and EIAs, rely on such a database for accurate analysis. Resources such as flora and fauna, wetland areas, land uses, water quality, and air quality are not systematically mapped or assessed, baseline studies are not conducted, nor are the effects of industrial and urban pollution on baseline conditions regulated, permitted, or monitored. Bridging this information gap and resolving the institutional limitations which perpetuate it will be crucial to preventing the aggravation of existing environmental problems and forestalling the creation of new ones.

Resource monitoring programs are an effective means to maintain the quality of a resource and regulate the impacts of human and industrial activities. There are two distinct types of monitoring programs:

- Nationwide monitoring of resources to continuously monitor the quality of resources (e.g., ambient air quality monitoring) conducted by the resource management agency

- Industrial monitoring programs that monitor the impacts of industrial activities on resources (e.g., effluent discharges to rivers) implemented by the polluting industry with oversight and enforcement by the corresponding resource management agency

However, basic data and baseline conditions must first be documented before these monitoring programs can be implemented. These data are essential tools of environmental management across all sectors for several reasons: 1.) Baseline data is needed for EIASs to accurately define environmental impacts to background conditions; 2.) Mapped and classified resources, such as ecologically protected areas and ambient air quality, are needed for the development of siting

criteria for industrial facilities; 3.) Information on the type, quality, and location of resources such as wetlands and endangered species is needed to develop countrywide environmental planning strategies.

A comprehensive national resource assessment and monitoring strategy may be developed. The strategy should include the following two programs for each resource:

1.) A resource assessment program to gather basic data and to determine baseline conditions. After baseline data is assessed, this program would function as a continuous monitoring program.

2.) A resource-specific monitoring program which would function as part of an overall permitting system for facilities that release pollutants that affect the resource.

For example, for water quality, a program would be developed to assess background conditions of the quality of water bodies throughout the country. This program, or a variation of it, could be left in place to function as an ongoing monitoring program continually monitoring water quality. The polluting industry would monitor its effluent discharges and report to the water quality management agency to demonstrate continued compliance with a water quality discharge permit administered by the agency. Alternatively, each agency responsible for a resource area may develop its own assessment and monitoring strategy.

As part of overall management of the resource, the responsible resource management agency should perform the following activities:

- **Resource survey and mapping.** The type and location of resources should be identified.
- **Resource classification.** The use classification should be assigned (e.g., endangered species, land use, or water use).
- **Resource evaluation.** The existing quality of the resource should be identified (e.g., surface water quality according to water quality, or parameters and air quality according to ambient air quality standards).
- **Resource planning.** Resource use plans should be developed.
- **Permitting.** Use and discharge permits should be administered.
- **Resource monitoring.** An ongoing monitoring program should regulate the quality of the resource (e.g., ambient air quality monitoring using air quality monitoring stations).

Some organizations in the Dominican Republic are already involved in some of these above activities and they may also be assigned additional tasks. However, only one agency should conduct all of these tasks for any resource area. For example, surface water quality might be assigned to INDRHI, flora and fauna to the Wildlife Department of the Secretariat for

Agriculture, and land use to the appropriate department in ONAPLAN. Alternatively, these tasks might be accomplished under an umbrella agency such as the Subsecretariat for Natural Resources under the Secretariat of Agriculture (SURENA/SEA). Existing agencies might also be converted into departments under the Comisión Nacional para el Medio Ambiente. No agency or organization, however, is yet involved in air quality management or the administration of industrial waste facilities. One of the important tasks in implementing the Environmental Law will be to assign the above duties to the appropriate agency or department of the Comisión Nacional para el Medio Ambiente or to set up a new entity responsible for air quality management and the administration of industrial waste facilities.

Existing data regarding resource mapping, evaluation, quality, and monitoring data should be incorporated into baseline studies so that future efforts are not duplicated. NGO involvement should not be overlooked in these efforts and available information developed by the NGO should be utilized in resource assessment activities and studies. For example, the Dominican Foundation for the Research and Conservation of Marine Resources has conducted surveys of coastal marine resources. NGO expertise could also be incorporated into resources assessment or planning studies. The capacity of these and other existing agencies to implement these tasks is yet undetermined and should be examined.

Assessment and monitoring programs are needed at least for the following resources: 1.) Flora and Fauna; 2.) Coastal Marine Resources (mangroves, coastal wetlands, and fisheries); 3.) Surface Waters and Wetlands; 4.) Forestry; 5.) Land Uses; 6.) Air Quality; 7.) Water Quality.

Although the establishment of basic data and baseline conditions for all resources is important for the reasons discussed in this section, the following resource assessment and monitoring programs should take priority and are recommended to begin immediately:

- Land Use Study
- Coastal Marine Resources
- Water Quality
- Air Quality

7.1.5 Training and Public Education

The training component in a technical assistance program should be initiated on two levels:

- Training of agency staff on national and sectoral levels
- Education of the general population

Training goals should reflect the staffing levels proposed for the Comisión para el Medio Ambiente and the environmental units to be installed in the sectoral agencies. For the staff of the Comisión para el Medio Ambiente and the environmental unit staffs in sectoral agencies,

training on the preparation, evaluation, and review of EIASs should be initiated in the U.S. and other World Bank or IDB countries having substantial experience with this process. Although the University of Santo Domingo is reportedly developing an environmental engineering program, no domestic university currently offers courses related to industrial pollution and urban planning and management. Agency personnel should also receive funding for courses and seminars on environmental issues specific to their sector. Since consultants may play a large role early in the development of local EIAS capability, national and sectoral agency staffs should also receive training on consultant management.

Environmental education and awareness programs should be initiated to make the general populations aware of the opportunities and limitations of their physical environment. This can be achieved through involvement of environmental professionals, professors, and NGOs, and environmental education in the primary and secondary schools. For example, the agriculture department at the Instituto Superior de Agricultura (ISA) and conservation and natural resources departments at the Technology Institute of Eastern Cibao, the Santiago University of Technology, the Central University of the East, and the Catholic University could be involved in educating teachers in surrounding areas about sustainable resource use. In more remote areas, teachers might best be reached though NGOs in the area.

7.1.6 Public Consultation/NGO Involvement

Soliciting the participation of potentially affected individuals, business establishments, and NGOs, and incorporating informed views into the EIAS are necessary components in the approval process. The Dominican Republic has a strong NGO base (see Annex D) in the areas of social development and environmental conservation. However, the public consultation requirements of the Environmental Law are new to the agencies in the Dominican Republic and substantial technical assistance will be necessary to initiate this process.

Consulting affected communities and NGOs has two primary purposes: One, understanding the concerns of affected groups and the degree to which they are impacted by a proposed project, and second, to incorporate their expertise regarding the nature of particular environmental problem. The institution of a public scoping process, like that discussed in Section 7.1.3, would obtain this type of public input. Following scoping, in order to ensure that public concerns are incorporated into the EIAS, public notification of all phases of the EIAS (public hearings and the availability of the draft and final EIASs) should reach affected communities and be conducted in a timely manner.

7.2 DEVELOPMENT OF POWER SECTOR ENVIRONMENTAL MANAGEMENT CAPABILITY

Recommendations for the development of the environmental management capacity in the power sector made in this section are intended to resolve, as much as possible, the issues identified in Section 4.4, "Environmental Issues in the Power Sector's Regulatory Framework." These recommendations for establishing a sector-specific EIAS process, environmental standards, a permit process, monitoring programs, and an institutional structure to implement this

environmental management system will require significant technical assistance and commensurate funding commitments.

7.2.1 Siting Considerations for New Power Facilities

The primary means for avoiding or minimizing the adverse impacts of power plants will be to employ environmental screening criteria in the site selection process. A site screening process should at least include the following site selection considerations:

- Engineering Considerations

  — Availability of adequate land area
  — Sufficient cooling water
  — Suitability of foundation conditions
  — Favorability of topography
  — Accessibility of transportation facilities
  — General plant and transmission line layout
  — Erosion control requirements
  — Existing surface grade

- Environmental Considerations

  — Air Quality
  - Meteorological conditions of the impact area
  - Topography of the impact area
  - Ambient air quality of the impact area

  — Water
  - Availability
  - Quality (baseline conditions)
  - Proximity to major groundwater recharge zones
  - Aquifer characteristics
  - Proximity to water bodies and wetlands
  - Drainage problems (such as local ponding)
  - Capacity of existing wastewater treatment facilities

  — Land Use/Socioeconomic
  - Characteristics of immediately surrounding area and region
  - Distance of plant from populated area
  - Size and location of surrounding communities
  - Culture and lifestyles of the area

  — Ecology
  - Proximity to sensitive plant communities
  - Proximity to sensitive, rare, or endangered wildlife habitats
  - Proximity to protected ecological areas

- Type and extent of present and past human disturbances

Siting considerations such as these should be applied to potential sites targeted for future development in the Power Sector Expansion Plan and siting criteria developed. For example, a site at a distance greater than three miles from a population center of 2,500 persons, in an area with low ambient air quality concentrations of SO_x, and outside protected ecological areas might be considered a candidate site.

The private company or governmental entity making the siting decision should conduct a site screening and selection study. It is not necessary that the site screening analysis use sophisticated models. Rather, the study should demonstrate that the considerations listed above have been fully addressed.

7.2.2 Power Sector Environmental Guidelines

Environmental guidelines providing instruction on environmental compliance with relevant laws and standards should be developed by the Comisión Nacional de Energía for incorporation into both its energy policy and the implementation of specific power sector projects. The guidelines should facilitate compliance with the national Environmental Law and other relevant environmental technical norms such as those to be developed by the Superintendencia under the Energy Law. The detailed recommendations in Section 7.1.1, "Environmental Guidelines," should be applied in the development of environmental compliance guidelines particular to the power sector. Specifically, the guidance should describe the following components:

- Training of agency staff on national and sectoral levels
- Education of the general population
- EIAS preparation and approval process
- Relationship of EIAS and "concesión definitiva" to necessary facility permits (water discharge permit, air emission permit)
- Preparation, implementation, and monitoring of a mitigation plan
- Data collection requirements, such as air quality monitoring methods specific to power sector emissions (SO_x, NO_x, and CO)
- Project specific studies, such as water quality evaluation of intake source and outfall receiving waters
- Required mitigation measures for power plant development
- General monitoring and reporting requirements (e.g., monitoring and reporting exceedances of CO or SO_x over required emission limits)

Where guidelines or requirements for these components have been developed by another agency (such as air quality monitoring techniques that are required by an air quality management agency), the Comisión Nacional de Energía may defer to that guidance.

7.2.3 Agency Authorization

In accordance with the Energy Law, the Comisión Nacional de Energía is charged with developing and administering energy policy. However, COENER currently has an almost identical mission and ONAPLAN also has energy planning responsibilities. The missions of existing agencies involved in energy planning need to be redefined to avoid institutional redundancy.

Under the Energy Law, the Superintendencia de Electricidad has been given the responsibility for the review of the environmental assessment and mitigation measures prepared by a private company applying for a "concesión definitiva." However, the administration of hydroelectric projects is currently under the jurisdiction of INDRHI. The division of agency authorization responsibilities should be clarified under one of the following two scenarios:

- The Superintendencia is responsible for thermoelectric projects and INDRHI for hydroelectric projects. In this case, organizationally, INDRHI would be placed under the auspices of the Comisión Nacional de Energía.

- The Superintendencia is the only agency with authority over hydro or thermal power projects. In this case, INDRHI's mission would be redefined.

For clarity, it is assumed that, in accordance with the Energy Law, the Superintendencia will be the sectoral agency responsible for the development of all power projects both hydro or thermoelectric.

Since the power sector is the primary user of coal in the Dominican Republic, the Superintendencia would also be responsible for the development of the coal ash commercialization program as recommended in Section 6.3.3, "Non-Land Disposal Options."

7.2.4 Inter-Agency Coordination

As for all other sectoral agencies, it is recommended that an environmental unit be placed within the Superintendencia. The environmental unit should be staffed with a power engineer knowledgeable in power sector environmental issues, an air quality specialist, a biology/water quality expert, and an energy/natural resource planner. The Comisión Nacional de Energía staff should include an environmental planner.

For power project development, the Superintendencia should function as the lead agency. Under the Energy Law, the project sponsor is responsible for preparing an assessment of the environmental consequences of facility implementation and proposing measures to mitigate the negative impacts. The Superintendencia is charged with the review, not the preparation, of this assessment and mitigation plan as part of its review of the application for a "concesión

definitiva." Although not stated in the Energy Law, it will be important to establish that this assessment must fulfill the EIAS requirements so that it also becomes the project EIAS, and that the environmental evaluation process is not duplicated. The Superintendencia would, therefore, assume the responsibilities of lead agency in the EIAS review and implementation.

Because the Superintendencia, as the lead agency, is not responsible for the actual preparation of the EIAS, it must establish close coordination with the applicant during the EIAS process. For example, regular meetings with the applicant, the Comisión Nacional para el Medio Ambiente, and the Superintendencia should take place to discuss data needs and to clarify the EIAS requirements regarding such issues as required mitigation measures and implementation of mitigation plans. If the site has not been designated in the Power Sector Expansion Plan, a site screening study should be prepared by either the Superintendencia or the project sponsor and reviewed by the Superintendencia. An EIAS should not be prepared until the preferred site has been selected using a sound siting rationale and approved by the Superintendencia.

In order to facilitate a multidisciplinary and objective approach to the preparation and review of EIASs, concerned agencies should be identified using a process proposed in Section 7.1.2, "Inter-Agency Coordination." The EIASs prepared for power sector projects are likely to involve the following interested agencies: water quality management, air quality management, and land use management. The role of the Comisión Nacional para el Medio Ambiente in the EIAS process is described in the next section.

7.2.5 Agency Procedures

The preparation and review of EIASs in the power sector should follow a process like that proposed in Section 7.1.3, "EIAS Preparation and Approval Procedures." The environmental unit of the Superintendencia will be primarily responsible for reviewing the EIAS in conjunction with the "concesión definitiva." According to the Energy Law, after the Superintendencia has completed its review of the application package, its recommendations are to be forwarded to the Comisión Nacional de Energía and, if approved at this level, the application is forwarded to the Office of the President for final signature approval.

As discussed in Section 4.4, in order to promote an independent, objective review of the environmental consequences of power sector development, the EIAS should be reviewed concurrently by the Comisión para el Medio Ambiente functioning as the environmental oversight agency. Both the environmental oversight agency and the Superintendencia should review the EIAS for adequacy and completeness in accordance with established national and sectoral environmental guidelines. The recommendation of the Comisión para el Medio Ambiente should be forwarded concurrent with the Superintendencia's recommendation to the Comisión Nacional de Energía. In order to integrate environmental aspects into energy development as mandated by the Energy Law, the recommendation of the Comisión para el Medio Ambiente should be incorporated with that of the Superintendencia in the approval recommendation considered by the Comisión Nacional de Energía and the Office of the President.

Although not mandated in the Energy Law, the environmental unit within the Superintendencia should be given the authority to require the applicant to re-evaluate the findings and proposed

mitigation if the impacts are not adequately addressed in the EIAS or if the proposed mitigation measures are inadequate to offset adverse impacts. In addition to an adequate EIAS, the approval of the "concesión definitiva" by the Superintendencia should be contingent upon the approval of an air quality permit, water discharge permit, and other relevant environmental permits. The Superintendencia should be granted legal authority to require that all environmental permits be approved by respective agencies before a positive recommendation may be forwarded to the Comisión Nacional de Energía. The relationship of the EIAS and the project approval process to all other environmental permits should be clearly defined in the environmental guidelines. For example, approval should not be granted until a waste disposal site has been identified (if necessary) and approved by the appropriate governmental entity.

7.2.6 Environmental Planning

Environmental planning activities should be incorporated into the energy policy dialogues and utility plans in the Comisión Nacional de Energía. The Comisión Nacional de Energía, bound by the Energy Law, should develop energy policy and facility plans that promote optimal resource use and incorporate environmental considerations. The environmental planner in the organization should, therefore, have a strong role in integrating natural resource and environmental planning criteria into the development and formulation of national energy policy and utility plans.

7.2.7 Public Education/Information

Fostering public participation in the EIAS process through public hearings, public scoping meetings, and public review of the EIAS would be the responsibility of the environmental unit of the Superintendencia. Various techniques can be used, including public notices published in newspapers and posted on and near the proposed project site. In addition to specific dates and times of scheduled hearings or review and comment periods, notifications should also identify the responsible agency personnel to call for project information.

The Superintendencia should continue to involve affected communities during construction and operation of new power facilities by designating an individual within its environmental unit responsible and accountable for responding to questions and concerns from the public. This individual should coordinate closely with a member of the onsite construction team, plant engineer, or onsite environmental engineer. Continuous public involvement may also be fostered by conducting scheduled plant tours emphasizing the in-place pollution controls and mitigation measures to better protect the environment. The environmental unit should also be responsible for making publicly available plant monitoring and reporting results, perhaps by publishing the data in local periodicals.

