Environmental Impact Assessment
Jorf Lasfar Power Plant

Sponsored by
CMS Generation Co.
ABB Energy Ventures Inc.

Prepared by
Radian International LLC

August 1, 1996
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<tr>
<td>ABB</td>
<td>ABB Energy Ventures BV. A sponsor and equity investor in the Project.</td>
</tr>
<tr>
<td>Ampere</td>
<td>A unit of electrical current.</td>
</tr>
<tr>
<td>avg.</td>
<td>Average.</td>
</tr>
<tr>
<td>B.C.E.</td>
<td>Before Common Era.</td>
</tr>
<tr>
<td>BOD</td>
<td>Biological oxygen demand.</td>
</tr>
<tr>
<td>BOD₅</td>
<td>Biological oxygen demand after five days.</td>
</tr>
<tr>
<td>CEREP</td>
<td>Centre d'Etudes et de Recherches sur l' Environnement et la Pollution</td>
</tr>
<tr>
<td>CFC</td>
<td>Chlorofluorocarbon.</td>
</tr>
<tr>
<td>cfd</td>
<td>Computational fluid dynamics.</td>
</tr>
<tr>
<td>cm</td>
<td>Centimeter.</td>
</tr>
<tr>
<td>cm/hr</td>
<td>Centimeters per hour.</td>
</tr>
<tr>
<td>CMS</td>
<td>CMS Generation Co. A Sponsor and equity investor in the Project and an affiliate of CMS Energy.</td>
</tr>
<tr>
<td>cm/s</td>
<td>Centimeters per second.</td>
</tr>
<tr>
<td>CO</td>
<td>Carbon monoxide.</td>
</tr>
<tr>
<td>COD</td>
<td>Chemical oxygen demand.</td>
</tr>
<tr>
<td>CNE</td>
<td>Conseil National de l'Environnement.</td>
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<tr>
<td>cp</td>
<td>Centipoise. A unit of viscosity.</td>
</tr>
<tr>
<td>dB</td>
<td>Decibel. A unit of sound level, amplitude, or loudness.</td>
</tr>
<tr>
<td>dBA</td>
<td>A-weighted decibels. A measurement adjusted to represent sound levels as the human ear hears them.</td>
</tr>
<tr>
<td>°C</td>
<td>Degrees Celsius.</td>
</tr>
<tr>
<td>DTP</td>
<td>Department des Travaux Publics.</td>
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<tbody>
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<td>EA</td>
<td>Environmental Assessment.</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment.</td>
</tr>
<tr>
<td>ERL</td>
<td>Effects range low.</td>
</tr>
<tr>
<td>ERM</td>
<td>Effects range medium.</td>
</tr>
<tr>
<td>ESP</td>
<td>Electrostatic precipitator. A device for controlling PM emissions.</td>
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<tr>
<td>Ex-Im</td>
<td>The Export-Import Bank of the United States. The export credit agency of the U.S.</td>
</tr>
<tr>
<td>g</td>
<td>Gram. A metric unit of mass equal to one one-thousandth of a kilogram.</td>
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<tr>
<td>GEC</td>
<td>GEC Alsthom. The French construction firm that built Units 1 and 2.</td>
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<tr>
<td>gr/MM Btu</td>
<td>Grains per million British thermal units.</td>
</tr>
<tr>
<td>HOCl</td>
<td>Hypochlorous acid.</td>
</tr>
<tr>
<td>hr</td>
<td>Hour.</td>
</tr>
<tr>
<td>ICPAES</td>
<td>Inductively coupled plasma atomic emissions spectrometer.</td>
</tr>
<tr>
<td>IGCC</td>
<td>Integrated gasification combined cycle.</td>
</tr>
<tr>
<td>ISCST3</td>
<td>Industrial Source Complex Short Term model.</td>
</tr>
<tr>
<td>J</td>
<td>Joule. A unit of energy.</td>
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<tr>
<td>JLPP</td>
<td>Jorf Lasfar Power Plant.</td>
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<tr>
<td>Jorf Lasfar</td>
<td>Arabic for &quot;yellow bluff.&quot; The name for the 50-80m high bluff that forms the east edge of the JLPP and which forms a sheer cliff to north of the Port.</td>
</tr>
<tr>
<td>kcal</td>
<td>Kilocalorie. The amount of heat required to raise the temperature of one kilogram of water by one °C at one atmospheric pressure.</td>
</tr>
<tr>
<td>kcal/kg</td>
<td>Kilocalories per kilogram.</td>
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<tr>
<td>kcal/kWh</td>
<td>Kilocalories per kilowatt hour.</td>
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<tbody>
<tr>
<td>kg</td>
<td>Kilogram. The fundamental unit of mass in the International System, equal to approximately 2.2046 lb in the U.S. Customary System.</td>
</tr>
<tr>
<td>kJ</td>
<td>Kilojoule. One thousand joules.</td>
</tr>
<tr>
<td>kJ/s</td>
<td>Kilojoules per second.</td>
</tr>
<tr>
<td>km</td>
<td>Kilometer. One thousand meters.</td>
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<tr>
<td>km/hr</td>
<td>Kilometers per hour.</td>
</tr>
<tr>
<td>kV</td>
<td>Kilovolt. One thousand volts.</td>
</tr>
<tr>
<td>kWh</td>
<td>Kilowatt-hours. A unit of electric power consumption indicating the total energy developed by a power of one kilowatt acting for one hour.</td>
</tr>
<tr>
<td>kWyear</td>
<td>Kilowatt year.</td>
</tr>
<tr>
<td>L</td>
<td>Liter. A unit of volume in the metric system, approximately equivalent to 1.056 liquid quarts in the U.S. Conventional System.</td>
</tr>
<tr>
<td>lb</td>
<td>Pound. A unit of mass in the U.S. Customary System, equal to 16 ounces.</td>
</tr>
<tr>
<td>lb/MM Btu</td>
<td>Pounds per million Btu.</td>
</tr>
<tr>
<td>Ldn</td>
<td>Sound measurements averaged over a 24 hour period and adjusted so that night time sounds are given a greater influence.</td>
</tr>
<tr>
<td>Leq</td>
<td>Equivalent sound level. A sound level in dBA averaged over a period of time, such as 60 seconds.</td>
</tr>
<tr>
<td>LPEE</td>
<td>Laboratoire Public d'Essais et d'Etudes.</td>
</tr>
<tr>
<td>m</td>
<td>Meter. The fundamental unit of length in the metric system, equivalent to 39.37 inches in the U.S. Customary System.</td>
</tr>
<tr>
<td>m²</td>
<td>Square meter.</td>
</tr>
<tr>
<td>m³</td>
<td>Cubic meter.</td>
</tr>
<tr>
<td>m³/hr</td>
<td>Cubic meters per hour.</td>
</tr>
<tr>
<td>m³/sec</td>
<td>Cubic meters per second.</td>
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<tr>
<td>ME</td>
<td>Ministère de l'Environnement.</td>
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<td>mg</td>
<td>Milligram. One one-thousandth of a gram.</td>
</tr>
<tr>
<td>mg/L</td>
<td>Milligrams per liter.</td>
</tr>
<tr>
<td>mg/m³</td>
<td>Milligrams per cubic meter.</td>
</tr>
<tr>
<td>mg/Nm³</td>
<td>Milligrams per normal cubic meter.</td>
</tr>
<tr>
<td>mho</td>
<td>A unit of conductance reciprocal to the ohm.</td>
</tr>
<tr>
<td>µg</td>
<td>Microgram. One one-millionth of a gram.</td>
</tr>
<tr>
<td>µg/L</td>
<td>Micrograms per liter.</td>
</tr>
<tr>
<td>µg/m³</td>
<td>Micrograms per cubic meter.</td>
</tr>
<tr>
<td>µmho</td>
<td>One one-millionth of a mho.</td>
</tr>
<tr>
<td>µmhos/cm</td>
<td>Micromhos per centimeter.</td>
</tr>
<tr>
<td>mL</td>
<td>Milliliter. One one-thousandth of a liter.</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter. One one-thousandth of a meter.</td>
</tr>
<tr>
<td>MMBtu</td>
<td>Million British thermal units.</td>
</tr>
<tr>
<td>MPN</td>
<td>Most probable number.</td>
</tr>
<tr>
<td>m/s</td>
<td>Meters per second.</td>
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<tr>
<td>MW</td>
<td>Megawatt. One million watts.</td>
</tr>
<tr>
<td>MWh</td>
<td>Megawatt hour.</td>
</tr>
<tr>
<td>N</td>
<td>Newton. The unit of force required to accelerate a mass of one kg one m/s per second.</td>
</tr>
<tr>
<td>NaOH</td>
<td>Sodium hydroxide</td>
</tr>
<tr>
<td>ng</td>
<td>Nanogram.</td>
</tr>
<tr>
<td>ng/J</td>
<td>Nanograms per joule.</td>
</tr>
<tr>
<td>NGM</td>
<td>Niveau général du Maroc.</td>
</tr>
</tbody>
</table>

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List of Acronyms, Abbreviations and Definitions for This EIA

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGO</td>
<td>Non-governmental organization.</td>
</tr>
<tr>
<td>NH₃</td>
<td>Ammonia.</td>
</tr>
<tr>
<td>Nm³</td>
<td>Normal cubic meter (normal = at 0°C and a pressure of one atmosphere).</td>
</tr>
<tr>
<td>NO₂</td>
<td>Nitrogen dioxide.</td>
</tr>
<tr>
<td>NO₃</td>
<td>Nitrate.</td>
</tr>
<tr>
<td>NOVs</td>
<td>Notice of Violations</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Oxides of nitrogen.</td>
</tr>
<tr>
<td>NOAA</td>
<td>U.S. National Oceanographic and Atmospheric Administration.</td>
</tr>
<tr>
<td>O₃</td>
<td>Ozone.</td>
</tr>
<tr>
<td>O&amp;M Cost</td>
<td>Operation and Maintenance Cost.</td>
</tr>
<tr>
<td>OCP</td>
<td>Office Chérifien des phosphates. The national phosphate production company of Morocco and the largest Moroccan company, the single largest exporter in Morocco, and ONE's largest individual customer.</td>
</tr>
<tr>
<td>ODEP</td>
<td>Office d' Exploitation des Ports. The national ports authority of Morocco.</td>
</tr>
<tr>
<td>OEM</td>
<td>Original equipment manufacturer.</td>
</tr>
<tr>
<td>ONCF</td>
<td>Office National des chemins de fer. The railroad transportation department.</td>
</tr>
<tr>
<td>ONE</td>
<td>Office National de l'Electricité. The national electric utility of Morocco.</td>
</tr>
<tr>
<td>Operator</td>
<td>An affiliate of CMS, who will be responsible for operation and maintenance of the Project.</td>
</tr>
<tr>
<td>OPIC</td>
<td>Overseas Private Investment Corporation, a US government agency (international lender).</td>
</tr>
<tr>
<td>ounce</td>
<td>A unit of mass in the U.S. Customary System, equivalent to 28.350 grams in the metric system.</td>
</tr>
<tr>
<td>%</td>
<td>Percent.</td>
</tr>
<tr>
<td>PC</td>
<td>Pulverized coal.</td>
</tr>
</tbody>
</table>

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### List of Acronyms, Abbreviations and Definitions for This EIA

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB</td>
<td>Polychlorinated biphenyl.</td>
</tr>
<tr>
<td>PFBC</td>
<td>Pressurized fluidized bed combustion.</td>
</tr>
<tr>
<td>pH</td>
<td>A measure of a solution's acidity or alkalinity.</td>
</tr>
<tr>
<td>Plan (The)</td>
<td>The comprehensive environmental management implementation plan developed by the Project Operator.</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate matter.</td>
</tr>
<tr>
<td>PM$_{10}$</td>
<td>Particulate matter less than 10 microns in diameter.</td>
</tr>
<tr>
<td>PO$_4$</td>
<td>Ortho Phosphate.</td>
</tr>
<tr>
<td>ppb</td>
<td>Parts per billion.</td>
</tr>
<tr>
<td>ppbV</td>
<td>Parts per billion by volume.</td>
</tr>
<tr>
<td>ppm</td>
<td>Parts per million.</td>
</tr>
<tr>
<td>Project</td>
<td>An independent power project at the existing Jorf Lasfar coal-fired plant site consisting of two existing 330 MW (gross) units and two new units of at least the same size to be completed by the Project Sponsors.</td>
</tr>
<tr>
<td>Project Sponsors</td>
<td>The CMS/ABB Consortium that will acquire the concession to operate the JLPP and construct two new units.</td>
</tr>
<tr>
<td>RADEEJ</td>
<td>Régie autonome de distribution d'eau et d'électricité d'El Jadida. The local water utility.</td>
</tr>
<tr>
<td>s</td>
<td>Second.</td>
</tr>
<tr>
<td>SACE</td>
<td>Sezione Speciale per L'Assicurezione del Credito L'Esportazione.</td>
</tr>
<tr>
<td>SO$_2$</td>
<td>Sulfur dioxide.</td>
</tr>
<tr>
<td>THC</td>
<td>Total hydrocarbons.</td>
</tr>
<tr>
<td>TKN</td>
<td>Total Kjeldahl nitrogen.</td>
</tr>
<tr>
<td>tonne</td>
<td>Metric ton.</td>
</tr>
<tr>
<td>tpd</td>
<td>Tonnes per day.</td>
</tr>
<tr>
<td>tpd/MW</td>
<td>Tonnes per day per megawatt.</td>
</tr>
</tbody>
</table>
List of Acronyms, Abbreviations and Definitions for This EIA

TPH  Total petroleum hydrocarbons.
TPY  Tonnes per year.
TSP  Total Suspended Particulates.
TSS  Total Suspended Solids.
Units 1 and 2  Two existing 330 MW (gross) coal-fired units constructed by GEC Alstom at the Jorf Lasfar project site.
Units 3 and 4  Two new coal-fired units of 348 MW (gross) to be constructed by the Contractors at the Jorf Lasfar Project site.
U.S.  United States.
U.S. EPA  U.S. Environmental Protection Agency.
V  Volt.
VOCs  Volatile Organic Compounds.
W  Watt.
WB Guidelines  The World Bank environmental guidelines.
YSI  Manufacturers of a monitoring device.
EXECUTIVE SUMMARY

This Environmental Impact Assessment (EIA) describes and evaluates the proposed expansion of the Jorf Lasfar Power Plant in Morocco. Each of the 10 sections of the EIA are summarized in this Executive Summary.

1.0 Introduction

CMS Generation Co. (CMS) and ABB Energy Ventures Inc. (ABB), hereafter referred to as “Project Sponsors”, have formed a joint venture for the purpose of acquiring the right to use and operate two existing 330 Megawatt (MW) coal-fired units and the construction and operation of two additional 348 MW coal fired units at the Jorf Lasfar Power Plant (JLPP) in Morocco. This CMS/ABB consortium activity is pursuant to the terms of an agreement with Morocco’s Office National de l’Electricité (ONE). The privatization and subsequent expansion of the JLPP (the “Project”) is a vital part of Morocco’s plans to meet a rapidly increasing demand for electric power. The location of the project is shown in Figure 1.

This EIA has been prepared by Radian International under contract to CMS and ABB. The EIA is required as a condition for obtaining project financing and loan guarantees from the World Bank, the Export-Import Bank of the U.S. (Ex-Im), Sezione Speciale per L’Assicurezione del Credito L’Esportazione (SACE) and the U.S. Overseas Private Investment Corporation (OPIC). In addition to meeting the requirements of lending institutions, the EIA will be submitted to the Moroccan Ministry of Environment for review and approval. Although there are not yet any Moroccan EIA requirements, the Ministry of the Environment is developing EIA guidelines and this report is intended to be consistent with those guidelines.

The proposed Project is critical to meeting Morocco’s energy strategy which includes the extension of electricity to the more than 40% of the population now without electric power. Through privatization of electric power production, Morocco can earn immediate revenues through sale of an operating concession on existing units and benefit from efficient power production from new units. As is documented in this EIA, the expansion of the JLPP, Morocco’s largest power plant, will be accomplished in a manner that is protective of the
Figure 1. Location of the Jorf-Lasfar Power Plant Project
environment while providing much needed cost-effective new power supplies. The proposed project will meet all applicable environmental discharge and ambient guidelines.

2.0 Policy, Legal and Administrative Framework

The Moroccan Government is in the process of developing environmental legislation and regulations. Currently, there are no Moroccan environmental standards or regulations applicable to new projects such as the JLPP. However, the Project will be subject to environmental ambient and discharge guidelines established by the World Bank and potential co-financiers, including OPIC, SACE, and Ex-Im.

Project Environmental Guidelines

The World Bank, OPIC, and Ex-Im have adopted slightly different environmental guidelines and policies. In order to be eligible for financial assistance from these institutions, the Project will need to comply with their respective environmental guidelines. Where there are differing requirements among the three sets of guidelines, the Project will comply with the most stringent one. Table 1 provides this most stringent combination of requirements. These are called the Project guidelines. It is noted that adoption of these Project guidelines is for purposes of obtaining financing for this specific Project, and is not intended to set precedent for other projects or facilities in Morocco.

Local Permitting

In Morocco, an application for a permit to construct a new facility must be presented to the relevant local authority. For the JLPP, the local authority is the Commune of Moulay Abdellah. The rural commune is the local government subdivision within a province. Upon receipt of the application, the local authority will request input from various Ministries (Public Works, Civil Protection, Employment, Health, Environment, etc.). Coordination of these authorities could eventually be done at the level of the corresponding province (El Jadida Province) rather than at the level of the commune itself. The following documents are needed to complete the permit application:

- A formal letter requesting the permit;
- Engineering drawings of the new facility and a corresponding engineering description;
Table 1. JLPP Project Guidelines

<table>
<thead>
<tr>
<th>Topic</th>
<th>Parameter</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambient Air Quality</strong></td>
<td>Particulates (TSP)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual mean (^{(1)})</td>
<td>70 (\mu g/m^3)</td>
</tr>
<tr>
<td></td>
<td>Maximum 24 hr avg. (^{(1)})</td>
<td>110 (\mu g/m^3)</td>
</tr>
<tr>
<td><strong>Sulfur Dioxide (SO(_2))</strong></td>
<td>Annual mean (^{(1)})</td>
<td>50 (\mu g/m^3)</td>
</tr>
<tr>
<td></td>
<td>Maximum 24 hr avg. (^{(1)})</td>
<td>125 (\mu g/m^3)</td>
</tr>
<tr>
<td></td>
<td>Maximum 1 hr avg. (^{(1)})</td>
<td>350 (\mu g/m^3)</td>
</tr>
<tr>
<td><strong>Nitrogen Oxides (NO(_2))</strong></td>
<td>Annual mean (^{(2)})</td>
<td>100 (\mu g/m^3)</td>
</tr>
<tr>
<td></td>
<td>Maximum 24 hr avg. (^{(1)})</td>
<td>150 (\mu g/m^3)</td>
</tr>
<tr>
<td></td>
<td>Maximum 1 hr avg. (^{(1)})</td>
<td>400 (\mu g/m^3)</td>
</tr>
<tr>
<td><strong>Stack Emissions</strong></td>
<td>Particulates (TSP) (^{(1)})</td>
<td>50 (mg/m^3)</td>
</tr>
<tr>
<td></td>
<td>Sulfur Dioxide (^{(1)}) (SO(_2))</td>
<td>0.2 tpd/MW</td>
</tr>
<tr>
<td></td>
<td>Nitrogen Oxides (^{(1)}) (NO(_2))</td>
<td>260 ng/l (270 g/MM Btu)</td>
</tr>
<tr>
<td><strong>Aqueous Effluent</strong></td>
<td>pH (^{(5)})</td>
<td>6 to 9</td>
</tr>
<tr>
<td></td>
<td>BOD (_3) (^{(5)})</td>
<td>50 mg/L</td>
</tr>
<tr>
<td></td>
<td>COD (^{(4)})</td>
<td>250 mg/L</td>
</tr>
<tr>
<td></td>
<td>Heavy Metals (^{(2)})</td>
<td>10 mg/L</td>
</tr>
<tr>
<td></td>
<td>Oil and Grease (^{(2)})</td>
<td>20 mg/L</td>
</tr>
<tr>
<td></td>
<td>TSS (^{(5)})</td>
<td>60 mg/L</td>
</tr>
<tr>
<td></td>
<td>Coliforms (^{(4)})</td>
<td>&lt; 400 MPN/100 mL</td>
</tr>
<tr>
<td></td>
<td>Residual Free Chlorine in</td>
<td>0.5 mg/L</td>
</tr>
<tr>
<td></td>
<td>Cooling Water (^{(1)})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature Increase at Edge of Mixing Zone</td>
<td>5°C above ambient unless receiving water &gt;28°C, then max. 3°C allowed</td>
</tr>
<tr>
<td><strong>Community Noise</strong></td>
<td>Residential (^{(2)})</td>
<td>55 dBA (Ldn)</td>
</tr>
<tr>
<td></td>
<td>Other (^{(2)})</td>
<td>70 dBA (Ldn)</td>
</tr>
<tr>
<td><strong>Occupational</strong></td>
<td>Noise (^{(1)})</td>
<td>85 dBA</td>
</tr>
<tr>
<td></td>
<td>SO(_2) (^{(1)})</td>
<td>5 mg/m(^3) (8 hr day avg.)</td>
</tr>
<tr>
<td></td>
<td>NO(_2) (^{(1)})</td>
<td>6 mg/m(^3) (8 hr day avg.)</td>
</tr>
<tr>
<td></td>
<td>TSP (^{(1)})</td>
<td>10 mg/m(^3) (8 hr day avg.)</td>
</tr>
</tbody>
</table>

\(^{(1)}\) OPIC Guidelines
\(^{(2)}\) World Bank, 1988
\(^{(3)}\) World Bank, Ex-Im, and OPIC are identical for this parameter.
\(^{(4)}\) Ex-Im, 1996
Evidence of compliance with the regulations for the design and construction of tanks and tank farms; and

A summary of the environmental impacts of the Project.

Application for an operating permit for Units 3 and 4 will be made to the Ministry of Public Works.

Role of Moroccan Organizations

Moroccan environmental standards are being initiated and drafted by an advisory working group named “Conseil National de l’Environnement” (CNE). CNE comprises officials from various relevant Ministries (Environment, Public Works, Agriculture, Industry-Commerce & Artisans, Energy & Mines, Transport, Health, etc.) and also includes several non-governmental organizations (NGOs). These include professional bodies, scientific institutions, and industrial associations. The CNE is chaired by a representative of the Ministry of Environment.

The Ministry of Environment will review and approve the JLPP EIA as required by the World Bank. The NGOs and the public will participate in the review and comment on the Project plan via the public forum. Representatives of the public and NGOs are scheduled to meet at separate forums in July 1996 to discuss the proposed Project.

3.0 Project Description

This section describes both the existing JLPP and the proposed expansion of the plant. This discussion addresses plant location and surrounding features, plant processes, and environmental discharges and controls.

Project Site Features

The plant is located on a narrow stretch of land between a 60 m high bluff to the east and the Atlantic Ocean to the west. The plant site is generally flat and at an elevation of approximately 7 m above the reference level of Morocco or Niveau général du Maroc (NGM) and is protected from high waves and storms by natural sand berms, sea walls, and breakwaters. The Port of Jorf Lasfar is adjacent to the northern boundary of the site. The port has a portion of one pier dedicated for receiving imported coal for use by ONE. A coal conveyor system transports the coal from the port to the site.
There are several small settlements located on the bluff to the east of the plant. The nearest dwelling is within 75 m of JLPP fenceline. The immediate area surrounding JLPP is in mixed agricultural and industrial land uses with a large phosphate plant, Office Chérifien des Phosphates (OCP), located approximately 2 km northeast of the plant.

**Description of Existing Facility**

The area within the JLPP fenceline occupies approximately 60 hectares and was designed to accommodate six 330 MW coal-fired steam generators and support facilities associated with a state-of-the-art pulverized-coal thermoelectric plant. Construction of the first two units (Units 1 and 2) was completed in 1994 and 1995, respectively, by a consortium of GEC Alsthom, B&V España, and Dragados Constructors. Table 2 presents the elements of the existing facility including the infrastructure that will be used jointly by the existing and proposed new units.

In 1995, the JLPP produced 4,100,000 MWh of electricity. The electricity generated is routed to a 225 kV substation which is connected to the ONE system grid via five overhead 225 kV transmission lines.

Both Units 1 and 2 are designed to fire pulverized-coal, and/or heavy fuel oil No. 2; however, coal is the primary fuel used to generate electricity. Currently, coal is supplied from the United States, Colombia, and South Africa, with the majority coming from the United States. In 1995, Units 1 and 2 consumed a total of 1,147,137 tonnes of coal.

Coal is shipped to the Port of Jorf Lasfar and is unloaded onto a conveyor system which transports the coal from the Port to JLPP. The coal is then unloaded onto the coal pile storage area. In addition to storing coal for use at JLPP, this facility provides up to 700,000 tonnes per year of coal for use at other ONE facilities.

Two types of water are used at the JLPP: 1) raw fresh water and 2) seawater. Raw fresh water is used for plant process operations (i.e., steam generation, equipment cleaning) and treated for sanitary water supply. Raw water is supplied to the site from the El Jadida water system via condense turbine exhaust steam so that it may be used again. Seawater is also used to convey bottom and fly ash to the Atlantic Ocean.
Table 2. Description of the JLPP

Existing JLPP Facilities

- Two 330 MW pulverized-coal fired steam generators of the CE/Sulzer type supplied by Babcock and Wilcox España;
- Two reheat steam turbines of the steam condensing and bleeding type manufactured by GEC Alsthom;
- Four (2/unit) cold side electrostatic precipitators (ESP) with three fields each. The ESP's are designed to remove 99% of the flue gas particulate matter;
- A distributed control and information system manufactured by GEC Alsthom;
- Boiler building with a height of 54.6 m;
- Turbine generator building;
- Ash handling building;
- 130 m stack - serving both Units 1 and 2, with separate flues;
- 225 kV indoor substation and five overhead 225 kV transmission lines, solid dielectric cable termination yard, a substation building for equipment, and a substation control house; and
- 60 kV switching station and 6.6 kV auxiliary system.

Existing Facilities that will be Common to All Four Units

- Administration building;
- Warehouse (sized for six electric generation units);
- A 1.5 km long open channel to discharge once-through condenser cooling seawater to the Atlantic Ocean. The channel is sized to accommodate once-through condenser cooling seawater from six units and widens to 26 m at the point of discharge;
- Two 90 cm diameter concrete pipe wastewater outfalls to the Atlantic Ocean;
- Machine shop and electronics repair shop;
- Two - 50,000 m³ fuel oil storage tanks;
- One 500 m³ diesel-oil storage tank;
- One 25 m³ propane storage tank;
- Coal storage yard sized to store coal for six 330 MW steam generators. In 1995 the coal yard stored up to 400,000 tonnes of coal at any one time;
- Coal handling facilities consisting of a conveyor system, transfer house, a stacker, and two reclaimers;
- Fuel oil receiving and unloading facilities;
- Chlorination system;
- Septic tanks for sanitary wastewater generated onsite;
- Demineralization water production system;
- Fire protection system;
- Seawater intake (sized for six units) and dikes to protect seawater intake area;
- Auxiliary boiler;
- Raw water supply (sized for six units); and
- Concrete-lined coal pile storm water runoff settling basin.
All wastewater streams generated at JLPP are eventually discharged to the Atlantic Ocean. Water discharges consist of the following types of wastewater streams: ash conveyance water, boiler blowdown, once-through condenser cooling sea water, sanitary wastewater, storm water, and demineralizer backwash/regeneration wastewater.

Both bottom and fly ash are sluiced in two parallel pipelines (one for bottom ash and the other for fly ash) with a slip stream of incoming seawater and discharged to the Atlantic Ocean. Both lines are submerged and extend 800 m into the Atlantic where the average depth is 13 m.

As of May 1996 there were 144 regular employees working at the JLPP. According to the ONE management staff, virtually all of the employees live in El Jadida and commute to work in company buses. Figure 2 shows the JLPP plant layout including the site for Units 3 and 4.

**Description of Proposed Expansion**

The proposed expansion consists of adding two new 348 MW power generating units and various support equipment. The additional equipment is listed in Table 3.

Pending financial closing, construction of the new units is anticipated to begin in March 1997. Construction of Unit 3 is scheduled to take no greater than 33 months. Completion of Unit 4 is planned to occur six months after the completion of construction of Unit 3. Unit 3 is currently scheduled to be operational by December 1999. At peak time, approximately 700 construction workers will be working at the site. Both skilled (about 53%) and unskilled workers (about 47%) will be hired to construct the units.

Construction materials may be transported to the facility via rail car or trucks. The construction of new rail, port facilities, or roads is not required for this project. Moreover, all construction and laydown areas will be inside plant site on areas that have been cleared of vegetation and previously disturbed from earlier construction. Purchase or use of property not currently owned by ONE will not be required for the construction of Units 3 and 4. Also, no relocation of families living near the plant will be necessary.
Table 3. Proposed Additions to JLPP

- Two 348 MW pulverized coal-fired steam generators (Units 3 and 4) capable of firing coal or heavy fuel oil No. 2 as support fuel only;
- Two steam turbine/generator units;
- Four (2 per unit) four-field, cold-side electrostatic precipitators designed to reduce PM emissions from Units 3 and 4 to 50 mg/m³;
- Two emergency diesel generators;
- Expansion of the water demineralization system (including two 1000 m³ demineralized water storage basins) to provide demineralized water for Units 3 and 4;
- Expansion of the seawater intake pumping station;
- A 130 m stack with separate flues to discharge air emissions from Units 3 and 4;
- A wastewater treatment system designed to meet project effluent guidelines;
- Electrical building;
- Ash handling system;
- Coal silos sized for at least 12 hours of full load operation;
- Extension of the coal stacker and reclaimer tracks by 300 m;
- Extension of the two 750 tonne per hour coal conveyor systems;
- Extension of the coal wetting system;
- A new raw water storage tank; and
- Extension of the existing fire water system.

In addition to the proposed new equipment, there will be several operational changes:

- Wastewater will be treated to meet World Bank effluent guidelines prior to disposal to the Atlantic Ocean. Wastewater from floor cleaning will be sent to an oil/water separator to remove oils and grease. The pH treatment of wastewater will be upgraded;
- Disposal of fly and bottom ash in the Atlantic Ocean will be terminated once an appropriate alternative has been implemented;
- Fuel oil unloading operations will be modified in order to minimize fuel spillage; and
- An Environmental Management Plan will be developed and implemented. The plan will address waste management procedures, environmental sampling, and environmental record keeping.

In order to keep emissions of SO₂ from the JLPP within Project guidelines, both the existing Units 1 and 2 and the proposed Units 3 and 4 will use coal required to contain less than 1.25% sulfur by weight on an annual average basis. It is anticipated that the coal will be supplied
from South Africa, Colombia, and the United States. Units 3 and 4 will use heavy fuel oil No. 2 for ignition, warm-up, and combustion stabilization below 35% load. When operating at the anticipated capacity factor of 82%, Units 1 through 4 will consume approximately 3.3 million tonnes of coal per year.

Employment at JLPP, following completion of Units 3 and 4, will be approximately 300. This is a net increase of 156 employees over staffing levels in early 1996.

4.0 Environmental Baseline

This section contains descriptions of the existing physical, biological, and sociocultural environment in the area potentially affected by the proposed Project. Key findings from this baseline survey are described below.

Physical Environment

The most prominent topographical feature of the immediate area is the 50 to 80 m high bluff that rises from the Atlantic Ocean. This escarpment forms a topographical barrier between the JLPP and the settlements and coastal highway that runs along the top of the bluff. The geology of the Project site is coastal Meseta. The soil at the site consists of compacted sandstone, cemented by carbonates.

The climate is temperate. Winds are predominately easterly and northeasterly—parallel to the coast. Annual rainfall is variable, ranging from 210 to 740 mm.

Although the Project Sponsors have begun collecting ambient air quality data for sulfur dioxide ($SO_2$), oxides of nitrogen ($NO_x$) and particulate matter (PM), sufficient data are not yet available at this time to fully characterize air quality. Approximately seven weeks of ambient air quality monitoring conducted by the Laboratoire Public d’Essais d’Etudes (LPEE) in 1994 prior to operation of Units 1 and 2 was used in this EIA to make a preliminary determination of air quality conditions. Based on these data, air quality is generally acceptable with the exception of occasional short-term high levels of $SO_2$ concentrations. The $SO_2$ spikes occurred when the wind was coming from the direction of the phosphate plant.
Ocean water sampling at ten sites offshore from the JLPP site was conducted to
determine marine water quality and sediment conditions. With some exceptions, most
parameters appeared to be normal for near shore conditions. Phosphate levels in the water were
uniformly high at all sampling stations. Two stations relatively close to the ash disposal site and
the phosphate plant discharge channel have copper concentrations in the seawater above the
acute toxicity level for marine life. A seawater sample from a station on the north end (nearest
the port) exceeds the chronic toxicity level for mercury. The station nearest the phosphate plant
outfall has concentrations of mercury in the sediment above the threshold associated with
“possible” biological effects. In the sediment for all stations, copper and arsenic concentrations
exceed the threshold for “possible” biological effects but are below the threshold for “probable”
biological effects.

Groundwater, which is encountered 6 m below the ground surface involves intermingling
between fresh water and ocean water. Oil and grease levels were found to be elevated but not
above World Bank discharge limits in a drinking water well sample.

A baseline noise survey was conducted. Ten of the 11 fence line measurements were
below the 70 Lₜₚ Project guideline. Noise levels at the nearest off-site residential area
measurement were marginally above the stringent 55 Lₜₚ level, which is the Project guideline for
residential areas. However, most residences are shielded by the crest of the bluff from the direct
propagation of noise from the JLPP. In general, noise conditions are normal. There have been no
complaints from nearby residents.

Biological Environment

The current environment has been influenced significantly by several centuries of human
habitation. There is only sparse vegetation immediately outside the JLPP and virtually none
inside. The only terrestrial animals observed during a biological investigation were domesticated
farm animals and pets outside the JLPP site. There are 10 endangered or threatened species that
may have Morocco as their historic range. None were observed on the biological survey and it is
highly unlikely that they are present in the areas that may be affected by the proposed Project.

Marine biological sampling was conducted offshore from the JLPP. The diversity and
quantity of fish and benthos in the sediments is considered low. This investigation did not
determine the cause of these apparently low quality marine biological conditions. The high
energy shoreline (rocky beach and heavy wave action) may reduce marine biodiversity. High metals concentrations in seawater and sediments may also be a contributing factor.

**Social and Cultural Environment**

No archeological or historical sites are known to exist on the site. The nearest identified sites are eight km to the north.

The demographics of Morocco and the area around the plant are characterized by a rapidly increasing and very young population. The annual rate of increase exceeds 2% and more than half of the population is less than 20 years old.