7.2.8 Training

In addition to the academic disciplines of engineering, environmental planning, and biology, the members of the Superintendencia should receive training in the following areas:

- Review and evaluation of EIASs and implementation of EIAS mitigations

- Environmental compliance techniques (permitting systems, monitoring programs, annual compliance auditing, and enforcement mechanisms) at the power plants

- Environmental impacts particular to the power sector

- Commercial and industrial applications of coal ash and coal ash marketing programs

Sector-specific technical information might best be provided in conferences and materials created by U.S. organizations such as the following:

Electric Power Research Institute (EPRI) 3412 Hillview Ave. Palo Alto, CA 94304 (415) 855-2000	The American Association of Coal Ash 1913 1st St. North West, 6th Floor Washington, D.C. 20006 (202) 659-2303 (for coal ash utilization techniques)

7.3 POWER SECTOR ENVIRONMENTAL STANDARDS

According to the current draft of the Environmental Law, environmental norms and standards applicable to many sectors are to be promulgated by the Comisión Nacional para el Medio Ambiente. According to the current draft of the Energy Law, environmental norms are also to be developed by the Comisión Nacional de Energía and enforced by the Superintendencia. In order to avoid overlap, environmental norms should be promulgated only by the environmental oversight agency. These norms should then be adopted by the Comisión Nacional de Energía.

Currently, air quality standards or disposal standards for industrial wastes do not exist in the Dominican Republic. Water quality and industrial effluent discharge standards that exist are neither consistently used nor enforced. Air and water quality standards that might be established by the Comisión Nacional para el Medio Ambiente would include both ambient and source emission or effluent standards.

7.3.1 Air Quality Standards

7.3.1.1 Ambient Air Quality Standards

Air quality should be protected by adopting air quality norms, as mandated in Chapter 22 of the Environmental Law. The norms would be used to measure the impact of a specific power plant on air quality. Ambient air quality standards are a yardstick for programs to prevent or abate the effects of air pollution by establishing the maximum allowable levels of air pollutants. These standards are adopted in consideration of health, illness, irritation to the senses, aesthetic value, interference with visibility, and effects on the economy and other relevant factors.

The recommended standards for ambient air quality are the USEPA primary standards, shown in Section 2.2.1, Table 2-5, "Ambient Air Quality Standards."

Table 7-1 Recommended Ambient Air Quality Standards

Pollutant	Time Avg.	USEPA Standard ($\mu g/m^3$)
Sulfur dioxide (SO_2)	3 hr. 24 hr. annual	1300 - -
Nitrogen dioxide (NO_2)	annual	100
Suspended Particulate Matter (PM_{10})	24 hr. annual	150 50
Carbon monoxide (CO)	1 hr. 8 hr.	40,000 10,000

7.3.1.2 Source Emissions

Source-specific emission standards should be adopted to limit pollutant emissions at the source. For the power facilities in the Dominican Republic, the U.S. New Source Performance Standard for Electric Utility Steam Generating Units for which Construction is Commenced After September 18, 1978 (40 CFR 60, Subpart Da) might be applicable. This standard limits the releases of particulate matter, sulfur dioxide, and nitrogen oxides based on a ratio (pound/million Btu) of pollutants to the heat input of the fuels fired.

A summary of these standards is shown below:

Standard for Particulate Matter:

13ng/J(0.03lb/MBtu) heat input derived from the combustion of solid, liquid or gaseous fuel

Standard for Sulfur Dioxide:

Applicable to solid or solid derived fuel:

520 ng/J(1.20 lb/MBtu) heat input and 10 percent of the potential combustion concentration (90 percent reduction)

30 percent of the potential combustion concentration (70 percent reduction) when emissions are less than 260 ng/J (0.60 lb/MBtu) heat input

Applicable to liquid and gaseous fuels:

340 ng/J(0.80 lb/MBtu) heat input and 10 percent of the potential combustion concentration (90 percent reduction)

100 percent of the potential combustion concentration (zero percent reduction) when emissions are less than 86 ng/J (0.20 lb/MBtu) heat input

Standard for Nitrogen Oxides:

Gaseous fuels: 86 ng/J(0.20 lb/MBtu)
Liquid fuels: 130 ng/J(0.30 lb/MBtu)
Solid fuels: 260 ng/J(0.60 lb/MBtu) Anthracite coal

7.3.2 Water Quality Standards

There are two distinct types of water quality standards: 1.) receiving water standards; and, 2.) effluent or discharge limitations. Receiving water quality standards are developed to protect and maintain the quality of national waters. Specific receiving water quality chemical constituent limitations are therefore based on the category of use of the water body into which an industry is discharging. For example, waters that are designated for recreational uses will have more stringent water quality limits than a water body designated for industrial uses. Effluent or discharge standards are developed to limit the total pollutant load to the receiving water body. Effluent standards for many industries are often technology-based because plant operational processes affect the final effluent quality.

Both types of water quality standards should be adopted by the appropriate resource management agency (such as INDRHI or INAPA) identified as part of the institutional study. Some standards have been developed through various laws and regulations and should be incorporated, as appropriate. The existing laws and regulations pertaining to water quality are outlined and analyzed in the report "Red Nacional de Monitoreo de Calidad de Aquas para la República Dominicana. Informe No. 63" (April 1993).

7.3.2.1 Receiving Water Standards

Although the Environmental Law does not mandate the designation of national water resources according to use classifications (recreational, industrial, ecological, or biological protection), these classifications must be made in order for receiving water standards to be chosen according to their compatibility with the intended use. Specific receiving water standards cannot be recommended at this time because existing water quality has not yet been determined and the intended uses for national surface waters are unknown. Table 7-2 lists exemplary receiving water quality standards for waters in climate zones similar to the Dominican climate that may be used as general guidelines for selecting or developing receiving water standards for marine waters. These standards in Table 7-2 were also selected because they represent coastal water uses such as general marine water use, open coastline, and embayments similar to existing coastal water uses in the Dominican Republic.

7.3.2.2 Effluent or Discharge Standards

The primary requirement of a discharge permit is to ensure that industry effluent meet a specific discharge limitation or standard. Some effluent discharge standards, for selected industrial categories, have already been developed in the Dominican Republic. Table 7-3 presents some of these existing limits (according to Law 436), as well as general industrial effluent standards from other relevant countries for comparison. These general industrial discharge standards would be applicable to most industrial effluents across all sectors. Parameters that may be applicable to power sector effluent discharges are highlighted in bold. These standards could be used as the basis for permitting cross-sectoral industrial discharges to receiving waters. Also presented in Table 7-3 are U.S. guidelines for the discharge of effluents specific to the power sector.

Table 7–2: Exemplary Marine Receiving Water Quality Standards

Parameter	Unit	United States (Federal) general use		Hawaii general use and open coast		Florida	Puerto Rico	Thailand /9/	
		4–day avg /1/	1–hour avg /1/	chronic /5/	acute /5/	recreation and conservation use/7/	conservation use /8/	natural area conservation use	industrial use
Ammonia, total	mg/l	/2/	/2/	0.0035	0.0035	–	–	<0.4	/10/
Arsenic	mg/l	0.036	0.069	0.036	0.069	<0.050	0.15	–	–
Barium	mg/l	–	–	–	–	–	1.00	–	–
Boron	mg/l	–	–	–	–	–	4.8	–	–
Cadmium	mg/l	0.0093	0.043	0.0093	0.043	0.0093	0.005	<0.005	<0.005
Cyanide	mg/l	0.001	0.001	0.001	0.001	0.001	0.02	<0.01	/10/
Chlorides	mg/l	–	–	–	–	<10% increase	–	–	–
Calcium	mg/l	–	–	–	–	–	–	–	–
Copper	mg/l	–	0.0029	–	–	0.0029	0.05	<0.05	/10/
Chromium, total	mg/l	–	–	–	–	–	0.3	<0.1	/10/
Chromium, +6	mg/l	0.05	1.1	–	–	0.005	–	<0.05	<0.1
Chlorine, residual	mg/l	0.0075	0.013	0.0075	0.013	0.01	–	<0.01	/10/
Color	–	–	–	–	–	–	–	not objectionable	not objectionable
Conductivity	uS/cm	10% variation	10% variation	10% variation	10% variation	10% variation	–	10% variation	/10/
Biological oxygen demand	mg/l	–	–	–	–	no nuisance increase	–	–	–
Chemical oxygen demand	mg/l	–	–	–	–	–	–	–	–
Detergents	mg/l	–	–	–	–	0.5	–	–	–
Phenols	mg/l	–	–	–	0.17	4600	–	<0.03	/10/
Manganese	mg/l	0.1	0.1	–	–	–	0.1	<0.1	/10/
Magnesium	mg/l	–	–	–	–	–	–	–	–
Mercury	mg/l	0.000025	0.0021	–	0.0021	0.000025	0.001	<0.0001	<0.0001
Nitrates	mg/l	–	–	Geo. mean < 0.0035	/6/	–	–	–	–
Nitrites	mg/l	–	–	Geo. mean < 0.0035	/6/	–	–	–	–
Nitrogen, total	mg/l	–	–	Geo. mean < 0.11	/6/	–	5.00	–	–
Phosphorous	mg/l	0.0001	0.0001	Geo. mean <0.016	/6/	0.00001	–	–	/10/
Nickel	mg/l	0.0071	0.014	0.0083	0.075	0.0083	0.0083	–	–
Silver	mg/l	0.0023	0.0023	–	0.0023	0.00005	0.002	–	–
Lead	mg/l	0.0056	0.14	–	0.14	0.0056	0.015	<0.05	/10/
pH	units	6.5–8.5	6.5–8.5	7.6–8.6	7.6–8.6	6.0–8.5	7.3–8.5	7.0–8.5	/10/
Selenium	mg/l	0.054	0.4	0.071	0.3	0.071	0.01	–	–
Sulfates	mg/l	–	–	–	–	–	2800	–	–
Sulfides (undiss. H2S)	mg/l	0.002	0.002	–	–	–	0.002	<0.01	/10/
Solids, suspended	mg/l	–	–	–	–	–	–	–	–
Solids, tot. dissolved	mg/l	10% variation	10% variation	–	–	–	–	–	–
Solids, total	mg/l	–	–	–	–	–	–	–	–
Solids, floating	mg/l	–	–	none	none	–	–	not objectionable	not objectionable
Turbidity	NTU			0.2	0.2	<29 over ambient	10		
Zinc	mg/l	0.058	0.17	0.086	0.095	0.086	0.05	<0.1	/10/
Iron	mg/l	–	–	–	–	0.3	–	<0.3	/10/
Oil and grease	mg/l	no floating sheens		–	–	5.00	–	not visible	not visible
Temperature	C	/3/		<1 C from ambient	<1 C from ambient	site specific	<32.2 C	32 C	< 3 C from ambient
Settleable solids (1h)	mg/l	–	–	–	–	–		–	–
Coliforms, total fecal	MNP	104 /4/	104 /4/	–	–	200 month. avg	Geo. mean < 200	–	–
Flow	m3/s	–	–	–	–	–	–	–	–
Dissolved oxygen	mg/l	–	–	75% saturation <	75% saturation <	4.0–5.0	5	4 <	/10/

/1/ US EPA Quality Criteria for Water. 1986
/2/ Ammonia concentrations highly dependent on temperature and pH
/3/ Weekly average temperature increase must be less than or equal to 1 C; in subtropical regions (south of Cape Canaveral and Tampa Bay, Florida and Hawaii) short–term temperature maximum = 32.2 C, true daily temperature maximum mean = 29.4 C
/4/ MNP is for marine waters at designated beach areas
/5/ Hawaii Water Quality Standards. Hawaii Administrative Rules, Title 11. The nitrogen, ammonia, and phosphorus values are the most conservative criteria for the given constituent. The nitrate and nitrite nitrogen criteria are actually combined into one value in the Hawaii standards although it is shown as two values in this table. The chronic/acute columns do not apply to nitrogen, ammonia, nitrate/nitrite nitrogen, orammonia.
/6/ The values presented are geometric means not to be exceeded and are the most conservative. The first value is for the wet season (average freshwater inflow lessthan 1% of the embayment volume per day) and the second is the dry criteria (freshwater inflow less than 1% of embayment volume per day).
/7/ Florida Water Quality Standards. Official Compilation of Rules and Regulations of the State of Florida, Title 17 – Department of Environmental Regulation Chapter 17–3, Water Quality Standards. Adopted 10/28/70, as amended. 5/29/90 amendment used.
/8/ Puerto Rico Water Quality Standards. Puerto Rico Environmental Quality Board, Water Quality Standards. Regulation adopted 1/4/74, as amended. 7/20/90 amendment used. Water quality designations intable are for coastal and estuarine waters for primary and secondary contact recreation and propagation/preservation of desirable species.
/9/ Coastal Water Quality Guidelines. Laws and Standards in Pollution Control in Thailand. Second Edition. Environmental Quality Standards Division Office of the National Environment Board. Thailand, July 1989
/10/ May be established as necessary.

Table 7–3: Comparison of Dominican Republic Industrial Effluent Water Quality Standards /1/ with International Standards

Parameter	Unit	General Industrial Effluent Standards						US EPA Power Sector Industrial Effluent Guidelines				
		D.R. NORDOM 436 /2/	France /2/	Germany /2/	Italy /2/	Cyprus /3/	Thailand /4/	Maximum 1 day /7/	30–day avg /7/	Maximum coal pile /7/	1 day max cooling water blowdown	30–day avg cooling water blowdown
Ammonia, total	mg/l	–	–	–	15 (NH4)	–	–	–	–	–	–	–
Arsenic	mg/l	0.5	–	–	0.5	–	0.25	–	–	–	/8/	/8/
Barium	mg/l	–	–	–	–	–	1.0 (5 recomm)	–	–	–	–	–
Boron	mg/l	5	–	–	–	–	–	–	–	–	–	–
Cadmium	mg/l	0.1	–	–	–	–	0.03 (0.1 recom)	–	–	–	/8/	/8/
Cyanide	mg/l	0.05	–	–	–	–	0.2	–	–	–	/8/	/8/
Chlorides	mg/l	1000	–	–	1200	–	–	–	–	–	–	–
Calcium	mg/l	700	–	–	–	–	–	–	–	–	–	–
Copper	mg/l	1	–	–	–	0.1	1	1.0 x Q	1.0 x Q	–	/8/	/8/
Chromium, total	mg/l	–	–	2	2(+3)	–	2		–	–	0.2 x Q	0.2 x Q
Chromium, +6	mg/l	0.5	–	0.5	0.2	–	0.5	–	–	–	/8/	/8/
Chlorine, residual	mg/l	0.3	–	–	–	–	–	0.2 x Q	0.2 x Q	–	/8/	/8/
Color	–	200–1000	–	–	no perceptible	–	–	–	–	–	–	–
Conductivity	uS/cm	2000	–	–	–	–	–	–	–	–	–	–
Biological oxygen demand	mg/l	50	40	200	40	30	20–60	–	–	–	–	–
Chemical oxygen demand	mg/l	70	–	150	100	80	–	–	–	–	–	–
Detergents	mg/l	5 (ABS/LAS)	–	–	–	–	–	–	–	–	–	–
Phenols	mg/l	0.1	–	–	–	–	1	–	–	–	/8/	/8/
Manganese	mg/l	10	–	–	–	–	5.0 (2.0 recom)	–	–	–	–	–
Magnesium	mg/l	500	–	–	–	–	–	–	–	–	–	–
Mercury	mg/l	0.01	–	–	–	–	0.005	–	–	–	/8/	/8/
Nitrates	mg/l	100	–	–	–	–	–	–	–	–	–	–
Nitrites	mg/l	–	–	–	–	–	–	–	–	–	–	–
Nitrogen, total	mg/l	–	–	–	–	–	–	–	–	–	–	–
Phosphorous	mg/l	–	–	–	–	–	–	–	–	–	–	–
Nickel	mg/l	2	–	–	–	–	0.2	–	–	–	/8/	/8/
Silver	mg/l	0.1	–	–	–	–	0.2	–	–	–	/8/	/8/
Lead	mg/l	0.1	–	–	–	–	0.2	–	–	–	/8/	/8/
pH	units	10	5.5–8.5	6.0–9.0	5.5–9.5	6.0–9.0	5.0–9.0	6.0–9.0	6.0–9.0	–	–	–
Selenium	mg/l	0.05	–	–	–	–	0.02	–	–	–	/8/	/8/
Sulfates	mg/l	1000	–	–	1000	–	–	–	–	–	–	–
Sulfides	mg/l	1	–	2	1	–	1	–	–	–	–	–
Solids, suspended	mg/l	500	30	–	80	–	/5/	100.0 x Q	30.0 x Q	50	–	–
Solids, tot. dissolved	mg/l	1200	–	–	–	80	/5/	–	–	–	–	–
Solids, total	mg/l	1700	–	–	–	–	–	–	–	–	–	–
Solids, floating	mg/l	sin ret 3 mm	–	–	–	–	–	–	–	–	–	–
Zinc	mg/l	10	–	–	–	0.1	5	–	–	–	1.0 x Q	1.0 x Q
Iron	mg/l	10	–	–	–	–	20	1.0 x Q	1.0 x Q	–	–	–
Oil and grease	mg/l	70	–	–	20	–	5 (15 recomm)	20.0 x Q	15.0 x Q	–	–	–
Temperature	C	35	–	–	–	10 C>ambient	–	–	–	–	–	–
Settleable solids (1h)	mg/l	1	–	–	0.3	–	1	–	–	–	–	–
Coliforms, total fecal	MNP		–	–	20000 (12000)	–	–	–	–	–	–	–
Flow	m3/s	0.4 Qmin recept	–	–	–	–	–	–	–	–	–	–
Dissolved oxygen	mg/l	–	–	–	–	–	–	–	–	–	–	–
Material extracted from petroleum ether	mg/l	–	–	10	0.2 (dissolved)	–	–	–	–	–	–	–

/1/ Not implemented or enforced /2/ Red Nacional de Monitoreo de Calidad de Aquas para la Republica Dominicana. Instituto Nacional de Recursos Hidraulica (INDRHI). Informe No. 63. Noviembre 1992

/3/ Republic of Cyprus Fisheries Law Cap 135 /4/ Tentative Industrial Effluent Guidelines for Discharging into the Eastern Seaboard Coastal Water (Map Ta Phut Area). Laws and Standards in Pollution Control in Thailand. Second Edition. Environmental Quality Standards Division Office of the National Environment Board. Thailand. July 1989. /5/ Mixture ratio of wastewater and receiving water 1/8 to 1/150, max 30 1/151 to 1/3 max 60, 1/3 to 1/500 max 150

/6/ Maximum 2000 if receiving water is > 2000 mg/l; dissolved solids in effluent should not be > 5000 mg/l within the receiving water

/7/ New Source Performance Standards for steam electric power generation (40 CFR 423, 7/8/83). These guidelines are not legally enforceable but can be used as permit conditions which are legally binding.

/8/ No detectable amounts of these pollutants are recommended to be contained in the cooling tower blowdown. Q= Flow Rate at the outfall

7.4 POWER SECTOR COMPLIANCE PROCEDURES

Procedures for environmental compliance in the power sector would consist of the implementation of the EIAS mitigation plan, and the issuance of environmental permits for discharges to water and air resources.

7.4.1 EIAS Mitigation Plan

Following EIAS approvals, the Superintendencia, through its environmental unit, would be responsible for ensuring compliance during construction and operation with the measures proposed in the applicant's mitigation plan. Some of the proposed mitigation measures in place during plant operation, such as water quality monitoring programs, may also be a condition of the environmental permits. To avoid overlapping responsibilities, the Superintendencia should be responsible only for those measures in the EIAS mitigation plan that are not part of any other environmental permit. An inspector from the environmental unit should visit the facility periodically during construction to ensure that construction mitigation measures such as erosion control are functioning as anticipated. During plant operation, an inspector from the Superintendencia's environmental unit should conduct scheduled inspections.

Enforcement responsibilities of the Superintendencia, including fines and criminal penalties, are still unclear. According to the Energy Law, the Superintendencia has the authority to enforce technical norms as developed by the Comisión Nacional de Energía, but is not granted specific authority to enforce the mitigation plan measures and exact penalties for noncompliance. Legal clarifications are required in this area.

7.4.2 Environmental Permits and Monitoring Programs

The purpose for requiring environmental permit applications for new power facilities is to demonstrate compliance with the national environmental standards to be developed under the Environmental Law (possibly similar to those described in this Section). Monitoring programs should be required as part of the permit and function to demonstrate continued compliance. The environmental permits should be administered through the appropriate resource management agency.

Responsible agencies should be identified to oversee the implementation of the emission and discharge monitoring programs at each plant. The responsibilities of the appropriate agency with respect to monitoring programs are the following:

- Establish monitoring methodology to be implemented at the plant (e.g., monitoring water quality, air quality, and solid wastes)
- Receive and review monitoring reports
- Oversee and enforce environmental quality standards

The permitting agency should be endowed with the authority to enforce standards and impose fines for violations.

7.4.2.1 Air Quality Permit and Monitoring Programs

Air Quality Permit. Although the Environmental Law does not specifically mandate the issuance of an air quality permit for polluting industries or activities, a permitting system should be developed as a vehicle for accomplishing the goal of protecting air quality and preventing its degradation. The proposed permitting system might follow the New Source Review process used in the U.S. In this process, the designated air quality management agency would conduct a review of all new or modified sources of air pollution under its jurisdiction. The applicant (individual, company, or governmental entity) seeking to construct a facility that emits or has the potential to emit designated pollutants to the atmosphere would apply to the air quality management agency for an Authority to Construct Permit. If the material submitted by the applicant is satisfactory, the administrating agency will issue an Authority to Construct Permit so that construction can begin.

The New Source Review process first would require that an applicant demonstrate the following:

- Best Available Control Technology (BACT) has been incorporated into the design of the plant.
- Emissions from the proposed source will not, in combination with emissions from nearby existing sources, cause ambient air quality standards to be exceeded.
- All major facilities are identified which are owned and operated by the applicant, and they comply with air quality laws and regulations.
- Adequate emission reductions will be achieved to offset the incremental addition of pollutants to the atmosphere.
- Fugitive emissions are controlled to the extent consistent with good engineering practice.
- All applicable Rules and Regulations have been considered and followed.

Before construction is complete and prior to operation, the applicant would apply for an annual Permit to Operate, which mandates the quantity of emissions (such as sulfur dioxide, nitrogen oxides, and particulates) and other conditions with which the operational facility must comply. Compliance with Permit to Operate conditions should be enforced. Sanctions for a failure to comply might be legal action, possibly resulting in the loss of Permit to Operate and a substantial fine. The Permit to Operate and its conditions should be reviewed annually by the responsible agency to ensure compliance with both previous conditions listed in the permit and any new or modified regulations which may have been introduced during the review period. The agency might charge fees to help defray the administrative costs for reviewing the application and granting the permit.

In the annual report to the responsible air quality management agency, the applicant should be required to provide operating records. The records would include data concerning fuels consumed, hours of operation, and records of emissions as measured at stack and offsite monitoring stations. The applicant might also be required to report exceedances within 24 hours, and to document these exceedances in the annual report.

For a good example of a successful air quality permit system under USEPA regulations, refer to the following San Francisco Bay Area Air Quality Management District. District Rules and Regulation, Manual of Procedures, Permit Handbook, and other technical documents relating to air quality management are available for purchase.

Bay Area Air Quality Management District
939 Ellis Street
San Francisco, CA 94109
Telephone: (415) 771-6000

Source Emission Monitoring Program. Emissions monitoring at the source, such as in-stack sampling and analysis of pollutants, may be accomplished by installing standard commercially available instrumentation systems. Source emissions monitoring, conducted by plant personnel, should sample the end-of-stack concentrations of particulate matter, sulfur dioxide, nitrogen oxides, and any other pollutants designated in the facility's Permit to Operate. The results should be systematically recorded and reported, as required, to the air quality management agency in order to demonstrate continuous compliance with the emission standards set forth in the permit conditions. As a cost reducing alternative, certain combustion parameters such as temperature and excess oxygen may be monitored to optimize plant operating characteristics and to reduce emissions through improvement of combustion efficiency. For control of sulfur dioxide, analyses of the fuel for consistency of expected sulfur content would ensure that SO_2 emissions are kept within intended limits.

Ambient Air Quality Monitoring Program. An ambient air quality monitoring program should be implemented as part of the resource assessment activities discussed in Section 7.1.4. The program would be conducted by the air quality management agency. This section addresses the configuration of an ambient air quality monitoring program remote from the source of pollutant emissions.

Air quality monitoring or air sampling and analysis at monitoring stations is a systematic program for determining the quality of ambient air and obtaining data over a reported interval at the required frequency. For example, the purpose of the monitoring effort should dictate the choice of one specific type of sampler or a combination of samplers such as continuous, manual batch, or automated sequential.

A successful monitoring program would address the following:

- Basic considerations
- System design
- Measurement principles
- System operation

Basic considerations. The basis for the monitoring program must be established. The objectives should be clear, a monitoring strategy adopted, and a list of definitions and specifications developed. The primary objective would be to evaluate air quality against a standard which is widely accepted, such as the USEPA ambient air quality standard, or a standard developed specifically for a project. Other objectives might be to determine the effect of a particular source, define background air quality, establish trends in air quality, or, to a lesser extent, evaluate changes in air pollutants from chemical or physical processes.

The monitoring strategy should make adjustments for time resolution, space resolution, and mobility. The time resolution adjustment provides a statistical variance factor which takes into account that no sampling or monitoring device faithfully represents the variability in ambient air. Space resolution addresses the variability of pollutant concentration with distance from the source. For example, sulfur released as sulfur dioxide will be converted in the atmosphere to particulate sulfate. Mobile or portable air monitoring equipment provides more flexibility in the geographical location of equipment.

If the terminology used for defining monitoring instrumentation performance is not consistent, it can prove to be a frequent source of misunderstandings. It is important that an official list of terminology be established for the project. Terms such as accuracy, lower detectable limit, rise time, fall time, and span drift should be defined.

System design. The design of the monitoring system includes considerations on where monitoring stations are sited, the physical design of the stations, design of sampling lines from the sample point to the analyzer in the station, and data acquisition.

The siting or placement of air monitoring stations depends on the objectives of the monitoring program. For example, stations might be located to identify the points of maximum pollutant concentrations, or to determine if pollutants are transported into the area of concern. Other factors, such as emission sources, demographics, and meteorology, may influence siting.

The number of stations, or the spacing between stations, must be established. Generally, no two sites are identical in air quality; however, the closer that two monitoring stations are, the more similar their air quality data will be. The question, then, is whether the difference in measurements justifies another station. There is no perfect station siting plan. However, a plan can be optimized to utilize available resources.

Air monitoring instruments, like other scientific equipment, operate best in proper environmental conditions. Air-conditioned shelters are available to maintain temperature and relative humidity within the range specified for the most sensitive instrument. Security and safety considerations include safe ventilated storage for gas cylinders, proper fire extinguishers, and grounded electrical service, where possible. For a complete remote air monitoring station, the USEPA recommends a minimum space allocation of 20.5 square meters, including space for instrumentation and laboratory, work area, compressed gas cylinder storage, miscellaneous storage, and toilet facilities.

Utilities required for the station include electrical power, hot and cold running water, and a sewer connection. The servicing and maintenance requirements for the stations themselves are not significant, and include normal building maintenance, custodial service, and care of heating, ventilating, and air conditioning equipment.

Air samples are brought from the sampling point to the analyzer in the shelter via a sampling line. It is important that the sample not be degraded or diluted in the sampling line. At this remote site, the data is collected, transformed from a continuous analog form to a digital form, and transmitted to other points where the data is used, further processed, or stored.

Measurement principles. Some methods of measurement may fall into both the physical and chemical categories. For example, chemiluminescent techniques, which are considered physical, also employ gas phase chemical reactions. For gaseous air contaminants, the following would be applicable: colormetric analyzers (spectrophotometry), electrometric analyzers, conductimetric analyzers, chemiluminescence analyzers, nondispersive infrared analyzers, ultraviolet absorption, and flame photometric analyzers. For particulate matter, the following would be commonly used: piezoelectric mass sensor, nephelometry, tape samplers, and charged particle mobility analyzer. The most common method is based on the measured gain in weight exhibited by a standardized sheet of filter paper aspirated at a known air flow rate in the ambient air for a period of 24 hours.

Air monitoring analyzers are continually being developed, and consideration should be given to the applicability of these.

System Operation. The validity of air quality data highly depends on how the system is operated. Important factors to consider would be proper installation of equipment, careful calibration of instruments and equipment, close adherence to established operating procedures, and proper servicing and maintenance. Detailed guidelines, procedures, and instructions should be provided for all procedures. Proper and adequate documentation must be maintained to support the accuracy and validity of the data. A formal quality assurance program should be implemented so that quantifiable statements could be made about the accuracy, precision, and reliability of the data. This program also provides a formal mechanism to identify, document, and correct deficiencies in a timely manner.

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7.4.2.2 Water Quality Permit and Monitoring

Water Quality Permit. Chapter 3, Article 28 of the Dominican Environmental Law mandates that a permit or license is required in order to utilize any water body in the Dominican Republic. A permitting system should be developed for industrial discharges to these waters. A discharge permitting system should follow the model established by the USEPA's National Pollutant Discharge Elimination System (NPDES) program. Under this program, permits are required when discharges to bays, lagoons, estuaries, rivers, lakes, streams, wetlands, or sewer systems are planned. Each point of discharge (i.e., outfall) should be described by the permit. Treatment before discharge may be required by conditions in the permit if the expected quality of the discharge has the potential to degrade the quality of the receiving water as established by the water quality management agency. Industrial discharges that should be regulated under the program include process wastewaters (including power facility outfall), contaminated area drainage, and stormwater runoff during construction.

The conditions of a discharge permit should be based on the following:

- Technology-based effluent limitations for the particular industrial category
- Water-quality-based effluent limitations of the receiving water
- Specific application of water quality plans for specifically-designated areas using best available technologies
- Compliance with any toxic and pre-treatment effluent standards

Water quality standards that may potentially be used in the proposed permit system are identified in Section 7.3, "Power Sector Environmental Standards."

Receiving Water Monitoring. At present, a specific monitoring program for potential industrial receiving waters is not recommended. The purpose of such a monitoring program would be to maintain the quality of these waters according to their intended use. When national water use priorities have been determined and use classifications established by the water quality management agency, a monitoring program should be instituted on a national level according to the recommendations made in Section 7.1.4, "Environmental Planning, Studies, and Monitoring Programs."

Effluent or Discharge Monitoring. Constituents that may be found in the cooling water effluent are dependent on the characteristics of the intake water, source and type of fuel and equipment coatings, and the use of biocides. Each of these categories influences the final type and concentrations of certain constituents in the cooling water effluent that cannot be accurately estimated until the final design phase.

Some of the compounds that may be found in this effluent include the following:

Aluminum, total	Copper, total	Potassium
Arsenic	Fluoride	Silica
Bicarbonate	Iron	Sodium
Boron	Magnesium	Sulfate
Calcium	Manganese	Total Dissolved Solids
Chloride	Nitrate	Zinc
Chromium	Phosphate	

These compounds and additional parameters such as flow rate at the outfall, pH, temperature, conductivity, and dissolved oxygen should be measured and reported to the appropriate water quality management agency on a quarterly basis, as required by their respective permits.

For a power facility fueled by either coal or oil, a monitoring program under a national discharge permitting system should be established that tracks not only the quality of the intake water for operational purposes but also the various waste streams. The waste streams that should be monitored include the following:

- Cooling water effluent
- Surface and stormwater discharge
- Plant wastewater
- Domestic sewage, if sewage is not piped to a local treatment plant

It is assumed that the cooling water effluent would constitute the major volume of the discharge from a power facility. It is possible in the plant design, however, that the surface water runoff collection system and plant wastewater and domestic sewage systems may be combined into one discharge line. If this line discharges to the receiving water, it would require monitoring. However, if this combined source discharge line is piped to a sewage treatment plant offsite, any monitoring requirements would be subject to the discretion of the treatment plant, and would be monitored and regulated in conformance with their requirements.

Under the assumption that there may be two major discharges from the plant (cooling water effluent and combined liquid wastes), each waste stream should be monitored weekly for all of the constituents for which standards have been established. Parameters such as pH and temperature, however, should be monitored continuously using a continuous monitoring strip chart. All analytical methods should conform with American Public Health Association (APHA) standard methods; American Society for Testing and Materials (ASTM) standard methods; or other internationally recognized testing methods for chemical analyses.

The monitoring activities should be assigned to one plant engineer who is responsible for the collection and analysis of the effluent and submittal of the data in the form of monitoring reports. The reports should include the plant site, monitoring period, chemical parameters

monitored, any exceedances, any plant upsets or unusual discharges, and measures taken to rectify these exceedances or upsets. The reports should be submitted on a quarterly basis to the appropriate responsible agency for review and approval.

The main body of the report should contain the actual analytical results of the effluent monitoring. Each discharge point should be reported separately and actual sampling dates clearly stated. Analytical equipment and methods used both at the power facility and the analytical chemistry laboratory (if one has been contracted to do the analyses) should also be identified.

7.4.2.3 Solid Waste Permit and Monitoring Program

Permit. Because coal ash commercialization and industrial utilization is recommended in this EA as the primary technique for treating waste associated with power generation, few new disposal sites will be needed. A sophisticated and expensive permit process for disposal facilities is, therefore, not recommended at this time. However, proper siting and design of any disposal facility associated with the power sector will be extremely important in maintaining environmental quality, and should follow a sound siting rationale recommended as mitigation in Section 6.3. A siting study should be conducted by the Superintendencia and approved by the appropriate entity responsible for oversight of industrial waste and the Comisión Nacional para el Medio Ambiente before site development may begin. The proposed disposal site design should follow the general design guidelines in Section 6.3, and should also be approved in that manner.