Despite improvements in the national economy, the unemployment rate is 15 to 20% and many rural residents in particular are underemployed and poor. Agriculture is important in the vicinity of the JLPP. The largest employers in the area are the phosphate plant, which employs 3200 persons, the port of Jorf Lasfar, which has 140 full time employees but frequently hires up to 1000 temporary dock workers, and the JLPP, which has 144 employees at present. Virtually all of these workers commute in company operated buses between their homes in the El Jadida urban area and the work sites.

Economic growth is tied closely to electric power availability and reliability. Recent curtailments of electric power resulted in an estimated 1% drop in the gross national product. The expansion of the JLPP will result in increased employment and a likely multiplier effect fostering growth of business and employment in the surrounding area.

Land use in the local area is characterized by the industrial complex currently comprising the port, the phosphate plant, and JLPP—and an encircling rural area. The rural area appears unchanged by time. Traditional methods of agriculture are practiced. There are no towns—only clusters of stucco dwellings in small settlements. The future land use projections indicate conversion of vacant lands set aside for industrial development. Aesthetic resources are high with several scenic vistas. There are no protected areas, nearby parks, or otherwise wild areas.
5.0 Audit of Existing Conditions

An environmental audit conducted at the JLPP in 1995 identified the following environmental concerns:

- Shallow soil contamination from fuel oil spills, primarily at the tank car unloading area;
- Lack of sufficient ambient air quality data to confirm earlier data by ONE that indicate occasional, short-term, high background ambient SO\textsubscript{2} concentrations (from the direction of the neighboring phosphate plant);
- Occasional excursions of pH in wastewater discharges and inadequate treatment of storm water runoff;
- Disposal of fly ash and bottom ash in the ocean; and
- Hazardous chemicals handling, storage and tracking.

The Project Sponsors will address each of these concerns.

6.0 Potential Future Impacts of Proposed Expansion

This section describes the impacts of constructing Units 3 and 4 at the JLPP and the incremental impacts of operating all four units.

6.1 Impacts of Construction

The land for Units 3 and 4 is already graded and cleared of vegetation. The construction site is an industrial area with high human activity and contains no wetlands or sensitive environmental habitats. New property or roads will not be required. Therefore, the construction activities will have little or no impact on the land resources.

During construction activities, unavoidable air pollutant emissions are likely to occur. The most prevalent construction emissions are fugitive dust. Fugitive dust control measures will be implemented during construction. Minor emissions of NO\textsubscript{x}, SO\textsubscript{2}, carbon monoxide (CO), PM and volatile organic compounds (VOCs) are also likely during construction. Overall, the impact
of heavy construction activities and site preparation on air quality will be short-term and confined to the immediate vicinity of the construction activity.

The only surface water body that may be affected by the construction at JLPP is the Atlantic Ocean. Although there is a slight potential for oil spills or leaks to reach groundwater, the Project Sponsors will assure that appropriate measures are implemented as necessary to prevent adverse impacts to the ocean and to groundwater.

No impact to biological resources to the land are expected. The construction site for Units 3 and 4 is a graded, industrial area that is already highly impacted by human activity. The construction site is not habitat for flora, fauna, wildlife and other biological resources. Little or no impact to biological resources in the marine environment are expected from the addition of two more units to the existing JLPP facility. No construction will occur over water. Measures for preventing surface water runoff and sediment loading will protect marine biology.

No impact to archeological and historical resources will occur because all construction will occur in areas that have been previously disturbed by the construction of Units 1 and 2.

The construction of JLPP Units 3 and 4 will have positive social and economic impacts. The construction contractor anticipates that at least 700 persons will be hired during peak construction with an average of 500 persons during the 39-month period of construction. Approximately 47% of the construction workers will be classified as unskilled. Many of these workers will be drawn from the many small settlements around the JLPP. Others will be hired from El Jadida and other Moroccan cities. It is likely that many of these unskilled workers will come from the ranks of the unemployed or underemployed. Many of the skilled workers will also be Moroccans although the number of in-country versus foreign workers has not yet been determined. Although temporary, this construction activity will create a stimulus for local and regional incomes.

Another economic benefit of the construction will be the estimated $43 million (U.S.) that will be spent to purchase other Moroccan goods and services. Most of the heavy equipment for the power plants, such as generators and turbines, will be purchased from Europe and the U.S. Capital equipment purchases will be from the U.S., Italy, and Switzerland. The JLPP sponsors will purchase local construction material such as concrete whenever it can be procured.
Thus, the construction will create jobs and economic growth both in Morocco and internationally.

Frequently, large capital projects in rural areas create adverse socioeconomic impacts as a result of sudden and large demands for housing and other services. This "boom" effect is then followed by a "bust" as the construction workers and their families move on to other projects. The construction of Units 1 and 2 in the early 1990s did not create this boom and bust effect for two reasons. First, a large number of rural Moroccans are unemployed or underemployed. Therefore, there was no need to bring in non-local unskilled workers. Second, the City of El Jadida had adequate temporary housing availability for the remaining workers who commuted to the work site each day by bus. The bus service was arranged by the construction contractor.

The contractor for Units 3 and 4 has indicated that they anticipate a similar pattern for the future construction: unskilled workers hired from the immediate area and temporary housing in El Jadida for the skilled and unskilled workers who do not live in this part of Morocco. No "tent cities" or other offsite temporary housing is necessary and none is planned. Because the workers will either walk to the site or will be bused in by the contractor, there should be no traffic congestion or parking problems often associated with large construction projects.

Construction-related noises will be temporary and intermittent. Moreover, the great majority of the homes in the nearest residential areas are shielded by the crest of the bluff from the ground-level noises at the power plant and therefore will be even less affected by construction noise because of the terrain.

6.2 Impacts of Operation

Land Use and Transportation

The operation of Units 1 through 4 at the JLPP will have a negligible impact on existing land use. Construction of the new units will not require the purchase or use of land outside of the JLPP property boundaries except as needed for an ash disposal site. All construction and operation will be on land that has been previously disturbed and converted to heavy industrial land use. Because of local land use controls around the industrial area, there will be no induced or secondary development such as housing tracts for new workers, restaurants and grocery stores, or after-work recreational and leisure retail establishments.
The proposed Project will not adversely affect transportation. The planned transport of JLPP workers using buses should effectively minimize increased traffic congestion along the El Jadida to JLPP stretch of Route 121. Increased coal use will result in a greater number of coal shipments through the port; however, the dock expansion and the current under utilization of port capacity indicates that the incremental increase in coal shipments will not create ship congestion in the port.

**Air Quality**

Emissions of $\text{SO}_2$, $\text{NO}_x$, and PM from the project are expected to increase from current levels. Emissions are anticipated to be within the project environmental guidelines, with the exception that PM emissions from existing Units 1 and 2 will meet the ESP performance guarantee of 125 mg/m$^3$.

Increases in stack emissions and their corresponding impact on ambient concentrations were evaluated as part of this environmental impact analysis. Table 4 presents a description of the emission estimation procedures for each investigated pollutant. The future ambient air concentrations were calculated using a very conservative dispersion modeling analysis, and were compared with applicable Project guidelines. The modeling results indicate that the impact of the increased emissions will not significantly impact air quality near the JLPP operations.

Ambient concentrations of $\text{SO}_2$ and $\text{NO}_x$ were determined from limited ambient monitoring performed by the LPEE in 1994. No PM sampling was performed. This sampling was done prior to operation on JLPP Units 1 and 2 and thus are not considered baseline concentrations for the purpose of this project. Project baseline ambient concentrations will include the existing impacts from JLPP Unit 1 and 2 operations. Radian is currently collecting ambient concentration data which will be included in the final version of this EIA. The results from the 1994 LPEE sampling indicate that the region surrounding the proposed project complies with Project guidelines for these two pollutants on an annual average basis. Measured NO$_2$ concentrations were significantly below the Project guidelines and are not considered of concern for this project.
Table 4. JLPP Maximum Air Emissions

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Estimated Current Maximum Emissions from Units 1 and 2 (tonnes/day)</th>
<th>Maximum Potential Emissions from Units 1 and 2 (tonnes/day)</th>
<th>Maximum Potential Emission from Units 1 through 4 (tonnes/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur Dioxide</td>
<td>79.2¹</td>
<td>158.4²</td>
<td>271.2³</td>
</tr>
<tr>
<td>Nitrogen Oxide</td>
<td>34.5⁴</td>
<td>35.1³</td>
<td>70.6⁶</td>
</tr>
<tr>
<td>Particulate</td>
<td>1.4⁵</td>
<td>5.9⁶</td>
<td>8.4⁹</td>
</tr>
</tbody>
</table>

¹ - Based on 0.75% S coal (0.12 tonne/MW-day) and 100% capacity factor.
² - Based on 1.5% S coal (0.24 tonne/MW-day) and 100% capacity factor.
³ - Based on 1.25% S coal (0.20 tonne/MW-day) on all 4 units.
⁴ - Based on tested emissions of 256 ng/J, heat rates of 2065 kcal/kWh, and 100% capacity factor.
⁵ - Based on predicted emissions of 260 ng/J, heat rates of 2065 kcal/kWh for Units 1 and 2 and 2080 kcal/kWh for Units 3 and 4, and 100% capacity factor.
⁶ - Based on tested emissions of 30 mg/Nm³, 100% capacity factor.
⁷ - Based on ESP guarantee of 125 mg/Nm³, 100% capacity factor. Calculations located in Appendix F of the main report.
⁸ - Based on emissions of 125 mg/Nm³ on Units 1 and 2 and 50 mg/Nm³ on Units 3 and 4 and 100% capacity factor on all 4 units.

SO₂ concentrations varied significantly but the annual average hourly concentration was determined to be 18.5 µg/m³, well below the Project guideline of 50 µg/m³ annual average. However, the maximum daily SO₂ concentration measured during the testing was 285 µg/m³, which is above the Project guideline of 125 µg/m³. Based on wind direction data and the fact that the testing was performed prior to operation of JLPP Units 1 and 2, the source of these high SO₂ excursions is believed to be the OCP phosphate plant located near JLPP. During the testing, which lasted 7 weeks, there were 7 occurrences when the measured SO₂ concentration was above the OPIC guideline of a maximum 1-hour average level of 350 µg/m³.

Ambient dispersion modeling for SO₂, NO₂, and PM was performed by Radian to predict the incremental impacts of the 4 unit operation relative to the measured 1994 ambient concentrations. This approach is considered very conservative for the following reasons:

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¹ The Project guideline of 125 µg/m³ was derived from the US OPIC guidelines. 1988 World Bank Guidelines recommend a maximum 24 hour average SO₂ concentration of 500 µg/m³ outside the plant fence line.
1. The analysis assumed an existing ambient SO$_2$ concentrations of 285 µg/m$^3$ (single highest 24 hour average) which is based upon a very limited duration sampling episode. This short sampling period will also artificially inflate the period (annual) average;

2. The project baseline was adjusted to include modeled maximum current ambient impacts of 41 µg/m$^3$ from Units 1 and 2 operations, even though the modeled maximum impacts occur at locations different from the maximum measured concentration; and

3. Allowable incremental increases were based upon keeping ambient incremental increases of SO$_2$ to well below World Bank Criterion II guidelines.

The World Bank guideline for the allowable SO$_2$ emissions increase for an area with a maximum ambient 24-hour average concentration of 326 µg/m$^3$ is 250 tonne/day. Based on the firing of an average 1.25 wt % S coal, the expected SO$_2$ emission increase over current operating levels is 192 tonne/day. In addition, the World Bank, Criterion II guideline for incremental increase in annual average SO$_2$ concentration for this area is 25 µg/m$^3$. Dispersion modeling predicts that the maximum annual average SO$_2$ concentration due to continuous operation of all four units at 100% capacity factor, firing 1.25 wt % S coal, is 14.1 µg/m$^3$, just over half the allowable Criterion II level. The conservative assumptions employed and the ample margins below the guideline values assure that the Project will not significantly impact local SO$_2$ air quality. The Project is currently collecting additional ambient air quality data and this analysis will be updated appropriately when sufficient data become available.

Maximum predicted NO$_2$ and PM emissions from all 4 units were also modeled to evaluate the potential ambient impacts. At the Project guideline NO$_x$ emission rate of 260 ng/J, the predicted ambient impact is less than the Project guidelines of 100 µg/m$^3$ annual average and 150 µg/m$^3$ maximum 24 hour average. The Project Sponsors have assured that PM emissions from Units 1 and 2 will be below the ESP performance guarantee of 125 mg/Nm$^3$. Although this is above the Project guideline of 50 mg/Nm$^3$, this emission rate on Units 1 and 2, even when combined with the impacts from Units 3 and 4, results in ambient concentrations that are less than 2% of the 24-hour ambient Project guideline of 110 µg/m$^3$ and 0.4% of the annual ambient Project guideline of 70 µg/m$^3$. Thus, PM emissions from all 4 units will not pose any risk to human health or the environment.
Surface Water Quality

Due to the topography of the area, the only surface water that could be impacted by JLPP is the Atlantic Ocean. At present, JLPP discharges its ash, wastewater, and storm water to the ocean.

The proposed expansion of JLPP includes major changes in ash and water management. Ash discharge to the ocean will be discontinued once an acceptable option is found. Storm water will be treated to assure compliance with Project guidelines. Sanitary wastewater will receive biological treatment and final disinfection of effluent. Metals will be removed and pH neutralized on cleaning wastewaters. These changes will ensure that the impact of JLPP on surface water will be significantly reduced, notwithstanding the expansion of power generation.

Groundwater Quality

Groundwater quality is not expected to be adversely impacted by the proposed Project. The addition of Units 3 and 4 will include a storm water and wastewater collection and treatment system designed to meet all Project discharge guidelines. Consequently, the groundwater will be better protected, which is important to local residents who obtain their drinking water from a well near the entrance to the plant. JLPP will continue to obtain all its process water from a pipeline, so no local withdrawals and concomitant lowering of the groundwater table will occur.

Surface Water—Thermal Impacts

The JLPP Units 1 and 2 condensers are cooled by way of once-through cooling water discharged into the Atlantic Ocean. Historical ambient water temperature data of the region indicate that the ambient water temperature does not exceed 25°C. The cooling water flow rate, temperature, and the ambient ocean water temperature were measured in the field during the fall of 1995 and the spring of 1996. The field results indicated that the Units 1 and 2 thermal discharges are well within the Project guidelines. The net temperature increase 100 m away from the discharge point is about 1°C.

The field results were used to calibrate a numerical model of the thermal discharges for all 4 units. The model results indicate that the thermal discharges of all 4 units result in a net temperature increase at a distance of 100 m away from the discharge point of less than 2.2°C, well within Project guidelines.
Biological Resources—Land
The operation of Units 1 through 4 will have no significant impact on terrestrial biological resources. As described in Section 3, there are no biological resources within the area to be disturbed by the construction and to be occupied by the new facilities associated with the proposed Project. Because the land use surrounding the JLPP will not undergo change as a result of induced growth, the plant and animal habitats will not be disturbed.

Biological Resources—Marine
The operation of Units 1 through 4 will have no adverse impact on the marine environment. It is probable that the Project will benefit the marine ecology through the cessation of ocean ash disposal and improvements in waste water quality.

Socioeconomic Impacts
The socioeconomic impacts of the operation of Units 1 through 4 are positive. In particular, the proposed Project offers significant direct and indirect economic benefits to the nation.

The expansion of the JLPP will require approximately 156 new employees. This increase in the permanent work force would increase staff levels from 144 at present to approximately 300. Most of these new positions will be from the local (El Jadida area) work force. These positive impacts will be directed largely to the El Jadida urban area where the new employees are likely to reside. Although the largely unskilled laborers in the immediate vicinity of the JLPP will benefit from construction hiring, only a few permanent staff positions are expected to be filled by those living in the immediate vicinity of the JLPP.

According to local planning authorities, the City of El Jadida is expanding its low and moderate income housing stock to ensure that adequate housing is available for new workers in the area—including the JLPP expansion. Some 27,000 new housing units are planned to be developed by the year 2000 in areas that are served by water, sewer, and electric power utilities. By maintaining convenient employee transportation to and from the JLPP, the Project Sponsors can assure that growth from new employment will be channeled largely to the El Jadida area where adequate housing and services will be available.
The aesthetic impacts of the proposed expansion will be minor. There will be an additional flue gas stack that will be visible for several km along the coast highway. Two additional generating units will be visible closer to the JLPP. Most of the new expansion, like the existing plant, will be shielded from view as a result of the terrain.

During the local permitting of the existing facility, an objection was raised by permitting authorities to the architectural design in the original plans. The building contractor worked with local authorities to develop an architectural motif that incorporates Moroccan Arabic design and that reduces some of the typical “industrial” look to the facility. This architectural motif will be incorporated into the two new units.

The most significant benefits of the proposed Project will be the increase in quantity, availability and the reliability of electric power to the nation. The Moroccan economy has improved in recent years; however, future economic progress is challenged by relatively high unemployment levels and problems with the availability and reliability of electric power. As shown in Figure 3, JLPP is expected to account for approximately one-half of Morocco’s electric power generation by the end of the decade. The addition of Units 3 and 4 are absolutely essential to avoid future losses in gross national product and increases in the cost of doing business as a result of recent electric power curtailments.

The benefits of the increased capacity from Units 3 and 4 will also directly affect most of the Moroccan rural population that is currently without electric power. Many of these rural villagers, who comprise approximately half of the country's population, will enjoy the benefits of electric power over the course of the next decade as a result of the rural electrification program. The success of this program depends, in part, upon the availability of electric power from Units 3 and 4.

Through the privatization of JLPP Units 1 and 2, the Government of Morocco will receive monetary benefits of an upfront payment of $263.1 million (US). Through the construction and operation of Units 3 and 4, additional power will be brought on line without the need for the increased indebtedness that would occur if JLPP were not privatized.

Noise
Noise impacts from the operation of the new units will not adversely affect the off-site residential areas and will remain within Project guidelines for fence line impacts. Blowing safety valves will be the loudest sounds from the plant. These should be very rare occurrences, but
Figure 3. Contribution of JLPP to Morocco’s Future Electricity Needs

Source: World Bank, 1994a

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when they occur, they can startle nearby employees, and to a lesser extent, wildlife and the public. The nearest off-site residential areas will be shielded from most of the JLPP noises by the crest of the bluff.

**Worker Health and Safety**

As discussed in Section 8, the operator of the Project will institute a worker health and safety program that will minimize the potential for accidents. These measures will be in line with operating practices at plants in the U.S. and Europe.

### 7.0 Analysis of Alternatives

The EIA evaluated alternatives relating to the project site, fuel selection, coal technology selection, air emission controls, wastewater treatment, and alternatives to ocean ash disposal.

The JLPP site is the most cost-effective site for future base load expansion because it was originally designed for additional units and certain common facilities for Units 3 and 4 are already installed. The incremental cost of adding these units given the existing infrastructure is low relative to greenfield sites. The original rationale for this site is its proximity to the port (ready access to imported coal), proximity to the ocean (availability of sea water cooling), and proximity to the utility's largest customer, the phosphate plant.

Although natural gas is a cleaner burning fossil fuel, natural gas pipeline supplies and pipelines are remote from the site and gas is more expensive. Heavy fuel oil is also more expensive and not appreciably cleaner burning. Light oil is appreciably more expensive. The JLPP infrastructure is designed to handle coal. Any change in fuels would lessen the advantage of using the existing infrastructure.

Clean coal technologies, such as fluidized bed combustion and integrated gasification combined cycle technologies, result in less environmental discharges than does conventional pulverized coal (PC) combustion. However, capital costs are higher and lack of operating experience on a plant of the proposed size make these impractical for Morocco at this point. Moreover, the JLPP site developers were constrained to the use of PC technology by the proposal request issued by ONE.
Several emission control alternatives were examined in order to reduce $\text{SO}_2$ and PM emissions. These include use of ultra low sulfur coal, use of "cleaned" coals, use of a seawater scrubber, or use of a limestone scrubber. It was concluded that Units 3 and 4 are capable of meeting Project guidelines using the analyzed coals. Therefore, further consideration of these strategies is not warranted due to the additional capital and operating costs.

The wastewater system for Units 3 and 4 is comprised of the following:

- Coal pile runoff will be treated before offsite release;
- Sanitary wastewater will be conveyed to a biological treatment system for removal of $\text{BOD}_5$ and suspended solids. The effluent will be disinfected prior to discharge;
- Effluent from the demineralizers and other chemical wastewaters will be neutralized;
- Metals-containing wastewater will be treated before discharge;
- Oily wastewater will be treated before offsite discharge.

Treatment of these wastewaters will be accomplished by methods proven successful at power plants throughout the world. The Project Sponsors are committed to ending the practice of ocean ash disposal once a reasonable alternative for disposing or marketing the material can be implemented. The most advantageous alternative to ocean dumping is beneficial reuse. There are basically two general methods for achieving this advantage: returning the ash to the coal supplier for beneficial reuse outside of Morocco, or developing markets within Morocco. In either case, the ash could be put to beneficial use in the cement and concrete industry, in agricultural settings, or in the construction industry. Furthermore, the use of ash as a resource is not restricted to any particular industry, but can be put to use in all these areas.

It is currently anticipated that beneficial use of all of the ash will be either impractical or cost-prohibitive, and the most likely solution for ash disposal is land disposal. Two potential land disposal sites are shown in Figure 4. One is the quarry used to build the port jetties and dikes; the other is an area unsuitable for agriculture south of the JLPP. The area to the south of JLPP is closer, but the impediments to this site potentially include land acquisition, potential for groundwater contamination, and the inordinately high landfill elevations required to dispose of...
Figure 4. Location of Alternative Ash Disposal Sites
the ash expected to be generated over the 30 year JLPP concession. This land area may be viable as an interim landfill. However, it may be possible to use the quarry depending on the results of initial geotechnical investigations to determine the probable fate and transport of leachate from the landfill operation. Assuming the run-on and leachate can be properly handled, and the groundwater table does not directly contact the bottom of the quarry, this location would appear to be the better alternative.

8.0 Mitigation and Environmental Management Plan

Mitigative measures are necessary to protect the environment from impacts resulting from the construction and operation of the new JLPP Units 3 and 4.

Mitigation of Construction-related Impacts

Potential environmental and human health impacts during construction include: increased fugitive dust emissions, soil erosion, stormwater runoff and sediment loading, groundwater contamination, and worker health hazards.

To mitigate increased fugitive dust emissions, dust suppression control methods such as spraying water on roads or dirt areas will be applied. Trucks carrying fine material may be sprayed or covered as necessary to reduce the generation of dust. Also, vehicular speeds will be controlled and buses will be used to transport workers to and from the Project site.

Erosion control measures such as silt curtains and hay bales may be used to prevent stormwater runoff from carrying sediment and/or surface water contamination to drainage areas and the Atlantic Ocean. Site retention areas or sediment retention ponds may be constructed to handle storm water runoff.

Spill prevention and clean up practices will be implemented as necessary to prevent contamination of stormwater runoff and possibly groundwater from accidental spills or leaks from construction equipment. Dewatering methods may be applied to remove surface water and shallow groundwater from pooling in excavation areas and prevent possible contamination or sediment loading from construction activities.
Mitigation of Operations-related Impacts

Emissions of \( \text{SO}_2 \) and \( \text{NO}_x \) are expected to meet Project guidelines for the current coals being considered. The following measures will help assure that compliance is maintained.

- Monitoring coal sulfur content on a per shipment basis to control \( \text{SO}_2 \) emissions;
- Proper operation and maintenance of coal burners and registers to control \( \text{NO}_x \) emissions; and
- Proper operation and maintenance of ESPs.

In addition to stack discharges, emissions from other sources will be minimized by:

- Regularly spraying the coal pile with water to reduce fugitive dust emissions; and
- Good housekeeping to minimize VOC emissions from paints, solvents, cleaning fluids, and fuel oil.

The following mitigative measures involving surface water, ash disposal, wastewater, traffic conditions, health and safety will also be taken to ensure that JLPP is in full compliance with Project guideline standards of operation:

- Settling basins for coal pile stormwater runoff will be used to intercept the suspended matter.
- Ash disposal at sea will be eliminated and replaced with land disposal/utilization of ash once an acceptable option is established by the Project Sponsors.
- Treatment of sanitary wastewater will be implemented to prevent contamination.
- If truck transport of coal ash is used, appropriate traffic signals and other controls will be implemented as necessary to prevent highway congestion and accidents from increased traffic to the JLPP facility. Also, transport of JLPP workers is expected to continue after construction of the new units and will reduce traffic congestion along Route 121.
- Lighting will be installed as required on stacks for aircraft warning. Also, Project Sponsors will provide landscaping.
- Efficient construction and operation will minimize the generation of waste.
An environmental management plan as well as a worker health and safety plan will be implemented to promote and maintain safe and environmentally sound operation practices.

**Environmental Management and Training**

A subsidiary of CMS Generation Co., as operator of the Project (the “Operator”), is obligated under the operations and maintenance agreement to operate the JLPP in such a manner that it complies with the JLPP Project guidelines of Table 1. The Operator has developed a comprehensive environmental management implementation plan (the Plan) that defines generic roles, responsibilities, and activities to be implemented at any facility it operates, to assure environmental protection and compliance with requirements. The Plan contains an environmental policy statement that requires the JLPP facility to 1) comply with environmental requirements, 2) plan and perform actions in support of environmental protection, 3) effectively communicate environmental issues, 4) establish responsibility for environmental performance, 5) develop standards and procedures to implement the policy, and 6) regularly review internal conformance of the policy.

Specific to the JLPP facility, the Operator requires compliance with the following corporate standards:

- **Acquisition and Possession of Permits** - JLPP should have a copy of all applicable permits and approvals on-site and obtain all permits or approvals required for site modifications.

- **Compliance with Requirements** - This standard ensures that JLPP facility management is aware of environmental requirements, and will establish the organizational and financial resources necessary to assure compliance with permit and regulatory requirements.

- **Commitment Schedule** - requires JLPP to develop an annual schedule describing environmental inspection, monitoring, reporting, notification, training, records management and other similar periodic commitment requirements.

- **Training** - requires all employees receive environmental training commensurate with their job responsibilities.

- **Environmental Excellence** - encourages JLPP to achieve high levels of compliance with emission and discharge limits, and seek opportunities to minimize waste.

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Agency Meetings/Discussions and Agency Inspections - authorizes the JLPP Plant Manager to communicate directly with representatives of governmental agencies on environmental matters.

Response to Environmental Emergencies - requires JLPP to develop an environmental emergency response plan to guide the plant's response to an actual or potential significant release (e.g., spills, gas leaks, explosion, etc.) to the environment.

Periodic Routine Reporting and Nonroutine Reporting - requires JLPP to handle routine communication with governmental environmental agencies and to report monthly to Operator management the status of its environmental compliance activities.

Recordkeeping - JLPP maintains files of all permits, standards, requirements, correspondence, procedures, monitoring data, etc necessary for proper documentation of its environmental and compliance activities.

Audits, Assessments, and Appraisals - JLPP receives periodic internal and independent assessments of its compliance and environmental management activities.

9.0 Monitoring Plan

The Project Operator will conduct environmental monitoring, recordkeeping and reporting during both construction and operational phases of the proposed Project as summarized in Table 5.

10.0 Interagency and Public Participation

The interagency and public participation process includes discussions with relevant government agencies, non-governmental organizations (NGOs) and the general public.

The government interagency input consisted of a series of interviews with key government agencies. These agencies include:

- Office Nationale de l'Electricité (ONE);
- Ministère de l'Environnement (ME);
<table>
<thead>
<tr>
<th>Phase</th>
<th>Category</th>
<th>Monitoring Parameters/ Frequency</th>
<th>Recordkeeping</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Fugitive Dust</td>
<td>Ongoing baseline ambient air monitoring will detect construction dust during initial construction phase. Thereafter visual observation of dust.</td>
<td>If excessive fugitive dust is detected, mitigation measure applied and recorded.</td>
<td>Annual report required by lenders and Moroccan government.</td>
</tr>
<tr>
<td></td>
<td>Hazardous materials spills</td>
<td>The condition of tanks and drums containing hazardous material will be routinely inspected</td>
<td>If spill is noted, describe material, amount, cause, and clean up methods utilized.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Operations</td>
<td>Groundwater</td>
<td>Annual sampling for oil and grease, heavy metals, pH, and conductivity at existing wells.</td>
<td>Maintain laboratory analysis and water table depth for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td></td>
<td>Waste Water</td>
<td>- Monthly sampling of pH, temperature, residual chlorine.</td>
<td>Maintain logs of sampling dates and laboratory analysis for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td></td>
<td>Air Emissions</td>
<td>- Annual testing of each unit individually.</td>
<td>Include stack test report in annual report. Maintain for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td></td>
<td>Baseline Ambient Air Quality</td>
<td>- May 1996 - May 1997 (12 months)</td>
<td>Maintain for 5 years at a minimum</td>
<td>In annual report</td>
</tr>
<tr>
<td></td>
<td>Operational Ambient Air Quality</td>
<td>- 12 months after Unit 4 becomes operational</td>
<td>Maintain for 5 years at a minimum</td>
<td>In annual report</td>
</tr>
<tr>
<td></td>
<td>Noise/Source Testing</td>
<td>- One time only</td>
<td>Maintain for 5 years at a minimum</td>
<td>In annual report</td>
</tr>
<tr>
<td></td>
<td>Noise/Occupational</td>
<td>- Annual measurement</td>
<td>Maintain for 5 years at a minimum</td>
<td>In annual report</td>
</tr>
<tr>
<td></td>
<td>Air quality/Occupational</td>
<td>- Annual measurement</td>
<td>Maintain for 5 years at a minimum</td>
<td>In annual report</td>
</tr>
</tbody>
</table>
Office d’Exploitation des Ports (ODEP);
Department des Travaux Publics (DTP);
Office of the Governor of the province of El Jadida; and
Office of the Caid of the Commune of Moulay Abdellah.

Two public forums were held in Morocco prior to the approval of this EIA by the Moroccan Ministry of the Environment. The purposes of the forum were to inform the public about the scope of the Project, present environmental and socioeconomic impacts, and solicit input from the public on the Project and the EIA methods and results. The approach and the results of the EIA were presented by representatives of Radian International. The forums were hosted by AFAK, a Moroccan NGO dedicated to informing the public and to improving the quality of life for the Moroccan people.

The first forum was for citizens living in the vicinity of the Project. This citizens forum was held on July 11, 1996 in the auditorium of the ODEP, which is located near the JLPP. More than 150 persons were present representing each of the 30 communes in the Province of El Jadida. Following presentations by the Project Sponsors, ONE, Radian, and various governmental authorities, including the Governor of El Jadida, there was an opportunity for public questions and comments. Because the citizens living near the Project site are predominately Arabic speakers, this forum was conducted largely in Arabic.

The second forum was for NGO representatives. It was held at the Sheraton Hotel in Casablanca and was attended by approximately 120 persons from among the more than 25 NGOs that had been invited to attend. The forum was conducted in French and followed a similar format to the citizens forum the day before. In addition to the NGOs, members of the news media were also in attendance. Summaries and excerpts of the presentations and the comments and responses from both forums are presented in Section 10 of this EIA.
1.0 INTRODUCTION

CMS Generation Co. (CMS) and ABB Energy Ventures Inc. (ABB), hereafter referred to as "Project Sponsors", are forming a joint venture, the Jorf Lasfar Energy Corporation (JLEC), for the purpose of acquiring the right to use and operate two existing 330 Megawatt (MW) coal-fired units and the construction and operation of two additional 348 MW coal fired units at the Jorf Lasfar Power Plant (JLPP) in Morocco. This ABB/CMS consortium activity is pursuant to the terms of: 1) Memorandum of Understanding executed on September 19, 1994, and 2) Protocol executed on April 26, 1996 with Morocco's Office National de l'Electricité (ONE). The privatization and subsequent expansion of the JLPP (the "Project") is a vital part of Morocco's plans to meet a rapidly increasing demand for electric power.

1.1 Purpose of this EIA

This Environmental Impact Assessment (EIA) has been prepared by Radian International (Radian) under contract to CMS and ABB. The EIA is required as a condition for obtaining project financing or loan guarantees from the World Bank, the Export Import Bank of the United States (Ex-Im), the Sezione Speciale per L'Assicurazione del Credito L'Esportazione (SACE), and the U.S. Overseas Private Investment Corporation (OPIC). In addition to meeting the requirements of lending institutions, the EIA will be submitted to the Moroccan Ministry of Environment for review and approval. Although there are not yet any Moroccan EIA requirements, the Ministry of the Environment is developing EIA guidelines. This report is intended to be consistent with those guidelines, and is expected to be accepted by the Ministry.

The components of the EIA process are to describe the project, identify potential environmental impacts, evaluate project alternatives, and recommend measures for avoiding and reducing negative impacts. An important aspect of the process is also to engage the public and non-governmental organizations (NGOs) in the review of the Project plans and the probable environmental, social and economic impacts.

1.2 Background to this Project

Morocco's population is increasing at a rate of approximately 2.5% per year while the demand for electric power is increasing at a rate of 7% per year. A dramatic increase in power production requirements has been caused by: (1) inadequate installed capacity which results in
power curtailments\(^1\); (2) an economic expansion that is outpacing the growth in population; and (3) Morocco's rural electrification program. In 1994, approximately half of Morocco's 26.5 million inhabitants lived in some 32,000 rural villages with an average of about 50 households each. Currently only 16% of this rural population is served by electricity. The rural electrification program seeks to bring electricity to most of this population (Laaouina, 1996).

With encouragement and funding support from the World Bank, the Moroccan government has embarked upon a major reform of its energy policies including a private sector development initiative. This initiative includes revisions to the Moroccan Electricity Code (legal reform), the establishment of an independent electricity regulatory board to oversee electricity pricing, and privatization of the country's power production through the sale of an operating concession on existing assets to independent power producers (World Bank, 1995). Under this strategy, Morocco's nationalized utility, the ONE, would be reorganized to focus on the rural electrification program and other transmission and distribution activities (Laaouina, 1996).

The concession of the 660 MW coal-fired JLPP was planned to be the first step in this privatization initiative by the Government of Morocco. Accordingly, in late 1994, ONE solicited proposals from international independent power producers for concession of the JLPP and to construct two additional 330 MW units thereby doubling the plant's capacity to 1320 MW. (To allow for plant degradation and to be able to meet its performance guarantees to ONE on a long-term basis, the Project Sponsors have subsequently proposed to increase the total plant capacity to 1356 MW.)

In February 1995, the proposal from the ABB/CMS consortium was accepted by ONE for continued negotiation. On April 26, 1996 the Project Sponsors and ONE formally signed agreements that would transfer the operation of the JLPP and require the Project Sponsors to construct and operate the two new units. These agreements are subject to the Project Sponsors obtaining financing and loan guarantees from the OPIC, the World Bank, Ex-Im, and other lenders. This financing is subject to the acceptance of this EIA by the lenders and the Moroccan

\(^1\)During 1993, Morocco experienced a real demand of 1850 MW while maintaining a capacity of only 1550 MW. Load shedding to industrial customers accounted for a 1% drop in the nation's gross national product (World Bank, 1994a and 1994b). The addition of JLPP Units 1 and 2 (660 MW) and imports from Algeria have temporarily relieved the need for "brownouts".

EIA 1-2 August 1, 1996
Ministry of Environment. The terms of reference document (the scope of work) for this EIA was reviewed and approved by World Bank staff in May 1996.

In summary, the proposed Project is critical to meeting Morocco's energy strategy including the extension of electricity to the more than 40% of the population now without electric power. Through privatization of electric power production, Morocco can earn immediate revenues through the sale of an operating concession on existing units and benefit from efficient power production from new units. As is documented in this EIA, the expansion of the JLPP, Morocco's largest power plant, will be accomplished in a manner that is protective of the environment while providing much-needed, cost-effective, new power generation supplies.

1.3 Scope of this EIA

Following this introduction, Section 2 presents the policy, legal and administrative framework within which this EIA was prepared. This section addresses Moroccan and international environmental policy, legislation, standards and guidelines. Section 3 describes the existing JLPP facility and the proposed expansion in terms of fuel consumption, environmental discharges, ancillary facilities and staffing.

Section 4 describes the physical, biological, and socio-cultural environmental setting for this Project. Section 5 summarizes a recent environmental audit of the existing JLPP with a focus on areas that need to be addressed to assure continuing compliance with World Bank, OPIC, and Ex-Im environmental guidelines. Section 6 projects future impacts outside the fence line from the operation and expansion of JLPP by the Project Sponsors. The focus of Section 6 is on the incremental increases and decreases in environmental effects from the Project as compared to current conditions.

World Bank EIA procedures require that alternatives to the Project be evaluated. This alternatives analysis is presented in Section 7. Section 8 identifies specific measures that will be incorporated to reduce or avoid negative environmental impacts of construction and operation of the four units by the Project Sponsors. Proposed monitoring of environmental related operations and discharges are identified in Section 9. The monitoring is to ensure that mitigation measures are carried out and that discharges and ambient levels are acceptable.
Section 10 of this EIA documents efforts by the Project Sponsors and Radian to coordinate Project plans with the Government of Morocco, and to take into account public concerns regarding the project.

Finally, there are several appendices that provide more details on material presented in the body of this EIA, photographs of the JLPP, and references.
2.0 POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

The following subsections describe the environmental regulatory guidelines and policies applicable to the construction, operation and management of the JLPP. Further, this review identifies the specific requirements to construct and operate the JLPP Units 3 and 4. Section 2.1 describes the requirements of the likely cofinancers for the Project. Sections 2.2 and 2.3 describes the Moroccan government and NGO involvement in the Project review and approach.

2.1 Requirements of Cofinancers

The Project Sponsors are considering direct financing or guarantees from the World Bank, OPIC, Ex-Im, and SACE. Therefore, environmental policies and guidelines from all four institutions are evaluated below.

2.1.1 The World Bank


The World Bank requires the development of an EIA for new construction projects. This EIA for the new units describes the project, the existing environment, the environmental impacts of the project, alternative options for achieving project goals at an equal or lower cost, and describes means of mitigating project impacts.

The World Bank encourages environmental audits for bank-financed acquisition of existing facilities. The audit should assess power plant impacts to land, air, surface water, and ground water; power plant housekeeping, maintenance practices, and process modifications; and recommendations of site specific targets for emissions and pollution reductions. Audits addressing JLPP Units 1 and 2 were conducted in 1995. The results are summarized in Section 5 of this EIA.
2.1.2 U.S. Overseas Private Investment Corporation (OPIC)

The OPIC has adopted draft environmental guidelines developed by the World Bank in 1994 as noted below. In comparison to the 1988 World Bank Guidelines, they are more stringent in several areas. OPIC also requires the submission of an EIA that is consistent with World Bank requirements.

2.1.3 Export-Import Bank of the United States (Ex-Im) Guidelines

The Ex-Im 1996 Guidelines are also applicable to this Project since financing support is being requested from this institution (Ex-Im, 1996). As with the OPIC Guidelines, Ex-Im Guidelines are more stringent than the World Bank's in several respects.

The Ex-Im Guidelines specify that chromates, chlorofluorocarbons (CFCs), polychlorinated biphenols (PCBs), or PCB-containing mineral oil should not be used in the water treatment system. The Ex-Im Guidelines require that ash disposal and coal storage should not impact the water resources of the region. The Ex-Im Guidelines also recommend the development of a comprehensive waste management plan and a hazardous waste handling and disposal plan. Recycling and reclamation is strongly encouraged. The new 1996 Guidelines also address ambient noise impacts at the fenceline.

2.1.4 Sezione Speciale per L'Assicurazione del Credito L'Esportazione (SACE)

It is assumed that SACE utilizes environmental guidelines consistent with those described above.

2.1.5 Comparison of Cofinancer Environmental Guidelines

World Bank requirements for ambient air quality and stack emissions are compared to OPIC and Ex-Im standards in Tables 2-1 and 2-2, respectively. Table 2-3 provides a comparison of the World Bank, OPIC, and Ex-Im standards for liquid effluent. Table 2-4 compares World Bank, OPIC, and Ex-Im guidelines for various other environmental and safety parameters such as noise and worker occupational guidelines.

2.1.6 JLPP "Project Guidelines"

In order to assure eligibility for cofinancing from any of the cofinancers, this EIA will adopt as its "Project guidelines" the most stringent criteria from any of the cofinancers for any given parameter. Table 2-5 presents these "Project guidelines". These Project guidelines are
Table 2-1. Comparison of World Bank, OPIC, and Ex-Im Bank Ambient Air Guidelines

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter (TSP)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Mean</td>
<td>1000 µg/m³</td>
<td>70 µg/m³ (TSP)</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum 24-hr avg.</td>
<td>500 µg/m³</td>
<td>110 µg/m³ (TSP)</td>
<td></td>
</tr>
<tr>
<td>Sulfur Dioxide (SO₂)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Mean</td>
<td>100 µg/m³</td>
<td>50 µg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum 24-hr avg.</td>
<td>1000 µg/m³ (inside fence)</td>
<td>125 µg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>500 µg/m³ (outside fence)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum 1-hr avg.</td>
<td>N/A</td>
<td>350 µg/m³</td>
<td></td>
</tr>
<tr>
<td>Nitrogen Oxides (as NO₂)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual Average</td>
<td>100 µg/m³</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Maximum 24-hr avg.</td>
<td>N/A</td>
<td>150 µg/m³</td>
<td></td>
</tr>
<tr>
<td>1-Hour Average</td>
<td>N/A</td>
<td>400 µg/m³</td>
<td></td>
</tr>
</tbody>
</table>

N/A = not available
TSP = Total Suspended Particulates
Table 2-2. Comparison of World Bank, OPIC, and Ex-Im Bank Stack Emissions Guidelines

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpolluted areas [&lt;500 (\mu g/m^3) inside the plant fence line and less than 260 (\mu g/m^3) outside the fence line.]</td>
<td>150 mg/m(^3)</td>
<td>50 mg/m(^3)</td>
<td>100 mg/Nm(^3) (a)</td>
</tr>
<tr>
<td>All other areas</td>
<td>100 mg/m(^3)</td>
<td>50 mg/m(^3) (TSP)</td>
<td>100 mg/Nm(^3) (a)</td>
</tr>
<tr>
<td>Sulfur Dioxide (SO(_2))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpolluted Areas [&lt;50 (\mu g/m^3)]</td>
<td>500 tpd (per boiler)</td>
<td>100 tpd (per boiler)</td>
<td>100 tpd (per boiler)</td>
</tr>
<tr>
<td>Total Mass Emission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All other areas: [&gt;50 (\mu g/m^3)] Total Mass Emission</td>
<td>100 tpd (per boiler)</td>
<td>100 tpd (per boiler) or 0.2 tpd/MW (whichever is lower)</td>
<td>100 tpd (per boiler)</td>
</tr>
<tr>
<td>Nitrogen Oxides (NO(_x))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaseous Fuels</td>
<td>0.20 lb/MM Btu (86 ng/J)</td>
<td>90 g/MM Btu (86 ng/J)</td>
<td>86 ng/J</td>
</tr>
<tr>
<td>Liquid Fuels</td>
<td>0.30 lb/MM Btu (130 ng/J)</td>
<td>135 g/MM Btu (130 ng/J)</td>
<td>130 ng/J</td>
</tr>
<tr>
<td>Solid Fuels</td>
<td>0.70 lb/MM Btu (300 ng/J)</td>
<td>270 g/MM Btu (260 ng/J)</td>
<td>260 ng/J</td>
</tr>
<tr>
<td>Lignite: 0.60 lb/MM Btu (260 ng/J)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TSP = Total Suspended Particulates
Total Mass Emission = Mass emission weight (tpd) of emissions per boiler.

(a) Normal cubic meter at 0°C and pressure at one atmosphere.
Table 2-3. Comparison of World Bank and Ex-Im Bank Liquid Effluent Guidelines

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6 to 9</td>
<td>6 to 9</td>
<td>6 to 9</td>
</tr>
<tr>
<td>BOD₃</td>
<td>50 mg/L</td>
<td>50 mg/L</td>
<td>50 mg/L</td>
</tr>
<tr>
<td>COD</td>
<td>N/A</td>
<td>N/A</td>
<td>250 mg/L</td>
</tr>
<tr>
<td>Heavy Metals (total)</td>
<td>N/A</td>
<td>10 mg/L</td>
<td>10 mg/L</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>N/A</td>
<td>20 mg/L</td>
<td>20 mg/L</td>
</tr>
<tr>
<td>Total Suspended Solids [TSS]</td>
<td>60 mg/L</td>
<td>60 mg/L</td>
<td>60 mg/L</td>
</tr>
<tr>
<td>Coliforms</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 400 MPN/100 mL</td>
</tr>
<tr>
<td>Residual free chlorine in cooling water discharge</td>
<td>N/A</td>
<td>0.5 mg/L</td>
<td>0.5 mg/L</td>
</tr>
<tr>
<td>Temperature increase [edge of mixing zone]</td>
<td>Max 5°C above ambient temperature of receiving water/Max 3°C if receiving water &gt; 28°C.</td>
<td>Max 5°C above ambient temperature of receiving water/Max 3°C if receiving water &gt; 28°C.</td>
<td>Max 5°C above ambient temperature of receiving water/Max 3°C if receiving water &gt; 28°C.</td>
</tr>
</tbody>
</table>

MPN = Most probable number

Table 2-4. Comparison of Other Applicable World Bank, OPIC, and Ex-Im Guidelines

<table>
<thead>
<tr>
<th>Parameter</th>
<th>World Bank 1988</th>
<th>OPIC (WB 1994)</th>
<th>Ex-Im</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational Noise</td>
<td>90 dBA(1)</td>
<td>85 dBA</td>
<td>N/A</td>
</tr>
<tr>
<td>Occupational SO₂ Concentrations</td>
<td>5 ppm(1)</td>
<td>5 mg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Occupational NO₂ Concentrations</td>
<td>5 ppm(1)</td>
<td>6 mg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Occupational TSP</td>
<td>10 mg/m³(1)</td>
<td>10 mg/m³</td>
<td>N/A</td>
</tr>
<tr>
<td>Community Noise Impacts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Farmland</td>
<td>70 dBA (Ldn)(2)</td>
<td>N/A</td>
<td>60 dBA (night)</td>
</tr>
<tr>
<td>-Residential</td>
<td>55 dBA (Ldn)(2)</td>
<td>N/A</td>
<td>55 dBA (night)</td>
</tr>
<tr>
<td>-Industrial</td>
<td>70 dBA (24 hr Ldn)(2)</td>
<td>N/A</td>
<td>75 dBA</td>
</tr>
</tbody>
</table>

1 World Bank, 1991b, p. 81
2 World Bank, 1988, p. 231
Ldn = Sound measurements averaged over a 24-hour period and adjusted so that night time sounds are given a greater influence.

\[
2.44 \times 10^{-5} \left( \frac{\text{mg}}{\text{m}^3} \right) \times \text{molecular weight} = \text{ppm}
\]
### Table 2-5. JLPP Project Guidelines

<table>
<thead>
<tr>
<th>Topic</th>
<th>Parameter</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Air Quality</td>
<td>Particulates (TSP)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▶ Annual mean</td>
<td>70 μg/m³</td>
</tr>
<tr>
<td></td>
<td>▶ Maximum 24 hr avg.</td>
<td>110 μg/m³</td>
</tr>
<tr>
<td></td>
<td>Sulfur Dioxide (SO₂)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▶ Annual mean</td>
<td>50 μg/m³</td>
</tr>
<tr>
<td></td>
<td>▶ Maximum 24 hr avg.</td>
<td>125 μg/m³</td>
</tr>
<tr>
<td></td>
<td>▶ Maximum 1 hr avg.</td>
<td>350 μg/m³</td>
</tr>
<tr>
<td></td>
<td>Nitrogen Oxides (NO₂)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▶ Annual mean (2)</td>
<td>100 μg/m³</td>
</tr>
<tr>
<td></td>
<td>▶ Maximum 24 hr avg. (3)</td>
<td>150 μg/m³</td>
</tr>
<tr>
<td></td>
<td>▶ Maximum 1 hr avg. (3)</td>
<td>400 μg/m³</td>
</tr>
<tr>
<td>Stack Emissions</td>
<td>Particulates (TSP) (1)</td>
<td>50 mg/m³</td>
</tr>
<tr>
<td></td>
<td>Sulfur Dioxide (SO₂) (1)</td>
<td>0.2 tpd/MW</td>
</tr>
<tr>
<td></td>
<td>Nitrogen Oxides (NO₂) (1)</td>
<td>260 ng/l (270 g/MM Btu)</td>
</tr>
<tr>
<td>Aqueous Effluent</td>
<td>pH (3)</td>
<td>6 to 9</td>
</tr>
<tr>
<td></td>
<td>BOD₅ (3)</td>
<td>50 mg/L</td>
</tr>
<tr>
<td></td>
<td>COD (4)</td>
<td>250 mg/L</td>
</tr>
<tr>
<td></td>
<td>Heavy Metals (2)</td>
<td>10 mg/L</td>
</tr>
<tr>
<td></td>
<td>Oil and Grease (2)</td>
<td>20 mg/L</td>
</tr>
<tr>
<td></td>
<td>TSS (3)</td>
<td>60 mg/L</td>
</tr>
<tr>
<td></td>
<td>Coliforms (4)</td>
<td>&lt; 400 MPN/100 mL</td>
</tr>
<tr>
<td></td>
<td>Residual Free Chlorine in</td>
<td>0.5 mg/L</td>
</tr>
<tr>
<td></td>
<td>Cooling Water (1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature Increase at Edge of Mixing Zone</td>
<td>5°C above ambient unless receiving water &gt;28°C, then max. 3°C allowed</td>
</tr>
<tr>
<td>Community Noise</td>
<td>Residential (2)</td>
<td>55 dBA (Ldn)</td>
</tr>
<tr>
<td></td>
<td>Other (3)</td>
<td>70 dBA (Ldn)</td>
</tr>
<tr>
<td>Occupational</td>
<td>Noise (1)</td>
<td>85 dBA</td>
</tr>
<tr>
<td></td>
<td>SO₂ (1)</td>
<td>5 mg/m³ (8 hr day avg.)</td>
</tr>
<tr>
<td></td>
<td>NO₂ (1)</td>
<td>6 mg/m³ (8 hr day avg.)</td>
</tr>
<tr>
<td></td>
<td>TSP (1)</td>
<td>10 mg/m³ (8 hr day avg.)</td>
</tr>
</tbody>
</table>

(1) OPIC Guidelines  
(2) World Bank, 1988  
(3) World Bank, Ex-Im, and OPIC are identical for this parameter.  
(4) Ex-Im, 1996
comparable in stringency to those recommended by the European Union (Commission of the European Communities, 1992) and the World Health Organization (World Health Organization, 1979 and 1987). As noted below, Morocco has not yet adopted ambient or discharge standards. Therefore, the Project Sponsors are proposing to meet the Project guidelines in Table 2-5, with the exception that particulate matter (PM) emissions from existing Units 1 and 2 will meet the electrostatic precipitator (ESP) performance guarantee of 125 mg/Nm³ as discussed in Section 6. It is noted that adoption of these Project guidelines is for purposes of obtaining financing for this specific Project, and is not intended to set precedent for other projects or facilities in Morocco.

2.2 Applicable Moroccan and Local Laws and Regulations

The new Ministry of Environment is developing environmental legislation in cooperation with the affected industrial sectors including international private investors. No specific legislation is in place at this time. Moroccan public officials have stated that Morocco’s environmental regulations will be similar in stringency to those of Greece, Portugal, Spain, and Turkey (MOE, 1996).

Morocco is planning to develop specific laws for each medium, i.e. water, air, waste, and soil rather than an integrated pollution control approach. The “potable water” regulation is currently pending final publication although it is not yet available to the public. The remainder of the environmental laws under consideration lag behind this water law and are at different stages of discussion and review. In addition to specific media-oriented laws, the “General Law for the Protection of the Environment” has been under development for nearly ten years and is intended to serve as the framework from which other laws are to be modeled.

2.2.1 Moroccan Environmental Impact Assessment

Moroccan authorities are developing an EIA Process for proposed new construction projects. Ministry of Environment officials have indicated that the successful completion of the EIA would play a role in the permit evaluation process for any new facility of significant potential environmental impact—especially if proposed by foreign investors. If the EIA indicates that the proposed project presents a significant hazard to the environment and human health, the EIA must also address and resolve these issues. Although the EIA regulations have not been proposed, the Ministry of Environment has indicated that it will review and comment on this JLPP EIA (MOE, 1996).
In addition to the legislative development initiatives mentioned above, the Ministry of Environment has contracted a study with a multinational team of consultants to identify economic and financial instruments that could be used to promote more environmentally sound behavior of companies. The study is intended to be translated into specific legal instruments by 1997. The Ministry intends to use this law to encourage the development of responsible investment patterns. Their stated intention is for “foreign companies investing in Morocco to act as examples that could be followed by local companies” (MOE, 1996).

### 2.2.2 The Moroccan Permitting Process

In Morocco, there are no required environmental permits per se. However, an application for a permit to construct a new facility must be presented to the relevant local authority. For the JLPP, although the local authority is the Commune of Moulay Abdellah, the activities, including input from various Ministries (Public Works, Civil Protection, Employment, Health, Environment, etc.) are being coordinated at the level of the corresponding province (El Jadida Province) rather than at the level of the commune itself. The following documents are part of the permit application:

- A formal letter requesting the permit;
- Engineering drawings of the new facility and a corresponding engineering description;
- A particular study following the regulations for the design and construction of tanks and tank farms; and
- A summary of the environmental impacts of the Project.

These documents are presented to the local authority by an authorized representative of the Project Sponsors. The Commune requires up to six weeks to respond. If the consultation process runs into excessive delays, the Commune may issue a temporary permit to allow the start of the construction.

Application for an operating permit for Units 3 and 4 will be made to the Ministry of Public Works.
2.3 Role of Moroccan Organizations

All new environmental standards are initiated and drafted by an advisory working group named “Conseil National de l'Environnement” (CNE). CNE is comprised of officials from various relevant Ministries (Environment, Public Works, Agriculture, Industry-Commerce & Artisans, Energy & Mines, Transport, Health, etc.) and also includes several NGOs. These include professional bodies; scientific institutions; and industrial associations. The CNE is chaired by a representative of the Ministry of Environment.

The role of CNE is to initiate and draft the technical aspects of the laws. Once the text reaches a certain degree of technical maturity, it is passed to the legal cabinet of the Ministry of Environment to shape the draft into a legal document. The CNE works in different committees that focus on specific topics (e.g., air issues) and the Ministry encourages specific relevant industries to participate in these committees. The time required for this level of technical preparation can range from six months to several years. All through this process, the Ministry of Environment views itself in the role of promoter and coordinator and encourages discussion and negotiation as approaches for developing the laws.

As described in Section 10, representatives of NGOs met in Casablanca on July 12 to review and comment on JLPP project plans. The coordination of this EIA with NGOs is an important part of the public participation process.
3.0 PROJECT DESCRIPTION

This section describes both the existing JLPP and the proposed expansion of the plant. This discussion addresses plant location and surrounding features, plant processes, and environmental discharges and controls.

3.1 Project Location and Area Description

As shown in Figure 3-1, the JLPP is located 127 km southwest of Casablanca, Morocco on the Atlantic coast. Figure 3-2 depicts the immediate vicinity surrounding the JLPP. El Jadida, with a population of approximately 150,000, is the nearest city to the site and is located on the Atlantic coast approximately 17 km to the northeast of JLPP. Key features of the project site and the surrounding area are described below.

The plant occupies 60 hectares and is located on a narrow stretch of land between a 60 m high bluff to the east and the Atlantic Ocean to the west. The plant site is generally flat and at an elevation of approximately 7 m above the Reference Level of Morocco or Niveau général du Maroc (NGM) and is protected from high waves and storms by natural sand berms, sea walls, and breakwaters.

The Port of Jorf Lasfar is adjacent to the northern boundary of the site. This modern port is designed to handle bulk material imports and exports. In addition, the port has a portion of one pier dedicated for receiving imported coal for use by ONE. A coal conveyor system transports the coal from the port to the site. There are several small settlements located on the bluff to the east of the plant. The nearest dwelling is within 75 m of the JLPP fenceline. The immediate area surrounding JLPP is in mixed agricultural and industrial land uses with a large phosphate plant located approximately 2 km northeast of the plant.

3.2 Description of Existing Facility

The area within the JLPP fenceline was designed to accommodate six 330 MW coal-fired steam generators and support facilities associated with a state-of-the-art pulverized-coal thermoelectric plant. Construction of the first two units (Units 1 and 2) was completed in 1994 and 1995, respectively, by a consortium of GEC Alstom, B&V España, and Dragados
Figure 3-1. Regional Map
Constructors. A general layout of the entire site is depicted in Figure 3-3. A plot plan of the portion of the plant containing the existing Units 1 and 2 and the proposed location of Units 3 and 4 is presented in Figure 3-4. The facility infrastructure related to Units 1 and 2 includes (ABB Project, 1996):

- Two 330 MW pulverized coal-fired steam generators of the CE/Sulzer type supplied by Babcock and Wilcox España;
- Two reheat steam turbines of the steam condensing and bleeding type manufactured by GEC Alsthom;
- Four (2/unit) cold side electrostatic precipitators (ESP) with three fields each. The ESP's are designed to remove at least 99% of the flue gas particulate matter;
- A distributed control and information system manufactured by GEC Alsthom;
- Boiler building with a height of 54.6 m;
- Turbine generator building;
- Ash handling building;
- 130 m stack - serving both Units 1 and 2 with separate flues;
- 225 kV indoor substation and five overhead 225 kV transmission lines, solid dielectric cable termination yard, a substation building for equipment, and a substation control house; and
- 60 kV switching station and 6.6 kV auxiliary system.

Infrastructure that will be common to the existing Units 1 and 2 and the proposed additional Units 3 and 4 are (ABB Project, 1996 and EPC, 1995):

- Administration building;
- Warehouse (sized for six electric generation units);
Figure 3-3. Jorf Lasfar Plot Plan
Figure 3-4. JLPP Layout
• A 1.5 km long open channel to discharge once-through condenser cooling seawater to the Atlantic Ocean. The channel is sized to accommodate once-through condenser cooling seawater from six units and widens to 26 m at the point of discharge;

• Two 90 cm diameter concrete pipe wastewater outfalls to the Atlantic Ocean;

• Machine shop and electronics repair shop;

• Two - 50,000 m$^3$ fuel oil storage tanks;

• One 500 m$^3$ diesel-oil storage tank;

• One 25 m$^3$ propane storage tank;

• Coal storage yard sized to store coal for six 330 MW steam generators. In 1995 the coal yard stored up to 400,000 tonnes of coal at any one time;

• Coal handling facilities consisting of a conveyor system, transfer house, a stacker, and two reclaimers;

• Fuel oil receiving and unloading facilities;

• Chlorination system;

• Septic tanks for sanitary wastewater generated onsite;

• Demineralization water production system;

• Fire protection system;

• Seawater intake (sized for six units) and dikes to protect seawater intake area;

• Auxiliary boiler;

• Raw water supply (sized for six units); and

• Concrete-lined coal pile storm water runoff settling basin.
3.2.1 Energy Generation

In 1995, the JLPP produced 4,100,000 MWh of electricity from the two 330 MW units (71% of rated capacity). However, because the units were recently started up, shake down testing has artificially lowered the capacity factors.

Raw coal from the coal pile is routed to an air drier/pulverizer. This equipment reduces the coal's moisture content and feeds the pulverized coal directly to the boilers. The heat given off during combustion of the coal is used to produce steam, which the turbine-generator converts into electricity. The electricity generated is routed to a 225 kV substation which is connected to the ONE system grid via five overhead 225 kV transmission lines.

3.2.2 Fuels Used

Both Units 1 and 2 are designed to fire pulverized coal and/or heavy fuel oil No. 2 (EPC, 1995). However, coal is the primary fuel used to generate electricity. Current coal is supplied from the United States, Colombia, and South Africa, with the majority coming from the United States. The ultimate analyses, lower heating values and higher heating values of the coals used are provided in Table 3-1. In 1995, Units 1 and 2 consumed a total of 1,147,137 tonnes of coal (Radian, 1996).

Coal is shipped to the Port of Jorf Lasfar and is unloaded onto a conveyor system which transports the coal from the Port to JLPP. The coal is then unloaded onto the coal pile storage area. The coal yard is lined with bentonite in order to minimize groundwater infiltration of coal pile storm water. In addition to storing coal for use at JLPP, this facility provides up to 700,000 tonnes per year of coal for use at other ONE facilities (ABB Project, 1996).

The heavy fuel oil No. 2 is shipped to the Port of Jorf Lasfar where it is unloaded onto rail tank cars, transported to JLPP, and is then unloaded into a pipe network that transports the fuel oil to one of the two 50,000 m³ storage tanks. A concrete wall and a compacted clay floor surrounds the fuel oil storage tanks in order to contain any spills. The fuel oil is routed to the units via a piping network from the storage tanks to the boilers. The fuel oil is heated to allow it to be properly atomized in the boilers. Physical properties of the heavy fuel oil No. 2 are presented in Table 3-2 (EPC, 1995).
### Table 3-1. Ultimate Analysis of Coals Used at JLPP During 1995

<table>
<thead>
<tr>
<th>Parameter</th>
<th>South Africa</th>
<th></th>
<th>Colombia</th>
<th></th>
<th>United States</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Average</td>
<td>Range</td>
<td>Average</td>
<td>Range</td>
<td>Average</td>
</tr>
<tr>
<td>% By Weight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.49 - 0.81</td>
<td>0.66</td>
<td>0.62 - 0.66</td>
<td>0.64</td>
<td>0.71 - 1.47</td>
<td>1.28</td>
</tr>
<tr>
<td>Ash</td>
<td>11.60 - 15.60</td>
<td>13.47</td>
<td>6.00 - 7.88</td>
<td>7.06</td>
<td>7.50 - 14.70</td>
<td>10.97</td>
</tr>
<tr>
<td>Volatiles</td>
<td>22.40 - 28.40</td>
<td>25.99</td>
<td>31.50 - 34.90</td>
<td>32.87</td>
<td>28.02 - 32.40</td>
<td>30.97</td>
</tr>
<tr>
<td>Carbon</td>
<td>65.50 - 68.20</td>
<td>67.30</td>
<td>69.43</td>
<td>69.43</td>
<td>62.45 - 69.75</td>
<td>66.58</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>3.35 - 4.00</td>
<td>3.66</td>
<td>4.45 - 4.78</td>
<td>4.56</td>
<td>4.13 - 5.34</td>
<td>4.52</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>NA</td>
<td>NA</td>
<td>1.37</td>
<td>1.37</td>
<td>1.25 - 1.45</td>
<td>1.33</td>
</tr>
<tr>
<td>Oxygen</td>
<td>7.85 - 8.38</td>
<td>8.12</td>
<td>10.08</td>
<td>10.08</td>
<td>4.81 - 8.30</td>
<td>6.34</td>
</tr>
<tr>
<td>Chlorine</td>
<td>NA</td>
<td>NA</td>
<td>0.03</td>
<td>0.03</td>
<td>0.01 - 0.26</td>
<td>0.10</td>
</tr>
<tr>
<td>Higher Heating Value (kcal/Kg)</td>
<td>6,146 - 6,479</td>
<td>6,318</td>
<td>6,578 - 7,082</td>
<td>6,801</td>
<td>6,280 - 6,747</td>
<td>6,575</td>
</tr>
<tr>
<td>Lower Heating Value (kcal/Kg)</td>
<td>5,924 - 6,245</td>
<td>6,105</td>
<td>6,287 - 6,835</td>
<td>6,529</td>
<td>6,258 - 6,472</td>
<td>6,301</td>
</tr>
</tbody>
</table>

NA = Not available
Source: Radian, 1996
Table 3-2. Properties of Heavy Fuel Oil No. 2 Used at JLPP

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range of Values *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight %</td>
<td></td>
</tr>
<tr>
<td>- Sulfur</td>
<td>≤4</td>
</tr>
<tr>
<td>- Hydrogen</td>
<td>12</td>
</tr>
<tr>
<td>- Carbon</td>
<td>85.2</td>
</tr>
<tr>
<td>- Ash</td>
<td>0.01</td>
</tr>
<tr>
<td>- Water and Sediment</td>
<td>1.5</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>0.92 - 1.00</td>
</tr>
<tr>
<td>Viscosity @ 50°C (cp)</td>
<td>0.110 - 0.380</td>
</tr>
<tr>
<td>Heating Value (kcal/Kg)</td>
<td></td>
</tr>
<tr>
<td>- Higher</td>
<td>10,070</td>
</tr>
<tr>
<td>- Lower</td>
<td>9,600</td>
</tr>
<tr>
<td>Flash Point</td>
<td>≥70°C</td>
</tr>
</tbody>
</table>

*Values taken from ONE (1996).

3.2.3 Air Emissions

Sources of air emissions at JLPP currently include, in order of magnitude: 1) combustion byproducts from the two boilers, 2) wind blown particulate emissions from the coal pile, and 3) evaporative emissions of volatile organic compounds (VOCs) from the two 50,000 m³ fuel oil storage tanks and other miscellaneous solvent and paint use.

Stack emissions from the boilers are a result of the combustion of coal and primarily consists of carbon monoxide (CO), oxides of nitrogen (NOₓ), particulate matter (PM), and sulfur dioxide (SO₂). Each of the boilers is equipped with a cold-side ESP which reduces PM emissions by approximately 99% (Radian, 1996). Air emissions from both of the boilers are discharged to the atmosphere through a 130 m high stack.

Estimated stack emissions from Units 1 and 2 during 1995 are presented in Table 3-3. Annual emissions of NOₓ and PM are based on emissions testing conducted by GEC Alsthom Corporation in 1995 (Radian, 1995). Annual emissions of SO₂ are based on the amount of coal used in 1995 and the average sulfur content of the coal. Stack emission calculations are presented in Appendix F.
The coal pile is periodically wetted to prevent coal fires and to reduce wind-blown dust emissions from the coal pile.

Table 3-3. 1995 Stack Emissions from JLPP Units 1 and 2 Firing Coal

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emissions</th>
<th>Units</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>0.20 a</td>
<td>tpd/MW</td>
<td>NA</td>
</tr>
<tr>
<td>NOₓ (maximum load)</td>
<td>0.53 b</td>
<td>lbs/MM Btu</td>
<td>NA</td>
</tr>
<tr>
<td>NOₓ (minimum load)</td>
<td>0.59 b</td>
<td>lbs/MM Btu</td>
<td>NA</td>
</tr>
<tr>
<td>PM</td>
<td>30 b</td>
<td>mg/m³</td>
<td>NA</td>
</tr>
</tbody>
</table>

* See Appendix F for SO₂ emission calculations
* Data from 1995 GEC Alsthom performance tests.
NA = no applicable standards

Evaporative emissions of VOCs from the heavy fuel oil No. 2 storage tanks, gasoline storage, painting, and metal parts degreasing and cleaning are considered insignificant due to the limited quantity of these materials used and the low vapor pressure of the fuel oil.

3.2.4 Water Use

Two types of water are used at the JLPP: 1) raw fresh water and 2) seawater. Raw fresh water is used as makeup for plant process operations (i.e., steam generation, equipment cleaning) and treated for sanitary water supply. Raw fresh water is supplied to the site from the El Jadida water system via the Régie autonome de distribution d’eau et d’électricité d’El Jadida (RADEEJ) aqueduct. Seawater from the Atlantic Ocean is used in a once-through configuration to condense turbine exhaust steam so that it may be used again. A process flow diagram of water used at JLPP is presented in Figure 3-5.

Prior to using the raw fresh water to produce steam, it is demineralized in order to prevent scale formation in the boilers. The demineralization process involves passing the raw fresh water through cation, anion, and mixed cation/anion exchange beds. The cation exchange bed removes cations such as Mg²⁺, Ca²⁺, Mn²⁺, Fe²⁺, etc., while the anion exchange bed removes anions such as SO₄²⁻, NO₃⁻, HCO₃⁻, etc.
Figure 3-5. Water Intakes
The mixed cation/anion exchange bed is used to polish the treated water. The cation bed exchanges $\text{H}^+$ for the cations in the water, while the anion bed exchanges $\text{OH}^-$ for anions in the water. Following exhaustion of the ion exchange beds, the bed is backwashed and then regenerated. The cation exchange bed is regenerated by passing $\text{H}_2\text{SO}_4$ through the bed, while the anion exchange bed is regenerated by passing $\text{NaOH}$ through the bed. The backwash and regeneration wastewaters are collected in a neutralization tank where either acid or base is added to adjust the pH of the wastewater between 6.5 and 8.5. Following pH adjustment the backwash/regeneration wastewater is discharged into the circulating water discharge channel which discharges to the Atlantic Ocean (EPC, 1995).

Following demineralization, hydrazine and ammonia are added to the water. Hydrazine is added to scavenge oxygen in the demineralized water in order to reduce corrosion of the boiler tubes. Ammonia is added to the water to inhibit rust.

Seawater is used at JLPP to convey bottom and fly ash to the Atlantic Ocean and to cool the steam and condense it so that it can be used again. The seawater is used in a once-through configuration (i.e., is used once then returned to the ocean). Prior to entering the plant, the seawater is chlorinated using sodium hypochlorite to prevent biofouling of the condensers (EPC, 1995).

### 3.2.5 Water Discharges

All wastewater streams generated at JLPP are eventually discharged to the Atlantic Ocean. Water discharges consist of the following types of wastewater streams:

- Ash conveyance water;
- Once-through condenser cooling sea water;
- Sanitary wastewater;
- Boiler blowdown, lab, and in-plant drains, etc.;
- Storm water; and
- Demineralizer backwash/regeneration wastewater.
A flow diagram of water discharges including any pre-treatment and the ultimate disposal is shown in Figure 3-6. Characteristics of the wastewater discharges based on sampling performed by Radian in 1995 and the corresponding project effluent standards are presented in Table 3-4 (Radian, 1995).

Once-through condenser cooling sea water is discharged directly into the Atlantic ocean via a 1.5 km long open channel. The average temperature difference between the intake and discharged seawater is 9° C (Radian, 1995).