In addition to transportation, operation, and economic site selection considerations, environmental siting criteria should be developed based on power plant ash data (ash production quantities, production processes and operation procedures) and any applicable regulations (zoning ordinances, master plans, and national solid waste disposal regulations). The study should evaluate potential disposal sites using environmental siting criteria developed from the following parameters:

- Aesthetics
  - Visibility of the site
- Air quality
  - Proximity to other polluting industries
- Topography
  - Natural slopes
  - Seismic considerations
  - Flood plain limitations
- Aquatic ecology

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— Proximity of outfall and intake to marine communities

- Water supply quality implications (ground and surface water)
- Presence of valuable cultural resources
- Land Use

  — Present and future land uses
  — Ash transportation routes

- Noise

  — Proximity to residential development
  — Public health and safety
  — Sensitive receptors to disposal site generated air and noise pollution
  — Downstream population and development

- Terrestrial Ecology

  — Critical habitat in the impact area

- Socio-economics

  — Effect on neighborhoods

Plant Coal Ash Monitoring Program. The quantity of coal ash generated at a plant should be tracked by the responsible plant engineer by recording the following parameters: 1.) quantity of ash generated on a daily or weekly basis; 2.) number of trucks entering/exiting the plant site; and, 3.) amount of fly ash and bottom ash generated.

The coal ash generated at the plant site should be characterized and recorded by the responsible plant engineer by conducting regular monthly analyses on both the ash and its leachate. The ash should be characterized according to the following characteristics: 1.) particle size; 2.) mineralogy; 3.) chemical composition of carbon, hydrogen, nitrogen, sulfur, cadmium, lead, copper, zinc, nickel, silver, and mercury. Ash leachate should be generated and analyzed for pH and the following metals: silver, arsenic, barium, cadmium, chromium, copper, lead, mercury, iron, magnesium, and selenium. A nearby laboratory should be identified to conduct these analyses. American Public Health Association (APHA) standard analytical methods or American Society for Testing and Materials (ASTM) are widely recognized and should be used.

Although similar chemical analysis would be conducted at the ash disposal site, a monitoring program for the site can only be recommended when a specific site is identified. Following the institutional study proposed in Section 7.1, the responsible entity should be identified to receive and review reporting results from the plant and the disposal site. The monitoring results from

both the plant site and the ash disposal site should be forwarded to this agency or department on a monthly basis.

7.5 EQUIPMENT SUPPORT FOR ENVIRONMENTAL MANAGEMENT IN THE POWER SECTOR

The following equipment would be needed to provide effective environmental management support. Because further planning is necessary to determine equipment specifications and quantities, order of magnitude costs are not provided herein.

- Computers, including hardware and software for managing environmental information and monitoring programs

- Fax machines

- Analytical standards and methods (APHA and ASTM), in Spanish

- Environmental reference documents (guidelines and procedures) from the United States

  — Example of EIS guidelines
  — Environmental audit procedures for power plants
  — Water discharge (NPDES) permit guidelines
  — Coal ash handling and treatment guidelines
  — Coal ash industrial utilization guidelines

- Monitoring Equipment

  — Turbidity monitor
  — Computerized strip charts for water pH
  — Computerized temperature probe
  — Calibration kits for water quality monitoring equipment
  — Noise meters
  — Ambient air quality monitoring stations and associated equipment
  — Source emission monitoring equipment (e.g. CEMs)

Support equipment for interim measures is discussed in the following section.

7.6 INTERIM MEASURES

Interim measures to address some of the existing environmental problems associated with the power sector are proposed in this section. Current constraints to environmental compliance in the Dominican power sector, stemming from a lack of environmental management and funds, as discussed in Section 2.4, "Environmental Compliance Constraints," severely limit the capability of the sector to conduct environmentally responsible development and operation of power generation facilities. The interim measures recommended in this section of the sectoral EA are proposed in view of these constraints and are intended as a short-term solution to some of the environmental problems caused by the operation of power facilities. These do not substitute the recommendations in the Action Plan for the long term development of environmental management capacity on the national and sectoral levels. Even with full implementation of these interim measures, environmental problems associated with the power sector will continue to worsen and new ones will be created if environmental management capability goes unimproved at both levels.

7.6.1 Interim Mitigation Measures for Power Sector Environmental Problems

7.6.1.1 Air Quality

Because the air quality impacts of existing plants were shown to be below levels of significance in Section 2.3.1, no air quality mitigation measures would be required with the exception of the Itabo I and II units. Should the Itabo site be selected for the two proposed units, the combined potential impacts of four units totaling 500 MW installed capacity would result in the need for mitigation measures for all the units. This would include use of operation of in-place ESPs and use of low sulfur fuel oil (2 wt. percent sulfur or less). Maintenance practices should also be implemented to increase combustion efficiency and ensure that pollution control equipment is operating properly.

The rehabilitation work currently in progress for Itabo Unit I should be immediately reviewed with a view of integrating low sulfur fuel and improved maintenance practices as part of the rehabilitation.

7.6.1.2 Safety/Maintenance

Preventive safety and plant maintenance programs should be conducted at each plant. A maintenance program would incorporate at least the following components:

- Written procedures (e.g., tagging and approval procedures)
- Preventive maintenance schedule and budget
- Spare parts inventory

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- Current plant documentation (e.g., design documents, manufacturing manuals)
- Consumables

A safety program developed using World Bank Occupational Health and Safety guidelines (see Annex E) would include the following components

- Emergency and contingency plan
- Safety teams (e.g., fire, hazardous materials, first aid)
- Onsite emergency supplies
- Safety training schedule
- Emergency warning systems (e.g., alarms, sirens, public address systems, radio communications, telephones)

Training should be carried out onsite twice a year.

7.6.1.3 Solid Waste Disposal

The absence of regulations, compliance guidelines, technology, and expertise, and disposal site permitting and enforcement severely limits the options for ensuring the proper environmental management of active power-related disposal sites throughout the Dominican Republic. The closure and remediation of the existing facilities that present serious and urgent public health impacts and environmental threats is recommended. The closure of the Itabo disposal site should take place immediately and the onsite amount of coal ash reduced and eventually remediated. The reduction of coal ash on-site should begin by commercializing the ash as proposed in this EA in Section 6.3.3, "Non-Land Disposal Options."

If the immediate closure of Itabo does not seem a likely possibility, the most technically feasible, timely, and cost-effective approach to mitigate public health impacts resulting from current disposal practices is to dedicate the active power-related disposal sites. Fencing should be installed around the perimeter of the sites, and under locked conditions the sites should be guarded and regularly patrolled, prohibiting the presence of animals and unauthorized persons, and the disposal of other wastes.

Regardless of whether environmentally hazardous disposal sites are closed or not, in order to lay the groundwork for long-term mitigation of environmental impacts related to solid waste disposal, several endeavors should be initiated immediately. Beginning at the most hazardous sites in the most populous areas, studies to determine the extent of contamination of ground and surface waters and public health impacts should be conducted. Specifically, the on-site ash and ash leachates should be analyzed for heavy metal concentrations; down-gradient groundwater wells installed and monitored for contamination; and soil samples should be taken from affected soils, a leachate extracted, and both analyzed for chemical composition. Research into various

options for the commercial and industrial uses for coal ash and alternative disposal methods for asphaltic sludge material should be undertaken immediately.

7.6.1.4 Coal Handling System

Currently, Itabo is the only power plant in the Dominican Republic equipped to handle coal. The coal is shipped from Colombia to the Dominican Republic through the Haina port, located about a mile from Itabo. Presently, the coal unloading procedure at the Haina port is rudimentary and crude. The impacts of coal handling at the Haina port are examined in detail in a separate study on coal handling at the Haina port available June, 1994. This report also provides more detailed recommendations on controlling dust emissions at the Haina port and at the plant site.

For coal handling operations at the Haina port, no effective technology can be recommended to prevent the currently problematic dust emissions at this location. A new and modern unloading system with dust control equipment would be required. This system would include continuous conveyors from the Haina Port unloading dock to the Itabo plant site.

At the plant site, the grizzly (location where the trucks unload the coal on the conveyor system) should be enclosed with a shed on three sides and finger curtains in the front. The dust inside the shed would be controlled with a sonic water-fog type dust suppression system. The same type of dust control method is recommended for all transfer points, the screening plant, the staker discharge, and the reclaim hoppers. The coal stockpile should be periodically sprayed with a sprinkler system. Further improvements for the prevention of coal dust emissions require major modifications of the present coal handling system at the plant.

7.6.2 Interim EIAS Guidelines for Power Expansion

In the case that the national or sectoral environmental management system is still incapable of implementing environmental review (via the EIAS as defined by the Environmental Law) by the time two new planned power plants are ready for approval, the project-specific EIAS should conform with the World Bank Operational Directive (OD) 4.01 for Category A EAs, since diverse and potentially significant impacts are anticipated from power sector development project(s). The EIAS should also be developed according to the requirements of the Dominican proposed Environmental Law, outlined in Section 3.0 (the proposed Environmental Law identifies power facilities as a major project that requires an environmental impact assessment).

Consistent with the "tiering" process inherent in preparation of this EA, the analysis of environmental impacts in the EIAS should be commensurate with the detailed engineering and siting information that will be available at the inception of the EIAS. The mitigation plan should include site and plant specific adaptations of the mitigation measures recommended in this sectoral EA (Section 6). Monitoring programs for water quality, air quality, solid waste, and mitigation should be developed in accordance with the recommendations made in this document (Section 7.4).

A public scoping process should be undertaken involving agencies, the public, NGOs, and, in particular, affected residential and business communities. To the extent possible, the EIAS

process should be combined with the planning, review, and project approval processes in place at the time of its preparation. Although the level of analysis and detail should be commensurate with the potential impacts, the basic components to be included in the project-specific EIAS are detailed below.

7.6.2.1 Executive Summary

This section would contain a concise summary of all adverse and potentially significant impacts.

7.6.2.2 Policy, Legal, and Administrative Framework

This section would contain the policy, legal, and administrative framework within which the EIAS is being prepared and institutional constraints affecting environmentally responsible project development specific to the Dominican Republic.

7.6.2.3 Project Description

This section would contain a concise description of the proposed project, including associated utilities, in its physical, ecological, and social context.

7.6.2.4 Baseline Data

This section would contain a description of the study area, including the transmission corridors and any associated offsite development, according to the relevant physical, biological, and socioeconomic conditions. Data gaps should be identified and studies on water quality, hydrological conditions, soil conditions, biological resources, and cultural resources should be initiated as appropriate.

7.6.2.5 Environmental Impacts

This section would contain an evaluation of all beneficial and adverse environmental impacts likely to result from the construction and operation of the proposed power generation facility. The following is a list of some anticipated adverse impacts. The list is not comprehensive, and more precise impacts should be identified when site delineation, plant engineering parameters, design parameters, and preferred fuel source are identified.

- Air quality

  — Short-term, localized impacts from construction activities such as grading, earth moving, and truck traffic

  — Substantial air emissions (SO_x, NO_x, CO, hydrocarbons, and particulate matter) from plant operation that result in the deterioration of ambient air quality, contribute to the degradation of global air quality, and substantially affect sensitive receptors

- Water quality

  — Alteration of surface water quality including, but not limited to, temperature, dissolved oxygen, or turbidity resulting from the thermal and chemical discharges from plant outfall into surface waters

  — Substantial reduction in the amount of water otherwise available for public water supplies and use due to plant cooling and process water requirements

- Biology

  — Change in diversity of species or number of any species of marine or aquatic life resulting from the thermal and chemical discharges from plant outfall

  — Impacts to fish migratory corridors, coral reefs, fishing areas, and other aquatic biological resources from the disposal of dredge material if port dredging is necessary

  — Change in diversity of species or numbers of any species of plant life (including trees, shrubs, grass crops, and aquatic plants) resulting from plant construction and operation

- Solid waste disposal

  — Soil, ground water, and surface water quality contamination and potential public health hazards which pose a threat to people, animal, or plant populations in the affected area resulting from the disposal of waste streams such as coal ash or sludge material

- Land use/recreation

  — Inconsistency of power plant development with present or intended land uses in the affected area causing substantial alteration of the present or intended land use pattern

  — Economic and recreational opportunity losses resulting from the impact of power plant development on the viability and attractiveness of surrounding recreational resources and tourism attractions

  — Impact to surrounding land uses in the event of accident or upset including, but not limited to, fire, explosion, oil spill, or fuel spill

- Aesthetics

  — Obstruction or degradation of any scenic vista important to the recreational or tourism use in the area resulting from plant stack, smoke plume, associated waste disposal activities, or the plant itself

- Soil Erosion

  — Wind and water erosion of soils due to the construction of a power facility on a shoreline or river bank

  — Deposition erosion from plant construction and operation which may modify the river or stream channel, or the bed of the ocean, bay, or inlet

- Traffic

  — Pressure on existing road capacity including fuel and waste transportation corridors and plant access roads to accommodate additional traffic generated from plant construction and operation

- Noise

  — Increase in existing noise levels due to construction and plant operations

  — Exposure of nearby residents to severe noise levels from plant operations

7.6.2.6 Analysis of Alternatives

This section would contain a consideration of reasonable project alternatives and would develop measures to mitigate significant environmental impacts resulting from the implementation of the proposed power facility and alternatives.

7.6.2.7 Mitigation Plan

This section would contain a mitigation plan in accordance with World Bank OD 4.01 Annex E, that identifies feasible and cost-effective measures to reduce potentially significant adverse impacts to acceptable levels. The mitigation plan should incorporate all the recommended mitigation measures identified in Section 6 of this EA. The mitigation proposed as part of the plan should be a project- and site-specific adaptation of these recommended mitigation measures. The plan should include an evaluation of impacts following mitigation; estimate mitigation costs; and identify institutional, training, and monitoring requirements.

7.6.2.8 Environmental Management and Training

This section would contain the EIAS and should describe onsite and agency roles and capabilities for environmental management and training. It would also recommend enhancement of existing units or establishment of new ones.

7.6.2.9 Environmental Monitoring Plan

The EIAS should include a feasible monitoring strategy which identifies the type, requirements, and implementation costs of the plan. The monitoring plan should differentiate between the monitoring of in-place mitigation measures recommended in the EIAS and the monitoring of emissions and discharges at the plant. The monitoring plan should mirror the programs established in Section 7.4, "Power Sector Compliance Procedures." Because environmental norms are not in existence, the EIAS should establish plant-specific environmental standards similar to those recommended in Section 7.3, "Power Sector Environmental Standards." Plant environmental compliance should be determined through application of these standards.

7.6.3 Interim Environmental Compliance for Power Expansion

This section identifies the requirements and responsibilities for implementing the project-specific EIAS. Depending on the functional status of the Superintendencia at project inception, either it or the Equipo Técnico will be the governmental entity responsible for project implementation and oversight.

7.6.3.1 Bid Package

The bid request documents should list the mitigation measures recommended for power expansion projects in the following sections of this sectoral EIAS:

- Section 6.1 Air Quality
- Section 6.2 Water Quality/Biology
- Section 6.3 Solid Waste Disposal
- Section 6.4 Land Use/Social

The bid requests should indicate that proposals are required to incorporate these measures into the intended plant design, mitigation plan, cost, and schedule. For example, plant design, cost and schedule should reflect the incorporation siting considerations to reduce environmental impacts and training of plant engineers and construction personnel regarding environmental controls and monitoring programs. The bid request should also clearly state that if the bidder is successful, these measures will become covenants of the loan.

7.6.3.2 EIAS Review and Approval

If the Superintendencia is not in place or does not have a trained environmental unit at the inception of the EIAS, it, or the Equipo Técnico, should delegate the EIAS review to a consultant. The EIAS should be reviewed for completeness and adequacy according to World Bank/IDB criteria. In addition, the EIAS should be reviewed for consistency with this sectoral EIAS, and any additional criteria should be identified by the Equipo Técnico or the Superintendencia. The World Bank/IDB will also have review responsibilities. The approval of the EIAS, and subsequent loan approval, will be contingent upon the fulfillment of these EIAS requirements.

7.6.3.3 Implementation of Mitigation and Monitoring Plans

Implementation of the mitigation plan and monitoring of both the mitigation measures and plant emissions and discharges will be the responsibility of the plant operators. An environmental coordinator or plant engineer should be designated as responsible for ensuring that the measures established in the mitigation plan are carried out for the duration of construction and plant operation. Continuous monitoring of mitigation measures during construction should be conducted in order to ensure that predicted impacts are within acceptable engineering and environmental limits and to provide early warning of unacceptable environmental impacts. In addition, the coordinator should also ensure that World Bank occupational health and safety guidelines for thermal power plant operation (see Annex E) are followed during plant operation. The coordinator should also be responsible for recording and reporting spills, occupational and environmental accidents, and emergencies. The onsite environmental coordinator should also be charged with implementing the plant-wide emissions and discharge monitoring programs developed in the project-specific EIAS. Back-up emergency services such as fire, police, and ambulance services should be evaluated, and an emergency contingency plan developed.

The Superintendencia or the Equipo Técnico should be responsible for overall environmental compliance of the plant during construction and operation. These responsibilities should include monitoring the implementation of the mitigation plan; overseeing the emissions monitoring programs; and receiving and evaluating effluent and air emissions reports. A consultant should be engaged to carry out these activities until the Superintendencia is fully staffed. During plant construction, scheduled plant visits should be conducted to ensure that mitigation measures and health and safety measures established in the project-specific EIAS are in place. In addition, annual audits of plant activities should be conducted in which compliance with the environmental standards identified in Section 7.3 are verified.