Sanitary wastewater is routed to septic tanks for solids removal. The liquid phase from the septic tanks is combined with other wastewater streams and discharged to the Atlantic Ocean.

Storm water runoff is collected from the following areas within JLPP: 1) coal pile, 2) fuel storage and unloading area, and 3) all other areas. Storm water from the coal pile area is routed to a concrete settling basin to allow suspended solids to settle out; storm water is discharged to the Atlantic Ocean. Storm water collected from the fuel oil storage and loading areas is routed to an oil/water separator to remove oils. The oils are recovered for reuse or sent off site to an incinerator and the treated storm water is discharged to the Atlantic Ocean. Storm water from all other areas is discharged directly to the Atlantic Ocean.

Demineralizer backwash/regeneration water is collected in two 1,000 m³ neutralization basins. Neutralization is accomplished by either adding acid (H₂SO₄) or base (NaOH). The treated demineralizer backwash/regeneration water is then discharged to the Atlantic Ocean.

### 3.2.6 Solid Wastes

Solid waste streams produced at JLPP include the following:

- Fly and bottom ash;
- Office trash/refuse;
- Sanitary wastes from workers (i.e., sludge from septic tanks); and
- Industrial wastes such as spent solvent, paints, spent demineralizer resins, and used oils.
Figure 3-6. Water Discharges
<table>
<thead>
<tr>
<th>Analyte</th>
<th>South Outfall</th>
<th>North Outfall</th>
<th>Unit 1 Condenser Discharge</th>
<th>Unit 2 Condenser Discharge</th>
<th>Project Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (average)</td>
<td>9.00</td>
<td>9.00</td>
<td>7.65</td>
<td>7.60</td>
<td>6 to 9</td>
</tr>
<tr>
<td>Dissolved O$_2$ (mg O$_2$/L)</td>
<td>7.0</td>
<td>7.4</td>
<td>7.6</td>
<td>7.6</td>
<td>NS</td>
</tr>
<tr>
<td>BOD$_5$ (mg O$_2$/L)</td>
<td>1.0</td>
<td>1.9</td>
<td>1.0</td>
<td>1.1</td>
<td>50</td>
</tr>
<tr>
<td>COD (mg O$_2$/L)</td>
<td>NAF</td>
<td>NAF</td>
<td>NAF</td>
<td>NAF</td>
<td>250</td>
</tr>
<tr>
<td>Total Suspended Solids (mg/L)</td>
<td>66.6</td>
<td>20.2</td>
<td>18</td>
<td>16.2</td>
<td>60</td>
</tr>
<tr>
<td>Residual free chlorine in cooling water discharge (mg/L)</td>
<td>NAF</td>
<td>NAF</td>
<td>NAF</td>
<td>NAF</td>
<td>0.5</td>
</tr>
<tr>
<td>Redox potential (mV)</td>
<td>411.3</td>
<td>418.5</td>
<td>352.0</td>
<td>387.5</td>
<td>NS</td>
</tr>
<tr>
<td>Oils and grease (mg/L)</td>
<td>NAF</td>
<td>NAF</td>
<td>NAF</td>
<td>NAF</td>
<td>20</td>
</tr>
<tr>
<td>TPH (mg/kg)</td>
<td>0.85</td>
<td>1.41</td>
<td>0.83</td>
<td>1.25</td>
<td>NS</td>
</tr>
<tr>
<td>Hg (mg/L)</td>
<td>0.0001</td>
<td>0.00023</td>
<td>0.00002</td>
<td>0.00005</td>
<td>NS</td>
</tr>
<tr>
<td>Cr total (mg/L)</td>
<td>0.01</td>
<td>0.013</td>
<td>0.001</td>
<td>0.001</td>
<td>NS</td>
</tr>
<tr>
<td>As (mg/L)</td>
<td>0.015</td>
<td>0.015</td>
<td>0.002</td>
<td>0.002</td>
<td>NS</td>
</tr>
<tr>
<td>Mn (mg/L)</td>
<td>0.06</td>
<td>0.18</td>
<td>0.01</td>
<td>0.01</td>
<td>NS</td>
</tr>
<tr>
<td>Cd (mg/L)</td>
<td>0.0008</td>
<td>0.0005</td>
<td>0.0004</td>
<td>0.0003</td>
<td>NS</td>
</tr>
<tr>
<td>Pb (mg/L)</td>
<td>0.01</td>
<td>0.015</td>
<td>0.001</td>
<td>0.001</td>
<td>NS</td>
</tr>
<tr>
<td>Ni (mg/L)</td>
<td>0.005</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.5</td>
</tr>
<tr>
<td>Mg (mg/L)</td>
<td>47.6</td>
<td>26.7</td>
<td>1368.0</td>
<td>1365.7</td>
<td>NS</td>
</tr>
<tr>
<td>Heavy metals (mg/L)</td>
<td>0.1</td>
<td>0.23</td>
<td>0.01</td>
<td>0.01</td>
<td>10.0</td>
</tr>
</tbody>
</table>

*Data from Radian Phase II Audit of JLPP

NS = No applicable standard

NAF = Not analyzed for this analyte
Bottom and fly ash are sluiced in two parallel pipelines (one for bottom ash and the other for fly ash) with a slip stream of incoming seawater and discharged to the Atlantic Ocean. Both lines are submerged and extend 800 m into the Atlantic where the average depth is 13 m. The bottom ash disposal line has experienced problems due to bottom ash accumulating on the ocean floor to the point that the disposal line is clogged. When this occurs, bottom ash is trucked to an existing trash disposal site located south of the plant and adjacent to the discharge channel on the plant site.

Under current operations, solids collected in the septic tanks are periodically pumped into a truck and transported to an offsite municipal sewage treatment plant. Office trash/refuse generated at the facility is disposed of in an off-site landfill.

Industrial wastes generated at the site are shipped to landfill for disposal. Used oil is stored in drums and either returned to the fuel oil tanks or sold to local companies for recycling or other uses.

3.2.7 Ancillary Facilities

Ancillary facilities include: 1) a rail line from the Port of Jorf Lasfar to JLPP, 2) a coal conveyor system from the Port to JLPP, 3) a portion of a dedicated pier for coal unloading at the Port, and 4) five - 225 kV overhead transmission lines connecting JLPP to the power grid (ABB Project, 1996).

The rail line between the Port of Jorf Lasfar and JLPP is primarily used to transport heavy fuel oil No. 2, sulfuric acid ($\text{H}_2\text{SO}_4$), caustic (NaOH), diesel fuel, propane, and equipment to JLPP. The conveyor system is used to transport coal from the Port to JLPP. Coal is unloaded at JLPP onto a series of coal piles. The two conveyors can each transport 750 tonnes of coal per hour. Hydrazine and ammonia are shipped to the site via trucks.

Electricity generated at JLPP is connected to the ONE system grid via five - 225 kV overhead transmission lines.
3.2.8 Staffing

As of May 1996 there were 144 regular employees working at the JLPP. According to ONE management staff, virtually all of the employees live in El Jadida and commute to work in company buses.

3.3 Description of Proposed Expansion

This section presents a discussion of the new infrastructure, operational changes, construction activities, and features of the new Units 3 and 4 (i.e., power generation, material usages, discharges to the environment, ancillary facilities, and staffing).

3.3.1 New Infrastructure and Operational Changes

The proposed expansion consists of adding two new 348 MW power plants and various support equipment. Specifically, the expansion will involve the addition of (ABB Project, 1996 and EPC, 1995):

- Two 348 MW pulverized coal-fired steam generators (Units 3 and 4) capable of firing coal or heavy fuel oil No. 2 as support fuel only;
- Two steam turbine/generator units;
- Four (2 per unit) four-field, cold-side electrostatic precipitators designed to reduce PM emissions from Units 3 and 4 to 50 mg/m$^3$;
- Two emergency diesel generators;
- Expansion of the water demineralization system (including two 1000 m$^3$ demineralized water storage tanks) to provide demineralized water for Units 3 and 4;
- Expansion of the seawater intake pumping station;
- A 130 m stack with separate flues to discharge air emissions from Units 3 and 4;
- A wastewater treatment system designed to meet project effluent guidelines;
- Electrical building;
- Ash handling system;
- Coal silos sized for at least 12 hours of full load operation;
Extension of the coal stacker and reclaimer tracks by 300 m;

- Extension of the two 750 tonne per hour coal conveyor systems;

- Extension of the coal wetting system;

- A new raw water storage tank; and

- Extension of the existing fire water system.

Figure 3-4 shows the proposed location of Units 3 and 4. In addition to the proposed new equipment, there will be several operational changes:

- Wastewater will be treated to meet Project effluent guidelines prior to disposal to the Atlantic Ocean. Wastewater from floor cleaning will be sent to an oil/water separator to remove oils and grease. pH treatment of wastewater will be upgraded;

- Disposal of fly and bottom ash in the Atlantic Ocean will be terminated once an appropriate alternative has been implemented;

- Fuel oil unloading operations will be modified in order to reduce fuel spillage; and

- An Environmental Management Plan will be developed and implemented. The plan will address waste management procedures, environmental sampling, and environmental record keeping.

3.3.2 Description of Construction Activities

Schedule

Pending financial closing, construction of the new units is anticipated to begin in March 1997. Construction of Unit 3 is scheduled to take no greater than 33 months. Completion of Unit 4 is planned to occur six months after the completion of construction of Unit 3. Unit 3 is scheduled to be operational by December 1999.
Construction Access
Site access to the JLPP is via Route 121. Construction materials may also be transported to the facility via rail car or barge. The construction of new rail, port facilities, or roads is not required for this project.

Site Preparation
The site for Units 3 and 4 was mostly graded and cleared of vegetation during the initial construction of Units 1 and 2. Purchase or use of property not currently owned by ONE will not be required (except as necessary for off-site land disposal of ash). Also, no relocation of families living near the plant will be necessary (ABB, 1996b). Figure 3-4 shows the site layout for Units 3 and 4. The cleared area reserved for Units 5 and 6 will be used for equipment laydown (ABB, 1996b). This area will also house the construction offices, fuel storage for the construction phase, and a batch plant.

It is not anticipated that there will be any large quantity of excavated material for disposal. Most of the excavated material will be used for fill and berms. A small disposal site will be required for the clean material unsuitable for fill. Construction debris will be taken to an authorized nearby landfill.

Construction materials may be transported to the facility via rail car or trucks. The construction of new rail, port facilities, or roads is not required for this project.

At peak of construction, approximately 700 workers will be working at the site. Both skilled (about 53%) and unskilled workers (about 47%) will be hired to construct the units. The majority of the work force will be recruited locally. Workers from other countries such as Switzerland, Italy, and the U.S. will also be used for the construction and will be housed in the city of El Jadida (ABB, 1996b).

For the duration of the project, all workers are required to follow OPIC and Ex-Im health and safety guidelines and comply with Moroccan legal requirements.

Buses will transport workers to the construction site from El Jadida. It is expected that the construction work force will reside primarily in El Jadida. No plans have been made to provide temporary housing for the workers. Construction will occur primarily during daylight.
hours. The startup, commissioning, and operation will be performed continuously based on three shifts (ABB, 1996b).

**Solid Wastes**

Solid wastes from Units 3 and 4 will be generated during construction. Construction activities will result in the following solid waste streams:

- Construction debris such as packaging material, wood, brick, concrete, and steel;
- Sanitary wastes generated by the construction workers; and
- Used oils, paint, and solvents.

Construction debris and industrial waste will be disposed of in an off-site landfill as directed by local authorities. Sanitary wastes will be collected from portable bathrooms via vacuum trucks and transported to a wastewater treatment plant.

### 3.3.3 Features of New Units

This section presents a discussion of power generation, fuels used, air emissions, water usage, water discharges, solid waste, ancillary facilities, and staffing associated with proposed Units 3 and 4.

**Power Generation**

The maximum continuous rating of Units 3 and 4 will be 348 MW each. Total capacity from all four units will be 1356 MW. JLPP is expected to be operated at a capacity factor of approximately 82%.

**Fuels Used**

In order to limit emissions of SO₂ from JLPP, both the existing Units 1 and 2 and the proposed Units 3 and 4 will use coal required to contain no more than 1.25% sulfur by weight on an annual average basis. It is anticipated that the coal will be supplied primarily from South Africa, Colombia, and the United States. As with Units 1 and 2, Units 3 and 4 will normally use heavy fuel oil No. 2 for ignition, warm-up, and combustion stabilization below 35% load. Unlike Units 1 and 2 which can operate up to full load on oil, Units 3 and 4 can only achieve 15% load while firing only oil. Coal and heavy fuel oil No. 2 will continue to be delivered to the Port of Jorf Lasfar and routed to JLPP via a conveyor system and railcar, respectively. When
operating at the anticipated capacity factor of 82%, Units 1 through 4 will consume approximately 3.3 million tonnes of coal per year.

**Stack Emissions**

Stack emissions from Units 1 and 2 and Units 3 and 4 are presented in Table 3-5. Also included in Table 3-5 are the guaranteed, not-to-exceed emissions from Units 3 and 4 (EPC, 1995).

PM emissions will be reduced to 50 mg/m³ via cold-side electrostatic precipitators installed on each of the units. Emissions from Units 3 and 4 will be discharged through a 130 m stack.

**Water Use**

The raw fresh water consumption of Units 1 and 2 is approximately 68 m³/hour. Raw fresh water and seawater usage rates for Units 3 and 4 will be similar to the usage rates of Units 1 and 2. In addition, treatment of raw water and seawater will be similar to that of Units 1 and 2.

**Table 3-5. Stack Emissions from JLPP Units 1 Through 4**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emission Units</th>
<th>Existing Units 1 and 2 (tpd/MW)</th>
<th>Expected Future Units 3 and 4 (lb/MM Btu)</th>
<th>Guaranteed Emission Limit for Units 3 &amp; 4 (lb/MM Btu load)</th>
<th>Project Guidelines</th>
<th>Moroccan Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO₂</td>
<td>tpd/MW</td>
<td>0.20 a</td>
<td>0.20 b</td>
<td>0.20</td>
<td>0.20</td>
<td>NA</td>
</tr>
<tr>
<td>NOₓ (maximum load)</td>
<td>lb/MM Btu</td>
<td>0.53 c</td>
<td>&lt;0.60 d</td>
<td>0.60</td>
<td>0.60</td>
<td>NA</td>
</tr>
<tr>
<td>NOₓ (minimum load)</td>
<td>lb/MM Btu</td>
<td>0.59 c</td>
<td>&lt;0.60 d</td>
<td>0.60</td>
<td>0.60</td>
<td>NA</td>
</tr>
<tr>
<td>PM</td>
<td>mg/m³</td>
<td>30 c</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>NA</td>
</tr>
</tbody>
</table>

* See Appendix F for SO₂ emission calculations
  * Based on a 1.25% sulfur coal (See Appendix F for calculations).
  * Data from 1995 GEC Alstom performance test.
  * NOₓ and PM emissions based on performance guarantees (EPC, 1995).
  * NA = No applicable standards.
Water Discharges
Addition of Units 3 and 4 will approximately double current discharges of: 1) once-through condenser cooling seawater, 2) demineralizer regeneration/backwash water, 3) storm drains, and 4) sanitary wastewater.

A new wastewater treatment system will be constructed as part of the JLPP expansion. The wastewater treatment system will be designed to ensure all wastewater discharges from JLPP meet the Project effluent guidelines presented in Table 2-5.

Solid Waste
Operation of Units 3 and 4 will increase all of the waste streams identified in Section 3.2.6; however, both bottom and fly ash will no longer be disposed of in the Atlantic Ocean once an appropriate alternative has been implemented. Options for alternative disposal and uses are described in Section 7.6.

Ancillary Facilities
Ancillary facilities for Units 3 and 4 will be the same as those for Units 1 and 2.

Staffing
Employment at JLPP, following completion of Units 3 and 4, will be approximately 300. This is a net increase of 156 employees over staffing levels in early 1996.
4.0 ENVIRONMENTAL BASELINE

This section describes the existing physical, biological, and sociocultural environment in the vicinity of the proposed Project.

4.1 The Physical Environment

4.1.1 Topography, Geology, and Soils

The salient topographical feature in the vicinity of the JLPP is the 50 to 80 m bluff that gives this area its name “Jorf Lasfar” which is Arabic for “yellow bluff.” As shown in Figure 3-2, this escarpment forms a sheer cliff from the rocky shoreline immediately north of the port of Jorf Lasfar. To the east of the port the bluff transitions from a steep slope to a more gentle slope in the vicinity of the JLPP.

South of the JLPP, the bluff becomes less pronounced. To the south the interface between sea and shore becomes more complex with marshes, tidal flats, and sand dune complexes. Inland, the area is hilly to gently sloping with elevation of generally less than 150 m.

The site topography of JLPP is level at 7 m above NGM with the exception of the coal storage area which is 6 m NGM (ONE, 1994).

The geology of the project site is coastal Meseta area. The geological structure belongs to the succession of geological layers which stretch from Casablanca to Safi. The geological layers from the ground level down are the following (ONE, 1994):

- **Tufa and loosely compacted sea sand (recent quaternary)**—The quaternary terrain gently slopes toward the Atlantic Ocean. The thickness of the terrain is not precisely known, but varies from a few meters to tens of meters. The tufa, rarely found near the seashore because of erosion, is a powdery calcareous formation which could present nodular or superficial encrustations because of the combined action of dissolution and evaporation.

- **Dune “sandstone” (consolidated quaternary)**—The dune “sandstone” is a soft rock formation, generally calcareous, with loosely cemented intercalations of sand. Its appearance is like that of sandstone; however, the percentage of silica is negligible. The layer may also be characterized as calcareous shell.
Cretaceous bedrock—The cretaceous bedrock consists of alternating bands of pure marl, soft, and indurate marl, as well as marlous limestone.

The soil at JLPP consists of compacted sandstone, cemented by carbonates with a fine stratification, in which shells are easily found, and with a depth of several tens of meters (Radian, 1995).

4.1.2 Climate

The climate of the Jorf Lasfar area is influenced by the proximity of the Atlantic Ocean to the west and the expansive coastal plain to the east. Overall the climate is temperate, with generally hot summers (May through September) and mild winters (ONE, 1994).

The coastal plain is relatively flat, extending eastward toward the Atlas Mountains. While blowing over the coastal plain, winds are unaffected by topography or vegetation, yet the reported speeds are not excessive. No sandstorms have been reported in the area. The annual windrose (Figure 4-1) obtained at El Jadida from 1950-1961, indicates a predominant wind flow from the north-northeast and northeast (i.e., from land toward water). As shown in the figure, the wind is from these directions almost half the time (48%). The predominance of the annual northeasterly pattern is caused primarily by the summer season winds. During the winter rainy season (November until May), winds are more variable with about half of the winds blowing from south through northwest (i.e., generally from water toward land).

Air temperatures range from a minimum winter temperature of 4°C to a maximum summer temperature of 42°C. Average annual temperatures are about 18°C, with average maximum monthly temperatures ranging from 18 to 27°C. The average relative humidity for the area is about 65%. Ocean temperatures range from a minimum of 12°C to a maximum of 25°C. Rainfall during the seasonal rainy period averages about 450 mm, but is extremely variable, with an annual range of 210 mm to 740 mm.

4.1.3 Existing Air Quality

The air quality of the immediate region around the JLPP was evaluated by the Laboratoire Public d’Essais et d’Etudes (LPEE) prior to construction of Units 1 and 2 (LPEE, 1994). The monitoring program was conducted over a seven-week period in 1994 (February 14 - March 31). The monitoring site was located about 1 km northeast of the power plant at an elevation of approximately 60 m NGM.
The atmospheric constituents monitored included SO₂, NO₂, NOₓ, VOCs, and O₃. Hourly measurements in parts per billion by volume (ppbV) were reported for each monitored constituent. These hourly values were then used to form daily (24-hour) and period averages. The meteorological parameters, wind speed and direction were concurrently monitored to provide supporting data. Wind directions reported during the period agreed favorably with those reported during the winter period at El Jadida. The results are summarized in Table 4-1.

Of the monitored constituents, only SO₂ and NO₂ have applicable Project ambient air guidelines. The average hourly monitored values for the entire seven-week period for these two pollutants were 7.1 ppb (18.5 µg/m³) and 3.7 ppb (6.9 µg/m³) for SO₂ and NO₂ respectively. The reported concentrations varied significantly over the course of the monitoring program. The maximum daily concentration of SO₂ was 109.2 ppb (285 µg/m³) and the maximum daily concentration of NO₂ was 7.2 ppb (14 µg/m³). The maximum hourly concentrations during the monitoring period were in excess of 1000 ppb of SO₂ and 25 ppb NO₂.

The occurrences of these high hourly concentrations of SO₂ were rare. During the monitoring period, 96% of the hourly values were less than 25 ppb (65 µg/m³) with 93% less than 10 ppb and 88% reported as less than 5 ppb. Only 0.7% (7 occurrences) of the hourly values exceeded the Project guideline for the maximum 1-hour average of 350 µg/m³ (134 ppb).

Each of the periods of high SO₂ concentrations occurred with winds blowing from the direction of the Office chérifien des phosphates (OCP) phosphate plant. These elevated concentrations probably result from periods of start-up and shut-down associated with the sulfuric acid plant operations at the OCP. Because of the type of operation, these start-up and shut-down periods can produce short durations of high emission levels of SO₂. The high one-hour concentrations indicated in the data record are thought to reflect these types of non-typical releases. During other periods with wind blowing from the OCP toward the monitoring site, the normal low background concentrations were found, indicating the atypical nature of these elevated concentrations.

The Project began collecting one year of ambient air quality data (SO₂, NOₓ, and PM) at the JLPP site beginning in May 1996. Analysis of these data will be presented as a supplement to this EIA as soon as sufficient data have been collected to form salient conclusions.
Table 4-1. Comparison of LPEE Ambient Monitoring Data (1994) with JLPP Project guidelines

<table>
<thead>
<tr>
<th>Atmospheric Constituent</th>
<th>Averaging Period</th>
<th>LPEE Ambient Monitored Values * (µg/m³)</th>
<th>JLPP Project guidelines (µg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur Dioxide</td>
<td>Annual Mean</td>
<td>19</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Maximum 24-hour avg.</td>
<td>285</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>Maximum 1-hour avg.</td>
<td>4675</td>
<td>350</td>
</tr>
<tr>
<td>Nitrogen Oxides (expressed as NO₂)</td>
<td>Annual Mean</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Maximum 24-hour avg.</td>
<td>14</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Maximum 1-hour avg.</td>
<td>27</td>
<td>400</td>
</tr>
</tbody>
</table>

* From the seven week monitoring data period in 1994, prior to construction of Units 1 & 2 (February - March, 1994)

4.1.4 Surface Water And Sediment Quality

Hydrographic, sedimentological, and geochemical sampling was conducted in the Atlantic Ocean at JLPP prior to the completion of Units 1 and 2 (LPEE, 1994; ONE, 1994). In April 1996, additional surface water and sediment samples were taken in the Atlantic Ocean near the JLPP in order to assess baseline conditions of the surface water, sediment, and biological environment (see Section 4.2) prior to construction of Units 3 and 4 of the JLPP.

The nearshore Atlantic Ocean near the JLPP is a relatively high-energy environment characterized by a rocky shoreline, and rocky subsurface out to 300 m offshore. Tides are semidiurnal, with two highs and two lows daily (ONE, 1994). The maximum amplitude at Jorf Lasfar is 3.5 m, and extremes are 3.9 and 0.4 m relative to hydrographic zero at -2.2 m NGM (ONE, 1994). Currents taken in the bay of Jorf Lasfar indicate an intensity of 20 cm/s, both at the surface and 3 m below the surface. Current direction is generally from the northeast to southwest offshore. Due to the coastal topography, the nearshore current direction is variable (ONE, 1994). In the shallow water near the rocky cliffs along the shoreline, currents could attain and surpass 1 m/s as a result of reflection from the cliffs.
Materials and Methods

Surface water and sediment samples were taken at 10 stations in the nearshore, sublittoral zone in the Atlantic Ocean near the JLPP. Water samples were taken on April 24 and 25, 1996 and sediment samples on April 26, 1996. Five stations were located 300 m offshore in water depths of 5.5 to 15 m, and five stations were 500 m offshore in water depths of 9.5 to 15 m (see Figure 4-2). Navigation techniques involved preplotting stations and triangulation. Samples were taken in the mornings, generally during high tides, with winds from the north at approximately 15 to 30 km/h.

Water for laboratory analyses was taken 10 cm below the surface with a two liter Niskin Bottle (see photo in Appendix E). Hydrographic data, including temperature, conductivity, salinity, and dissolved oxygen, were measured at each station with a YSI Meter. A Secchi disc was used to measure water clarity. Surficial sediment samples were taken with a Wildco Ponar grab sampler (volume of 8,200 mL) (see photo in Appendix E). Four replicate samples were taken at each station. Samples were described at the time of collection for sediment type and other visual characteristics and later subsampled and stored for sedimentological, geochemical, and biological analyses in the laboratory. Water depths were taken with a Ratheon fathometer.

Laboratory analyses of the water and sediments were conducted by the LPEE in Casablanca. The samples were analyzed for Cd, Cu, Fe, Mn, Ni, Pb, Se, Zn, As, total Cr (Crt), and V using an inductively coupled plasma atomic emission spectrometer (ICP-AES). Hg was also analyzed via cold vapor atomic absorption spectrophotometry.

Results and Discussion

Hydrography—As shown in Table 4-2, the hydrographic parameters of temperature, conductivity, salinity, dissolved oxygen, and pH varied little between stations. Temperatures ranged from 16.2 to 17°C; salinities, from 33.9 to 34.1 mg/L; conductivities, from 42,920 to 43,750 µmhos/cm; dissolved oxygen, from 5.93 to 6.96 mg/L; and pH, from 7.22 to 7.47. Ranges and values appear to be normal for nearshore, sublittoral surface waters at this time of year. Secchi disc values from 2.12 to 2.9 m indicate good water clarity (LPEE, 1996). Oxygen levels appear high enough to not be limiting to the fauna. Seawater with mean dissolved oxygen values above 5 mg/L is characterized as water with "exceptional aquatic life use" and typically has high species diversity and a balanced trophic structure (TNRCC, 1995).
Figure 4-2. Marine Biology/Water Quality Sampling Sites
Table 4-2. Hydrographic Measurements, Gross Sediment Type, and Sample Dates and Times for Each Station

<table>
<thead>
<tr>
<th>Stations</th>
<th>Temperature (°C)</th>
<th>Conductivity/Salinity (micromhos/cm)/ (ppt)</th>
<th>pH</th>
<th>DO (mg/L)</th>
<th>Depth (m)</th>
<th>Sediment</th>
<th>Secchi Disc (m)</th>
<th>Sample Time</th>
<th>Sample Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16.2</td>
<td>42,920/34</td>
<td>7.36</td>
<td>6.5</td>
<td>15</td>
<td>Sand</td>
<td>2.75</td>
<td>9:20</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>2</td>
<td>16.4</td>
<td>43,150/34</td>
<td>7.39</td>
<td>6.93</td>
<td>12</td>
<td>Sand</td>
<td>2.3</td>
<td>10:00</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>3</td>
<td>16.3</td>
<td>43,000/34</td>
<td>7.47</td>
<td>6.96</td>
<td>15</td>
<td>Muddy sand</td>
<td>2.7</td>
<td>10:20</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>4</td>
<td>16.5</td>
<td>43,150/34</td>
<td>7.42</td>
<td>6.9</td>
<td>15</td>
<td>Muddy sand</td>
<td>2.3</td>
<td>10:35</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>5</td>
<td>16.6</td>
<td>43,120/33.9</td>
<td>7.22</td>
<td>6.73</td>
<td>11.5</td>
<td>Sand</td>
<td>2.12</td>
<td>8:00</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>6</td>
<td>16.3</td>
<td>43,120/34</td>
<td>7.33</td>
<td>6.62</td>
<td>12.5</td>
<td>Sand</td>
<td>2.6</td>
<td>8:20</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>7</td>
<td>16.3</td>
<td>43,070/34</td>
<td>7.33</td>
<td>6.61</td>
<td>6.5</td>
<td>Shelly sand</td>
<td>2.5</td>
<td>8:55</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>8</td>
<td>16.4</td>
<td>43,130/34</td>
<td>7.38</td>
<td>6.42</td>
<td>10</td>
<td>Sand</td>
<td>2.2</td>
<td>9:10</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>9</td>
<td>16.4</td>
<td>43,200/34.1</td>
<td>7.4</td>
<td>6.47</td>
<td>5.5</td>
<td>Shelly sand</td>
<td>2.3</td>
<td>9:35</td>
<td>April 24, 1996</td>
</tr>
<tr>
<td>10</td>
<td>17</td>
<td>43,750/34</td>
<td>7.38</td>
<td>5.93</td>
<td>9.5</td>
<td>Sand</td>
<td>2.9</td>
<td>9:55</td>
<td>April 24, 1996</td>
</tr>
</tbody>
</table>

DO = Dissolved oxygen
Surface water and sediment samples were taken by LPEE in June, July, and August 1994 (LPEE, 1994) at 32 stations in the same general area as the stations sampled in April 1996. Surface water temperature, conductivity, and pH were taken at each station. As expected, water temperatures were higher in the summer of 1994, 18°C at all stations, as compared to the spring average temperature in 1996 of 16.4°C. Conductivities and pH were also higher. The pH values were between 7.7 and 8.05; conductivities were between 58,300 and 61,600 µmhos/cm.

**Surface Water**—With a few exceptions trace metal concentrations in surface waters were generally low, as shown in Table 4-3. Also, no clear distribution trends could be detected. Concentrations of vanadium, selenium, and arsenic were either below or just above detection limits at all stations. Most concentrations of cadmium and manganese were either below, at, or just above detection limits. The range for cadmium was from <0.08 to 0.19 µg/L, and for manganese, from <0.04 to 0.20 µg/L. Concentrations of iron, nickel, lead, zinc, and total chromium were relatively low. Copper concentrations were high at two stations. Copper values ranged from <0.08 to 20.9 µg/L. Copper values for stations 2 (20.9 µg/L) and 4 (18.8 µg/L) were high, although the mean of 5.58 µg/L for all samples was low. Mercury concentrations were relatively low, except for Station 10 at 1.49 µg/L.

Ranges in trace metal concentrations in surface waters taken from near the JLPP in the previous LPEE study (LPEE, 1994) were compared to values for the same elements analyzed from samples taken in 1996. For some metals, the range in values was similar. For example, values for total chromium from the 1994 study ranged from 0.8 to 3.0 µg/L. Values based on the 1996 water samples ranged from <0.76 to 3.34 µg/L. Also, values for lead were similar, ranging from 0.8 to 3.0 µg/L in 1994 and <1.2 to 3.73 in 1996. Values for arsenic and nickel were generally higher in 1994 than in 1996. Arsenic values ranged from 0.5 to 2.0 µg/L, whereas, most concentrations were below detection limits in 1996. Nickel values ranged from 0.9 to 2.5 in 1994 and < 0.2 to 1.94 µg/L in 1996. Values for cadmium, copper, mercury, and zinc were generally higher in samples taken in 1996 than in samples from 1994. In 1996, cadmium ranged from <0.08 to 0.19 µg/L. In 1994, the range was from 0.02 to 0.07 µg/L. Copper ranged from <0.08 to 21 µg/L in 1996, but in 1994, copper ranged only from 1 to 3.5 µg/L. Zinc values ranged from 0.27 to 17.6 µg/L in 1996, and 0.9 to 2.5 µg/L in 1994. Mercury values ranged from 0.11 to 1.49 µg/L in 1996, and 0.01 to 0.04 µg/L in 1994. Surface waters were not analyzed for iron, manganese, selenium, and vanadium in 1994, and, therefore, could not be compared to results from the 1996 samples.
<table>
<thead>
<tr>
<th>Stations</th>
<th>Cd</th>
<th>Cu</th>
<th>Fe</th>
<th>Mn</th>
<th>Ni</th>
<th>Pb</th>
<th>Se</th>
<th>Zn</th>
<th>As</th>
<th>Cr</th>
<th>V</th>
<th>Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.16</td>
<td>0.87</td>
<td>12.5</td>
<td>0.04</td>
<td>0.83</td>
<td>3.73</td>
<td>&lt;1.2</td>
<td>1.26</td>
<td>&lt;0.22</td>
<td>0.52</td>
<td>0.22</td>
<td>0.51</td>
</tr>
<tr>
<td>2</td>
<td>0.18</td>
<td>20.9</td>
<td>18.6</td>
<td>0.04</td>
<td>1.54</td>
<td>2.46</td>
<td>&lt;1.2</td>
<td>3.70</td>
<td>&lt;0.8</td>
<td>0.82</td>
<td>&lt;0.08</td>
<td>0.63</td>
</tr>
<tr>
<td>3</td>
<td>0.12</td>
<td>3.87</td>
<td>5.93</td>
<td>0.06</td>
<td>0.61</td>
<td>1.36</td>
<td>&lt;1.2</td>
<td>11.7</td>
<td>&lt;0.8</td>
<td>0.51</td>
<td>&lt;0.08</td>
<td>0.61</td>
</tr>
<tr>
<td>4</td>
<td>0.19</td>
<td>18.8</td>
<td>14.7</td>
<td>0.15</td>
<td>1.94</td>
<td>2.17</td>
<td>&lt;1.2</td>
<td>17.6</td>
<td>&lt;0.8</td>
<td>1.04</td>
<td>&lt;0.08</td>
<td>0.31</td>
</tr>
<tr>
<td>5</td>
<td>0.11</td>
<td>2.86</td>
<td>3.66</td>
<td>&lt;0.04</td>
<td>0.76</td>
<td>&lt;1.2</td>
<td>&lt;1.2</td>
<td>3.31</td>
<td>&lt;0.8</td>
<td>1.10</td>
<td>&lt;0.08</td>
<td>0.58</td>
</tr>
<tr>
<td>6</td>
<td>0.08</td>
<td>0.15</td>
<td>5.19</td>
<td>0.06</td>
<td>0.29</td>
<td>&lt;1.2</td>
<td>&lt;1.2</td>
<td>1.80</td>
<td>&lt;0.8</td>
<td>&lt;0.16</td>
<td>&lt;0.08</td>
<td>0.11</td>
</tr>
<tr>
<td>7</td>
<td>&lt;0.08</td>
<td>0.88</td>
<td>6.34</td>
<td>&lt;0.04</td>
<td>0.46</td>
<td>&lt;1.2</td>
<td>&lt;1.2</td>
<td>2.06</td>
<td>&lt;0.8</td>
<td>0.80</td>
<td>&lt;0.08</td>
<td>0.63</td>
</tr>
<tr>
<td>8</td>
<td>&lt;0.08</td>
<td>&lt;0.08</td>
<td>3.13</td>
<td>0.09</td>
<td>0.33</td>
<td>&lt;1.2</td>
<td>&lt;1.2</td>
<td>2.07</td>
<td>&lt;0.8</td>
<td>&lt;0.16</td>
<td>&lt;0.08</td>
<td>0.17</td>
</tr>
<tr>
<td>9</td>
<td>&lt;0.08</td>
<td>1.16</td>
<td>16.6</td>
<td>&lt;0.04</td>
<td>1.32</td>
<td>&lt;1.2</td>
<td>&lt;1.2</td>
<td>0.27</td>
<td>&lt;0.8</td>
<td>3.34</td>
<td>&lt;0.08</td>
<td>0.96</td>
</tr>
<tr>
<td>10</td>
<td>&lt;0.08</td>
<td>4.12</td>
<td>13.6</td>
<td>0.20</td>
<td>&lt;0.2</td>
<td>1.4</td>
<td>&lt;1.2</td>
<td>2.84</td>
<td>0.82</td>
<td>0.8</td>
<td>&lt;0.08</td>
<td>1.49</td>
</tr>
</tbody>
</table>
All values for trace metals from surface waters near the JLPP, except copper at stations 2 and 4 and mercury at Station 10, were generally well below the generally accepted values for marine acute or chronic toxicity (TNRCC, 1995). Acute toxicity kills in the short term (minutes to days); chronic toxicity causes cumulative effects over the long term (months to years), including illness and death. The marine acute toxicity criterion for copper is 16.27 μg/L, and 4.37 μg/L for chronic toxicity. Copper concentrations from stations 2 and 4 were above both values. The marine acute toxicity criterion for mercury is 2.1 μg/L, and 1.1 μg/L for chronic toxicity. The mercury concentration at Station 10 was above the chronic toxicity value. Note that Station 10 is furthest removed from JLPP and the closest to the port.

Table 4-4 shows measurements for a diverse set of water quality parameters, including total suspended solids (TSS); the nutrients, Total Kjeldahl Nitrogen (TKN), nitrate (NO₃), nitrite (NO₂), ammonia (NH₄), and orthophosphate (PO₄); potential contaminants, total hydrocarbons (THC), and phenols; and chlorophyll a. Total suspended solid values, or the concentration of suspended sediment in water, were low, less than 10 mg/L.

Concentrations of the various forms of nitrogen were also low. However, phosphate levels appear to be relatively high, ranging from 0.748 to 1.08 mg/L. Concentrations of the contaminant, total hydrocarbon, were mostly below detection limits. Phenol concentrations were all below the detection limit.

Of the water quality parameters taken in 1996, only total hydrocarbons and phenols were also measured in 1994 (LPEE, 1994). Total hydrocarbons concentrations in 1994 were generally near zero, except for a station with a relatively high concentration of 9.97 mg/L. Phenol concentrations were all very low in 1994.

Although there are no numerical standards for nutrients in marine waters, accepted screening levels for coastal waters (TNRCC, 1994b) can be applied to nutrient values from surface waters near the JLPP. Concentrations for all nutrients, except orthophosphate, were below accepted screening levels. Concentrations of orthophosphate at all 10 stations were above the accepted screening level for coastal waters of 0.2 mg/L, indicating nutrient enrichment may result in algal blooms and impairment to aquatic life habitats. As shown in Figure 4-2, the outfall from the OCP phosphate plant is just south of the JLPP site.
Table 4-4. Surface Water Parameters (All Values Except for Chlorophyll a are in mg/L)

<table>
<thead>
<tr>
<th>Stations</th>
<th>TSS</th>
<th>TKN</th>
<th>NO₂</th>
<th>NO₃</th>
<th>NH₄</th>
<th>PO₄</th>
<th>THC</th>
<th>Chlorophyll a (µg/L)</th>
<th>Phenols</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5.43</td>
<td>0.624</td>
<td>0.027</td>
<td>0.012</td>
<td>0.02</td>
<td>0.768</td>
<td>&lt;0.5</td>
<td>1.28</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>2</td>
<td>8.28</td>
<td>0.55</td>
<td>0.015</td>
<td>0.014</td>
<td>0.012</td>
<td>0.791</td>
<td>&lt;0.5</td>
<td>0.96</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>3</td>
<td>6.86</td>
<td>0.902</td>
<td>0.02</td>
<td>0.013</td>
<td>0.016</td>
<td>0.748</td>
<td>&lt;0.5</td>
<td>0.64</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>4</td>
<td>5.7</td>
<td>0.485</td>
<td>0.028</td>
<td>0.014</td>
<td>0.014</td>
<td>0.78</td>
<td>&lt;0.5</td>
<td>0.96</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>5</td>
<td>6.3</td>
<td>0.118</td>
<td>0.022</td>
<td>0.01</td>
<td>0.012</td>
<td>1.08</td>
<td>&lt;0.5</td>
<td>0.801</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>6</td>
<td>5.3</td>
<td>0.058</td>
<td>0.018</td>
<td>0.011</td>
<td>0.016</td>
<td>0.825</td>
<td>&lt;0.5</td>
<td>1.068</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>7</td>
<td>9</td>
<td>0.1</td>
<td>0.011</td>
<td>0.015</td>
<td>0.012</td>
<td>1.05</td>
<td>&lt;0.5</td>
<td>1.068</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>8</td>
<td>5.7</td>
<td>0.15</td>
<td>0.01</td>
<td>0.018</td>
<td>0.009</td>
<td>0.906</td>
<td>&lt;0.5</td>
<td>0.534</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>9</td>
<td>4.7</td>
<td>0.063</td>
<td>0.013</td>
<td>0.015</td>
<td>0.007</td>
<td>0.924</td>
<td>&lt;0.5</td>
<td>0.802</td>
<td>&lt;0.025</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>0.14</td>
<td>0.016</td>
<td>0.014</td>
<td>0.008</td>
<td>0.954</td>
<td>&lt;0.5</td>
<td>0.534</td>
<td>&lt;0.025</td>
</tr>
</tbody>
</table>

TSS = Total suspended solids
TKN = Total kjeldahl nitrogen
THC = Total hydrocarbons
PO₄ = Orthophosphate
Sediment—Trace metal concentrations in surficial sediments range from very low to high, as shown in Table 4-5. Sediment at all stations is predominantly sand, with some mud and shell, as shown in Table 4-2. Selenium levels at all stations were below the detection limit of <3.0. Also, nearly all values for cadmium, except in sediments at station 1 (0.62 ppm), were below the detection limit of <0.2 ppm. Concentrations for the other metals were above detection limits at all ten stations. The following are ranges and means (in parentheses) in ppm for the other trace metals: copper, 36.3 to 56.7 (49.2); iron, 4,539 to 17,402 (8,476); manganese, 39.8 to 87.3 (67.2); nickel, 4.55 to 18.2 (10.04); lead, 23.2 to 63 (44.72); zinc, 25 to 63.2 (39.21); arsenic, 32.1 to 48.2 (41.74); chromium, 17.2 to 68.3 (39.49); vanadium, 14.9 to 60.4 (34.73); and mercury, 0.023 to 0.264 (0.091).

The highest metal concentrations tended to occur at stations 1 or 3. For example, high concentrations for 8 of the 12 trace metals were from sediments at either station 1 or 3. Both station 1 and 3 were 300 m offshore, in water depths of 15 m, as shown in Figure 4-2 and Table 4-2. Cadmium, nickel, lead, chromium, and mercury were highest at station 1; copper, zinc, and arsenic were highest at station 3. Of the metals above detection limits, only iron (station 2), manganese (station 9), and vanadium (station 5) were highest at other stations.

In comparing the results of the LPEE (1994) study with results from samples taken in 1996, the range in concentrations for most trace metals in sediments taken in 1994 was similar to or greater than those concentrations found in 1996 sediment. For example, the range in concentrations for copper was 18 to 66 ppm in 1994 samples, as compared to 36.3 to 56.7 ppm in 1996 sediments. Also, the range for zinc was 24 to 94 ppm in 1994 samples, but 25 to 63.2 ppm in 1996. The range in concentrations for nickel and lead was similar. On the other hand, arsenic values were much higher in sediment samples from 1996. The highest arsenic value in 1994 was 8.6 ppm; whereas, the highest value from sediment taken in 1996 was 48.2 ppm. Sediments were not analyzed for iron, manganese, selenium, vanadium, and mercury in 1994.

Data on the mixtures and concentrations of contaminants, alone, do not provide an effective basis for estimating the potential for adverse effects to organisms (Long et al., 1995). The United States National Oceanic and Atmospheric Administration (NOAA), in conjunction with Canada and Florida, developed effects-based guidelines to help identify marine and estuarine sediments in which the potential for biological effects is greatest (Long et al., 1995). Briefly, the approach in developing the guidelines involved: (1) assembling, evaluating, and collating all available information in which measures of adverse biological effects and chemical
## Table 4-5. Trace Metal Concentrations In Sediment (ppm)

<table>
<thead>
<tr>
<th>Stations</th>
<th>Cd</th>
<th>Cu</th>
<th>Fe</th>
<th>Mn</th>
<th>Ni</th>
<th>Pb</th>
<th>Se</th>
<th>Zn</th>
<th>As</th>
<th>Cr</th>
<th>V</th>
<th>Hg</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.62</td>
<td>55.1</td>
<td>5493</td>
<td>39.9</td>
<td>18.2</td>
<td>63.0</td>
<td>&lt;3.0</td>
<td>54.2</td>
<td>47.8</td>
<td>68.3</td>
<td>42.1</td>
<td>0.264</td>
</tr>
<tr>
<td>2</td>
<td>&lt;0.2</td>
<td>37.0</td>
<td>17402</td>
<td>59.6</td>
<td>15.3</td>
<td>26.2</td>
<td>&lt;3.0</td>
<td>32.3</td>
<td>38.1</td>
<td>44.6</td>
<td>53.6</td>
<td>0.080</td>
</tr>
<tr>
<td>3</td>
<td>&lt;0.2</td>
<td>56.7</td>
<td>8085</td>
<td>65.9</td>
<td>8.81</td>
<td>53.1</td>
<td>&lt;3.0</td>
<td>63.2</td>
<td>48.2</td>
<td>55.5</td>
<td>45.6</td>
<td>0.098</td>
</tr>
<tr>
<td>4</td>
<td>&lt;0.2</td>
<td>36.3</td>
<td>13152</td>
<td>62.1</td>
<td>9.1</td>
<td>23.1</td>
<td>&lt;3.0</td>
<td>26.8</td>
<td>32.1</td>
<td>29.8</td>
<td>33.8</td>
<td>0.060</td>
</tr>
<tr>
<td>5</td>
<td>&lt;0.2</td>
<td>52.1</td>
<td>11662</td>
<td>55.2</td>
<td>12.9</td>
<td>52.4</td>
<td>&lt;3.0</td>
<td>52.1</td>
<td>45.2</td>
<td>65.9</td>
<td>60.4</td>
<td>0.093</td>
</tr>
<tr>
<td>6</td>
<td>&lt;0.2</td>
<td>51.5</td>
<td>4539</td>
<td>55.7</td>
<td>12.6</td>
<td>48.8</td>
<td>&lt;3.0</td>
<td>51.8</td>
<td>35.7</td>
<td>44.2</td>
<td>40.2</td>
<td>0.073</td>
</tr>
<tr>
<td>7</td>
<td>&lt;0.2</td>
<td>45.7</td>
<td>5947</td>
<td>76.4</td>
<td>5.54</td>
<td>47.3</td>
<td>&lt;3.0</td>
<td>25.0</td>
<td>40.8</td>
<td>17.6</td>
<td>14.9</td>
<td>0.090</td>
</tr>
<tr>
<td>8</td>
<td>&lt;0.2</td>
<td>55.5</td>
<td>6293</td>
<td>84.8</td>
<td>4.55</td>
<td>42.2</td>
<td>&lt;3.0</td>
<td>26.5</td>
<td>41.8</td>
<td>17.2</td>
<td>16.4</td>
<td>0.064</td>
</tr>
<tr>
<td>9</td>
<td>&lt;0.2</td>
<td>48.9</td>
<td>5326</td>
<td>87.3</td>
<td>5.60</td>
<td>46.2</td>
<td>&lt;3.0</td>
<td>26.1</td>
<td>42.4</td>
<td>22.3</td>
<td>16.5</td>
<td>0.062</td>
</tr>
<tr>
<td>10</td>
<td>&lt;0.2</td>
<td>53.6</td>
<td>5865</td>
<td>85.4</td>
<td>7.70</td>
<td>44.8</td>
<td>&lt;3.0</td>
<td>34.1</td>
<td>45.3</td>
<td>29.5</td>
<td>23.8</td>
<td>0.023</td>
</tr>
</tbody>
</table>
concentrations in sediments were reported; (2) identifying the ranges in chemical concentrations that were rarely, occasionally, or frequently associated with effects; and (3) determining the incidence of biological effects within each of the ranges in concentrations for each chemical as an estimate of guideline accuracy (Long et al., 1995). The distributions of the effects data were determined using percentiles. The lower 10th percentile of the effects data for each chemical was identified and referred to as effects range-low (ERL). The median, or 50th percentile of the effects data, was identified and referred to as the effects range-median (ERM). The two guideline values, ERL and ERM, delineate three concentration ranges for trace metals: (1) concentrations below the ERL value represent minimal-effects range (effects on organisms would rarely be observed); (2) concentrations equal to and above the ERL, but below the ERM, represent a possible-effects range, within which effects could occasionally occur; and concentrations equivalent to and above the ERM value represent a probable-effects range within which effects would frequently occur.

In comparing concentrations from sediments near the JLPP with published ERL and ERM values, mean concentrations for most metals are below the ERL values, meaning adverse effects would rarely be observed. All trace metal concentrations in the sediments fall below ERL values, except values for copper and arsenic, and one for mercury. All values for copper and arsenic are above the ERL values of 34 and 8.2 ppm, respectively, but well below the ERM values of 270 and 70 ppm, meaning adverse biological effects on organisms could occasionally occur. All mercury values are below ERL (0.15 ppm) and ERM (0.71 ppm), except for samples from Station 1, which exceed the ERL.

Table 4-6 presents an overview of how the measured heavy metal concentrations compare with criteria of ecological toxicity as described in this section. The following issues emerge:

- Stations 2 and 4 (relatively close to the ash outfall and the OCP discharge channel) have copper concentrations in the seawater above the acute toxicity criterion.

- Station 1 (close to the OCP outfall) has sediment mercury levels above the ERL criterion (biological effects possible).

- Station 10 (near the port) exceeds the chronic toxicity criterion for mercury in seawater.
In the sediment of all stations, copper and arsenic exceed ERL (biological effects possible), but are well below ERM (biological effects probable).

Table 4-6. Water and Sediment Heavy Metal Toxicity Summary

<table>
<thead>
<tr>
<th></th>
<th>Marine Water Acute and Chronic Toxicity Criteria&lt;sup&gt;a&lt;/sup&gt;</th>
<th>ERL and ERM Sediment Guidelines&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>Cu</td>
<td>Stations 2 and 4 above both criteria, all other stations</td>
<td>All stations above ERL, but well below ERM</td>
</tr>
<tr>
<td></td>
<td>below both criteria</td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>Mn</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>Ni</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>Pb</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>Se</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>Zn</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>As</td>
<td>All stations well below both criteria</td>
<td>All stations above ERL, but well below ERM</td>
</tr>
<tr>
<td>Cr</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>V</td>
<td>All stations well below both criteria</td>
<td>All stations below both criteria</td>
</tr>
<tr>
<td>Hg</td>
<td>Station 10 above chronic criterion, all other stations</td>
<td>Station 1 above the ERL, all other</td>
</tr>
<tr>
<td></td>
<td>below both criteria</td>
<td>stations below both criteria</td>
</tr>
</tbody>
</table>

<sup>a</sup> TNRCC, 1995

<sup>b</sup> Long et al., 1995. At or above ERL, biological effects could occasionally occur. At or above ERM, biological effects will frequently occur.

4.1.5 Groundwater

The groundwater is encountered about 6 m below ground level. Typically at such close proximity to the sea, saltwater intrudes below a freshwater lens. The interface between the two is usually well-defined and referred to as the halocline. It moves up and down with the tides. At this site, the freshwater lens is probably recharged from the plains between Casablanca and Safi (Radian, 1995).
Local residents use a drinking water well located outside the fence line near the main entrance of JLPP. During the Phase II EA, water from the drinking water well was sampled. Concentrations of oil and grease (11.5 mg/L) and total petroleum hydrocarbons (TPH) (0.2 mg/kg) were found in the drinking water. The Project guideline discharge criterion for oil and grease is 20 mg/L, but no drinking water standard was found. Similar levels of oil and grease were found in sampling wells around the site. The cause of this is unclear, but the uniformity of the data suggests a source other than point contamination from JLPP operations. Metals were also detected in the groundwater, but these were attributed to the regional content of metals in the subsurface soil, rather than to JLPP site activities (Radian, 1995).

4.1.6 Noise

Noise can be defined as unwanted sound. Its volume is measured in units of energy or pressure called decibels (dB). Noise has both quantity and quality. The quality of the noise is affected by its pitch, or frequency. Sound levels that are weighted to approximate the frequency detected by the human ear are called A-weighted decibels or dBA. Table 4-7 presents common sounds and typical dBA that are associated with these sounds. Community noise guidelines rely on "day-night" average sound levels measured in dBA. The day-night average, or Ldn, weights nighttime noise 10 dBA higher because communities are more sensitive to night time noises. As shown in Table 2-5, the Project guideline for community noise is 55 Ldn at the nearest residential area. This level was set to avoid interference from enjoyment of outdoor activities and is more protective than is necessary from a human health standpoint. The level of 70 dBA is adequate to protect against hearing loss for anyone exposed to this level on a long term basis (EPA, 1974).

A baseline noise survey was conducted around the fenceline of the JLPP in May 1996 using a hand held instrument that measures dBA averaged over a 30-second period. The 11 noise sampling locations are shown in Figure 4-3 along with the Ldn levels for these locations. Also, an additional sampling location (Site No. 11) was established on top of the bluff opposite the JLPP. This point is representative of the residential areas located on top of the bluff, although not at any specific residence. The results of the baseline survey are as follows:
Table 4-7. Common Noise Levels in dBA

<table>
<thead>
<tr>
<th>Sound</th>
<th>dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold of hearing</td>
<td>0</td>
</tr>
<tr>
<td>Breathing</td>
<td>10</td>
</tr>
<tr>
<td>Quiet bedroom at night</td>
<td>20</td>
</tr>
<tr>
<td>Library</td>
<td>40</td>
</tr>
<tr>
<td>U.S. EPA guideline for avoidance of interference with quiet residential outdoor enjoyment</td>
<td>55 Ldn</td>
</tr>
<tr>
<td>Normal conversation</td>
<td>60</td>
</tr>
<tr>
<td>Busy traffic intersection</td>
<td>90</td>
</tr>
<tr>
<td>Power lawn mower</td>
<td>100</td>
</tr>
<tr>
<td>Loud motorcycle</td>
<td>110</td>
</tr>
<tr>
<td>Jet aircraft at 6 m</td>
<td>140</td>
</tr>
</tbody>
</table>

Reference (Radian, 1993)

When compared with the World Bank 1988 guidelines, 10 of the 11 fenceline measurements were below the 70 Ldn guideline for industrial and agricultural land uses. (The immediate area surrounding the power plant is industrial with some cultivated farmland on the bluff.) The one measurement above the 70 Ldn guideline was only marginally above at 70.9 Ldn. As shown in Table 4-8 and Figure 4-3, the dominant noise source for sites on the south end of the plant was the generating units. Only one of the units was in operation at the time of the measurements. However, the operation of the second unit would be expected to increase sound levels by no more than 3 dBA. On the other hand, wind conditions during the survey may have accounted for several decibels. The dominant noise sources for the sites to the north were the equipment associated with the port or coal handling. For some of the sites, the dominant nighttime noise source were natural sounds such as the roar of the ocean, croaking frogs, and chirping crickets. Given that the 70 Ldn level was initially set by the U.S. Environmental Protection Agency (U.S. EPA) to be fully protective of hearing “with an ample margin of safety,” the fenceline levels do not pose a problem with respect to the immediate surrounding land uses (port, rail line, cultivated land beyond the railroad, power plant site area outside of the security fence).
Table 4-8. Radian Noise Survey Results

<table>
<thead>
<tr>
<th>Sample Site</th>
<th>Daytime (dBA)</th>
<th>Dominant Noise</th>
<th>Nighttime (dBA)</th>
<th>Dominant Noise</th>
<th>Day-Night Ave Ldn</th>
<th>Project Guidelines (Ldn)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Main gate</td>
<td>65.3</td>
<td>Generating unit</td>
<td>63.2</td>
<td>Generating units</td>
<td>69.9</td>
<td>70.0</td>
</tr>
<tr>
<td>2. East fenceline</td>
<td>63.4</td>
<td>Generating unit</td>
<td>59.9</td>
<td>Generating units</td>
<td>67.0</td>
<td>70.0</td>
</tr>
<tr>
<td>3. East fenceline</td>
<td>61.7</td>
<td>Generating unit</td>
<td>56.6</td>
<td>Frogs</td>
<td>64.2</td>
<td>70.0</td>
</tr>
<tr>
<td>4. East fenceline</td>
<td>57.6</td>
<td>Pump yard motors</td>
<td>52.4</td>
<td>Generating units</td>
<td>60.0</td>
<td>70.0</td>
</tr>
<tr>
<td>5. East fenceline</td>
<td>60.5</td>
<td>Port equipment</td>
<td>44.0</td>
<td>Generating units</td>
<td>59.0</td>
<td>70.0</td>
</tr>
<tr>
<td>6. Northeast corner</td>
<td>64.0</td>
<td>Port equipment</td>
<td>45.6</td>
<td>Crickets</td>
<td>62.3</td>
<td>70.0</td>
</tr>
<tr>
<td>7. West fenceline</td>
<td>54.2</td>
<td>Port equipment</td>
<td>48.8</td>
<td>Ocean</td>
<td>56.5</td>
<td>70.0</td>
</tr>
<tr>
<td>8. West fenceline</td>
<td>57.2</td>
<td>Ocean</td>
<td>57.4</td>
<td>Ocean</td>
<td>63.8</td>
<td>70.0</td>
</tr>
<tr>
<td>9. West fenceline</td>
<td>61.7</td>
<td>Generating units</td>
<td>62.8</td>
<td>Generating units</td>
<td>69.1</td>
<td>70.0</td>
</tr>
<tr>
<td>10. Southwest corner</td>
<td>64.1</td>
<td>Generating units</td>
<td>64.6</td>
<td>Generating units</td>
<td>70.9</td>
<td>70.0</td>
</tr>
<tr>
<td>11. Offsite - residential receptor</td>
<td>53.3</td>
<td>Generating units</td>
<td>49.3</td>
<td>Generating unit</td>
<td>56.6</td>
<td>55.0</td>
</tr>
<tr>
<td>12. Northwest corner</td>
<td>66.6</td>
<td>Port equipment</td>
<td>47.6</td>
<td>Port equipment</td>
<td>64.8</td>
<td>70.0</td>
</tr>
</tbody>
</table>

1. All readings are 30 second Leq
2. World Bank 1988 guidelines
Figure 4-3. Baseline Noise Survey Results
Site number 11 is located on top of the bluff in view of the JLPP. It is a conservative representation of the nearest residential area outside the JLPP site. The single measurement of 56.6 Ldn is marginally above the 55 Ldn annual average World Bank 1988 Guideline level. This level was set by the U.S. EPA to avoid interference from outdoor enjoyment of quiet residential areas. Most of the residences in the settlements on top of the bluff are located further away from the edge of the bluff and therefore shielded from ground level power plant noises. We would expect these residences to be subject to even lower noise.

4.2 The Biological Environment

4.2.1 Terrestrial Biota

Flora and Fauna

A vegetation map of Africa classifies the natural vegetation for the Atlantic and Mediterranean coastal areas of Morocco, including the area near the JLPP, as Mediterranean evergreen forest-hard-leaf scrub. However, few remnants of the natural vegetation appear to currently remain in the area. The current vegetation in the area is probably most accurately classified as a Mediterranean Anthropic Landscape (White, 1983). White (1983) states that "most fertile lowlands have been cultivated since Roman times, and few vestiges of natural vegetation remain. Wheat is the most widely planted crop, but peas, beans, and onions are plentiful, and there are many groves of olive, citrus, fig, and grape." Hedge rows are composed of Agave, Acacia karro, Arundo donax, and Opuntia. Eucalyptus and Pinus halepensis are planted locally as windbreaks and for fuel and timber (White, 1983). Sparse plant cover of shallower soils are grazed by sheep and cattle, and overstocking causes soil erosion. Rocky areas support Ziziphus lotus, dwarf Chamaerops, and unpalatable herbs such as Ferula communis, Asphodelus microcarpus, and Urginea maritima.

Vegetation observed in April near the JLPP included wild flowers of the family Compositae (possibly of the genus Helianthes), thistles, Daucus sp. of the carrot family, Umbelliferae, the grass, Sporobolus sp., and a scrubby oak or Quercus sp. On slopes above the JLPP, a blooming succulent or halophytic species (cf. Portulaca oleracea) was abundant. The

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1 There is a residence apparently on the JLPP site but outside the security fence. It is located beyond site number 2 and therefore would be expected to have an Ldn of below 65.
same species was also seen growing on beach dunes near El Jadida. There were also several areas near the JLPP that were devoid of vegetation.

Fields of corn and wheat are common near the JLPP. Along the road to Agadir, to the south of the JLPP, "truck farms" of carrots, onions, tomatoes, and other species were seen growing near the road or between the road and the Atlantic shoreline. Hedgerows along the road were composed of *Arundo donax* and *Tamarix* sp. Palustrine or estuarine wetlands were not observed near the powerplant, nor were seagrasses or submerged aquatic vegetation seen in the shallow, subtidal areas. Green algae were common on the rocks along the shoreline.

The only terrestrial animals observed in the immediate vicinity of the JLPP during the field trip in April 1996 were domesticated farm animals and pets.

**Endangered or Threatened Species**

A total of 10 endangered or threatened species are listed as having their historic range or may have their historic range in Morocco (USFWS, 1994). These are shown in Table 4-9. None of these were observed during biological field investigations in April 1996. It is considered unlikely that these species would be within JLPP boundaries. Five of the 10 species are endangered mammals, one is an endangered bird, and four are endangered or threatened sea turtles. The sea turtles' historic ranges are listed as either circumglobal in tropical and temperate oceans or tropical and temperate seas, and, therefore, may occur on the Atlantic coast of Morocco. The loggerhead sea turtle has been observed on the Atlantic Coast of Morocco (Brongersma, 1972). None of these species was observed or is believed to be present at the JLPP site.

Table 4-9. Status of Endangered or Threatened Species That May Have Historic Ranges in Morocco

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbary deer</td>
<td><em>Cervus elaphus barbarus</em></td>
<td>E</td>
</tr>
<tr>
<td>Cuvier's gazelle</td>
<td><em>Gazella cuvieri</em></td>
<td></td>
</tr>
<tr>
<td>Mhorr gazelle</td>
<td><em>Gazella dama mhorr</em></td>
<td>E</td>
</tr>
<tr>
<td>Moroccan gazelle</td>
<td><em>Gazella dorcas massaesyla</em></td>
<td>E</td>
</tr>
<tr>
<td>Barbary hyena</td>
<td><em>Hyaena hyaena barbara</em></td>
<td>E</td>
</tr>
<tr>
<td>Spanish imperial eagle</td>
<td><em>Aquila heliaca adalberti</em></td>
<td>E</td>
</tr>
<tr>
<td>Green sea turtle</td>
<td><em>Chelonia mydas</em></td>
<td>E</td>
</tr>
<tr>
<td>Kemp's ridley sea turtle</td>
<td><em>Lepidochelys kempi</em></td>
<td>E</td>
</tr>
<tr>
<td>Leatherback sea turtle</td>
<td><em>Dermochelys coriacea</em></td>
<td>E</td>
</tr>
<tr>
<td>Loggerhead sea turtle</td>
<td><em>Caretta caretta</em></td>
<td>T</td>
</tr>
</tbody>
</table>

E=endangered; T=threatened
4.2.2 Marine Biota

**Macrobenthos**

Bottom sediments develop communities of invertebrates that live on and in these sediments. Included in the fauna, referred to as the benthos, are polychaete annelid worms; clams or bivalves (Molluscs of the Class Pelecypoda); snails or gastropods (Molluscs of the Class Gastropoda); species of crabs and other smaller crustaceans; echinoderms, such as brittlestars (Class Ophiuroidea); and other groups. Macrobenthic invertebrates are here defined as those invertebrates larger than 2 mm.

This study is generally a qualitative or semiquantitative characterization of the macrobenthos near the JLPP. This is probably the first study of the macrobenthos in the nearshore Atlantic near the JLPP. Previous sampling efforts (LPEE, 1944; ONE, 1994) did not include the macrobenthos.

**Materials and Methods**—As mentioned in a previous section on surface water and sediment quality, surficial sediment samples were taken at each station (Figure 4-2) with a Wildco Ponar grab sampler. Approximately one grab sample per station was analyzed for macrobenthos. Sediment samples were washed through a 2.0 mm screen and stored in a solution of 10% formalin. Samples were then examined microscopically at the LPEE laboratories, and organisms were identified to species level, when possible, and counted.

**Results and Discussion**—A total of 19 macrobenthic species were found in surficial sediments from the 10 stations near the JLPP. Four invertebrate phyla were represented. Molluscs dominated, both in number of species (15) and individuals (57). The most abundant molluscan species were the pelecypods, *Donax sp.* and *Mactra sp.*, and the gastropod, *Vermetus* sp. *Donax* was the only molluscan species with more than two individuals at a station. Barnacles (*Balanus* sp. and *B. perforans*) were relatively abundant at two stations. Although polychaetes were not abundant in any of the samples and only present at two stations, sediments from stations 6 and 10 had worm tubes of cemented sand grains, possibly of the polychaete families Oweniidae or Pectinariidae. The limpets (molluscan family Patellidae), barnacles, and the gastropod, *Vermetus* sp., may be found on the rocks near the shoreline. These results are summarized in Table 4-10.
Table 4-10. Macrobenthic Species and Numbers of Individuals Per Station

<table>
<thead>
<tr>
<th>Species</th>
<th>Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum Mollusca</td>
<td></td>
</tr>
<tr>
<td>Class Pelecypoda</td>
<td></td>
</tr>
<tr>
<td>Family Mytilidae</td>
<td></td>
</tr>
<tr>
<td>Mytilus barbatus</td>
<td>1 2</td>
</tr>
<tr>
<td>Perna pecta</td>
<td></td>
</tr>
<tr>
<td>Mytilus galloprovincialis</td>
<td>2 1</td>
</tr>
<tr>
<td>Mytilus edulis</td>
<td></td>
</tr>
<tr>
<td>Family Donacidae</td>
<td></td>
</tr>
<tr>
<td>Donax sp.</td>
<td>6 5 4</td>
</tr>
<tr>
<td>Family Thraciidae</td>
<td></td>
</tr>
<tr>
<td>Thracia sp.</td>
<td>2</td>
</tr>
<tr>
<td>Family Mactridae</td>
<td></td>
</tr>
<tr>
<td>Mactra sp.</td>
<td>1 2 1</td>
</tr>
<tr>
<td>Family Veneridae</td>
<td></td>
</tr>
<tr>
<td>Venerupis sp.</td>
<td>2</td>
</tr>
<tr>
<td>Circumphalus sp.</td>
<td></td>
</tr>
<tr>
<td>Family Cardiidae</td>
<td></td>
</tr>
<tr>
<td>Acanthocardia sp.</td>
<td>2</td>
</tr>
<tr>
<td>Class Gastropoda</td>
<td></td>
</tr>
<tr>
<td>Family Vermetidae</td>
<td></td>
</tr>
<tr>
<td>Vermetus sp.</td>
<td>2 1 2 2</td>
</tr>
<tr>
<td>Family Patellidae</td>
<td></td>
</tr>
<tr>
<td>Patella nigra</td>
<td>1 1 2</td>
</tr>
<tr>
<td>Patella caerulea</td>
<td>2 2 1</td>
</tr>
<tr>
<td>Family Littorinidae</td>
<td></td>
</tr>
<tr>
<td>Litorina saxatilis</td>
<td>2</td>
</tr>
<tr>
<td>Family Nassaridae</td>
<td></td>
</tr>
<tr>
<td>Hinia reticulata</td>
<td>1 2</td>
</tr>
<tr>
<td>Phylum Arthropoda</td>
<td></td>
</tr>
<tr>
<td>Class Crustacea</td>
<td></td>
</tr>
<tr>
<td>Subclass Cirripedia</td>
<td></td>
</tr>
<tr>
<td>Balanus perforans</td>
<td>10</td>
</tr>
<tr>
<td>Balanus sp.</td>
<td>10</td>
</tr>
<tr>
<td>Subclass Malacostraca</td>
<td></td>
</tr>
<tr>
<td>Order Decapoda</td>
<td></td>
</tr>
<tr>
<td>Pagurus sp.</td>
<td>3 2</td>
</tr>
<tr>
<td>Phylum Annelida</td>
<td></td>
</tr>
<tr>
<td>Class Polychaeta</td>
<td>3 2</td>
</tr>
<tr>
<td>Phylum Echinodermata</td>
<td></td>
</tr>
<tr>
<td>Class Ophiuroidea</td>
<td></td>
</tr>
<tr>
<td>Ophiura sp.</td>
<td>1</td>
</tr>
</tbody>
</table>
Stations 4, 8, and 9 were the most diverse in terms of numbers of species, with seven species at each station. Station 7 had no macrobenthic species, and stations 1 and 2, only one species apiece. Although species richness and abundance was generally very low, this may be typical for this high-energy, nearshore benthic environment (LPEE, 1996).

**Pelagic and Demersal Fish and Invertebrates**

Pelagic and demersal fish and invertebrates were collected in the nearshore Atlantic Ocean near the JLPP. The term pelagic, in this case, refers to those fish species that were caught primarily near the surface or in the water column and that probably feed on zooplankton (microscopic animals) or nekton (other smaller fish or invertebrates) in the water column. Demersal fish and invertebrates are those species that were caught primarily on or near the bottom, and feed, primarily, on benthic invertebrates that live on or in the sediments or vegetation attached to the rocks. The line between plankton or demersal feeding is generally not sharp.

This part of the marine biology study is a qualitative characterization of the fish and invertebrate fauna living in the nearshore Atlantic Ocean near the JLPP. Previous sampling efforts (LPEE, 1994; ONE, 1994) did not include fish sampling in their studies. Although commercial and recreational fishing is conducted near the JLPP, this is probably the first time the fish community near the JLPP has been described.