7.6.4 Interim Enforcement

Mechanisms for enforcement of loan covenants specific to required mitigation measures, monitoring requirements, and compliance with environmental standards will need to be identified or developed. Since the loan for power expansion projects will be made directly to the Dominican government through the national bank and loan monies forwarded to the successful bidder in lump sum, retraction of loan monies is not an enforcement option. Currently, there are no penalties for environmental infractions in the power sector and the Equipo Técnico is not

endowed with authority to enforce any new penalties that might be developed for power expansion project. If the Superintendencia is in place, it may have the legal authority to impose penalties for noncompliance with environmental norms, but enforcement options should be clarified.

7.6.5 Ambient Air Monitoring Stations

Although a complete program of air quality monitoring, promulgation of permanent air quality standards, compliance regulations, and enforcement procedures cannot be implemented in the near term, the installation of ambient air monitoring stations is proposed as a first step in that process.

7.6.6 Interim Support Equipment

The following equipment is necessary to support the implementation of the environmental mitigations recommended in this section. These mitigation measures and support equipment are necessary to define and alleviate the urgent environmental problems that have been described in this EA.

- Spare parts inventory
- Consumables
- Onsite emergency supplies
- Emergency warning systems
- Ambient air quality monitoring systems
- Computers
- Fax machines
- Water monitoring equipment
  - — Turbidity monitor
  - — Computerized strip charts for pH
  - — Computerized temperature probe
  - — Calibration kits for water quality monitoring equipment
- Coal ash monitoring equipment
- Soil monitoring equipment

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7.7 ORDER OF MAGNITUDE COSTS FOR ACTION PLAN IMPLEMENTATION

The following order of magnitude costs for action plan implementation reflect interim measures to be undertaken by the Dominican in order to ensure that the two new units are built and operated according to the environmental guidelines and standards described in this EA and to be recommended in the subsequent project-specific EIASs. More complete descriptions of activities to be performed for each of the following budget line items are referenced to sections 7.6, "Interim Measures", below.

Consultant Review of EIAS for 2 new units	**(Ref. to 7.6.3.2)**
Subtotal	**$ 100,000**
Power Plant Safety & Maintenance Program	**(Ref. to 7.6.1.2)**
Develop written maintenance procedures, schedules & budgets	200,000
Safety training procedures	100,000
Maintenance training Program for 9 existing fossil plants	225,000
Safety training for 9 existing fossil plants	225,000
Spare parts inventory	*
Consumables	*
Onsite emergency supplies	*
Emergency warning systems	*
Subtotal	**$ 750,000**
	(Ref. to 7.6.1.3)
Solid Waste Disposal Contamination Studies	
Identification of the most hazardous disposal sites	50,000
Remedial investigations of the most hazardous disposal sites	1,950,000
Assessment of commercial/industrial application of coal ash	120,000
Subtotal	**$2,120,000**
	(Ref. to 7.6.3.3)
Oversight of Mitigation and Monitoring Plans	
Subtotal	**$ 100,000**

	(Ref. to 7.6.6)
Interim Support Equipment	
Computers (5 units)	15,000
Fax Machines (5 units)	5,000
Water Quality Monitoring Equipment	20,000
Coal Ash Monitoring Equipment	50,000
Soil Monitoring Equipment	50,000
Subtotal	**$ 140,000**
GRAND TOTAL	**$3,210,000**

* For these items, an assessment of the plant needs to be made to estimate funding requirements.

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9. ORGANIZATIONS AND PERSONS CONSULTED

The following organizations and people were consulted when preparing this EA.

Comisión Nacional para el Medio Ambiente
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ANNEX A

PLANT DATA, EXISTING POWER PLANTS IN THE DOMINICAN REPUBLIC

ANNEX A

CHARACTERISTICS AND PLANT DATA OF POWER PLANTS OPERATING IN THE DOMINICAN REPUBLIC, MARCH, 1994

PLANT NAME	HAINA	ITABO
LOCATION	Santo Domingo	Santo Domingo
SIZE - No. OF UNITS AND POWER RATING	Unit 1 - 54 MW Unit 2 - 54 MW Unit 3 - 84.9 MW Unit 4 - 84.9 MW Unit 5 - 84.9 MW	Unit 1 - 125 MW Unit 2 - 125 MW
AGE (OR YEAR COMMISSIONED)	Unit 1 - 1968 Unit 2 - 1968 Unit 3 - 1979 Unit 4 - 1979 Unit 5 - 1979	Unit 1 - 1984 Unit 2 - 1989
CURRENT STATUS (OPERATIONAL, UNDER REPAIR, ETC.)	Unit 1 - 48 MW (available) Unit 2 - 0 MW (available) Unit 3 - 36 MW (available) Unit 4 - 52 MW (available) Unit 5 - 70 MW (available)	Unit 1 - 0 MW (under rehabilitation) Unit 2 - 115 MW (available)
TYPE OF BOILER, GAS TURBINE, OR DIESEL ENGINE	Boilers Pressure: 88 bars Temperature: 515 °C Vapor Production: 180 tons/hr (units 1 and 2) 280 tons/hr (units 3 to 5)	Unit 1 Boiler (Foster Wheeler, Spain) Unit 2 Boiler (Hitachi Zoosen, Japan) High Pressure Section: 141 bars and 535 °C Low Pressure Section: 38.5 bars and 535 °C Vapor Production: 389.5 tons/hr (High Pressure) 348.5 tons/hr (Low Pressure)

PLANT NAME	HAINA		ITABO	
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel-oil (11/16/93)		Fuel-oil (11/09/93)	
	Specific Gravity (60/60 °F):	0.9698 (0.9950 Max.)	Specific Gravity (60/60 °F):	0.9732 (0.9950 Max.)
	Heating Value:	18,339 Btu/lb (18,000 Btu/lb Min.)	Heating Value:	18,311 Btu/lb (18,000 Btu/lb Min.)
	Sulfur:	3.0% by weight	Sulfur:	2.75% by weight
	Specific Fuel Consumption (1993)		Specific Fuel Consumption (1993)	
	Unit 1	10,481 Btu/KWh	Unit 1	11,300 Btu/KWh
	Unit 2	12,896 Btu/KWh	Unit 2	11,300 Btu/KWh
	Unit 3	16,099 Btu/KWh		
	Unit 4	14,400 Btu/KWh		
	Unit 5	11,116 Btu/KWh		
SECONDARY FUEL AND SPECIFIC FUEL CONSUMPTION	Gas-oil		Coal - Colombian (06/19/93)	
	(Not available)		Volatile Matter:	37.39% (42.79% dry)
			Carbon:	45.60% (52.19%)
			Heating Value:	11,484 Btu/lb (13,143 Btu/lb dry)
			Sulfur:	0.56% by weight (0.64% dry)
			Specific Fuel Consumption (1993)	
			Unit 1	10,018 Btu/KWh
			Unit 2	10,018 Btu/KWh

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PLANT NAME	PUERTO PLATA	TIMBEQUE
LOCATION	Puerto Plata	Santo Domingo
SIZE - No. OF UNITS AND POWER RATING	Unit 1 - 26.5 MW Unit 2 - 36.8 MW	Unit 1 - 21 MW Unit 2 - 21 MW
AGE (OR YEAR COMMISSIONED)	Unit 1 - 1966 Unit 2 - 1982	Unit 1 - 1974 Unit 2 - 1974
CURRENT STATUS (OPERATIONAL, UNDER REPAIR, ETC.)	Unit 1 - 19 MW (available) Unit 2 - 0 MW (under rehabilitation)	Unit 1 - 15 MW (available) Unit 2 - 18 MW (available)
TYPE OF BOILER, GAS TURBINE, OR DIESEL ENGINE	Boiler Babcock Wilcox Furnace Peabody with pulverization system through vapor	Unit 1 and 2 Gas Turbines General Electric, Frame 5, Open Cycle Gas Turbine
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel-oil (02/07/92) Specific Gravity (60/60 °F): 0.9698 (0.9950 Max.) Heating Value: 18,315 Btu/lb Sulfur: 2.75% by weight Specific Fuel Consumption (1993) Unit 1 12,884 Btu/KWh Unit 2 (Not Applicable)	Gas-oil (Fuel #2) Specific Gravity (60/60 °F): 0.876 Heating Value: 19,335 Btu/lb Sulfur: 1.07% by weight Specific Fuel Consumption (1993) Unit 1 16,146 Btu/KWh Unit 2 16,505 Btu/KWh
SECONDARY FUEL AND SPECIFIC FUEL CONSUMPTION	No secondary fuel	Not available

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PLANT NAME	SANTO DOMINGO	BARAHONA (Gas Turbine)
LOCATION	Santo Domingo	Barahona
SIZE - No. OF UNITS AND POWER RATING	Unit 5 - 12.65 MW Unit 6 - 12.65 MW Unit 7 - 12.65 MW Unit 8 - 26.50 MW	Unit 1 - 28.3 MW
AGE (OR YEAR COMMISSIONED)	Unit 5 - 1954 Unit 6 - 1957 Unit 7 - 1959 Unit 8 - 1963	Unit 1 - unavailable
CURRENT STATUS (OPERATIONAL, UNDER REPAIR, ETC.)	Unit 5 - 11.00 MW (available) Unit 6 - 0 MW (retired & decomissioned) Unit 7 - 0 MW (retired & decomissioned) Unit 8 - 0 MW (under rehabilitation)	Unit 1 - 0 MW (new turbine under erection)
TYPE OF BOILER, GAS TURBINE, OR DIESEL ENGINE	Boilers Unit 5 - Combustion Engineering Unit 8 - Babcock and Wilcox	Gas Turbine A new turbine to original specifications is under construction by FIAT (Italy) with Westinghouse license.
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel-oil (02/07/92) Specific Gravity (60/60 °F): 0.975 Heating Value: 18,312 Btu/lb Sulfur: 2.75% by weight Specific Fuel Consumption (1993) Unit 5 14,740 Btu/KWh Unit 6 (Not Applicable) Unit 7 (Not Applicable) Unit 8 13,079 Btu/KWh	Gas-oil (Fuel #2) Specific Gravity (60/60 °F): 0.8762 Heating Value: 19,313 Btu/lb Sulfur: 2.00% by weight Specific Fuel Consumption (1993) (Not Applicable)
SECONDARY FUEL AND SPECIFIC FUEL CONSUMPTION	Gas-oil (only during start-up) Specific Gravity: 0.85 Heating Value: 41.7 MJ/kg	No secondary fuel

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PLANT NAME	SAN PEDRO DE MACORÍS (Steam Turbine)	SAN PEDRO DE MACORÍS (Gas Turbine)
LOCATION	San Pedro de Macorís	San Pedro de Macorís
SIZE - No. OF UNITS AND POWER RATING	Unit 1 - 33 MW	Unit 1 - 28.3 MW
AGE (OR YEAR COMMISSIONED)	Unit 1 - 1989	Unit 1 - 1974
CURRENT STATUS (OPERATIONAL, UNDER REPAIR, ETC.)	Unit 1 - 30 MW (available)	Unit 1 - 25 MW (available)
TYPE OF BOILER, GAS TURBINE, OR DIESEL ENGINE	Boiler Babcock Wilcox Furnace Peabody with pulverization system through vapor	Gas Turbine: Westinghouse
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel-oil (02/07/92) Specific Gravity (60/60 °F): 0.975 Heating Value: 18,312 Btu/lb Sulfur: 2.75% by weight Specific Fuel Consumption (1993) Unit 5 11,543 Btu/KWh	Gas-oil (Fuel #2) Specific Gravity (60/60 °F): 0.876 Heating Value: 19,335 Btu/lb Sulfur: 1.07% by weight Specific Fuel Consumption (1993) Unit 1 15,671 Btu/KWh
SECONDARY FUEL AND SPECIFIC FUEL CONSUMPTION	No secondary fuel	No secondary fuel

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PLANT NAME	SANTIAGO	FALCON BRIDGE
LOCATION	Santiago de los Caballeros	Bonao
SIZE - No. OF UNITS AND POWER RATING	Unit 1 - 12 MW	Unit 1 - 66 MW Unit 2 - 66 MW Unit 3 - 66 MW
AGE (OR YEAR COMMISSIONED)	Unit 1 - 1989	Unit 1 - 1985
CURRENT STATUS (OPERATIONAL, UNDER REPAIR, ETC.)	Unit 1 - 12 (contracted for)	Unit 1 - 40 (contracted for)
TYPE OF BOILER, GAS TURBINE, OR DIESEL ENGINE	Diesel Engine: (unavailable)	Boiler: (unavailable)
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Gas-oil (Fuel #2) Specific Gravity (60/60 °F): 0.876 Heating Value: 19,335 Btu/lb Sulfur: 1.07% by weight Specific Fuel Consumption (1993) Unit 1 13,781 Btu/KWh	Fuel-oil Specific Gravity (60/60 °F): 0.999 Heating Value: 18,015 Btu/lb Sulfur: 3.56% by weight Specific Fuel Consumption (1993) Unit 1 11,500 Btu/KWh
SECONDARY FUEL AND SPECIFIC FUEL CONSUMPTION	No secondary fuel	No secondary fuel

PLANT NAME	WARTSILA	WARTSILA
LOCATION	Puerto Plata	Santo Domingo
SIZE - No. OF UNITS AND POWER RATING	Unit 1- 18 MW	Unit 1 - 40 MW
AGE (OR YEAR COMMISSIONED)	Unit 1 - 1991	Unit 1 - 1989
CURRENT STATUS (OPERATIONAL, UNDER REPAIR, ETC.)	Unit 1 - 18 (available)	Unit 1 - 0 MW (unavailable)
TYPE OF BOILER, GAS TURBINE, OR DIESEL ENGINE	Diesel Engine: Wärtsilä	Diesel Engine: Wärtsilä
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel-oil #6 - Diluted by Gas Oil Specific Gravity (60/60 °F): 0.882 Heating Value: 18,267 Btu/lb Sulfur: 2.85% by weight Specific Fuel Consumption Unit 1 9,100 Btu/KWh	Fuel-oil #6 - Diluted by Gas-Oil Specific Gravity (60/60 °F): 0.882 Heating Value: 18,267 Btu/lb Sulfur: 2.85% by weight Specific Fuel Consumption Unit 1 9,100 Btu/KWh
SECONDARY FUEL AND SPECIFIC FUEL CONSUMPTION	No secondary fuel	No secondary fuel

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PLANT NAME	LOS MINA		
LOCATION	Santo Domingo		
SIZE - No. OF UNITS AND POWER RATING	Unit 1 - 35 MW Unit 2 - 35 MW Unit 3 - 65 MW Unit 4 - 65 MW		
AGE (OR YEAR COMMISSIONED)	Unit 1 - 1981 Unit 2 - 1981 Unit 3 - 1992 Unit 4 - 1992		
CURRENT STATUS (OPERATIONAL, UNDER REPAIR, ETC.)	Unit 1 - 22 MW (available) Unit 2 - 23 MW (available) Unit 3 - 0 MW (under rehabilitation) Unit 4 - 0 MW (under rehabilitation)		
TYPE OF BOILER, GAS TURBINE, OR DIESEL ENGINE	Gas Turbines: Unit 1 Unit 2 Unit 3 Unit 4	 FIAT FIAT Westinghouse Westinghouse	
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Gas-oil (Fuel #2) Specific Gravity (60/60 °F): Heating Value: Sulfur: Specific Fuel Consumption Unit 1 Unit 2 Unit 3 Unit 4	 0.876 19,335 Btu/lb 1.07% by weight 15,618 Btu/KWh 15,782 Btu/KWh 16,281 Btu/KWh 16,567 Btu/KWh	
SECONDARY FUEL AND SPECIFIC FUEL CONSUMPTION	No secondary fuel		

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On-site interviews with CDE plant operating personnel and managers.
CDE Departamento de Planificación.