**Materials and Methods**—Both pelagic and demersal fish and invertebrates were collected with a gillnet. The net used for surface fishing was 80 m by 5.6 m, the one used for bottom fishing was 70 m by 2.8 m. The fish and invertebrates were collected over a 5 day period, primarily near stations 1 and 2 and stations 7 and 8, as shown in Figure 4-2 and Table 4-11. The gillnet was set at 7 pm each sample day and then retrieved at 8 am the next day. It was set up at different distances from shore, hence the terms ocean-side or shore-side samples, as shown in Table 4-11. Tides during the sampling periods were generally high when the net was set during the early evening, low in the early morning hours, then high again when the net was retrieved.
<table>
<thead>
<tr>
<th>Fish</th>
<th>Pelagic Species</th>
<th>Densal Species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Near Stations 1 &amp; 2</td>
<td>Near Stations 7 &amp; 8</td>
</tr>
<tr>
<td>Diplodus vulgaris</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Diplodus sargus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diplodus senegalensis</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Belone svetovidivi</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Trachinotus ovalus</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Trachurus trachurus</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Scomber japonicus</td>
<td>3*</td>
<td>1</td>
</tr>
<tr>
<td>Lepidopus caudatus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sardina aurita</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Sardina pilchardus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dicologoglossa cuneata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campogramma glycyos</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sarpa salpa</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Crustaceans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maja squinado</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Scyllarus arcus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Callinectes palidus</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*100m Southwest, ocean side
Results and Discussion

A total of 13 fish and 3 invertebrates species were collected from the nearshore Atlantic Ocean near the JLPP (Table 4-11). Fish abundance and diversity at each sample location and in the area, in general, was low. Of the pelagic species, the ocean-side sample near stations 1 and 2 was the most diverse in terms of species richness, with five total species. Demersal fish species were also most abundant in the ocean-side sample near stations 1 and 2 (five total species). The most abundant pelagic fish species was the sardine, *Sardina pilchardus*; however, with only 4 individuals from near stations 7 and 8, it was not very abundant. The most abundant demersal fish species was the porgy, *Diplodus vulgaris*, occurring at 3 of the 4 demersal sample locations.

Demersal species also included crustaceans, the spider crab, *Maja squinado*, the lobster, *Scyllarus arcus*, and the portunid or swimming crab, *Callinectes pallidus*. *Maja squinado* was relatively abundant, occurring in all four demersal samples. The ocean-side sample near stations 1 and 2 contained all three crustacean species.

The diversity and quantity of fish and benthos in the sediments is considered low. This investigation did not determine the cause of these apparently low quality marine biological conditions. The high energy shoreline (rocky beach and heavy wave action) may reduce marine biodiversity. High metals concentrations in seawater and sediments may also be a contributing factor.

4.3 The Social and Cultural Environment

This section briefly describes the history, demography, economics, and land use of the country and the area around the JLPP. Because of the coastal location of the JLPP and the importance of fishing to Moroccan economy, Moroccan fisheries are discussed in this section as well. Finally, local infrastructure, aesthetics, and proximity of parks and natural areas to the JLPP are briefly addressed.

4.3.1 History and Archeology

The first identified group of people in Morocco was the Berber population which is believed to have entered northwest Africa from Asia in the second millennium BC. From the earliest days of its history, the Moroccan coasts attracted various civilizations in search of trading ports, agricultural resources, and raw materials. There was some Roman influence along the Mediterranean and north Atlantic coastal areas, but the Roman influence was superficial and did
not extend down to El Jadida and Jorf Lasfar areas. From the 8th through the 12th centuries, Arabic invasions resulted in the spread of Islam in urban areas of Morocco. Over the next two centuries Islam dominated the entire country (Nelson, 1985).

From the 11th through the 13th centuries, three Berber dynasties ruled Morocco, building an empire that extended from Libya to Spain with Marrakesh as its capital. In the 15th century, this "Moorish" culture and reign began to decline. By the early 16th century the Portuguese had established a series of forts along the Atlantic Coast. The last of the fortress cities to remain in Portuguese hands was Mazagan. Founded at the site of an older Almohad fortress, Mazagan fell to local forces in 1769. Mazagan is now the city of El Jadida and is the closest site to the JLPP of predominant historical significance (Simonis, 1995). The site of the old Portuguese city in El Jadida and the Moulay Abdellah Amghar site are located 17 km north of the JLPP (Elhaiba, 1996).

During the 19th century Europeans began to establish trade with Morocco. Various European powers contested for control of North Africa with the French gaining the upper hand in late 19th and early 20th centuries. The French controlled Morocco until the country became independent in 1956. Spain still retains authority over a few small coastal enclaves. The French developed ports and highways and began the process of industrialization. French along with Arabic is widely spoken among urban educated Moroccans.

The nearest archeological site to the JLPP has been identified as Tit's Minaret and archeological wall, located eight km north of the JLPP (Elhaiba, 1996) in Moulay Abdellah. There are no historical or archeological resources located on land that would be affected by the construction and operation of Units 3 and 4 of the JLPP.

4.3.2 Demographics

As shown in Table 4-12, the 1994 census showed that Morocco's population was more than 26.5 million. The mid-1995 population estimate for the country was 29.2 million. The current rate of population increase is estimated at 2.2%. By contrast the annual growth rate in France is 0.3%; the annual world population growth rate is 1.5% (Johnson, 1996). High birth rates have resulted in an increasingly youthful median age. More than half of the population is under 20 years old (Simonis, 1995). The growth in population has been focused in the country's largest urban areas. During the 1980s annual urban population growth rates were about 4.5%.
compared to about 1.5% for the rural areas (EIU, 1990). Rural areas still account for about half of Morocco's population. Literacy rates in rural areas are 23% compared to about 64% in urban areas (Simonis, 1995).

Table 4-12. Population Growth for Morocco, El Jadida Province, and Commune Moulay Abdellah

<table>
<thead>
<tr>
<th></th>
<th>1982</th>
<th>1994</th>
<th>% Annual Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morocco</td>
<td>20,265,000</td>
<td>26,544,000</td>
<td>+2.2</td>
</tr>
<tr>
<td>El Jadida Province</td>
<td>766,198</td>
<td>970,894</td>
<td>+2.2</td>
</tr>
<tr>
<td>Moulay Abdellah Commune</td>
<td>24,718</td>
<td>30,926</td>
<td>+2.0</td>
</tr>
</tbody>
</table>

Source: Moroccan census data from Elhaiba, 1996 and Findlay, 1985

Morocco consists of 40 provinces. The JLPP is located in El Jadida Province which has as its provincial capital the city of El Jadida. Outside of the urban areas, the provinces are composed of rural communes of which there are more than 750 (Nelson, 1985). The JLPP and the immediate surrounding area is in the Commune of Moulay Abdellah. As shown in Table 4-12, the population of El Jadida province is almost 1 million, while the population of Moulay Abdellah Commune was just over 30,000. The cluster of settlements on the bluff above the JLPP is called Oulad Ghadbane Center. It consists of 489 families (Elhaiba, 1996). More than two-thirds of the population of El Jadida province lives in rural communes (Nelson, 1985).

At least one-fourth of the population are native Berber-speakers and the most of the remainder are native Arabic speakers. The distinction between Berbers and Arabs in Morocco is largely linguistic because of the centuries of intermarriage between the two groups. Those living in the vicinity of the JLPP are Arabic speakers.

4.3.3 Economic Conditions

The Moroccan economy is composed of three principal sectors: mining, agricultural, and everything else. The mining sector is dominated by phosphates. Morocco has the largest reserves of phosphates in the world and is the largest exporter of phosphates and the third largest
producing country. The phosphate industry includes mining and export of phosphate rock and manufacturing of phosphate derivatives such as phosphoric acid and fertilizers. Phosphate and its derivatives are the single most important export (U.S. State Department, 1994). The largest phosphate manufacturing complex in the country is located immediately adjacent to the JLPP. Most of the phosphate is mined between 100 and 200 km to the east of the Jorf Lasfar area at the Khouribga and the Youssoufia mines. More than 24,000 persons are employed directly by the OCP.

Agriculture employs about 40% of the work force and generates almost one fifth of the nation's gross domestic product. Morocco is a net exporter of fruits and vegetables and a net importer of cereals. The main crops in Morocco are sugar beets, sugar cane, vegetables and cereals. (Nelson, 1985). With only about 3% of the nation's population, the Province of El Jadida accounts for 38% of the country's fruit production, 35% of the sugar production, 13% of the milk and meat production, and 11% of the cereal production (Elhaiba, 1996).

Vegetables, such as carrots and tomatoes, and cereals, such as barley, are grown in the farms around the JLPP. The farming is done on small plots using traditional methods and relatively little modern equipment such as tractors. Large scale hot houses are common south of the JLPP where tomatoes are grown hydroponically. Sheep, cattle, and goats graze in areas not suitable for cultivation. The fishing industry has developed rapidly during the 20th century. See Section 4.3.4 for a discussion of commercial fisheries.

The third leg of the Moroccan industry is a rapidly growing and a diversified mix of industries, such as textiles, and services such as tourism. Tourism is becoming an important growth industry in El Jadida province as mainly European visitors discover the beauty of the Moroccan Atlantic Coast. The beaches between Jorf Lasfar and El Jadida are becoming a popular tourist area; the coastal stretch south of the JLPP also appears to be conducive to future beach resorts.

Political System and Economic Privatization

The Moroccan government is a constitutional monarchy. The country is transitioning to a modern market economy. Through the appointment of the provincial governors and the administrative chiefs that oversee the rural communes, the king still maintains considerable
authority. Much of the planning function and the recommendation of legislative matters is in the hands of elected officials.

In addition to moving the country in the direction of a Western style democracy, the king is also promoting privatization of many previously government-owned industries. Privatization and other economic reforms (such as fiscal restraint, removing trade barriers, reduced barriers to business formation) are credited with reducing inflation and poverty rates. The rate of inflation has been reduced from 12% per year in the mid-1980s to 5% in the mid-1990s. According to the Moroccan government, between 1985 and 1994 the number of families living in poverty dropped by one third and per capita income doubled to an equivalent of $1100 (U.S.) (Simonis, 1995).

Privatization has the support of the king and the elected officials. The National Assembly voted overwhelmingly to sell 113 government-owned enterprises in 1989 (EIU, 1990). During the 1990s the pace of privatization has continued. The proposed acquisition and expansion of the JLPP by the Project Sponsors will be the single largest privatization initiative for Morocco and will be the first of the country's electric power facilities to be privatized.

Employment and Unemployment
Despite the relative improvement of the Moroccan economy, the gross domestic product per capita in Morocco is still only about one half the world average of U.S. $5200 in 1993 (Simonis, 1995). The economy is having a difficult time outpacing its population growth. This results in relatively high unemployment rates.

Unemployment is a problem—particularly among the growing ranks of young adults. The government reports an unemployment rate of 16% in 1993 which is roughly twice that of most developed countries (Johnson, 1996). Others report higher unemployment rates nearing 20%. The unemployment rate for young adults is twice the general rate (Simonis, 1995). No unemployment rate data were available for the local area: El Jadida Province and Moulay Abdellah Commune.

Agriculture employs 60% of the active population of the Moulay Abdellah Commune. The largest employer in the area is the OCP phosphates plant which employs 3200 persons. The Office d'Exploitation des Ports (ODEP) employs 140 persons full time but provides temporary work for about 1000 dock workers (Elhaiba, 1996). The JLPP employs 144 persons full time.
The activities of the port are discussed more fully below. The great majority of the full-time personnel at the ODEP, OCP, and JLPP live in El Jadida and are transported to their jobs by bus.

**Importance of Electric Power to the Future of Economic Growth**

More than 80% of Morocco's rural population is without electric power. During the late 1980s and early 1990s, electric power supplies were not sufficient to meet power demands. In 1993, demand for electric power reached 1850 MW—20% higher than available supplies. The lack of available power resulted in load shedding, "blackouts" and "brownouts." These curtailments resulted in an estimated 1% drop in the gross national product (World Bank, 1994a and 1994b). The power shortages significantly reduced productivity and raised product costs. The cause of the power shortages was a combination of reduced hydroelectric output as a result of drought conditions, increased operating problems at thermal electric plants, and failure to bring on new power plants (World Bank 1994b).

In order to keep pace with the growing demand for power—which will increase much faster than overall population and economic growth because of the extension of electric power to rural villages—ONE has initiated an ambitious power expansion plan. Table 4-13 presents the projected power demand growth for the 1993 through year 2000 period (World Bank, 1994a).

The Jorf Lasfar Units 1 and 2 together with the proposed Units 3 and 4 play a critical role in Morocco's plans to establish adequate supplies. By the year 2000, the four JLPP units will account for one third of Morocco's total installed capacity and (as discussed in Section 6) approximately half of its projected generation of electricity. Clearly, the proposed expansion of the JLPP is vital to the economy of Morocco.

**4.3.4 Commercial Fisheries**

Commercial fishing is important to the Moroccan economy. In 1991, the Moroccan catch was 600,082 tonnes. It has ranged between 500,000 and 600,000 tonnes since 1986, the first time it exceeded 500,000 tonnes. This suggests that, overall, some limit of fisheries productivity has been reached off Moroccan coasts. In 1986, the Moroccan fishing industry employed 100,000 people (American Consulate General, 1987). No more recent data on fisheries employment were found, but, based on the stable annual catch, there is no reason to believe that the number would have risen substantially since then. Approximately three-quarters of the catch is from coastal fisheries; the rest is from deep sea fisheries. Approximately 87% of the coastal
## Table 4-13. Morocco - Power Capacity Balances - MW. (Based on firm capacity)

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>A. Peak Demand</strong></td>
<td>1850</td>
<td>1925</td>
<td>2060</td>
<td>2205</td>
<td>2360</td>
<td>2525</td>
<td>2700</td>
<td>2890</td>
</tr>
<tr>
<td><strong>B. Existing Hydro</strong></td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
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<tr>
<td><strong>C. Planned Hydro</strong></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>- Matmata (240 MW)</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>80</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>- Alwahda (248 MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>35</td>
<td>35</td>
<td>35</td>
<td>35</td>
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<tr>
<td>- M'Dez (52 MW)</td>
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<td></td>
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<tr>
<td>- El Menzel (148 MW)</td>
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<tr>
<td>- D.E.O. (92 MW)</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Total Firm Hydro Capacity</strong></td>
<td>50</td>
<td>210</td>
<td>210</td>
<td>210</td>
<td>290</td>
<td>290</td>
<td>325</td>
<td>463</td>
</tr>
<tr>
<td><strong>E. Existing Thermal</strong></td>
<td>1520</td>
<td>1605</td>
<td>1605</td>
<td>1605</td>
<td>1650</td>
<td>1470</td>
<td>1470</td>
<td>1470</td>
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<tr>
<td><strong>F. Planned Thermal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>- Gas Turbines (200 MW)</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
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<tr>
<td>- IPP Heavy Fuel (350 MW)</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
<td>350</td>
</tr>
<tr>
<td>- J. Lasfar III (330 MW)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>- J. Lasfar IV (330 MW)</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G. Total Thermal Capacity</strong></td>
<td>1520</td>
<td>2135</td>
<td>2465</td>
<td>2465</td>
<td>2510</td>
<td>2805</td>
<td>3690</td>
<td>3690</td>
</tr>
<tr>
<td><strong>H. Less Thermal Plant Outages</strong></td>
<td>360</td>
<td>523</td>
<td>682</td>
<td>682</td>
<td>684</td>
<td>699</td>
<td>743</td>
<td>743</td>
</tr>
<tr>
<td><strong>I. Total Firm Thermal Capacity</strong></td>
<td>1160</td>
<td>1612</td>
<td>1783</td>
<td>1783</td>
<td>1826</td>
<td>2106</td>
<td>2947</td>
<td>2947</td>
</tr>
<tr>
<td><strong>J. Imports from Algeria</strong></td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>300</td>
<td>300</td>
<td>300</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>K. Capacity Balance</strong></td>
<td>-490</td>
<td>47</td>
<td>83</td>
<td>88</td>
<td>56</td>
<td>171</td>
<td>572</td>
<td>520</td>
</tr>
<tr>
<td><strong>L. % Reserve</strong></td>
<td>-26</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>21</td>
<td>18</td>
</tr>
</tbody>
</table>

Source: World Bank, 1994a
production is pelagic, with sardines accounting for almost the entire tonnage of pelagic catch. Sardines represent 55% of the total Moroccan catch (Institut Scientifique de Pêches Maritimes, 1991).

The different species caught have widely different monetary value, however, so that the distribution of the tonnages does not at all correlate with the contribution of each species to the total economic value of the catch. For example, pelagic fish have a low unit value and contribute only 14% of the total value. In 1991, the high seas fishery was responsible for 64% of the total value of the Moroccan catch. Note that almost all the coastal fishery is on the Atlantic side of Morocco. Of the 1991 coastal catch, 34% was consumed, 36% was processed into byproducts, 27% was canned, and 3% was frozen.

Of four commercially valuable species (sardine, pandora, large-eyed dentex, and rose shrimp), only one (pandora) has a population concentration reported within 100 km of JLPP.

Large crustaceans like lobsters are present all along the coast, where there is extensive but undocumented subsistence fishing by local people using lobster pots and trammels. In Moulay Abdellah these people are thought to number approximately 200.

Commercial fishing out of the port of Jorf Lasfar only started in 1990. During the second quarter of 1995, 139 tons of fish were landed compared to 3,830 tons in El Jadida during the same time period. The port of Jorf Lasfar is thus a very small commercial fishing base (Direction Provinciale d’El Jadida, 1995).

There is no evidence that the existing power plant at Jorf Lasfar has had any impact on fisheries. Considering the planned improvements in water management and ash disposal accompanying the two proposed units, all marine biological resources should be even better protected in the future.

4.3.5 Land Use and Transportation

Land Use—Existing

Prior to the 1970s, the area around the current JLPP was characterized by scattered settlements (clusters of homes) and individual farms and residences. The land above the bluff has been a major agricultural area comprised of many small plots of forage grasses, grains, and
occasional vegetables. There is some irrigated agriculture south of the power plant where vegetables, such as carrots and tomatoes, are grown. Along the coastal highway south of the plant there are many large greenhouses for hydroponically grown tomatoes.

In the 1970s, the Jorf Lasfar area was selected for the site of the OCP phosphates plant. One of the largest of its kind in the world, the OCP plant was constructed on the plain above the escarpment that rises immediately east of the shoreline. The port of Jorf Lasfar was expanded to serve the OCP by shipping in sulfur and other raw materials and exporting phosphate product. The new modern port was opened in the early 1980s and serves other users including the JLPP.

Figure 4-4 generally shows the existing land uses. The three large industrial uses are the JLPP, the port, and the OCP phosphates plant. Most of the remaining land use is in agriculture. The residential land uses are the traditional settlements—clusters of stucco houses consisting of extended families. There are no new modern residential developments, such as apartments or subdivisions, to house workers at the three major industries. The workers are mainly from El Jadida and are transported to work in buses in less than a half hour commute.

The land use presents an interesting contrast of the traditional agrarian economy and lifestyle existing side-by-side with new state-of-the-art industrial facilities. The presence of the industrial activities does not seem to have affected the traditional patterns of land use and activities.

In the area depicted in Figure 4-4, the predominant land use is still agriculture including hundreds of individual scattered residences. Industrial land uses are second in areal extent, the third ranking land use is the area that is not in agriculture and is either vacant or used for grazing of sheep or goats. Within the OCP-owned property, much of the land formerly owned by small farmers has been reserved for future growth of the phosphate or related industries. Other "vacant" areas are not suitable for tillage. The quarry, which is described in Section 7, was created by the need for rock to construct the long jetties and piers at the port and at the JLPP.

Land Use—Future

Figure 4-4 also shows a projection of future land uses. Two marked areas currently not used or in agricultural use are projected to be converted to industrial or heavy commercial uses. The vacant area currently within the OCP property boundary could become occupied with expanded OCP operations or phosphate-related industries. Conceivably, this area could be
Figure 4-4. Existing and Future Land Use in the Vicinity of the JLPP
occupied by other chemical or manufacturing firms. The second area projected to be converted to industrial use is north of the OCP property, east of the port, and west and southwest of the quarry. The ODEP owns, or is acquiring, this land for use as an industrial park. There are plans for subdividing this property and developing it in phases. Several new industrial tenants have already been identified. Factors attracting the future industrial growth are the proximity of the port and the easy access to expanded electricity supplies.

With the varied industrial and commercial uses planned for this area, retail and multifamily residential uses may ultimately be developed. It is not possible at this time to project when or where these will occur. Current land use controls discourage construction worker housing near this complex (Elhaiba, 1996).

Transportation
The Jorf Lasfar area is served by paved highways, a large port, and railroad. The nearest commercial airport is in Casablanca. Route 121 is the coastal road that connects El Jadida and Casablanca to the north with Safi, Agadir, and Morocco's southern provinces. It is a two-lane highway with small segments of four lanes in the immediate vicinity of the highway exchange leading down to the port. The railroad, and multiple side tracks and spurs, connects the OCP, JLPP, and port with El Jadida and points inland.

The port of Jorf Lasfar is located 110 km southwest of Casablanca and 150 km northeast of Safi. The port was opened to international trade in 1982 and is currently one of the main ports in Morocco. Its primary cargo is phosphate and its derived products from the OCP phosphate plant.

The port infrastructure includes a cumulative length of wharf of 1955 m, 2 jetties, a water reservoir of 200 hectares, platforms of 110 hectares, 13 piers including 9 specialized piers, warehouses of 6,600 m², sulfur warehouse of 150,000 m², refrigerated warehouse of 1,800 m², and 5 km of railroads.

In 1993, the port of Jorf Lasfar handled 5.6 million tonnes of goods. Most of that (80%) was phosphate and phosphate-derived products. It is expected to become the largest mineral port in Africa. A business volume summary is provided in Table 4-14.
Table 4-14. Leading Exports and Imports of the Port of Jorf Lasfar

<table>
<thead>
<tr>
<th>Export 1993 in million tons</th>
<th>Import 1993 in million tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphoric Acid 1.1</td>
<td>Cereal 0.25</td>
</tr>
<tr>
<td>Fertilizers 1.7</td>
<td>Ammonia 0.46</td>
</tr>
<tr>
<td>Phosphate 0.4</td>
<td>Coal 0.34</td>
</tr>
<tr>
<td>Sulfur 4.3</td>
<td></td>
</tr>
</tbody>
</table>

4.3.6 Aesthetics and Protected Natural Areas

The west coast of Morocco south of El Jadida offers many scenic vistas. The land-water interface offers a variety of landscapes ranging from long stretches of white sandy beaches to rugged cliffs and rocky shorelines. Inland are gentle rocky hillsides with picturesque villages seemingly unchanged from the 19th century. The aesthetic resources are valuable in their own right but also offer the prospects of increased tourism with revenues and job opportunities for underemployed local unskilled labor. According to the Provincial Department of Tourism (DTP), tourism is a major economic boon to the area. There are more than 40,000 tourist visits a year to more than 1000 hotel rooms and restaurants (Elhaiba, 1996).

The Jorf Lasfar area with its vertical cliffs, windswept hillsides, and pastoral scenes still retains much of the original scenic value that it held prior to the development of the port, the OCP plant, and the JLPP. This is particularly true to those who view the southwest facing vertical cliffs from the escarpment above the port. The actual port and most of the JLPP facilities are not visible from distances beyond the escarpment. The JLPP stack does protrude above the escarpment. However, even the stack is not visible for more than a few kilometers on either side of the plant entrance from Route 121, the coastal highway. Photographs of the area are shown in Appendix E.

The most visually intrusive elements to the current landscape are (1) the large transmission towers leading east from the plant across the coast highway and (2) the OCP facility with its complex of storage tanks, port-to-plant conduits and pipe racks, processing facilities, and many stacks emitting visible white discharges. (The emissions from the JLPP stack were only barely visible during site visits in April 1996). The OCP facilities are more visually intrusive, in part, because they are built on the high ground above the escarpment, whereas the JLPP and port are screened from view by the terrain.
The blue waters of the Atlantic Ocean are part of the scenic resource in the immediate vicinity. The discharges from the OCP outfall create a clearly visible brown plume in the water at the outfall just south of the JLPP cooling water discharge outlet. There are no visible discharges in the water from JLPP.

There are no "wildlands", natural areas, public park, or other protected areas in the vicinity of the JLPP. The nearest public park of any kind is a beach recreational area in Sidi Bouzid, 21 km north of the JLPP (Elhaiba, 1996).
5.0 AUDIT OF EXISTING CONDITIONS

The purpose of this section is to identify environmental conditions associated with the existing JLPP based largely on Phase I and Phase II environmental assessments (EA) conducted by Radian International (Radian) in 1995. Additional information is provided from operational assessments by the Project Sponsors, and from subsequent Radian plant visits and information provided by JLPP staff.

The Phase I EA included the following tasks: a survey of the project site; preliminary evaluation of potential sources of soil, water, and air contamination; and a preliminary review of the relevant Moroccan environmental regulations applicable to the site (ABB Project, 1996). The Phase II EA included the following tasks: a review of the draft WB Guidelines; a review of the Ex-Im Bank Guidelines; research of the Morocco environmental regulations and permitting process; and an examination of the JLPP wastewater discharge, thermal discharge analysis, and atmospheric emissions compliance analysis (Radian, 1995).

The following is a discussion of potential issues related to ambient air quality, water discharges, the handling of hazardous materials, soil and groundwater contamination, and ocean ash disposal.

5.1 Air Quality

In the Phase II EA, Radian reviewed the emissions from JLPP to determine compliance with World Bank guidelines based on preliminary atmospheric emissions data from a performance guarantee test for Units 1 and 2 conducted by GEC Alsthom. The performance test included an evaluation of gaseous emissions at various boiler operating loads, burner and dampers settings with and without overfire air. $\text{NO}_x$, CO, and PM were measured and analyzed. $\text{SO}_2$ emissions were not measured; the $\text{SO}_2$ emissions were calculated using the sulfur content of the coal.

JLPP Units 1 and 2 comply with the 1988 World Bank, OPIC, and Ex-Im emission limits of these three pollutants (see Table 3-3). However, there are insufficient ambient air quality monitoring data to determine whether the ambient guidelines are achieved. Ambient monitoring data were collected for seven weeks prior to the construction of the JLPP Units 1 and 2. These
preliminary data indicate that the OCP facility located northeast of the JLPP may be the source of occasional significant short-term SO\textsubscript{2} concentrations in the area.

These preliminary data indicated that SO\textsubscript{2} ambient levels, prior to construction of Units 1 and 2, may be above Project guidelines. To address this concern, the Project Sponsors contracted with Radian to conduct one year of ambient monitoring at the JLPP. Data from the first several weeks of this monitoring are used in this EIA for the air quality analyses in Sections 4 and 6.

5.2 Water Discharges

The JLPP discharges three types of aqueous streams: process wastewater, thermal discharges, and storm water runoff. As a result of the findings described below, the Project Sponsors will install wastewater treatment processes that will meet Project guidelines. The specific details of the types and number of wastewater treatment systems have not been determined at this time.

During the Phase II investigation, a total of 12 samples were collected from wastewater discharge sampling points and near the cooling water intakes to determine the background ocean water quality. The samples were tested for their pH, temperature, conductivity, and ambient temperature. The samples were then combined to form a composite sample. The composite samples as well as background samples were analyzed for TPH, oils and grease, heavy metals, total organics, dissolved oxygen, total suspended solids, redox potential, and five-day biological oxygen demand.

A 24-hour monitoring of wastewater quality indicated that there were two exceedances of the pH guidelines from the north outfall. The cause of these pH fluctuations is unknown. With the exception of a single TSS value, the sample results for the other parameters as stated above complied with the Project guidelines (Radian, 1995).

During the Phase II EA, the ambient temperature and the water temperature were measured at the plant intake, the discharge point for condenser Units 1 and 2, and the point of channel discharge into the ocean. The data indicated a 9°C increase between intake and discharge to the ocean. Thermal modeling was conducted to see if the thermal discharges exceeded Project guidelines. These guidelines specify the net temperature increase must not exceed 5°C at the edge of the mixing zone, for seawater under 28°C. Note that no seawater...
temperatures above 25°C are expected in the area. The modeled increases ranged from 0.9° to 1.3° C, well within the guidelines. In addition, chlorine levels in condenser cooling waters currently being discharged from the JLPP facility meet Project guidelines of 0.2 mg/L (Radian, 1995).

The third type of aqueous discharge is storm water runoff. Storm water runoff from the coal pile area is routed to a runoff basin, from which it is discharged directly into the Atlantic Ocean. Storm water runoff from other areas surrounding the plant is routed to the two 36-inch concrete discharge pipes and is discharged without further treatment to the Atlantic Ocean via an open channel.

Plans to improve the control of coal storage runoff and potential oil spills from plant equipment at all units of the JLPP facility are in progress and will protect against an exceedance of Project guidelines for total suspended solids and oils and grease.

5.3 Hazardous Materials

Hazardous materials handled at a typical coal fired power plant include PCBs, asbestos, fuel oil, and bulk chemicals. However, the Phase I EA indicates that the existing plant is free of PCBs and the insulation of the facility is determined to be free of asbestos (ABB Project, 1996).

A diesel-powered emergency power generator is used to allow an orderly shutdown of the plant in case of a blackout. Currently the plant has one storage tank with a capacity of 500 m³ to store the diesel fuel for this emergency generator. JLPP also has two reservoirs containing 50,000 m³ of fuel oil used for flame stabilization and start-up of the two existing units, and one reservoir containing 25 m³ of propane. The JLPP has a garage and petrol station for maintaining the facility vehicles (CMS, 1996).

Used oil is stored in drums and returned to the fuel oil storage tanks for reuse or sold to local companies for recycling or other uses. In the event of an oil spill, the employees use sand and rags as an absorbent, both of which are disposed of in normal trash removal. No formal notification is performed when any type of spill occurs. The plant indicated that they had no spills last year (1995), other than fuel oil spillage next to the fuel oil discharge station (CMS, 1996).
During the Phase I EA, underground storage tanks were found to be constructed with adequate leak detection and containment measures and above ground storage tanks had adequate leak containment systems. However, the investigation showed that past practice in unloading fuel oil tank cars has resulted in spillage and shallow hydrocarbon contamination of subsurface soil in the oil unloading area.

Adjacent to the demineralizer building there are two rooms, one for resin storage and the other for ammonia and hydrazine. Currently the resins, empty hydrazine and sodium hypochlorite (NaOCl) drums are stored in one room, and full hydrazine and NaOCl drums are stored in the other. There is no required manifesting or documentation. Labeling of containers is accomplished, but not extensively (CMS, 1996).

5.4 Soil and Groundwater

The Phase II analysis of the soil (based on six soil borings and piezometer sampling) indicated that the concentrations of metals varied significantly. No comparative background soil heavy metals data are available. However, the variation in the data suggests that the heavy metals concentrations are probably not the result of plant operations.

Low levels of total petroleum hydrocarbons were found in soil in the fuel oil handling and storage area. This was attributed to improper fuel oil handling and surface oil spills that were noted during investigation.

During groundwater analysis, the water levels in the piezometers were recorded at different times to assess the interaction between the groundwater and the ocean tides. The results showed a strong interaction between the groundwater and ocean water surface elevations. Groundwater was detected at a depth of approximately six meters. Also, the metal concentrations detected in the groundwater are believed to be related to the regional content of metals in the subsurface soil rather than plant activities. Groundwater, which is encountered 6 m below the surface was found to contain oils and grease at levels above the World Bank discharge limits. No direct relationship between existing JLPP operations and these oil and grease levels were determined.

5.5 Ash Disposal

Currently, ash is disposed of in the ocean. Both bottom ash and fly ash are sluiced through pipes to a point about 800 m from the shoreline where the ocean depth is 13 m. On
occasions, there are bottom ash discharge pipe pluggage problems. On these occasions, the plant disposes of the ash by trucking it to a disposal site located south of the plant adjacent to the discharge channel. This temporary disposal site is not large enough for long term ash disposal (CMS, 1996).

Analysis demonstrates that total metal concentrations at the ash discharge point are well below Project guidelines for water quality. However, as discussed in Section 4, elevated levels of mercury were measured in the vicinity of the OCP and ash outfalls. Nevertheless, World Bank recommendations are that ash disposal should be in landfills or in lined disposal cells (World Bank, 1996). The Project Sponsors intend to terminate ocean disposal as soon as an appropriate alternative can be implemented. An analysis of these options is presented in Section 7.

5.6 Summary

As depicted in Figure 5-1, the environmental conditions that were identified during past audits at the existing JLPP were:

- Shallow soil contamination from fuel oil spills primarily at the tank car unloading area;
- Lack of sufficient ambient air quality data to confirm data collected by ONE that indicate occasional, short-term, high background ambient SO$_2$ concentrations (from the direction of the neighboring phosphate plant);
- Occasional excursions of pH in wastewater discharges and inadequate treatment of storm water runoff;
- Disposal of fly ash and bottom ash in the ocean; and
- Hazardous chemicals handling, storage and tracking.

The Project Sponsors are addressing each of these concerns as documented in Section 6, 7, and 8.
Figure 5-1. Issues and Existing Environmental Conditions at JLPP
6.0 POTENTIAL FUTURE IMPACTS OF PROPOSED EXPANSION

This section describes the impacts of constructing Units 3 and 4 at the JLPP and the incremental impacts of operating all four units.

6.1 Impacts of Construction

This section examines the potential impacts from construction of Units 3 and 4 at the JLPP. The construction of the units may impact land, soil, air, surface water, groundwater, socioeconomic, noise level, archeological or historical resources. The potential impacts are addressed below.

6.1.1 Land and Soil

The land for Units 3 and 4 is already graded and cleared of vegetation. The construction site is an industrial area with high human activity and contains no wetlands or sensitive environmental habitats. No new property or roads will be purchased or built as part of the construction activities. Therefore, the construction activities will have little or no impact on the land resources.

6.1.2 Air Quality

During construction activities, unavoidable air pollutant emissions are likely to occur. The most prevalent construction emissions are fugitive dust.

Construction-phase fugitive dust emissions will be generated during excavation and vehicular activity. Should the project require an onsite concrete batch plant, this plant could also constitute a source of fugitive dust. The quantities of fugitive dust emitted by the site construction vehicular traffic depends on a number of factors, including the frequency of operations, specific operations being conducted, weather, and soil conditions. A large portion of the construction operations, such as foundation excavation, will be intermittent and of a temporary nature. Standard construction practices used to control dust, such as wet suppression and control of vehicular speed, will help minimize the air quality impact of construction activities.

It is anticipated that total gaseous emissions released into the atmosphere during construction will be small. Potential sources of VOC emissions are evaporative losses associated
with onsite painting, refueling of construction equipment, and the application of adhesives and waterproofing chemicals. The frequency and extent of these activities are anticipated to be limited and would have minimal impact on air quality.

Use of the construction equipment will result in temporary, short-term emissions of VOC, NO$_x$, PM, and SO$_2$. These pollutants will be present in the exhaust. The exhaust emissions will be similar in nature and extent to those from vehicles on the nearby highway. Therefore, there should be no impact from construction equipment exhaust emissions.

Open burning of construction debris is expected to occur if allowed by local authorities and if the composition of that debris consists of wood products and other relatively clean-burning components. Pollutant emissions of PM, CO, hydrocarbons, and NO$_x$ will depend on the amount and moisture content of the debris. Only minor, short-term air quality impacts are expected to result from open burning since these operations will be intermittent.