ANNEX B

AIR QUALITY

PLANT NAME	ITABO (10)					
LOCATION	Santo Domingo					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	125.00	MW	(1984)		
	Unit 2 -	125.00	MW	(1989)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	0.00	MW	374,463	MWh (1993)	
	Annual Operating Hrs.	0.00			617.06	lbs/MWhr
	Unit 2 -	115.00	MW	761,289	MWh (1993)	
	Annual Operating Hrs.	6,619.90			617.06	lbs/MWhr
TYPE OF BOILER	Boiler: Unit 1 - (Foster Wheeler, Spain) and Unit 2 - (Hitachi Zoosen, Japan)					
	High Pressure Section:	141	bars and	535	degrees C	
	Low Pressure Section:	38.5	bars and	535	degrees C	
	Vapor Production:	389.5	tons/hr (High Pressure)			
		348.5	tons/hr (Low Pressure)			
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 6	1	(Assuming only Fuel Oil was burned during the year 1993)			
	Specific Gravity (60/60 F):	0.975				
	Heating Value:	18,312	Btu/lb			
	Sulfur:	2.75	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	11,300	Btu/kWh			
	Unit 2 -	11,300	Btu/kWh			
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	28.49	lb of PM-10/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	0.00	lb of PM-10/hr	0.00	tons of PM-10/yr *	
	Unit 2 -	249.05	lb of PM-10/hr	749.39	tons of PM-10/yr *	
	Plant Totals -	249.05	lb of PM-10/hr	749.39	tons of PM-10/yr *	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	431.75	lb of SO2/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	0.00	lb of SO2/hr	0.00	tons of SO2/yr *	
	Unit 2 -	3,773.81	lb of SO2/hr	11,355.56	tons of SO2/yr *	
	Plant Totals -	3,773.81	lb of SO2/hr	11,355.56	tons of SO2/yr *	
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	67.00	lb of NOx/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	0.00	lb of NOx/hr	0.00	tons of NOx/yr *	
	Unit 2 -	585.63	lb of NOx/hr	1,762.18	tons of NOx/yr *	
	Plant Totals -	585.63	lb of NOx/hr	1,762.18	tons of NOx/yr *	
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	0.00	lb of CO/hr	0.00	tons of CO/yr *	
	Unit 2 -	43.70	lb of CO/hr	131.51	tons of CO/yr *	
	Plant Totals -	43.70	lb of CO/hr	131.51	tons of CO/yr *	
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.76	lb of CO/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr *	
	Unit 2 -	6.64	lb of NMTOC/hr	19.99	tons of NMTOC/yr *	
	Plant Totals -	6.64	lb of NMTOC/hr	19.99	tons of NMTOC/yr *	
SECONDARY FUEL AND SPECIFIC FUEL CONSUMPTION	Coal - Colombian					
	Ash	4.99	% by weight			
	Heating Value (dry):	11,679	Btu/lb			
	Sulfur (dry):	0.56	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	10,018	Btu/kWh			
	Unit 2 -	10,018	Btu/kWh			
SECONDARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (5)	EPA Emission Factor -	12.97	lb of PM-10/ton of Coal			
	Unit 1 -	0.00	lb of PM-10/hr	0.00	tons of PM-10/yr *	
	Unit 2 -	581.73	lb of PM-10/hr	1,750.47	tons of PM-10/yr *	
	Plant Totals -	581.73	lb of PM-10/hr	1,750.47	tons of PM-10/yr *	
SECONDARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS (5) (6)	EPA Emission Factor -	21.28	lb of SO2/ton of Coal			
	Unit 1 -	0.00	lb of SO2/hr	0.00	tons of SO2/yr *	
	Unit 2 -	954.16	lb of SO2/hr	2,871.12	tons of SO2/yr *	
	Plant Totals -	954.16	lb of SO2/hr	2,871.12	tons of SO2/yr *	
SECONDARY FUEL - NITROGEN OXIDE (NOx) EMISSIONS (5) (7)	EPA Emission Factor -	34.00	lb of NOx/ton of Coal			
	Unit 1 -	0.00	lb of NOx/hr	0.00	tons of NOx/yr *	
	Unit 2 -	1,524.51	lb of NOx/hr	4,587.31	tons of NOx/yr *	
	Plant Totals -	1,524.51	lb of NOx/hr	4,587.31	tons of NOx/yr *	
SECONDARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (5) (8)	EPA Emission Factor -	0.50	lb of CO/ton of Coal			
	Unit 1 -	0.00	lb of CO/hr	0.00	tons of CO/yr *	
	Unit 2 -	22.42	lb of CO/hr	67.46	tons of CO/yr *	
	Plant Totals -	22.42	lb of CO/hr	67.46	tons of CO/yr *	
SECONDARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (5) (8) (9)	EPA Emission Factor -	0.04	lb of NMTOC/ton of Coal			
	Unit 1 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr *	
	Unit 2 -	1.79	lb of NMTOC/hr	5.40	tons of NMTOC/yr *	
	Plant Totals -	1.79	lb of NMTOC/hr	5.40	tons of NMTOC/yr *	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

(1) Assumed actual plant operating hours in determining annual emission rates PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) Assume the plant uses subbituminous coal and the firing configuration is pulverized coal fired, wet bottom.

(6) These emission results include SO2, SO3, and gaseous sulfates. On average for bituminous coal, 95% of fuel sulfur is emitted as SO2, and only about 0.7% of fuel sulfur is emitted as SO3 and gaseous sulfate. An equally small percent of fuel sulfur is emitted as particulate sulfate. Small quantities of sulfur are also retain in the bottom ash.

(7) Expressed as NO2. Generally, 95+ volume % of nitrogen oxides present in combustion exhaust will be in the form of NO, the rest NO2. The factor represents emissions at baseline operation (i.e., 60 to 110% load and no NOx control measures.

(8) The factor represents nominal value achievable under normal operating conditions. Values one or two orders of magnitude higher can occur when combustion is not complete.

(9) Non-methane total organic compounds are expressed as C12 to C16 alkane equivalents.

(10) All input data was furnished by CDE.

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PLANT NAME	HAINA (5)					
LOCATION	Santo Domingo					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	54.00	MW	(1968)		
	Unit 2 -	54.00	MW	(1968)		
	Unit 3 -	84.90	MW	(1979)		
	Unit 4 -	84.90	MW	(1979)		
	Unit 5 -	84.90	MW	(1979)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	48.00	MW	211965	MWh (1993)	
	Annual Operating Hrs.	4,415.94		lbs/MWhr	572.36	lbs/MWhr
	Unit 2 -	0.00	MW	8,549	MWh (1993)	
	Annual Operating Hrs.	0.00		lbs/MWhr	704.24	lbs/MWhr
	Unit 3 -	36.00	MW	217,192	MWh (1993)	
	Annual Operating Hrs.	6,033.11		lbs/MWhr	879.15	lbs/MWhr
	Unit 4 -	52.00	MW	284,483	MWh (1993)	
	Annual Operating Hrs.	5,470.83		lbs/MWhr	786.37	lbs/MWhr
	Unit 5 -	70.00	MW	233,242	MWh (1993)	
	Annual Operating Hrs.	3,332.03		lbs/MWhr	607.03	lbs/MWhr
TYPE OF BOILER	Boiler					
	Pressure:	88	bars			
	Temperature:	515	degrees C			
	Vapor Production:	180	tons/hr (units 1 and 2)			
		280	tons/hr (units 3 and 5)			
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 6					
	Specific Gravity (60/60 F):	0.975				
	Heating Value:	18312	Btu/lb			
	Sulfur:	3	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	10481	Btu/kWh			
	Unit 2 -	12,896	Btu/kWh			
	Unit 3 -	16,099	Btu/kWh			
	Unit 4 -	14,400	Btu/kWh			
	Unit 5 -	11,116	Btu/kWh			
PRIMARY FUEL - (1) PARTICULATE MATTER (PM-10) EMISSIONS	EPA Emission Factor -	28	lb of PM-10/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	96.42	lb of PM-10/hr	193.528884	tons of PM-10/yr *	
	Unit 2 -	0.00	lb of PM-10/hr	0.00	tons of PM-10/yr *	
	Unit 3 -	111.07	lb of PM-10/hr	304.59	tons of PM-10/yr *	
	Unit 4 -	143.51	lb of PM-10/hr	356.86	tons of PM-10/yr *	
	Unit 5 -	149.12	lb of PM-10/hr	225.86	tons of PM-10/yr *	
	Plant Totals -	500.12	lb of PM-10/hr	1,080.84	tons of PM-10/yr *	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	431.75	lb of SO2/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	1,460.99	lb of SO2/hr	2,932.56	tons of SO2/yr *	
	Unit 2 -	0.00	lb of SO2/hr	0.00	tons of SO2/yr *	
	Unit 3 -	1,683.08	lb of SO2/hr	4,615.55	tons of SO2/yr *	
	Unit 4 -	2,174.55	lb of SO2/hr	5,407.54	tons of SO2/yr *	
	Unit 5 -	2,259.70	lb of SO2/hr	3,422.44	tons of SO2/yr *	
	Plant Totals -	7,578.32	lb of SO2/hr	16,378.09	tons of SO2/yr *	
PRIMARY FUEL - (2) NITROGEN DIOXIDE (NOx) EMISSIONS	EPA Emission Factor -	67.00	lb of NOx/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	226.72	lb of NOx/hr	455.08	tons of NOx/yr *	
	Unit 2 -	0.00	lb of NOx/hr	0.00	tons of NOx/yr *	
	Unit 3 -	261.18	lb of NOx/hr	716.25	tons of NOx/yr *	
	Unit 4 -	337.45	lb of NOx/hr	839.15	tons of NOx/yr *	
	Unit 5 -	350.66	lb of NOx/hr	531.10	tons of NOx/yr *	
	Plant Totals -	1,176.02	lb of NOx/hr	2,541.59	tons of NOx/yr *	
PRIMARY FUEL - (3) CARBON MONOXIDE (CO) EMISSIONS	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	16.92	lb of CO/hr	33.96	tons of CO/yr *	
	Unit 2 -	0.00	lb of CO/hr	0.00	tons of CO/yr *	
	Unit 3 -	19.49	lb of CO/hr	53.45	tons of CO/yr *	
	Unit 4 -	25.18	lb of CO/hr	62.62	tons of CO/yr *	
	Unit 5 -	26.17	lb of CO/hr	39.63	tons of CO/yr *	
	Plant Totals -	87.76	lb of CO/hr	189.67	tons of CO/yr *	
PRIMARY FUEL - (4) NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS	EPA Emission Factor -	0.76	lb of CO/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	2.57	lb of NMTOC/hr	5.16	tons of NMTOC/yr *	
	Unit 2 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr *	
	Unit 3 -	2.96	lb of NMTOC/hr	8.12	tons of NMTOC/yr *	
	Unit 4 -	3.83	lb of NMTOC/hr	9.52	tons of NMTOC/yr *	
	Unit 5 -	3.98	lb of NMTOC/hr	6.02	tons of NMTOC/yr *	
	Plant Totals -	13.34	lb of NMTOC/hr	28.83	tons of NMTOC/yr *	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

PLANT NAME	SANTO DOMINGO (5)						
LOCATION	Santo Domingo						
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 5 -	12.65	MW	(1954)			
	Unit 6 -	12.65	MW	(1957)			
	Unit 7 -	12.65	MW	(1959)			
	Unit 8 -	26.50	MW	(1963)			
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 5 -	8.50	MW	66187	MWh (1993)		
	Annual Operating Hrs.	7,786.71			804.94	lbs/MWhr	
	Unit 6 -	0.00	MW	0	MWh (1993)		
	Operating Hours	0.00			0.00	lbs/MWhr	
	Unit 7 -	0.00	MW	0	MWh (1993)		
	Operating Hours	0.00			0.00	lbs/MWhr	
	Unit 8 -	0.00	MW	46,412	MWh (1993)		
	Operating Hours	0.00			714.23	lbs/MWhr	
TYPE OF BOILER	Boiler						
	Units 5 through 7 - Combustion Engineering						
	Units 8 - Babcock and Wilcox						
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 6						
	Specific Gravity (60/60 F):	0.975					
	Heating Value:	18312	Btu/lb				
	Sulfur:	2.75	% by weight				
	Specific Fuel Consumption						
	Unit 5 -	14740	Btu/kWh				
	Unit 6 -	0	Btu/kWh				
	Unit 7 -	0	Btu/kWh				
	Unit 8 -	13,079	Btu/kWh				
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	28	lb of PM-10/1000 gallon of Fuel Oil No. 6				
	Unit 5 -	24	lb of PM-10/hr	84.9863341	tons of PM-10/yr *		
	Unit 6 -	0.00	lb of PM-10/hr	0.00	tons of PM-10/yr *		
	Unit 7 -	0.00	lb of PM-10/hr	0.00	tons of PM-10/yr *		
	Unit 8 -	0.00	lb of PM-10/hr	0.00	tons of PM-10/yr *		
	Plant Totals -	24.01	lb of PM-10/hr	84.99	tons of PM-10/yr *		
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	431.75	lb of SO2/1000 gallon of Fuel Oil No. 6				
	Unit 5 -	363.85	lb of SO2/hr	1,287.81	tons of SO2/yr *		
	Unit 6 -	0.00	lb of SO2/hr	0.00	tons of SO2/yr *		
	Unit 7 -	0.00	lb of SO2/hr	0.00	tons of SO2/yr *		
	Unit 8 -	0.00	lb of SO2/hr	0.00	tons of SO2/yr *		
	Plant Totals -	363.85	lb of SO2/hr	1,287.81	tons of SO2/yr *		
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	67.00	lb of NOx/1000 gallon of Fuel Oil No. 6				
	Unit 5 -	56.46	lb of NOx/hr	199.85	tons of NOx/yr *		
	Unit 6 -	0.00	lb of NOx/hr	0.00	tons of NOx/yr *		
	Unit 7 -	0.00	lb of NOx/hr	0.00	tons of NOx/yr *		
	Unit 8 -	0.00	lb of NOx/hr	0.00	tons of NOx/yr *		
	Plant Totals -	56.46	lb of NOx/hr	199.85	tons of NOx/yr *		
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 6				
	Unit 5 -	4.21	lb of CO/hr	14.91	tons of CO/yr *		
	Unit 6 -	0.00	lb of CO/hr	0.00	tons of CO/yr *		
	Unit 7 -	0.00	lb of CO/hr	0.00	tons of CO/yr *		
	Unit 8 -	0.00	lb of CO/hr	0.00	tons of CO/yr *		
	Plant Totals -	4.21	lb of CO/hr	14.91	tons of CO/yr *		
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.76	lb of CO/1000 gallon of Fuel Oil No. 6				
	Unit 5 -	0.64	lb of NMTOC/hr	2.27	tons of NMTOC/yr *		
	Unit 6 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr *		
	Unit 7 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr *		
	Unit 8 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr *		
	Plant Totals -	0.64	lb of NMTOC/hr	2.27	tons of NMTOC/yr *		
SECONDARY FUEL	Gas Oil (used only during start-up)						
	Specific Gravity:	0.85					
	Heating Value (dry):	17924	Btu/lb				

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

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PLANT NAME	PUERTO PLATA (5)					
LOCATION	Puerto Plata					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	26.5	MW	(1966)		
	Unit 2 -	36.8	MW	(1982)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	19	MW	141970	MWh (1993)	
	Unit 1- Annual Op. Hrs	7,472.11			703.58	lbs/MWhr
	Unit 2 -	0.00	MW	0	MWh (1993)	
	Unit 2 - Annual Op. Hrs	0.00			0.00	lbs/MWhr
TYPE OF BOILER	Boiler					
	Babcock Wilcox					
	Furnace					
	Peabody with pulverization system through vapor					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 6					
	Specific Gravity (60/60 F):	0.978				
	Heating Value:	18312	Btu/lb			
	Sulfur:	2.75	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	12884	Btu/kWh			
	Unit 2 -	0	Btu/kWh			
PRIMARY FUEL - (1) PARTICULATE MATTER (PM-10) EMISSIONS	EPA Emission Factor -	28.4925	lb of PM-10/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	47	lb of PM-10/hr	159.340514	tons of PM-10/yr *	
	Unit 2 -	0	lb of PM-10/hr	0	tons of PM-10/yr *	
	Plant Totals -	46.91	lb of PM-10/hr	159.34	tons of PM-10/yr *	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	431.75	lb of SO2/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	710.90	lb of SO2/hr	2,414.50	tons of SO2/yr *	
	Unit 2 -	0.00	lb of SO2/hr	0.00	tons of SO2/yr *	
	Plant Totals -	710.90	lb of SO2/hr	2,414.50	tons of SO2/yr *	
PRIMARY FUEL - (2) NITROGEN DIOXIDE (NOx) EMISSIONS	EPA Emission Factor -	67.00	lb of NOx/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	110.32	lb of NOx/hr	374.69	tons of NOx/yr *	
	Unit 2 -	0.00	lb of NOx/hr	0.00	tons of NOx/yr *	
	Plant Totals -	110.32	lb of NOx/hr	374.69	tons of NOx/yr *	
PRIMARY FUEL - (3) CARBON MONOXIDE (CO) EMISSIONS	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	8.23	lb of CO/hr	27.96	tons of CO/yr *	
	Unit 2 -	0.00	lb of CO/hr	0.00	tons of CO/yr *	
	Plant Totals -	8.23	lb of CO/hr	27.96	tons of CO/yr *	
PRIMARY FUEL - (4) NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS	EPA Emission Factor -	0.76	lb of CO/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	1.25	lb of NMTOC/hr	4.25	tons of NMTOC/yr *	
	Unit 2 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr *	
	Plant Totals -	1.25	lb of NMTOC/hr	4.25	tons of NMTOC/yr *	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

PLANT NAME	SAN PEDRO DE MACORIS (5)					
LOCATION	San Pedro de Macoris					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	33	MW	(1989)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	30	MW	229113	MWh (1993)	
	Operating Hours	7637.1			630.351682	lbs/MWhr
TYPE OF BOILER	Boiler Babcock Wilcox Furnace Peabody with pulverization system through vapor					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 6					
	Specific Gravity (60/60 F):		0.975			
	Heating Value:		18312	Btu/lb		
	Sulfur:		2.75	% by weight		
	Specific Fuel Consumption					
	Unit 1 -	11543	Btu/kWh			
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	28.4925	lb of PM-10/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	66.365374	lb of PM-10/hr		230.381363	tons of PM-10/yr *
	Plant Totals -	66.365374	lb of PM-10/hr		230.381363	tons of PM-10/yr *
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	431.75	lb of SO2/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	1,005.64	lb of SO2/hr		3,490.99	tons of SO2/yr *
	Plant Totals -	1,005.64	lb of SO2/hr		3,490.99	tons of SO2/yr *
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	67.00	lb of NOx/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	156.06	lb of NOx/hr		541.74	tons of NOx/yr *
	Plant Totals -	156.06	lb of NOx/hr		541.74	tons of NOx/yr *
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	11.65	lb of CO/hr		40.43	tons of CO/yr *
	Plant Totals -	11.65	lb of CO/hr		40.43	tons of CO/yr *
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.76	lb of NMTOC/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	1.77	lb of NMTOC/hr		6.15	tons of NMTOC/yr *
	Plant Totals -	1.77	lb of NMTOC/hr		6.15	tons of NMTOC/yr *