Overall, the impact of heavy construction activities and site preparation on air quality will be short-term and confined to the immediate vicinity of the construction activity. This is because most of the fugitive dust created by construction traffic and earth-moving operations consist of particulates (total suspended particulates), which tend to settle quickly rather than remaining suspended for long distances. In summary, it is not expected that vehicular emissions, fugitive dust, or smoke from open-burning operations will present any significant air quality problems during the construction period.

### 6.1.3 Surface Water

The only surface water body that may be affected by the construction at JLPP is the Atlantic Ocean. Construction activities may increase the suspended sediment load of storm water runoff from the site. Oil and grease from construction equipment may be leaked or spilled on the ground, potentially contaminating storm water runoff.

The construction contractor will implement good housekeeping practices to minimize the potential for such construction-related impacts on storm water runoff. These practices include prompt disposal of trash and construction materials, collection of refuse and oily rags, and prompt cleanup of spills of flammable liquids. Site drainage will be designed to prevent the creation of muddy or pooled water areas. If observation of storm water runoff from the
construction site reveals offsite discharge of sediment-contaminated stormwater, additional control measures may be employed.

### 6.1.4 Groundwater

There is a slight potential for oil spills or leaks to reach groundwater, especially during excavation for the construction of Units 3 and 4. Groundwater movement and quality during construction can be monitored at observation wells onsite to detect contamination.

Also, seepage of surface water in deep and shallow excavations may impact the aquiferous zone which is 6 m below ground level. Dewatering practices during excavation can be implemented to prevent potential cross-media groundwater contamination.

### 6.1.5 Biological Resources

No construction-related impact to biological resources to the land are expected. The construction site for Units 3 and 4 is a graded, industrial area that is already highly impacted by human activity. The construction site is not habitat for flora, fauna, wildlife and other biological resources.

Very little terrestrial wildlife was observed in the immediate vicinity of the JLPP during the field trip in April 1996. None was seen on the JLPP property; also, no endangered or threatened species were observed or are believed to be present at the JLPP.

Little or no impact to biological resources in the marine environment are expected from the construction of two more units at the existing JLPP facility. No construction will occur over water.

### 6.1.6 Archeological and Historical Resources from Construction

No impact to archeological and historical resources will occur because all construction will occur in areas that have been previously disturbed by the construction of Units 1 and 2. As identified in Section 4.3.1, the nearest archeological site is 8 km north of the JLPP.
6.1.7 Socioeconomic Impacts from Construction

The construction of JLPP Units 3 and 4 will have a positive social and economic impact locally and in other parts of the world. Moreover, there will be no significant adverse impacts as a result of demands on local housing and other infrastructure and services.

The construction contractor anticipates that at least 700 persons will be hired during peak construction with an average of 500 persons during the 39-month period of construction. Approximately 47% of the construction workers will be classified as unskilled (ABB, 1996b). Many of these workers will be drawn from the many small settlements around the JLPP. Others will be hired from El Jadida and other Moroccan cities. It is likely that many of these unskilled workers will come from the ranks of the unemployed or underemployed. Many of the skilled workers will also be Moroccans, although the number of in-country versus foreign workers has not yet been determined. Although temporary, this construction activity will create a stimulus for local and regional incomes.

Another economic benefit of the construction will be the estimated $43 million (U.S.) that will be spent to purchase other Moroccan goods and services. Most of the heavy equipment for the power plants, such as generators and turbines, will be purchased from Europe and the U.S. Capital equipment purchases will be from the U.S., Italy, and Switzerland (ABB, 1996a). The JLPP Sponsors will purchase local construction material such as concrete whenever it can be procured. Thus, the construction will create jobs and economic growth both in Morocco and internationally.

Frequently, large capital projects in rural areas create adverse socioeconomic impacts as a result of sudden and large demands for housing and other services. This "boom" effect is then followed by a "bust" as the construction workers and their families move on to other projects. The construction of Units 1 and 2 in the early 1990s did not create this boom and bust effect for two reasons. First, a large number of rural Moroccans are unemployed or underemployed. Therefore, there was no need to bring in non-local unskilled workers. Second, the City of El Jadida had adequate temporary housing availability for the remaining workers who commuted to the work site each day by bus. The bus service was arranged by the construction contractor.

The contractor for Units 3 and 4 has indicated that they anticipate a similar pattern for the future construction: unskilled workers hired from the immediate area and temporary housing in
El Jadida for the skilled and unskilled workers who do not live in this part of Morocco (ABB, 1996b). No "tent cities" or other offsite temporary housing is necessary and none is planned. Because the workers will either walk to the site or will be bused in by the contractor, there should be no traffic congestion or parking problems often associated with large construction projects.

### 6.1.8 Noise Impacts from Construction

Construction-related noise impacts will occur largely in three phases: foundation preparation and pouring, steel erection and equipment installation, and site cleanup and plant start up. Typical noise levels at 15 m for construction equipment from the first two phases are as follows:

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Maximum Noise Level at 15 m (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete pouring trucks</td>
<td>87</td>
</tr>
<tr>
<td>Cranes</td>
<td>86</td>
</tr>
<tr>
<td>Air compressors</td>
<td>89</td>
</tr>
<tr>
<td>Excavation equipment</td>
<td>90</td>
</tr>
<tr>
<td>Welders</td>
<td>73</td>
</tr>
<tr>
<td>Diesel locomotives</td>
<td>97</td>
</tr>
<tr>
<td>Dump trucks</td>
<td>87</td>
</tr>
</tbody>
</table>

These noises will not adversely impact the nearest sensitive off-property receptors—the residential areas on top of the bluff east of the JLPP. This is because the distance to the nearest off-property residential areas is great enough to attenuate these sounds. Also, almost all of the residences are behind the edge of the bluff and therefore shielded by the terrain from the sound patterns. This shielding should reduce construction related noises to levels that are typical of residential areas.

In summary, construction-related noises will be temporary and intermittent. Moreover, the great majority of the homes in the nearest residential areas are shielded by the crest of the bluff from the ground-level noises at the power plant and therefore will be even less affected by construction noise.
6.2 Impacts of Operation

This section describes the incremental impacts that are anticipated from the operation of all four units at the JLPP.

6.2.1 Land Use and Transportation

The operation of Units 1 through 4 at the JLPP will have a negligible impact on existing land use. The construction of the new units will not require the purchase or use of land outside of the JLPP property boundaries. All construction and operation will be on land that has been previously disturbed and converted to heavy industrial land use. Because of local land use controls around the industrial area, there will be no induced or secondary development such as housing tracts for new workers, restaurants and grocery stores, or after-work recreational and leisure retail establishments (Elhaiba, 1996). Development of a landfill for disposal of fly ash and bottom ash will require some off-site development as discussed below and in Section 7 of this report. No new conversion of non-industrial land uses to industrial uses is anticipated.

Instead, the indirect effects on land use will be almost entirely focused on the already developed El Jadida urban area. Worker residences and services for workers for the existing JLPP are confined to El Jadida. Therefore, it is presumed that this new increment of activity will also be confined to El Jadida. The residential, commercial, and urban infrastructural development of El Jadida is mature and large. The incremental impact of the JLPP expansion on this development will be relatively small (Elhaiba, 1996).

If the quarry area is used for ash disposal, the ultimate long term effect would be to convert this currently unusable site to industrial use. As the quarry is filled and sections reclaimed, it could become available for productive use. Alternatively, this area at the reclaimed quarry site could potentially be used for agricultural use.

The proposed Project will not adversely affect transportation. The planned transport of JLPP workers using buses should avoid any significant increase in traffic congestion along the El Jadida to JLPP stretch of Route 121. Increased coal use will result in greater number of coal shipments through the port. The master plan for Port operations provides for coal shipments for up to six units at the JLPP. Currently, the coal dock is being expanded by ODEP under contract to ONE. The dock expansion and the current under-utilization of port capacity indicates that the incremental increase in coal shipments will not create ship congestion in the port.
Truck transport of ash to the quarry, or other land disposal area, could create the potential for increased highway congestion. However, rail transport, which would require construction of new track, would use grade-separated crossings as necessary to avoid interference with highway traffic. If truck transport of coal ash is used—either for land disposal or to market the ash as a construction material—appropriate traffic signals and other controls may be necessary to avoid highway congestion and accidents.

### 6.2.2 Air Quality

This section describes future air quality impacts of the four-unit, JLPP operation on the surrounding environment. Emissions of sulfur dioxide, nitrogen oxides, and particulate matter from the project are expected to increase as compared to current levels as shown in Table 6-2. A description of the emission estimation procedures for each investigated pollutant is provided in Appendix F. This section also compares future ambient air concentrations, as calculated through a very conservative dispersion modeling analysis, with the applicable Project guidelines. The modeling results indicate that the impact of the increased emissions will not significantly impact air quality near the JLPP operations.

#### Table 6-2. JLPP Maximum Stack Emissions

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Estimated Current Maximum Emissions from Units 1 and 2 (tonnes/day)</th>
<th>Maximum Potential Emissions from Units 1 and 2 (tonnes/day)</th>
<th>Maximum Potential Emission from Units 1 through 4 (tonnes/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur Dioxide</td>
<td>79.2&lt;sup&gt;1&lt;/sup&gt;</td>
<td>158.4&lt;sup&gt;2&lt;/sup&gt;</td>
<td>271.2&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Nitrogen Oxide</td>
<td>34.5&lt;sup&gt;4&lt;/sup&gt;</td>
<td>35.1&lt;sup&gt;5&lt;/sup&gt;</td>
<td>70.6&lt;sup&gt;6&lt;/sup&gt;</td>
</tr>
<tr>
<td>Particulate</td>
<td>1.4&lt;sup&gt;7&lt;/sup&gt;</td>
<td>5.9&lt;sup&gt;8&lt;/sup&gt;</td>
<td>8.4&lt;sup&gt;9&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

1. Based on 0.75% S coal (0.12 tonne/MW-day) and 100% capacity factor.
2. Based on 1.5% S coal (0.24 tonne/MW-day) and 100% capacity factor.
3. Based on 1.25% S coal (0.20 tonne/MW-day) on all 4 units.
4. Based on tested emissions of 256 ng/J, heat rates of 2065 kcal/kWh, and 100% capacity factor.
5. Based on emissions of 260 ng/J, heat rates of 2065 kcal/kWh, and 100% capacity factor.
6. Based on predicted emissions of 260 ng/J, heat rates of 2065 kcal/kWh for Units 1 and 2 and 2080 kcal/kWh for Units 3 and 4, and 100% capacity factor.
7. Based on tested emissions of 30 mg/Nm<sup>3</sup>, 100% capacity factor.
8. Based on ESP guarantee of 125 mg/Nm<sup>3</sup>, 100% capacity factor. Calculations located in Appendix F.
9. Based on emissions of 125 mg/Nm<sup>3</sup> on Units 1 and 2 and 50 mg/Nm<sup>3</sup> on Units 3 and 4 and 100% capacity factor on all 4 units.
Emission Estimation

The units that comprise the Jorf Lasfar power plant are designed to fire a medium volatile, low sulfur, high ash bituminous coal. Since becoming operational in 1994, the plant has fired coal from the United States, South Africa, and Colombia.

Radian has studied the impact that representative coals from these sources may have on emissions from the Jorf Lasfar plant. Data for this study was based on historic coal use, anticipated future coal sources, plant operational experience, and emissions tests performed at Jorf Lasfar.

The current PM and NO\textsubscript{x} emissions from Units 1 and 2 were measured during performance testing conducted by GEC Alsthom in 1995 and are presented in Table 6-3. As shown each of the tested pollutant emission rates are below the Project guideline values. The SO\textsubscript{2} emission rate was calculated based on fuel sulfur analysis.

Table 6-3. JLPP Units 1 and 2 - Emission Performance Test Results

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Particulate Matter (PM)</td>
<td>30 mg/Nm\textsuperscript{3}</td>
</tr>
<tr>
<td>NO\textsubscript{x} (full load)</td>
<td>0.53 lb/MM Btu</td>
</tr>
<tr>
<td>NO\textsubscript{x} (minimum load)</td>
<td>0.59 lb/MM Btu</td>
</tr>
</tbody>
</table>

Particulate Matter

**Units 1 and 2**—Currently particulate matter emissions from Units 1 and 2 are controlled by electrostatic precipitators guaranteed to meet an emission rate of 125 mg/Nm\textsuperscript{3}. Each ESP handles half the boiler flue gas flow and has three fields.

The ESP manufacturer's performance correction curves were used to adjust the collection efficiency for specific coals in terms of flue gas flow, moisture, inlet dust loading, and fuel sulfur. Table 6-4 shows the predicted ESP collection efficiency and particulate emissions for various representative coals that have been fired at the plant.
Table 6-4. Predicted Unit 1 and 2 PM Emissions and ESP Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Performance Test</th>
<th>U.S.</th>
<th>U.S.</th>
<th>South Africa</th>
<th>South Africa</th>
<th>Colombia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur (Wt %)</td>
<td>1.19</td>
<td>0.71</td>
<td>1.4</td>
<td>0.46</td>
<td>0.67</td>
<td>0.62</td>
</tr>
<tr>
<td>Ash (Wt %)</td>
<td>8.36</td>
<td>7.50</td>
<td>7.82</td>
<td>12.80</td>
<td>11.60</td>
<td>6.00</td>
</tr>
<tr>
<td>ESP Efficiency, %</td>
<td>98.57</td>
<td>99.11</td>
<td>98.74</td>
<td>98.67</td>
<td>98.39</td>
<td></td>
</tr>
<tr>
<td>PM Emissions (mg/Nm³)</td>
<td>30.0</td>
<td>94.5</td>
<td>60.3</td>
<td>140.8</td>
<td>134.5</td>
<td>80.9</td>
</tr>
</tbody>
</table>

*Coal fired during GEC Alsthom 1995 performance testing of Units 1 and 2
*Data received from ABB (1996a).

As shown in the table, actual tested emissions were below the Project guideline of 50 mg/Nm³ and well below the ESP guarantee of 125 mg/Nm³. However, based on predicted ESP performance, potential PM emissions could vary greatly, depending on the ash and sulfur content of the coal (sulfur reduces ash resistivity and improves collector performance). Although the test data would indicate that PM emissions will be substantially below the ESP guarantee, the Project Sponsors cannot assure performance such as that observed during the emissions test throughout the range of coals burned or the life of the equipment. Therefore, the Project guideline adopted for PM emissions for Units 1 and 2 is 125 mg/Nm³. As shown later in this section, the air quality impact which would result from adopting this guideline is negligible. Potential alternative measures that could be utilized in the unlikely event that future testing shows the 125 mg/Nm³ guideline cannot be consistently met while burning representative coals are discussed in Section 7.

Units 3 and 4—Units 3 and 4 have a slightly greater capacity (348 MW) and a higher heat rate (2,080 kcal/kWh) than Units 1 and 2. However they will also be equipped with more efficient ESP's with guaranteed outlet emissions that are less than 50 mg/Nm³, even with one field out of service.
SO\(_2\) Emissions

SO\(_2\) emissions are primarily a function of the fuel sulfur content and quantity of coal consumed. The analysis used to predict SO\(_2\) emissions from the plant was based on the assumption that all of the fuel sulfur is converted to SO\(_2\). The SO\(_2\) emission calculations are based on an annual average sulfur content of 1.25%, which corresponds to the Project guideline of 0.20 tonne/day-MW.

NO\(_x\) Emissions

Emissions of NO\(_x\) are a function of fuel nitrogen content, furnace cleanliness (slagging), furnace size, burner design, excess O\(_2\), pulverizer performance, and pulverizer selection. Tangentially fired boilers typically have the lowest emissions of large electric utility boilers. Firing different coals in a boiler may cause NO\(_x\) emissions to increase or decrease. This is not necessarily due to a different constituent analysis, but more likely due to the physical properties such as grindability and ash fusion temperature which affect the fineness of the grind and the furnace cleanliness, respectively. A finely ground coal could improve fuel/air mixing while a low ash fusion temperature coal may result in greater accumulations of slag on the furnace walls, inhibiting furnace heat transfer and raising flame temperatures. Each of these instances may cause NO\(_x\) to increase. For JLPP, the excess O\(_2\) and selection of active burner levels will have the greatest impact on NO\(_x\).

NO\(_x\) emissions were measured during performance testing conducted by GEC Alsthom in 1995 (Table 6-3). The results indicate that NO\(_x\) emissions at full load are 12% lower than the Project guidelines and NO\(_x\) emissions at minimum load are 1.7% lower than the Project guidelines. Maximum NO\(_x\) was produced at minimum load, a characteristic of tangentially fired boilers. The normal load profile of the plant will be for the units to be operated near maximum rated output for 24 hours per day. Thus the daily emissions would be expected to be weighted closer to the full load NO\(_x\) emissions level.

NO\(_x\) might be expected to vary ±10% from the reported data due to operational and fuel variations. Of particular note is the location of the active burners. The boiler is equipped with five levels of burners but only four levels are required (or used) to achieve normal full load. Plant operating personnel prefer to fire the lower four levels, but in practice this may not always be so. Experience at similar plants shows that NO\(_x\) can be reduced when fuel is biased to lower burner levels; however, the use of upper burner levels usually does not significantly increase NO\(_x\).
in tangential furnaces since the burner tilts would be somewhat more negative in this configuration to control excessive steam temperature. This will help to minimize any NO\textsubscript{x} increase. The testing was performed with the lower level of burners out of service and should represent the highest NO\textsubscript{x} emissions of any of the possible burner level configurations.

The test results were obtained with the use of some over fire air, which is an effective NO\textsubscript{x} control technique. Radian estimates based on past experience, that NO\textsubscript{x} reduction of 20 - 30\% would be possible using proven techniques of combustion modifications of existing controls and hardware if additional NO\textsubscript{x} reduction were to become necessary at some time in the future.

Units 3 and 4 are will retain a tangentially fired burner arrangement. NO\textsubscript{x} emission from these units are guaranteed to meet project emission guidelines.

**Ambient Air Quality Dispersion Modeling Analysis**

Using the above emission estimations as input, an air quality dispersion modeling analysis was conducted to assess the potential incremental impact of all four units operating at the JLPP. Because of limited data, the modeling analysis was designed to produce the most conservative assessment of the potential impact possible. The analysis consisted of:

- calculating representative emission rates based on annual usage;
- determining an appropriate dispersion model;
- developing an appropriate receptor grid for the region; and
- defining a representative meteorological data set.

The modeled emission rates and stack parameters are tabulated below (Table 6-5). The emissions modeled were incremental increases in Unit 1 and 2 emissions over current levels and the maximum of the pollutant-specific Project emissions guideline values for Units 3 and 4.
Table 6-5. Jorf Lasfar Modeled Source Parameters

<table>
<thead>
<tr>
<th>Source</th>
<th>Modeled Emission Rates</th>
<th>Modeled Stack Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SO₂ (tonne/day)</td>
<td>NO₂ (tonne/day)</td>
</tr>
<tr>
<td>Unit 1 and 2</td>
<td>52.8⁴</td>
<td>0.6⁹</td>
</tr>
<tr>
<td>Unit 3 and 4</td>
<td>139⁶</td>
<td>36.1⁶</td>
</tr>
</tbody>
</table>

⁴ Based on firing 1.25 wt % W coal and a capacity factor of 100%. Units 1 and 2 emissions are incremental increases from current levels based on firing 0.75 wt % S coal.
⁵ Based on incremental increase from tested (Units 1 and 2) emissions of 0.59 lb/MM Btu vs Project guideline of 0.60 lb/MM Btu.
⁶ Based on the incremental increase between tested (Units 1 and 2) emissions of 30 mg/Nm³ and ESP performance guarantee of 125 mg/Nm³.
⁷ Based on Units 3 and 4 at 0.20 tonne/MW-day (1.25% S coal) and 100% capacity factor.
⁸ Based on Units 3 and 4 at 0.60 lbs/MM Btu and 100% capacity factor.
⁹ Based on Units 3 and 4 at 50 mg/Nm³ and at 100% capacity factor.

The emission rates were modeled using the U.S. EPA-approved Industrial Source Complex Short-Term (ISCST3 version dated 96113) model. The ISCST3 model is a steady-state Gaussian plume model designed to calculate ground-level concentrations in simple, intermediate, and complex-terrain for both short- and long-term averaging periods. All U.S. EPA regulatory default parameters were invoked in the model selections and rural dispersion coefficients were used.

A receptor grid was developed for the Jorf Lasfar area. A polar ring of receptors was centered on the existing Units 1 and 2 stack extending outward to a distance of 15 km. Within this radius, the terrain varies from sea level to about 80 m above sea level. Because of the variable terrain, elevations were determined for each receptor location. The nearby receptor grid (0-5 km) with terrain contours is depicted in Figure 6-1.

The ISCST3 model requires sequential, hourly-average representative meteorological data to calculate concentrations at each receptor location. The hourly data needed include wind speed and flow vector (direction toward which wind is blowing), atmospheric stability, ambient temperature, and mixing height. There is little routine meteorological data readily available from the El Jadida/Jorf Lasfar area to support dispersion modeling.
Figure 6-1. Jorf Lasfar Area Receptor Grid with Terrain Contours
As described in Section 4.1.3, meteorological parameters (wind speed and direction) were measured in support of the ONE ambient monitoring program. The data were obtained during the seven week sampling period from February 15, 1994 through March 30, 1994. A windrose of the data obtained for the period is shown in Figure 6-2. The relative frequency of direction compares favorably with the winter period windrose obtained at the El Jadida site (Figure 4-1). The average wind speed for the seven week period was about 4 m/s.

Because some data gaps were found in the meteorological record, missing data periods were considered invalid and discarded. There was no attempt to interpolate or fill missing wind speed or wind direction data. A total of nearly 700 sequential hours of data were used in the modeling analysis to determine different averaging period concentrations (24-hour and period).

The hourly atmospheric stability classifications were determined based on the U.S. EPA sigma-theta criteria. The sigma-theta method identifies an initial stability class (1-6) depending on the variability of the wind direction during the previous hour and the time of day (day or night). The initial class is refined according to the hourly wind speed. Sigma-theta measurements (a surrogate measurement for the degree of lateral dispersion) were not taken during the 7 week monitoring period, hence only the wind speed and time of day criteria were used to develop the stability classifications. All nighttime stabilities were set to neutral (4) and daytime stabilities were set according to wind speed (winds less than 3 m/s were set to stability 1, winds between 3 and 4 m/s were set to stability 2, winds between 4 and 6 m/s were set to stability 3, and winds greater than 6 m/s were set to stability 4). No stability class was allowed to vary by more than 1 classification per hour and the hours of sunrise and sunset were set to neutral stability in accordance with U.S. EPA criteria. The stability classifications modeled should yield a conservative assessment of potential air quality concentrations. Because of the seaside location of the power plant, there is potential for fumigation (penetration of air from the ocean on shore). However, the rather persistent winds from land toward water will minimize potential fumigation, therefore, no attempts were made to quantify fumigation impacts.

No ambient temperatures or mixing heights were available for the seven week data period; therefore, conservative surrogates were used. Because the stack exhaust temperatures are well above ambient temperatures, hourly average temperature data is not an important modeling criterion. Further, to ensure that no interaction between plume height and mixing height would occur (i.e., once above the mixing height, plumes do not repenetrate the boundary layer) the mixing height was set at 5000 m above sea level. Under relatively calm (1 m/s wind speed) and
FREQUENCY OF WIND DIRECTION AND SPEED

Figure 6-2. Jorf Lasfar Windrose

JORF LASFAR
ON-SITE
METEOROLOGICAL DATA
(2/15/94 through 3/30/94)
WINDROSE

NOTE - WIND DIRECTION IS THE DIRECTION WIND IS BLOWING FROM

1-3 4-5 6-10 11-15 16-21 22-99
(12 s) (30 s) (40 s) (14 s) (3 s) (1 s)

WIND SPEED SCALE (KNOTS)
unstable conditions (stability class 1), the effective plume heights from all four units at the power plant would be near 2000 m above grade. Any mixing heights above that would maintain plume heights below the mixed layer.

In addition to the conservative assumptions built into the model and its parameters, the following additional conservatism was built into the analysis:

- “Annual” averages calculated by the model are based on the 693-hour period of record. Due to the persistence of meteorological conditions over the short term, maximum concentrations calculated for a period of shorter duration are usually higher than those calculated for a longer period (i.e., the actual annual average concentration should be less than the “annual” average concentration calculated by the model).

- Predicted ambient impacts from Project operations are based on maximum emissions from Units 3 and 4, as well as the following increases at Units 1 and 2 over estimated current emissions:
  - SO₂ emissions increased to a 1.25% sulfur content basis over estimated current emissions based on 0.75% sulfur; and
  - PM emissions from Units 1 and 2 increased to a 125 mg/Nm³ (ESP performance guarantee) basis over estimated current emission based on tested concentration of 30 mg/Nm³.

- As shown in Figure 6-1, almost half the model receptors are over water, where there are no people, animals or vegetation to be impacted by plant emissions; however, no attempt was made to limit the analysis to any specific receptors.

Radian believes that this conservatism provides an ample margin of safety to account for the limited available monitoring data. We expect that when additional air quality data (now being collected) and more realistic assumptions can be incorporated into the analysis, the results will show even smaller Project impacts.

Results of the ISCST3 modeling analysis are shown in Table 6-6. As shown, the maximum impacts from the Jorf Lasfar power plant occur between 1.5 and 4 km from the source, over water. Comparison of the maximum concentrations with the JLPP guideline ambient air quality standards is also shown in the table. For SO₂, PM and NOx impacts, the incremental impacts associated with the Project were modeled. The incremental impact included the change in coal quality on Units 1 and 2 as compared to current operations, and the additional impacts of Units 3 and 4. This approach was straightforward for PM and NOx. For PM the emission from
Units 1 and 2 were increased to the ESP guarantee of 125 mg/Nm$^3$ from current emissions of 30 mg/Nm$^3$. For NO$_2$, the increase from Units 1 and 2 were increased from 0.59 lbs/MM Btu (tested levels) to 0.60 lbs/MM Btu.

**Table 6-6. Jorf Lasfar Modeled Air Quality Concentrations**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging Period</th>
<th>Location of Maximum Impact$^a$</th>
<th>Maximum Concentration (µg/m$^3$)</th>
<th>JLPP Project Guideline Ambient Air Quality Standards (µg/m$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Distance (m)</td>
<td>Direction$^b$ (deg N)</td>
<td></td>
</tr>
<tr>
<td>SO$_2$</td>
<td>24-hour</td>
<td>1500</td>
<td>290</td>
<td>96.9</td>
</tr>
<tr>
<td></td>
<td>Annual$^c$</td>
<td>4000</td>
<td>280</td>
<td>14.1</td>
</tr>
<tr>
<td>NO$_2$</td>
<td>24-hour</td>
<td>1500</td>
<td>290</td>
<td>18.5</td>
</tr>
<tr>
<td></td>
<td>Annual$^c$</td>
<td>4000</td>
<td>290</td>
<td>2.7</td>
</tr>
<tr>
<td>PM</td>
<td>24-hour</td>
<td>1500</td>
<td>290</td>
<td>2.4</td>
</tr>
<tr>
<td></td>
<td>Annual$^c$</td>
<td>4000</td>
<td>290</td>
<td>0.3</td>
</tr>
</tbody>
</table>

$^a$ Grid origin centered on Unit 1 and 2 stack.  
$^b$ Direction is measured clockwise from north. 290° is approximately west-northwest of JLPP over the Atlantic Ocean.  
$^c$ Period averages from the 693 hours of meteorological data were used to compare to the annual standards. Usually shorter-term averaging periods produce higher concentrations than annual periods, hence the period average comparison is usually conservative.

SO$_2$ presented a special case due to the provisions of the World Bank guidelines. One of the guideline criteria is to maintain incremental impacts to below the World Bank Criterion II levels for SO$_2$ concentrations reflective of the surrounding environment. Because the measurements reported in Section 4.1.3 were obtained before JLPP Units 1 and 2 were operational (7 week ambient monitoring), to properly analyze the incremental impact from the project, the monitored background concentrations were increased to include the contribution from current Unit 1 and 2 operations. The methodology employed to increase the monitored SO$_2$ background concentration is discussed below.

The highest 24-hour interval SO$_2$ concentration (285 μg/m$^3$) reported in Section 4.1.3 was increased to include the highest modeled concentration resulting from current Units 1 and 2 emissions of 79 tonne/day. The maximum predicted 24-hour impact from current JLPP Units 1...
and 2 operations is $41 \mu g/m^3$, which was used to adjust the baseline 24-hour SO$_2$ concentration up to $326 \mu g/m^3$ (it should be noted that the measured value of $285 \mu g/m^3$ is at a different location than was predicted by the dispersion model). From the World Bank Criterion II table, interpolation calculates a maximum allowable annual average increment of $25 \mu g/m^3$. This approach was used only for the annual average because the World Bank Criterion II is specific to this averaging period. Using the emission rates on Table 6-2, modeling shows an incremental annual average impact for the Project (change in coal on Units 1 and 2 and new Units 3 and 4) of $14.1 \mu g/m^3$, just over half the allowable Criterion II level.

The Project guidelines include a maximum 1-hour average for both SO$_2$ and NO$_x$. Dispersion modeling to predict short-term, 1-hour impacts was not performed due to the limited amount of meteorological data. Dispersion modeling for annual and 24-hour averages utilized the data collected by LPEE in 1994 which only covered a seven week period. It is Radian’s opinion that this limited data was not sufficient to predict statistically significant impacts for the short-term averaging periods. After the one year of ambient monitoring data is collected, short-term dispersion modeling will be performed.

The Project Sponsors have assured that PM emissions from Units 1 and 2 will be below the ESP performance guarantee of $125 mg/Nm^3$. As shown in the modeling analysis, this emission rate on Units 1 and 2, even when combined with the impacts from Units 3 and 4, results in ambient concentrations that are only 2% of the 24-hour ambient Project guideline and 0.4% of the annual ambient Project guideline. Thus, PM emissions from all 4 units will not pose any risk to human health or the environment.

As noted above, results of the analysis indicated that impacts associated with the increased emissions do not significantly impact air quality of the immediate region. This modeling analysis demonstrates that Project air quality guidelines are achieved for SO$_2$, NO$_x$, and PM even with the conservative assumptions employed.

### 6.2.3 Surface Water Quality

The only surface water to be impacted in the area is the Atlantic Ocean. JLPP potentially impacts it locally via discharges of ash and wastewater. In this section we will briefly review the nature and magnitude of any discharges, the potential concern associated with each, any observed impacts, and possible mitigation measures.
Discharges to the Ocean

Water usage and discharges at JLPP are discussed in Section 3. A detailed review of ocean discharges by JLPP is provided in Section 7.6; a summary of these discharges follows.

Bottom ash and fly ash are sluiced into the ocean using seawater as the transport medium. The point of discharge is 800 m off shore in 13 m of depth and in an area of breakers, to maximize dispersion. Approximately 140,000 dry tonnes per year of ash are discharged in this manner.

The large coal storage area north of the plant is 1 m lower than the powerhouse, isolating the coal pile runoff from other JLPP drainage. Coal yard runoff is directed to the ocean via three outlets, one for each pair of units in the original JLPP design. Prior to discharge, storm water from the area of the coal yard serving Units 1 and 2 passes through a settling basin. A second settling basin will be added for the area serving Units 3 and 4.

Other storm waters and wastewaters are conveyed to the ocean via a combined sewer system, and discharged from two outfalls near the plant. Oily wastewater is pretreated in an oil/water separator. Sanitary wastewater flows through septic tanks for solids settling before entering the sewer network. Demineralizer backwash and regeneration water, boiler acid cleaning water, and air preheater cleaning water are neutralized in a settling basin before discharge to the sea.

Seawater is used to cool the JLPP condensers. Except during a heavy rainstorm (rare for this arid region), this stream of cooling water dwarfs the storm water and wastewater streams. The cooling water is chlorinated to control biofouling of the condensers. Its temperature rises by approximately 9°C between intake and discharge.

Potential Concerns

Specific environmental concerns are associated with each type of discharge. They are briefly listed here. Note that these are typical potential concerns; they may or may not be relevant to JLPP. Later in this section, we describe how these concerns will be addressed.
Ash Discharge to the Atlantic Ocean:

- Heavy metals could be concentrated in the ash and leach out into the seawater, exceeding desirable limits.

- Turbidity, smothering of benthos, sea floor elevation. The turbulence around the outfall should disperse and dilute the ash. Nevertheless, it has been observed that the bottom ash outfall sometimes plugs up temporarily, which may indicate local heaping of the bottom ash.

Stormwater:

- Hydrocarbons: oil/water separators may not stop emulsions, and can allow dissolved organics to reach the ocean. Although some of these organics are toxic (e.g. benzene), they are generally also very biodegradable, and the discharged amounts appear to be very small.

- Turbidity: storm events are likely to entrain large amounts of particulates, especially from the coal storage yard. These can interfere with marine life by reducing visibility, and by their covering and clogging action. However, storm events are rare and brief, probably allowing quick recovery.

Wastewater:

- Sanitary wastewater: Without disinfection, organisms harmful to human health could be discharged to the near shore zone, where they can accumulate in harvested species of molluscs, crustaceans, and fish. This represents a potential health hazard to bathers and consumers of seafood. No evidence of related health problems was found; however, no testing for such organisms was carried out.

- Toxics: Metals, cleaning solutions, and corrosives may be discharged either directly or after pH neutralization.

- pH excursions: pH extremes could cause marine life kills near the outfalls. No apparent damage was found during the site visit.

Cooling Water:

- Thermal discharge: Many near shore organisms have a narrow temperature range, or cannot tolerate sudden temperature changes. Temperature increases will also decrease the solubility of oxygen in water.
Observed Impacts

Some foaming of the cooling water was observed; its origin is unknown. Note that a spectrum of naturally occurring compounds can cause foaming. Some red staining of the outfall channel was also observed. The temperature rise of the water between intake and outlet is approximately 9°C. Modeling shows that the resulting rise at the edge of the mixing zone is 0.9 to 1.3°C, well within Project guidelines of 5.0°C.

A pH excursion above 9 was observed in one of the wastewater outfalls. At the sampling points nearest the ash outfall and the OCP discharge (points 2 and 4), seawater copper and iron concentrations were found that were approximately three times higher than at the other sampling points. Mercury was highest near the harbor (see Section 4). Otherwise, no evidence of major water quality impacts was found.

Although no major water quality impacts were found, the Project Sponsors will take steps to ensure ongoing compliance with Project guidelines as discussed in Section 8. Some areas of concern remain such as the long term impact of ocean ash disposal, the potential discharge of organisms harmful to human health, the release of untreated dissolved organics from cleaning solutions, oil/water underflow, etc. The following mitigation approaches will address the potential concerns listed earlier in this section:

- Land disposal/utilization of ash will eliminate problems associated with ash disposal at sea.
- Properly sized settling basins for the entire coal pile runoff will intercept most of the particulate matter in the runoff.
- Improved monitoring and control of neutralization system discharges will ensure continuous adherence to project effluent guidelines.
- Secondary treatment and disinfection (chlorination) of sanitary effluent, sized for 300 people, will be added during the construction of Units 3 and 4.