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

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PLANT NAME	LOS MINA (5)						
LOCATION	Santo Domingo						
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	35	MW	(1981)			
	Unit 2 -	35	MW	(1981)			
	Unit 3 -	65	MW	(1992)			
	Unit 4 -	65	MW	(1992)			
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	22	MW	122471	MWh (1993)		
	Unit 1- Annual Op. Hrs	5,566.86				807.76	lbs/MWhr
	Unit 2 -	23.00	MW	111124	MWh (1993)		
	Unit 2- Annual Op. Hrs	4,831.48				816.24	lbs/MWhr
	Unit 3 -	0.00	MW	67526	MWh (1993)		
	Unit 3- Annual Op. Hrs	0.00				842.05	lbs/MWhr
	Unit 4 -	0.00	MW	203,565	MWh (1993)		
	Unit 4- Annual Op. Hrs	0.00				856.84	lbs/MWhr
TYPE GAS TURBINES	Gas Turbines						
	Unit 1 -	FIAT					
	Unit 2 -	FIAT					
	Unit 3 -	Westinghouse					
	Unit 4 -	Westinghouse					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 2						
	Specific Gravity (60/60 F):		0.876				
	Heating Value:		19335	Btu/lb			
	Sulfur:		1.07	% by weight			
	Specific Fuel Consumption						
	Unit 1 -	15618	Btu/kWh				
	Unit 2 -	15782	Btu/kWh				
	Unit 3 -	16281	Btu/kWh				
	Unit 4 -	16567	Btu/kWh				
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	2	lb of PM-10/1000 gallon of Fuel Oil No. 2				
	Unit 1 -	5	lb of PM-10/hr			12.3290368	tons of PM-10/yr
	Unit 2 -	5	lb of PM-10/hr			11.304214	tons of PM-10/yr*
	Unit 3 -	0	lb of PM-10/hr			0	tons of PM-10/yr*
	Unit 4 -	0	lb of PM-10/hr			0	tons of PM-10/yr*
	Plant Totals -	10.02	lb of PM-10/hr			23.63	tons of PM-10/yr*
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	151.94	lb of SO2/1000 gallon of Fuel Oil No. 2				
	Unit 1 -	370.15	lb of SO2/hr			936.64	tons of SO2/yr*
	Unit 2 -	391.04	lb of SO2/hr			858.78	tons of SO2/yr*
	Unit 3 -	0.00	lb of SO2/hr			0.00	tons of SO2/yr*
	Unit 4 -	0.00	lb of SO2/hr			0.00	tons of SO2/yr*
	Plant Totals -	761.20	lb of SO2/hr			1,795.42	tons of SO2/yr*
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	20.00	lb of NOx/1000 gallon of Fuel Oil No. 2				
	Unit 1 -	48.72	lb of NOx/hr			123.29	tons of NOx/yr*
	Unit 2 -	51.47	lb of NOx/hr			113.04	tons of NOx/yr*
	Unit 3 -	0.00	lb of NOx/hr			0.00	tons of NOx/yr*
	Unit 4 -	0.00	lb of NOx/hr			0.00	tons of NOx/yr*
	Plant Totals -	100.20	lb of NOx/hr			236.33	tons of NOx/yr*
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/lb of Fuel Oil No. 2				
	Unit 1 -	12.18	lb of CO/hr			30.82	tons of CO/yr*
	Unit 2 -	12.87	lb of CO/hr			28.26	tons of CO/yr*
	Unit 3 -	0.00	lb of CO/hr			0.00	tons of CO/yr*
	Unit 4 -	0.00	lb of CO/hr			0.00	tons of CO/yr*
	Plant Totals -	25.05	lb of CO/hr			59.08	tons of CO/yr*
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.34	lb of NMTOC/lb of Fuel Oil No. 2				
	Unit 1 -	0.83	lb of NMTOC/hr			2.10	tons of NMTOC/yr*
	Unit 2 -	0.88	lb of NMTOC/hr			1.92	tons of NMTOC/yr*
	Unit 3 -	0.00	lb of NMTOC/hr			0.00	tons of NMTOC/yr*
	Unit 4 -	0.00	lb of NMTOC/hr			0.00	tons of NMTOC/yr*
	Plant Totals -	1.70	lb of NMTOC/hr			4.02	tons of NMTOC/yr*

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

PLANT NAME	TIMBEQUE (5)					
LOCATION	Santo Domingo					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	21	MW	(1974)		
	Unit 2 -	21	MW	(1974)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	15	MW	87593	MWh (1993)	
	Unit 1- Annual Op. Hrs	5839.5333			835.07	lbs/MWhr
	Unit 2 -	18	MW	79555	MWh (1993)	
	Unit 2- Annual Op. Hours	4419.7222			853.63	lbs/MWhr
TYPE GAS TURBINES	Gas Turbines Unit 1 and 2 manufactured by General Electric, Frame 5, Open Cycle Gas Turbines					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 2					
	Specific Gravity (60/60 F):	0.876				
	Heating Value:	19335	Btu/lb			
	Sulfur:	1.07	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	16146	Btu/kWh			
	Unit 2 -	16505	Btu/kWh			
PRIMARY FUEL - (1) PARTICULATE MATTER (PM-10) EMISSIONS	EPA Emission Factor -	2	lb of PM-10/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	3.434388	lb of PM-10/hr	9.1160105	tons of PM-10/yr*	
	Unit 2 -	4.2129003	lb of PM-10/hr	8.46356778	tons of PM-10/yr*	
	Plant Totals -	7.6472883	lb of PM-10/hr	17.5795783	tons of PM-10/yr*	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	152	lb of SO2/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	261	lb of SO2/hr	692.543318	tons of SO2/yr*	
	Unit 2 -	320.05	lb of SO2/hr	642.98	tons of SO2/yr*	
	Plant Totals -	580.96	lb of SO2/hr	1,335.52	tons of SO2/yr*	
PRIMARY FUEL - (2) NITROGEN DIOXIDE (NOx) EMISSIONS	EPA Emission Factor -	20.00	lb of NOx/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	34.34	lb of NOx/hr	91.16	tons of NOx/yr*	
	Unit 2 -	42.13	lb of NOx/hr	84.64	tons of NOx/yr*	
	Plant Totals -	76.47	lb of NOx/hr	175.80	tons of NOx/yr*	
PRIMARY FUEL - (3) CARBON MONOXIDE (CO) EMISSIONS	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	8.59	lb of CO/hr	22.79	tons of CO/yr*	
	Unit 2 -	10.53	lb of CO/hr	21.16	tons of CO/yr*	
	Plant Totals -	19.12	lb of CO/hr	43.95	tons of CO/yr*	
PRIMARY FUEL - (4) NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS	EPA Emission Factor -	0.34	lb of NMTOC/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.58	lb of NMTOC/hr	1.55	tons of NMTOC/yr*	
	Unit 2 -	0.72	lb of NMTOC/hr	1.44	tons of NMTOC/yr*	
	Plant Totals -	1.30	lb of NMTOC/hr	2.99	tons of NMTOC/yr*	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

PLANT NAME	SAN PEDRO DE MACORIS (5)					
LOCATION	San Pedro de Macoris					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	28.3	MW	(1974)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	25	MW	31206	MWh (1993)	
	Annual Operating Hrs	1248.24		810.499095	lbs/MWhr	
TYPE GAS TURBINES	Gas Turbine					
	Manufacturer:	Westinghouse				
	Type:					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 2 (Assumed)					
	Specific Gravity (60/60 F):	0.876				
	Heating Value:	19335	Btu/lb			
	Sulfur:	1.07	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	15671	Btu/kWh			
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	2	lb of PM-10/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	5.5555859	lb of PM-10/hr	3.15213843	tons of PM-10/yr*	
	Plant Total -	5.5555859	lb of PM-10/hr	3.15213843	tons of PM-10/yr*	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	151.94	lb of SO2/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	422.05786	lb of SO2/hr	239.467957	tons of SO2/yr*	
	Plant Total -	422.06	lb of SO2/hr	239.47	tons of SO2/yr*	
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	20.00	lb of NOx/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	55.56	lb of NOx/hr	31.52	tons of NOx/yr*	
	Plant Total -	55.56	lb of NOx/hr	31.52	tons of NOx/yr	
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	13.89	lb of CO/hr	7.88	tons of CO/yr*	
	Plant Total -	13.89	lb of CO/hr	7.88	tons of CO/yr*	
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.34	lb of NMTOC/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.94	lb of NMTOC/hr	0.54	tons of NMTOC/yr*	
	Plant Total -	0.94	lb of NMTOC/hr	0.54	tons of NMTOC/yr*	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

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PLANT NAME	BARAHONA (5)					
LOCATION	Barahona					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	28.3	MW	(1977)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	0	MW	0	MWh (1993)	
	Annual Operating Hrs	0			836.01719	lbs/MWhr
TYPE GAS TURBINES	Gas Turbine A new turbine with plant original specifications is under construction by FIAT (Italy) with Westinghouse authorization.					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 2					
	Specific Gravity (60/60 F):	0.8762				
	Heating Value:	19313	Btu/lb			
	Sulfur:	2	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	16146	Btu/kWh			
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	2	lb of PM-10/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0	lb of PM-10/hr	0	tons of PM-10/yr	
	Plant Total -	0	lb of PM-10/hr	0	tons of PM-10/yr	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	284	lb of SO2/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0	lb of SO2/hr	0	tons of SO2/yr	
	Plant Total -	0	lb of SO2/hr	0	tons of SO2/yr	
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	20.00	lb of NOx/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.00	lb of NOx/hr	0.00	tons of NOx/yr	
	Plant Total -	0.00	lb of NOx/hr	0.00	tons of NOx/yr	
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.00	lb of CO/hr	0.00	tons of CO/yr	
	Plant Total -	0.00	lb of CO/hr	0.00	tons of CO/yr	
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.34	lb of NMTOC/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr	
	Plant Total -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

PLANT NAME	SANTIAGO (5)					
LOCATION	Santiago de los Caballeros					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	12	MW	(1989)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	10	MW	82099	MWh (1993)	
	Annual Operating Hrs	8209.9			712.75	lbs/MWhr
TYPE OF ENGINE	DIESEL ENGINE					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 2					
	Specific Gravity (60/60 F):		0.876			
	Heating Value:		19335	Btu/lb		
	Sulfur:		1.07	% by weight		
	Specific Fuel Consumption					
	Unit 1 -	13,781.00	Btu/kWh			
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	2	lb of PM-10/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	1.9542219	lb of PM-10/hr		7.29271208	tons of PM-10/yr*
	Plant Total -	1.9542219	lb of PM-10/hr		7.29271208	tons of PM-10/yr*
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	151.94	lb of SO2/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	148.46224	lb of SO2/hr		554.027337	tons of SO2/yr*
	Plant Total -	148.46224	lb of SO2/hr		554.027337	tons of SO2/yr
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	20	lb of NOx/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	19.54	lb of NOx/hr		72.93	tons of NOx/yr*
	Plant Total -	19.54	lb of NOx/hr		72.93	tons of NOx/yr*
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	4.89	lb of CO/hr		18.23	tons of CO/yr*
	Plant Total -	4.89	lb of CO/hr		18.23	tons of CO/yr*
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.34	lb of NMTOC/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.33	lb of NMTOC/hr		1.24	tons of NMTOC/yr*
	Plant Total -	0.33	lb of NMTOC/hr		1.24	tons of NMTOC/yr*

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

* Assumed actual plant operating hours in determining annual emission rates

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

PLANT NAME	FALCON BRIDGE (5)					
LOCATION						
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	198	MW	(1985)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	40	MW	297538	MWh (1993)	
	Annual Operating Hrs	7440.95			638.36	lbs/MWhr
TYPE OF BOILER	Boiler					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 6					
	Specific Gravity (60/60 F):	0.999				
	Heating Value:	18015	Btu/lb			
	Sulfur:	3.56	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	11,500.00	Btu/kWh			
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	35.94	lb of PM-10/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	110.30726	lb of PM-10/hr	373.086716	tons of PM-10/yr*	
	Plant Total -	110.30726	lb of PM-10 / hr	373.086716	tons of PM-10/yr*	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	558.92	lb of SO2/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	1715.6123	lb of SO2/hr	5802.62986	tons of SO2/yr*	
	Plant Total -	1715.6123	lb of SO2/hr	5802.62986	tons of SO2/yr*	
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	67	lb of NOx/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	206	lb of NOx/hr	695.5847	tons of NOx/yr*	
	Plant Total -	205.66	lb of NOx/hr	695.58	tons of NOx/yr*	
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	15.35	lb of CO/hr	51.91	tons of CO/yr*	
	Plant Total -	15.35	lb of CO/hr	51.91	tons of CO/yr*	
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.76	lb of NMTOC/1000 gallon of Fuel Oil No. 6			
	Unit 1 -	2.33	lb of NMTOC/hr	7.89	tons of NMTOC/yr*	
	Plant Total -	2.33	lb of NMTOC/hr	7.89	tons of NMTOC/yr*	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

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PLANT NAME	WARTSILA (5)					
LOCATION	Santo Domingo					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	40	MW	(1989)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	40	MW	252050	MWh (1993)	
	Annual Operating Hrs	6301.25		lbs/MWhr	498.166092	lbs/MWhr
TYPE OF POWER STATION	DIESEL ENGINE					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 6 - Diluted by Fuel-Oil No. 2					
	Specific Gravity (60/60 F):	0.882				
	Heating Value:	18267	Btu/lb			
	Sulfur:	2.85	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	9,100.00	Btu/kWh			
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	2.00	lb of PM-10/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	5.43	lb of PM-10/hr	15.5421476	tons of PM-10/yr*	
	Plant Total -	5.42634	lb of PM-10/hr	15.5421476	tons of PM-10/yr*	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	404.7	lb of SO2/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	1098.0199	lb of SO2/hr	3144.95358	tons of SO2/yr*	
	Plant Total -	1098.0199	lb of SO2/hr	3144.95358	tons of SO2/yr*	
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	20	lb of NOx/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	54.2634	lb of NOx/hr	155.421476	tons of NOx/yr*	
	Plant Total -	54.26	lb of NOx/hr	155.42	tons of NOx/yr*	
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	13.57	lb of CO/hr	38.86	tons of CO/yr*	
	Plant Total -	13.57	lb of CO/hr	38.86	tons of CO/yr*	
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.34	lb of NMTOC/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.92	lb of NMTOC/hr	2.64	tons of NMTOC/yr*	
	Plant Total -	0.92	lb of NMTOC/hr	2.64	tons of NMTOC/yr*	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

PLANT NAME	WARTSILA (5)					
LOCATION	Puerto Plata					
SIZE- No. OF UNITS, RATING, AND YEAR COMMISSIONED	Unit 1 -	16.2	MW	(1991)		
CAPACITY AVAILABLE AND ANNUAL GENERATION	Unit 1 -	0	MW	109626	MWh (1993)	
	Operating Hours	0		lbs/MWhr	498.166092	lbs/MWhr
TYPE OF POWER STATION	DIESEL ENGINE					
PRIMARY FUEL AND SPECIFIC FUEL CONSUMPTION	Fuel Oil No. 6 - Diluted by Fuel-Oil No. 2					
	Specific Gravity (60/60 F):	0.882				
	Heating Value:	18267	Btu/lb			
	Sulfur:	2.85	% by weight			
	Specific Fuel Consumption					
	Unit 1 -	9,100.00	Btu/kWh			
PRIMARY FUEL - PARTICULATE MATTER (PM-10) EMISSIONS (1)	EPA Emission Factor -	2.00	lb of PM-10/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.00	lb of PM-10/hr	0	tons of PM-10/yr*	
	Plant Total -	0	lb of PM-10/hr	0	tons of PM-10/yr*	
PRIMARY FUEL - SULFUR DIOXIDE (SO2) EMISSIONS	EPA Emission Factor -	404.7	lb of SO2/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0	lb of SO2/hr	0	tons of SO2/yr*	
	Plant Total -	0	lb of SO2/hr	0	tons of SO2/yr*	
PRIMARY FUEL - NITROGEN DIOXIDE (NOx) EMISSIONS (2)	EPA Emission Factor -	20	lb of NOx/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0	lb of NOx/hr	0	tons of NOx/yr*	
	Plant Total -	0	lb of NOx/hr	0	tons of NOx/yr*	
PRIMARY FUEL - CARBON MONOXIDE (CO) EMISSIONS (3)	EPA Emission Factor -	5.00	lb of CO/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.00	lb of CO/hr	0.00	tons of CO/yr*	
	Plant Total -	0.00	lb of CO/hr	0.00	tons of CO/yr*	
PRIMARY FUEL - NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS (4)	EPA Emission Factor -	0.34	lb of NMTOC/1000 gallon of Fuel Oil No. 2			
	Unit 1 -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr*	
	Plant Total -	0.00	lb of NMTOC/hr	0.00	tons of NMTOC/yr*	

Emission Factor Notes:

Hourly emissions of each pollutant was estimated using emission factors published by US-EPA in publication AP-42, Supplement F.

(1) PM-10 values include that particulate collected in the PM-10 filter cyclone of an EPA Method 201 or 201A sampling train. Particulate emission factors for residual oil combustion are, on average, a function of fuel oil grade and sulfur content.

(2) Test results indicate that at least 95% by weight of NOx is NO for all boiler types.

(3) CO emissions may increase by factors of 10 to 100 if the unit is improperly operated or not well maintained.

(4) Volatile organic compound emission can increase by several orders of magnitude if the boiler is improperly operated or is not well maintained.

(5) All input data was furnished by CDE.

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SUMMARY OF DOMINICAN REPUBLIC POWER SECTOR EMISSIONS FOR THE YEAR 1993 *	
PARTICULATE MATTER (PM-10) EMISSIONS	2,745.22 tons of PM-10/yr
SULFUR DIOXIDE (SO2) EMISSIONS	47,798.98 tons of SO2/yr
NITROGEN DIOXIDE (NOx) EMISSIONS	6,787.63 tons of NOx/yr
CARBON MONOXIDE (CO) EMISSIONS	624.39 tons of CO/yr
NON-METHANE TOTAL ORGANIC COMPOUND (NMTOC) EMISSIONS	80.80 tons of NMTOC/yr

Summary Table Notes:

* It was assumed that only Fuel Oil was burned at Itabo during the year 1993.

ANNEX C

LIST OF GOVERNMENT INSTITUTIONS

ANNEX C

LIST OF GOVERNMENT INSTITUTIONS RESPONSIBLE FOR ENVIRONMENTAL QUALITY PROTECTION

RESOURCE AND/OR AREA OF ACTION	INSTITUTION	YEAR CREATED	LEGAL INSTRUMENT	RESPONSIBILITY
FORESTS AND WATER SOURCES	Forestal General Directorate	1962	Law 5856	Conserve, develop and exploit the forests, as well as all matters related to transportation and other commercial trade aspects of forest products.
MARINE RESOURCES	Marine Biology Research Center (CIBIMA), Autonomous University of Santo Domingo (UASD)	1962		Scientific investigation of marine and coast flora and fauna.
NATURAL RESOURCES	Natural Resources Undersecretariat	1965	Law No. 8	This is an agency that plans, executes and supervises the national policy on natural resources. It rationalizes the use of soils, monitors recuperation of affected areas and is responsible for its management.
WATER	National Institute for Drinking Water and Sewerage (INAPA)	1965	Law No. 5	This agency is responsible for the planning, design and management of drinking water and sewerage systems at the national level.
WATER	National Institute for Hydraulic Resources	1965	Law No. 6	Evaluates the country's hydraulic resources. Conservation of water sources.
MINERALS	Mining National Directorate	1971	Law No. 146	Regulates all mining activities.
ROCKY AGGREGATES	Earth Shell General Directorate	1971	Law No. 123	Ecological and environmental protection through control of the extraction of construction materials.
	Commission to Study Environmental Contamination	1972	Decree 2592	Study the contamination levels to which urban centers and natural ecosystems are exposed to.
METEOROLOGICAL PHENOMENA	National Meteorological Office	1956	Decree 2298	Provide meteorological services to the country. Provide advisory services on the subject for better use of resources.
NATURAL RESOURCES	National Museum of Natural History (MNHN)	1974		Study of natural resources. Collection of fossil samples.
WATER	Santo Domingo Water and Sewerage Corporation (CAASD)	1974	Law No. 498	Develop drinking water supply plans, manage and expand Santo Domingo's aqueduct and sewerage systems.
FERAL AREAS	Parks National Directorate	1974	Law No. 67	Develop, manage and protect a system of recreational, historical, natural and indigenous areas for its conservation and perpetuation of the country's natural and human endowment.
FAUNA	National Zoological Park (ZOODOM)	1975	Decree 114	Center for the promotion of research and culture of biological sciences in general and the preservation of national fauna.

FLORA	Dr. Rafael M. Moscoso National Botanical Park	1976	Decree 465	Promotion of all aspects related to botanical sciences; preserve the national flora.
ENVIRONMENT	Environment Department	1977	Technical Secretariat of the Presidency	Disseminate national policies to develop regulatory framework in this area.
STANDARDS AND REGULATIONS	Quality Standards and Systems National Directorate (DIGENOR)	1978	Law 602	Establishes standards and regulations for the manufacturing and processing of food, water, etc.
FAIMA	National Wildlife Council	1978	Decree 32/78	Establish regulations on wildlife and their habitats. Conserve and promote those species in danger of extinction as well as conserve areas for such protection.
WATER AND EARTH	Earth and Water Department, SURENA-SEA	1978	Resolution 24/78	Carry out soil studies, regulate the use and conservation of water sources, provide education on the rational use of natural resources, construct small dams and carry out drainage works in farm lands.
WILDLIFE	Wildlife	1979	Resolution 26/79	Promote the development, conservation and management of the country's flora and wildlife. Suggest limits and special handling of sanctuaries or flora reserve areas.
SEA AND RIVER FAUNA	Fishing Resources	1979	Resolution 26/79	Regulate fishing, carry out studies to determine the volume and production capacity, prepare and supervise fish breeding promotion projects.
NATURAL RESOURCES	National Resources Inventory Department, SURENA-SEA	1979	Internal Resolution	Carries out periodic inventories, ordering works and studies on natural resources as well as the impact of projects on these resources.
MARINE WILDLIFE	Marine Wildlife Conservation Commission	1980	Decree 2011	Study and establish flora and fauna protection measures in the entire national territory.
NATURAL RESOURCES	Environmental Education Department, SURBA-SEA	1982	Resolution 20/82	Monitor the adequate use of the country's natural resources, carry out environmental training programs among the urban and rural population, teachers, community leaders, technicians and natural resources inspectors.
FORESTS	Forestal Technical Commission	1982	Decree 318	This is the leading agency of the forestal sector; advises the Executive Branch on matters of natural vegetation and the type of agricultural crop planting.
ENVIRONMENT	National Commission on the Environment	1987	Decree 157	Control, reduction and elimination of hazardous activities to the health of living beings and prevention of ecosystem deterioration.

ENVIRONMENTAL CONTAMINATION	Ecological Technical Commission	1990	Decree 226/90	Safeguard the country's rivers from contamination from solid, chemical wastes, etc.

Source: UNCED Dominican Republic Country Report (1991).

ANNEX D

MAJOR NGOs

ANNEX D
MAJOR NON-GOVERNMENT ORGANIZATIONS

Name	History and Functions
Community/Forestry Development NGOs	
(a) Asociación para el Desarrollo de San José de Ocoa, Inc. (JUNTA)	Established in 1968 with a Board of Directors composed of both private and public sector representatives, and funded from both international, private, and government (Technical Secretariat of the Presidency) sources. Its specialty is the organization of rural inhabitants for community projects through the development or strengthening of local committees composed of local community leaders.
(b) Floresta, Inc.	Floresta was established in 1984 with a private sector Board of Directors and an Executive Director. Activities emphasize assistance for the development of agroforestry as an alternative to slash-and-burn agriculture to communities and small farmers willing to participate in the program.
(c) Plan Sierra, Inc.	Plan Sierra was established in 1979 with a Board of Directors composed of public and private sector representatives, and whose President is President of the Dominica Republic. Activities include integrated rural development, technical forest management, seeding and wood production, agroforestry promotion and research in the 2,000 km^2 area of the Municipio de San José de las Matas covering the Yaque del Norte and Bao river watersheds. Their budget is large (about RD $6 million as of 1991). They receive revenues from the sale of forest and agricultural products, but operations are financed with international donations and fixed monthly appropriation from the Government. This NGO is a PRONATURA member.
(d) Progressio (Fundación para el Mejoramiento Humano)	Progressio was established in 1983 with a private sector Board of Directors and an Executive Secretary. They are now tying to concentrate on more comprehensive watershed planning and management, including land use, soil conservation, and agroforestry concerns with the promotion of reforestation with trees for multiple use. They are preparing a management plan for the upper and mid watersheds of the Rio Camu with financing through PRONATURA by the debt-nature swap — RD$1,666,100 was channeled to this project.
(e) Fundación Dominicana de Desarollo	The Foundation was created by Decree 8438 in 1962, with one year term presidency. The Foundation is focusing poverty alleviation through employment creation for the rural and urban poor by providing an assistance for small business and job training. The Foundation is operated by 70 staff, and its operating budget is about RD$2 million year. The Foundation is supported by 500 members-individuals and private enterprises in the country, and various international donors including IDB, F. , UNDP, Canadian and German governments.

ANNEX D
MAJOR NON-GOVERNMENT ORGANIZATIONS

Environmental NGOs		
(a)	Federación Dominicana de Asociaciones Ecologistas (FEDOMASEC)	A Federation incorporated in 1989, is a mostly volunteer organization, and is composed of about 40 ecological associations and conservation groups in the country. The Federation has four goals: (i) to promote the conservation, preservation, study, and sustainable development of natural resources primarily through environmental education and publicizing of environmental transgressions; (ii) to bring together groups dedicated to the study and preservation of natural resources; (iii) to promote the training and formation of new groups; and (iv) to support governmental agencies and programs related to the sustainable management of natural resources and the creation of a national conservation strategy.
(b)	Foundation for Science and Art, Inc.	The Foundation was established in 1989 as non-profit organization chaired by the prominent scholars. It is active in the promotion of natural resource conservation through the development of national seminars, publication, compilation of documents, and public campaign through art exhibition regarding environmental issues in the country. In particular, the Foundation prepared a base document for the UNCED country report in 1991. The Foundation is operated by 8 staff and 120 volunteers with an annual budget amounting to around RD$1 million, financed by the revenues from its various activities including publications and seminars.
(c)	Green Caribe Foundation	In 1993, Green Caribe Foundation is being proposed by the former director of DNP as an international NGO for the Caribbean region. The Foundation aims to establish a regional national park network integrating 45 countries in the Caribbean region, and a mechanism for regional environmental conservation to cope with the regional environmental problems, especially focusing on tourism and environment in the Caribbean region.

SOURCE: World Bank, Environmental Issues Paper (Unpublished), 1993.

ANNEX E

THE WORLD BANK OCCUPATIONAL HEALTH AND SAFETY GUIDELINES

THE WORLD BANK APRIL 1984

POWER PLANTS, COAL AND FUEL OIL

OCCUPATIONAL SAFETY AND HEALTH GUIDELINES

Introduction

1. In the power plant, the main safety hazards involve burns, slips and falls. Fire and explosions may occur from flame out. The main health hazards include bronchitis and dermatitis. Exposure to sulphur dioxide, carbon monoxide, and nitrogen dioxide many occur. Dermatitis can be a problem for workers exposed to fuel oil residues and coal ash dust. Coal ash dust may contain up to 10% silica and exposure to free silica can occur. Oil ash may contain up to 40% of vanadium oxides which are highly toxic. Excessive noise from generators can be a serious problem. Heat and humidity can contribute to heat stress among boiler workers.

These guidelines will cover recommendations on safety and health within the plant to prevent and reduce accidents and occupational diseases among employees.

Safety

2. Steam pipes should be provided with thermal insulation.

3. Shield guards and guard railings should be provided where belts, pulleys, shafting, gears or other moving parts are located.

4. All elevated platforms, walkways, stairways, and ramps should be equipped with handrails, toeboards and non-slip surfaces.

5. Electrical equipment should be grounded and checked for defective insulation. All electrical installations and equipment should be in accordance with the standards of the National Electrical Code.

6. Workers responsible for cleaning boilers should be provided with special footwear, masks and dust-proof clothing.

7. Maintenance workers and cleaners who enter enclosed areas for cleaning fuel oil residues or coal ash dust must wear self-contained air respirators.

8. The cleaning of boilers may require the use of corrosive acids, such as sulfuric acid

and hydrochloric acid, as well as caustic chemicals. The workers using these chemicals should war protective clothing and goggles. Emergency eyewash and showers should be available in the working area.

9. A program for fire safety should be regularly carried out. This is important to establish a safety program in case of fires due to flame out.

10. Good housekeeping practices should include the following: keeping all walkways clear of debris; cleaning up oil spots and excess water as soon as they are noticed; and regular inspection and maintenance of all machinery.

Electrocution

11. Electrical hazards and electrocution constitute a serious safety problem in power plants. the higher the voltage, the greater the risk. Rigid procedures for deenergizing and checking the electrical equipment should be followed before any maintenance and repair work can begin. Some work may have to be done on energized equipment. If this is the case, a supervisor should be present during the whole period of work and should ensure that all safety measures are taken to prevent any accidents. Revival techniques after electrocution should be part of any first aid course being taught to the employees.

Health

12. Sanitary facilities and requirements. Good sanitary and washing facilities must be provided. This will help to reduce dermatitis among the employees due to contact with acids, caustic chemicals, solvents, oils, as well as coal ash and fuel oil residue dust, which are involved in or a result of the various processes. Employees should be encouraged to wash up before eating. A separate lunchroom should be provided outside the work area.

Temperature and Humidity

13. Temperature and humidity are problems in the boiler rooms. Temperatures can go as high as 130 °F and this can result in heat stress. General ventilation can help reduce this problem. It is often necessary in these high temperature areas to give the boiler room workers some time away from the areas to reduce and control heat stress.

Noise

14. Excessive noise can be a serious problem in power plants. Excessive noise can cause permanent hearing loss. Loud background (90 dBA) dulls human senses, including visual acuity, and increases accident rates. The noise level around the generators or other equipment should be lower than 90 decibels (dBA), if impossible, those working near the equipment should have an insulated room where the noise level is below 75 dBA and should be supplied with ear protection to be worn when working around the equipment. A worker

could stay in the noise insulated room from which he can monitor the equipment through a window or by remote control. Good maintenance of equipment can help to reduce noise. Generators must be designed to meet noise level standards.

Dermatitis

15. Dermatitis or skin diseases is a major health complaint. It can be caused by the following: chemical burns from acids or alkalis used to clean boilers; solvents used in cleaning of electrical parts; oils used on the equipment; and exposure to dust from coal ash and fuel oil residues. Protective creams will help reduce the skin problems. Encouraging employees to wash up frequently may also be helpful.

Toxic Gases

16. Sulphur dioxide, carbon monoxide, and nitrogen dioxide can leak from improperly operating boilers. In order to protect workers in this area, the air should be monitored; the TLV for these gases are as follows:

Sulphur dioxide	5 ppm	(13 mg/m^3)
Carbon monoxide	50 ppm	(55 mg/m^3)
Nitrogen dioxide	5 ppm	(9 mg/m^3)

Proper servicing and maintenance of the boilers usually will control this problem.

Dust

17. In modern power plants, the operations for providing fuel are usually partially or fully automatic for coal pulverization and fuel oil. The workmen responsible for boiler maintenance and cleaning are exposed to dusts from coal ash or oil residues. These areas should be monitored for dust levels.

Nuisance dust levels should not be allowed to go above 10 mg/m^3 or 30 mppcf (million particles per cubic foot). Continued excessive dust must be controlled with exhaust ventilation and dust collection equipment. Dust masks should be made available if dust control equipment breaks down.

Coal ash dust may contain up to 10% free silica. Air levels should be checked for free silica to determine if there is excessive exposure to workers. If these levels are over 1% free silica, then dust control collection equipment should be used, or the TLV adjusted accordingly (see Guidelines on Dust Emissions).

Working in Confined Space

18. Entry into closed tanks and other confined spaces can be a dangerous job. The tanks

containing the fuel oil residues or coal ash may have high levels of gases which can be a fire and explosion hazard. The air levels should be checked for high levels of gases, and excess gases should be exhausted before cleaning. Closed spaces may be short of oxygen or they may contain toxic fumes or gases. The worker entering the tank must wear protective clothing and a respirator that receives outside air must wear protective clothing and a respirator that receives outside air through a supply house; a stand-by man should be stationed outside the tank to watch over the safety of the person in the tank. Lights necessary to work in the enclosed metal tanks should be fed with 6 volt or 12 volt power to decrease chances of electrocution.

Medical examinations

19. Pre-employment and periodic medical examinations of all workers should be examined.

Training

20. The education and training of employees in good safety practices is the responsibility of management. Employees should be instructed in the following: proper use of all equipment operated; safe lifting practices; location and handling of fire extinguishers; and the use of personal protective equipment.

Record Keeping

21. Management is required to keep records of all accidents and illnesses which have involved the employees in the plant. This information should be made available to the World Bank. An evaluation of injury and health data will assist the Bank to evaluate the effectiveness of its occupational safety and health program.

Source: 1. I.L.O. Geneva. *Occupational Health and Safety Encyclopedia, Vol. II,* Power Station, p. 1108.