6.2.4 Thermal Discharge Impacts

Radian performed an evaluation of the impacts of JLPP’s thermal discharges on the Atlantic Ocean as compared to the Project guidelines. The analysis focused on the impact of the thermal discharges while all 4 units are in operation and at full load.
The condenser design rejected heat load is 363,470 kJ/s. At this load, the predicted condenser pressure is 0.049 bar at a cooling water inlet temperature of 20°C and a cooling water volume flow of 11.2 m³/s. Each condenser's cooling water is discharged into a common open concrete channel. The channel width at the discharge of the 1.5 km length channel is 26 m outside the fence. A serrated cascade weir is constructed at about the midpoint along the channel length to dissipate the potential energy of the channel water as it drops in elevation.

The channel water temperature profile was measured in September 1995 and in April 1996. The condenser cooling water net temperature increase was measured to be less than 9°C. The Project guidelines for ocean thermal discharges dictate that the net temperature increases at 100 m away from the discharge should be less than 5°C, since the receiving water temperature is less than 28°C.

The impacts of the JLPP Units 1 and 2 thermal discharges were measured in the ocean during the water quality sampling activities. The thermal impacts of JLPP were also determined via modeling techniques to determine the net ocean water temperature increase at 100 m away from the discharge, with all 4 boilers operating at full load.

The thermal discharge analysis consisted of an integrated field testing and mathematical modeling of the thermal plume discharges. The model simulations cover reasonable thermal discharge scenarios. For this analysis, the edge of the mixing zone was defined to be 100 m to assure adherence with the Project guidelines.

An order of magnitude analysis indicated that the following factors dominate the JLPP cooling water dispersion rate:

- Ocean bottom depth and gradient;
- Mean ocean wave motion and current velocity;
- Geometric shape of the discharge channel;
- Maximum discharge plume mass flow rate;
- Mean discharge plume water temperature; and
- Mean ocean water temperature.

Field activities were carried out to quantify these parameters. Where field data was not available, conservative estimates were made.
The dissipation of the thermal discharges into the ocean were evaluated using a full capability computational fluid dynamics (CFD) simulation developed by Combustion, Heat and Mass Transfer (CHAM) based in London, United Kingdom. Specific environmental flow applications include ocean thermal discharges (Markatos and Simitovic, 1983), waste water discharges into reservoirs (Rizk, 1992), and flow over aerating weirs (Hadjeriouah, 1993). Data gathered during the field investigations was used to calibrate the model. The model was then tested against actual thermal data collected during 2-unit full-load operation in order to ensure accurate calibration. Once calibrated, the model input parameters were adjusted for 4-unit full-load operation and the simulation was run.

Modeling analysis confirms that the Project guidelines for thermal discharges will be achieved with all four JLPP units operating at full load at all historical ocean temperatures. Figure 6-3 shows the temperature profile of the plume at increasing distances from the shoreline as modeled by the CFD simulation for full load operation of all four boiler units. The data from the model indicate a 2.2°C rise in the ambient water temperature at 100 m offshore. A detailed discussion of the modeling parameters and approach may be found in appendix G.

6.2.5 Groundwater

At Jorf Lasfar, groundwater is encountered about 6 m below ground level. Typically at such close proximity to the sea, saltwater intrudes below a freshwater lens. The interface between the two may be well-defined and is referred to as the halocline. It moves up and down with the tides. At Jorf Lasfar, the lens is probably recharged from the plains between Casablanca and Safi.

During the Phase II EA, Radian sampled the groundwater around JLPP and also sampled a drinking water well just outside the fence line near the main entrance. As expected, some salt water intrusion from the sea was noted in the nearshore wells. Metals concentrations correlate with those in the surrounding formation. As described in Section 4.1.5, somewhat elevated levels of oil and grease were found in monitoring wells around the site.

The addition of Units 3 and 4 will include stormwater and wastewater collection and treatment systems designed to meet all Project discharge guidelines. Consequently, no impacts on groundwater are expected. JLPP will continue to obtain all its raw water supplied from a
Figure 6.3: Temperature Profile at the Plume Centerline

Temperature Profile at the Plume Centerline

Distance from shore (m)

0 20 40 60 80 100 120 140 160

(C) Temperature vs. distance

Max. temperature
municipal water system, so no local withdrawals and concomitant lowering of the groundwater table are expected.

6.2.6 Biological Resources—Land

The vegetation in the area was described in Section 4 as profoundly modified by agriculture, with little or no natural vegetation remaining. This situation is common around the Mediterranean Sea and other areas that have been agricultural for many centuries. There is some soil erosion due to overgrazing. Fields of corn and wheat are common, and vegetable farms are found south of JLPP. No palustrine or estuarine wetlands were observed near JLPP. No endangered animal species were observed or are believed present near the plant.

The expansion of JLPP will occur within the existing fenceline. The land that will be used is essentially a vacant lot on the existing JLPP site. For these reasons it not likely that the proposed expansion could have any direct additional impact on local terrestrial biological resources.

6.2.7 Marine Resources

The operation of Units 1 through 4 will have no adverse impact on the marine environment. It is possible that the Project will benefit the marine ecology.

Water quality and sediment analyses showed relatively high concentrations of copper and mercury. The marine biological baseline survey found a relatively low variety and quantity of fish and benthic organisms. These observations may be due to one or more of the following: a naturally low occurrence of marine life as a result of the high energy beach environment (rugged shoreline and heavy wave action), JLPP surface water runoff and plant discharges, the deposition of fly ash and bottom ash from the JLPP on the ocean bottom approximately 800 m offshore, and other discharges from neighboring facilities.

It is not necessary to know whether and to what extent these causes may contribute to low quality marine conditions in order to determine that the future impacts of the proposed action to the marine environment will be either negligible or, more likely, positive. The Project Sponsors will end the practice of ocean disposal of ash as soon as an appropriate alternative can be implemented. To the extent that ash disposal may have been a factor in any adverse marine
biological effects, the proposed Project will improve marine conditions by avoiding future impacts from additional disposal.

Similarly, improvements that the Project Sponsors are proposing for wastewater discharges will reduce impacts that may be occurring as a result of existing treatment of wastewater. To the extent that surface water quality improves as a result of these planned improvements, marine life will be positively affected.

### 6.2.8 Archeological and Historical Resources

The operation of Units 1 through 4 at the JLPP will have no impact on archeological or historical resources. As noted earlier, all construction and operations for the proposed Project involve land that has been previously disturbed and converted to industrial uses. For this reason, no archeological survey was required or conducted.

### 6.2.9 Socioeconomic Impacts

The socioeconomic impacts of the operation of Units 1 through 4 are positive. In particular, the proposed Project offers significant direct and indirect economic benefits to Morocco. This section addresses local, national, and international social and economic effects of the proposed Project.

**Local Effects**

The expansion of the JLPP will create new, long-term employment opportunities for approximately 156 personnel during normal plant operations, plus a doubling of the total workforce temporarily during plant maintenance and overhaul activities. This increase in the permanent work force would increase staff levels from 144 at present to 300. Most of these new positions will be from the local work force. Current employees will be given the option of remaining with ONE or joining the Project Sponsors staff. The terms and condition of the privatization of the JLPP oblige the Project Sponsors to maintain salaries at current or higher levels. For these reasons, the impacts on local employment (and existing employees) will be positive. In addition, there will be indirect positive impacts as a result of increased spending by new employees. These positive impacts will be manifested largely in the El Jadida urban area where the new employees are likely to reside. Although the largely unskilled laborers in the immediate vicinity of the JLPP will benefit from construction hiring and periodic maintenance
activities, only a few permanent staff positions are expected to be filled by those living in the immediate vicinity of the JLPP.

According to local planning authorities, the City of El Jadida is expanding its low and moderate income housing stock to ensure that adequate housing is available for new workers in the area—including the JLPP expansion. Some 27,000 new housing units are expected to be developed by the year 2000 in areas that are served by water, sewer, and power utilities. By contrast, much of the existing housing stock closer to the JLPP is judged to be inadequate (Elhaiba, 1996).

By maintaining convenient employee transportation to and from the JLPP, the Project Sponsors can assure that growth from new employment will be channeled largely to the El Jadida area where adequate housing and services will be available.

The aesthetic impacts of the proposed expansion will be minor. There will be an additional flue gas stack that will be visible for several km along the coast highway. Two additional generating units will be visible from locations closer to the JLPP. Most of the new expansion, like most of the existing plant, will be shielded from view as a result of the terrain.

During the local permitting of the existing facility, an objection was raised by permitting authorities to the architectural design in the original plans. The building contractor worked with local authorities to develop an architectural motif that incorporates Moroccan Arabic design and that reduces some of the typical “industrial” look to the facility. This architectural motif will be incorporated into the two new units.

The only adverse aesthetic impact that may result from the expansion will be additional high voltage transmission lines and towers. Improvements in Morocco’s electric power transmission system are being evaluated in a separate World Bank-sponsored study and are not in the scope of this EIA.

**National Effects**

The most significant benefits of the proposed Project will be the increase in quantity, availability and the reliability of electric power to the nation.
As discussed in Section 4, the Moroccan economy has improved in recent years. However, future economic progress is challenged by relatively high unemployment levels and problems with the availability and reliability of electric power. As shown in Figure 6-4, JLPP will account for approximately one-half of Morocco's electric power generation by the end of the decade. The addition of Units 3 and 4 are absolutely essential to avoid future losses in gross national product and increases in the cost of doing business as a result of recent electric power curtailments.

The benefits of the increased capacity from Units 3 and 4 will also directly affect 80% of the Moroccan rural population that is currently without electric power. Many of these rural villagers, who comprise approximately half of the country's population, will enjoy the benefits of electric power over the course of next decade as a result of the rural electrification program. The success of this program depends, in part, upon the availability of electric power from Units 3 and 4.

Through the privatization of JLPP Units 1 and 2, the Government of Morocco will receive the monetary benefits of an upfront payment of $263.1 million (U.S.). Through the construction and operation of Units 3 and 4, additional power will be brought on line without the need for the increased indebtedness that would occur if JLPP were not privatized.

**International Effects**

Morocco has extensive business relationships with its European neighbors to the north and cultural connections and business relationships with its Arab neighbors to the east. The proposed Project, with both American and European partners, will continue to expand Moroccan commercial relationships with both Europe and the U.S.

**6.2.10 Noise**

Noise impacts from the operation of the new units will not adversely affect the off-property residential areas and will remain within Project guidelines for fence line impacts.

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1 As noted in Section 4, the four JLPP units will account for approximately one third of Morocco's installed capacity by the end of year 2001. Because JLPP is a base load power plant, its share of power generation (i.e., kWh produced) will be approximately half of the country's total electricity production.
Figure 6-4. Yearly Electric Power Requirements for Morocco and JLPP Contribution to Supply

Source: World Bank, 1994a
The construction contract has guaranteed the following source noise levels (i.e., 1 m from source) from the new equipment at Units 3 and 4:

- Safety valves (when blowing) at 30 m <95 dBA
- HP and LP turbine bypass <110 dBA
- Turbine generator <90 dBA
- All other equipment <88 dBA

Blowing safety valves will be loudest sounds from the plant. These should be very rare occurrences, but when they occur, they can create a startle effect on nearby employees, and to a lesser extent, wildlife and the public. The nearest off-site residential areas are shielded from most of the JLPP noises by the crest of the bluff. Most of these residences are at least 500 m from the new units. However, the nearest residence is only about 75 m. At this point, the safety valve blasts would be attenuated to about 70 dBA which is well below occupation limits set to protect hearing loss. Such levels would be a nuisance but considering their infrequency of occurrence, this is not considered a significant impact.

In addition to source noise limitations, the construction contractor has guaranteed that site boundary impacts would be below 65 dBA. This does not include the effect of Units 1 and 2, which, at most, would be an additional 6 dBA. Thus, the boundary line guarantee would result in a maximum potential boundary line impact of 71 dBA, which is marginally above the Project guideline of 70 Ldn (dBA). Further testing as described in Section 9 will be used to monitor noise levels to determine if mitigation is necessary. Most off-property residential receptors would experience no more than a 5 to 6 dBA maximum increase in noise, and most of the residences would be below the 55 Ldn annual average guideline because of the shielding effect of the terrain. All of the residences would be below health-based (hearing preservation) guidelines.

6.2.11 Worker Health and Safety

As discussed in Section 8, the Project Sponsors will institute a worker health and safety program that will minimize the potential for accidents. These measures will be in line with operating practices at plants in the U.S. and Europe.
7.0 ANALYSIS OF ALTERNATIVES

This section explains why and how certain decisions regarding the proposed Project were made and analyzes options for issues including: site selection, fuel selection, alternative coal technologies, alternative air emission controls, coal sources, alternative wastewater treatment options, and alternatives to ocean ash disposal.

7.1 Rationale for Site Selection

In 1994, the ONE requested proposals from international independent power producers to acquire the concession to operate Units 1 and 2 at JLPP and to add two additional units of at least the same size as the existing units at the site. The Project Sponsors, as well as other proposers, were constrained by the terms of the request to the existing JLPP site. The JLPP was originally designed for the construction of a total of six generating units. Given that there is substantial existing infrastructure already in place for the additional units, the least-cost baseload power generation option for ONE is the expansion of the JLPP. Moreover, the environmental impacts of a plant expansion would almost certainly be less than a "greenfield" project.

The original decision to site Morocco's largest power plant at Jorf Lasfar was made by ONE during the late 1980s. The rationale for locating at this site is its proximity to: (1) the ocean; (2) the Port of Jorf Lasfar; and (3) the large phosphate production plant owned and operated by the OCP, which already makes the location an "industrial" area.

The proximity to the ocean allows for once-through cooling using ocean water without the need for cooling towers or construction of a cooling reservoir. The proximity to the Port, with its ship and rail infrastructure, allows for easy delivery of construction materials and plant equipment and provides ready access to coal and fuel oil shipments. The proximity to the OCP plant reduces power transmission costs. The OCP plant is one of the largest of its kind in the world and is ONE's largest single customer. (Laaouina, 1996).

The JLPP, the Port of Jorf Lasfar, and the OCP facility are the core of an industrial complex that will be developed over the course of the next several decades. This industrial complex was sited away from existing urban centers, such as Casablanca, as a means of decentralizing industry for social and environmental reasons (Laaouina, 1996).
In summary, there were several compelling reasons for selecting the location of the JLPP at the Jorf Lasfar location. Moreover, the Project Sponsors were constrained through the international tender from proposing alternative sites.

7.2 Rationale for Coal as a Fuel

The two existing generating units at JLPP use coal as the primary fuel with No. 2 heavy fuel oil as a backup. The two proposed units will use coal as the primary fuel and heavy fuel oil No. 2 for start-up and flame stabilization only. As with the siting decision discussed above, the selection of a fuel other than coal was not an option for the Project Sponsors in their response to the public tender from ONE. The only reasons for changing the fuel selection for the additional new units would be overriding economic or environmental ones.

The only fossil fuel options for the future JLPP units are coal, fuel oil, and natural gas. Fuel oil storage capability would have to be increased significantly in order to provide a reasonable supply for six units. Given the lack of available suitable space at the immediate site, this amount of storage would require construction of oil tanks on the bluff above the plant. The use of fuel oil could provide for marginally reduced emissions, depending upon the quality of the oil, but would pose higher risks of oil spills and contamination of soil and water. In addition, the cost premium of burning oil instead of coal in units the size of Units 3 and 4 is estimated to be more than $50 million (U.S.) per year.

Natural gas is the cleanest fuel for power production. However, natural gas can only be transported economically through large diameter pipelines. Very little natural gas is produced in Morocco and this production is remote from Jorf Lasfar. A large natural gas pipeline is being constructed from Algeria to Europe crossing over the Straits of Gibraltar from Morocco. Of the 1435 km total length, 540 km traverses through the northern part of Morocco. Of the 18.5 billion m$^3$ annual throughput of the pipeline, some 8.5 billion m$^3$ will be marketed in Morocco. However, no trunk lines are planned for the El Jadida region and therefore use of natural gas in Units 3 and 4 is not considered a viable option (Laaouina, 1996).

In summary, the JLPP was originally designed and constructed to burn coal on all six units. The use of alternative fossil fuels (other than for back up and start up) for Units 3 and 4 is not reasonable.
7.3 **Rationale for Pulverized Coal Technology**

The JLPP uses conventional pulverized coal (PC) technology to generate electric power. Clean coal technologies, such as pressurized fluidized bed combustion (PFBC) and integrated gasification combined cycle (IGCC) are being demonstrated at several sites throughout the world. These technologies, particularly IGCC, offer the prospects of lower air emissions than the best controlled PC technologies combined with higher plant efficiencies and therefore lower fuel costs (DOE, 1994). However, the high capital costs and lack of operating experience of these technologies make them currently unattractive for most developing countries. Also, as noted above, the original design of the JLPP is for units that are similar to the existing PC boilers. The siting constraints, increased construction costs, and operational issues associated with adding a new technology at the existing JLPP also render the use of clean coal technologies impractical for this site at this time.

7.4 **Alternative Air Emission Controls**

Although continued use of coals from existing sources results in \((SO_2)\) emissions from all four units that meet the Project emissions guideline of 0.20 tpd per MW, the preliminary ambient air quality data (ONE, 1994) indicated that there are occasional episodes when high ambient levels of \(SO_2\) concentrations are experienced. Since these data were collected in 1994 prior to the construction of Units 1 and 2, the source of these intermittent elevated short-term \(SO_2\) concentrations is not JLPP. To ensure adequate protection of ambient air quality, in light of existing levels, alternatives for reducing \(SO_2\) emissions from JLPP were evaluated.

7.4.1 **Alternative \(SO_2\) Controls**

This section presents four alternative \(SO_2\) air emission control strategies considered for Units 3 and 4. The control strategies evaluated include the use of: 1) a seawater scrubber, 2) a limestone scrubber, 3) "ultra-low" sulfur coals, and 4) "cleaned" coals.

**Seawater Scrubber**

In a seawater scrubber, seawater and flue gas are brought into contact in a packed scrubber tower. The seawater flows down the scrubber while the flue gas flows up the scrubber (i.e., a counter-current design). The \(SO_2\) in the flue gas is absorbed by the seawater and quickly reacts with water to produce sulfite ions \((SO_3^{-1})\). The spent seawater is then routed to an aeration basin where the \(SO_3^{-1}\) is oxidized to sulfate \((SO_4^{2-})\), a major constituent of seawater.
The seawater scrubber produces no solid waste streams, and the increased \( \text{SO}_4^{2-} \) concentration in the spent seawater is well within the natural variations of seawater. However, trace heavy metals in the coal, such as chromium, can be transferred from the flue gas to the seawater, possibly requiring wastewater treatment systems to achieve project effluent guidelines. The seawater scrubber process is shown schematically in Figure 7-1.

The seawater scrubber design and cost data are based on the following assumptions:

- A 90% \( \text{SO}_2 \) removal efficiency;
- Labor rate of 12 dirhams ($1.50 U.S.)/hr;
- 20 workers total for all shifts;
- Seawater from condenser outlet at a rate of 40,500 m\(^3\)/hr.
- Coal lower heating values ranging from 5,800 to 6,930 kcal/kg-coal;
- Coal sulfur content ranging from 0.25% to 1.0%;
- Specific heat rate of 2,140 kcal/kWh; and
- Annual fixed charge rate of 17.25%.

Based on these assumptions, the total annual cost (annual charges on the capital investment + variable annual cost + fixed annual cost) of the seawater scrubber is $14.47 (U.S.)/kW-year and the \( \text{SO}_2 \) emission rate would be 0.012 tonnes/day-MW (for a coal with an average \( \text{SO}_2 \) content of 0.75%). The cost per tonne of \( \text{SO}_2 \) removed ranges from $297 (U.S.) to $984 (U.S.), depending upon the fuel sulfur content, with lower sulfur fuels having a higher cost per tonne due to the fixed capital equipment cost necessary to treat the volume of flue gas generated.

Although the seawater scrubber produces no solid byproducts that must be landfilled, it does reduce the generating unit's net electrical output approximately 2.2 MW by increasing the station’s auxiliary power requirements. The increased auxiliary power requirements result from the increased flue gas fan power needed to compensate for the flue gas pressure drop across the scrubber and from the power required by the scrubber’s absorber pumps and seawater treatment plant aeration fans.

---

1 The fuel sulfur level of the seawater scrubbing process is limited by the economics rather than for strictly technical reasons. Above approximately 1% sulfur, the volume of seawater that must be used to provide sufficient alkaline reagent becomes very large, and both capital costs and operating costs (primarily associated with seawater pumps and pumping costs) rapidly increase to the point where this system is not economically competitive with alternative \( \text{SO}_2 \) control processes.
Figure 7-1. Schematic Diagram of Seawater Scrubber Process with Bypass Reheat
Limestone Scrubber

In a limestone scrubber process, the flue gas exiting the ESP is passed upward through an absorber tower where it comes into intimate contact with a downward flow of a slurry of limestone (CaCO$_3$) in water. The SO$_2$ in the flue gas is removed by reaction with the limestone to produce calcium sulfite (CaSO$_3$-2H$_2$O). The CaSO$_3$-2H$_2$O is then oxidized by air injected into the hold tank to produce gypsum (CaSO$_4$-1/2H$_2$O) which can be dewatered, mixed with fly ash, and landfilled. If the gypsum is washed following dewatering, it can produce a commercial-quality product. The entire process is shown schematically in Figure 7-2.

The limestone scrubber design and cost data are based on the following assumptions:

- A 90% SO$_2$ removal efficiency;
- Coal lower heating value of 6,930 kcal/Kg-coal;
- Coal sulfur content of 1.0%$^2$;
- Limestone cost of $13 (U.S.)/tonne;
- Waste disposal cost of $5.50(U.S.)/tonne;
- Labor rate of 12 dirhams ($1.50 U.S.)/hr;
- 32 workers on all shifts$^3$;
- Specific heat rate of 2,140 kcal/kWh; and
- Annual fixed charge rate of 17.25%.

Based on these assumptions the total annual cost (annual charges on the capital investment + variable annual cost + fixed annual cost) of the limestone scrubber is $59.41(U.S.)/kW-year and the SO$_2$ emission rate will be 0.012 tonne/day-MW (for a coal with an average SO$_2$ content of 0.75%). The cost per tonne of SO$_2$ removed is $1221 (U.S.).

Like the seawater scrubber, the limestone scrubber reduces the generating unit’s net electrical output by increasing the auxiliary power requirements; however, the limestone scrubber’s auxiliary power requirement (2.9 MW) is approximately 30% greater, when burning

$^2$ A limestone scrubber is capable of treating fine gas from coal with a sulfur content much greater than 1%. The 1% sulfur assumption was selected based on providing an appropriate cost comparison with the previously discussed seawater scrubber and on the observation that world-market prices for 1% and 2.5% sulfur coals are approximately the same, on a cost per kcal basis (reference: Mr. Manfred Raschke, Ph.D.).

$^3$ The limestone scrubber requires more operating and maintenance labor than the seawater scrubber because of its more complex mechanical equipment and the scaling and erosive nature of the slurries being circulated through the process.
SOURCE: Cooper and Alley, 1986.

Figure 7-2. Schematic Diagram of a Limestone Scrubber
the same 1% sulfur coal. These power requirements are for the increased power requirements of the flue gas fans and the power requirements of the scrubber pumps, reagent preparation system, and waste dewatering system. The limestone scrubber also produces a large quantity of gypsum solids (approximately 3.6 tonnes of gypsum per tonne of \( \text{SO}_2 \) removed). This material must be either landfilled or disposed of as a commercial product.

"Ultra-Low" Sulfur Coals

Since the amount of \( \text{SO}_2 \) produced is dependent on both the amount of fuel used and the sulfur content of the fuel, it is possible to reduce \( \text{SO}_2 \) emissions by substituting the existing low sulfur coal with an "ultra-low" sulfur coal. The ultimate analyses for a range of "ultra-low" sulfur coals considered for use at JLPP are presented in Table 7-1.

The \( \text{SO}_2 \) emissions produced by an average "ultra-low" sulfur coal, as presented in Table 7-1, is approximately 0.03 tonnes/day-MW, well below the project emission guideline of 0.20 tonnes/day-MW. However, the cost differential for the "ultra-low" sulfur coals considered for use at JLPP is estimated to be approximately 4.3% greater than the cost for other low sulfur coals, which meet project guidelines.

In addition, the use of an "ultra-low" sulfur coal would be expected to increase PM emissions, since the existing ESP's collection efficiency would decrease as the coal sulfur content decreases. Therefore, the use of "ultra-low" sulfur coals at JLPP is not recommended.

Cleaned Coals

Coal cleaning can be achieved through five processes:

- Crushing;
- Sizing;
- Cleaning;
- Product dewatering, and;
- Water clarification.
Table 7-1. Range of Ultimate Analyses of “Ultra-Low” Sulfur Coals Considered for Use at JLPP

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composition (% by weight)</td>
<td></td>
</tr>
<tr>
<td>- Sulfur</td>
<td>0.10 - 0.29</td>
</tr>
<tr>
<td>- Ash</td>
<td>9.29 - 11.10</td>
</tr>
<tr>
<td>- Moisture</td>
<td>7.20 - 8.09</td>
</tr>
<tr>
<td>- Volatiles</td>
<td>NA</td>
</tr>
<tr>
<td>- Carbon</td>
<td>65.86 - 71.53</td>
</tr>
<tr>
<td>- Hydrogen</td>
<td>3.92 - 4.13</td>
</tr>
<tr>
<td>- Nitrogen</td>
<td>NA</td>
</tr>
<tr>
<td>- Oxygen</td>
<td>NA</td>
</tr>
<tr>
<td>- Chlorine</td>
<td>NA</td>
</tr>
<tr>
<td>Higher Heating Value (kcal/Kg)</td>
<td>6,939 - 7,225</td>
</tr>
<tr>
<td>Lower Heating Value (kcal/Kg)</td>
<td>6,695 - 6,975</td>
</tr>
</tbody>
</table>

NA= Not available

Coal cleaning is typically performed at the mine to reduce both the ash and sulfur content of the coal. By reducing the ash and sulfur content of the coal, emissions of SO₂ and PM are reduced. In addition, the amount of bottom ash produced is reduced. The five cleaning processes can be combined for six degrees of coal cleaning, ranging from a simple system providing coal sizing and removal of trash to full coal preparation system that produces a highly clean coal and a moderately cleaned “middle product” coal. In the U.S., nearly all of the coal mined underground is cleaned to some degree to reduce the ash content. More extensive cleaning is usually necessary to reduce the sulfur content.

Although coal cleaning can be utilized to reduce SO₂ and PM emissions, no data have yet been obtained from the potential coal suppliers on the effectiveness of, or costs for, cleaning their respective coals to fully evaluate this alternative. Project Sponsors have requested these data from potential coal suppliers.

**Conclusion**

The coals being considered for JLPP Units 3 and 4 appear to be capable of achieving both project emission guidelines and project ambient guidelines. SO₂ emission reduction alternatives
are not warranted due to the additional capital and operating costs that would be incurred. The additional costs for a seawater scrubber would have a 30-year present value of over $24 million (U.S.). The additional costs of a limestone scrubber would have a 30-year present value of over $96 million (U.S.).

7.4.2 Alternative Particulate Matter (PM) Control Options

The Project Sponsors are confident that PM emissions from Units 1 and 2 can be kept below the ESP guarantee of 125 mg/Nm$^3$. As discussed in Section 6.2.2, variations in coal ash and sulfur content affect PM emissions. This section discusses PM mitigation strategies that can be used as a means of making adjustments to PM emission levels which have changed as a result of using different coals or decreased ESP performance. The most often used strategies are flue gas conditioning and modifications to the electric power wave forms applied to the ESP.

Additives are used as a means of controlling the resistivity of the fly ash in the ESP. Collection efficiency is improved as fly ash resistivity is reduced. Additives can generally regain lost efficiency and regain the original performance level following a fuel change. The common means of modifying resistivity include the injection of:

- ammonia;
- sulfur trioxide;
- dual use of ammonia and sulfur trioxide;
- ADA-23 (proprietary acidic compound);
- sodium sulfate and bisulfate;
- water; and
- others.

The key to the application of additives is a combination of detailed analysis of composition of the coal fly ash, the temperature environment, and particle size, and the proper vaporization and mixing of the additive with the particle-laden flue gas.

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*These values are based on 30 years of operation at an average unit capacity factor of 82%. A levelized fixed charge rate of 18.85% was applied to the initial capital investment. Annual costs were estimated to escalate at a rate of 6% per year. The present value discount rate used was 19.58%.*
The other prime means of adjusting PM emissions is through modification of the wave shape, wave height, and frequency of the voltage signals applied to the electrodes and collector sections. Saw tooth waves (as opposed to square waves) of higher voltage at varying pulse frequencies have been found effective as an ESP performance adjustment factor. Wave height and frequencies are determined by test and experience. These modifications have been found to achieve significant reductions in PM emissions with only moderate installation expenses, although unit outages would have to be taken into account.

Other approaches that have been proven useful include flow balancing to reduce "sneaking" of flue gas and adjusting flue gas flows between channels to make these more uniform. Combustion improvement can be used to reduce the carbon content of the fly ash, so reducing this portion of the fly ash reduces inlet loading and improves resistivity. Coal washing can be used to reduce ash content. Electrical controls and rapping sequence can also be optimized.

Radian emphasizes that the potential of excessive particulate emissions is low, even based on relatively conservative predictions. Before any of the options listed above is considered, the performance of the actual ESP’s will be verified to determine the ESP outlet particulate emissions. If emission testing shows that the particulate emissions exceed 125 mg/Nm$^3$ when representative fuels are fired, Project Sponsors will investigate the necessity and cost effectiveness of applying any of the solutions above to reduce particulate emissions.

7.5 Alternative Wastewater Treatment Options

This section reviews the present wastewater production of JLPP, the present treatment processes, and a possible alternative process.

7.5.1 Wastewater Production

JLPP produces three types of effluents:

- Ash is sluiced to the ocean using seawater. The ash is discharged approximately 800 m offshore in 13 m of depth.
- The power plant condensers are cooled with a very large stream of seawater. The seawater is chlorinated upstream of the plant for control of biofouling, and ultimately discharged back to the ocean.
A variety of storm water and wastewater flows are produced and eventually discharged into the ocean. Some pretreatment of these effluents occurs.

Ash disposal is a solid waste management issue and so is discussed later in this section. The disposal of ash at sea will be discontinued and will be replaced with landfilling or beneficial reuse.

As noted in Section 6.2.4 of this report, the thermal discharge, although large and continuous, appears to have minimal impact on the environment and is well within project and World Bank guidelines.

The focus of the remainder of this subsection is on storm water and wastewater. The different streams present at JLPP are summarized on Figure 3-6. Except for the condenser cooling water, most of these streams are intermittent.

**Storm Water**

The unrealistic design storm of 10 cm/hr would temporarily create a potential storm water stream of 36,000 m³/hr over the area of JLPP. The large coal storage area north of the plant by itself could produce 17,000 m³ of runoff per hour. This coal yard is 1 m lower than the powerhouse, thus isolating the coal pile runoff from other JLPP drainage. Units 1 and 2 coal pile runoff is directed to the ocean via a single outlet which passes through a settling basin.

Storm water away from the powerhouse is collected in catch basins and drains to the sea via an open channel. Any storm water that may contain oil, such as runoff from the transformer pad or from oil storage tank areas, is directed to an oil/water separator prior to discharge. The recovered oil is used as No. 2 fuel oil, while the aqueous phase goes to the JLPP sewer system, and from there is discharged into the ocean via two 90 cm diameter concrete outfalls situated near the JLPP plant.

**Wastewater**

Boiler blowdown, and floor and equipment wash water are discharged directly to the sewer system. Sanitary wastewater flows through septic tanks for settling before entering the sewer network. Every building with bathrooms has such a septic tank, sized according to the expected number of users in the building.
Demineralizer backwash and regeneration water, boiler acid cleaning wastewater, and air heater cleaning water are neutralized in a settling basin before discharge to the sea.

7.5.2 Present Treatment

As discussed in the previous section, wastewater treatment at present consists of the following:

- Settling of storm water runoff from the Units 1 and 2 coal pile;
- Oil/water separation of oily wastewater;
- Settling and pH adjustment of air heater/boiler wash water;
- Septic tank settling of sanitary wastewater; and
- pH neutralization of very acidic or basic effluents.

7.5.3 Treatment Criteria and Compliance

The JLPP Project guidelines are summarized in Table 2-5. The existing plant condition as discussed in Section 6.2.3 indicates that compliance with Project guidelines may not always be achieved:

- Two pH excursions above pH 9 were measured;
- It is unlikely that the septic system can reduce BOD to the 50 mg/L level by itself, and no disinfection of the effluent is performed; and
- TSS exceeded the 60 mg/L standard in one of the wastewater samples.

Various options are available to address these concerns for Units 1 and 2, as discussed below. Units 3 and 4 will be designed to meet Project guidelines.

7.5.4 Wastewater Treatment Options for Units 1 and 2

The following options for treatment of wastewater effluents from Units 1 and 2 will be evaluated for possible implementation should monitoring indicate that Project guidelines cannot be consistently be met:
1) Unit 1 and 2 coal pile runoff is collected in a settling basin. Effluents from this basin will be monitored for TSS and pH. If measured values exceed Project guidelines, alternatives such as increasing basin size, adding neutralization capability, or combining the runoff water with that from the coal pile for Units 3 and 4 will be evaluated, and cost-effective measures will be implemented.

2) Unit 1 and 2 sanitary wastewater effluents will be monitored for BOD$_5$. If the measured levels exceed Project guidelines, alternatives such as routing these effluents to the sanitary wastewater treatment system for Units 3 and 4 will be evaluated and cost-effective measures will be implemented. The sanitary wastewater treatment system for Units 3 and 4 will be sized for 300 people, and will employ comminuting pumps to lift the wastewater to a treatment system for removal of BOD and suspended solids. The effluent will be disinfected prior to discharge.

3) Location, calibration and use of pH monitoring equipment will be reviewed and upgraded as necessary to assure that effluents from the neutralization basins are accurately monitored and pH adjusted prior to discharge.

7.6 Ash Disposal Alternatives
The Project Sponsors are committed to ending the practice of ocean ash disposal once a reasonable alternative for disposing or marketing the material can be implemented. To that end, an ash disposal options analysis was conducted (Radian, 1996).

Based on an analysis of the coal ash and projected future coal consumption rates for all four units, the volume of coal ash that would be produced over the 30-year concession to operate the plant is approximately 6.8 million m$^3$. The coal ash disposal options analysis considered disposal of this quantity of ash in a landfill and also evaluated beneficial reuse.

7.6.1 Landfill Sites
Two areas were identified as potential landfill sites: a large abandoned quarry under the control of the Department of Public Works and a vacant area not suitable for farming located south of the JLPP. These are described below and shown in Figure 7-3.

The Quarry Site
The quarry is located 5 km northeast of the plant, directly north of the main entrance to OCP. Paved roads lead from JLPP to the quarry and there is a well-graded unpaved road that leads down into the quarry at the southwest corner. The quarry is an irregular shape characterized
Figure 7-3. Potential Landfill Sites
by a fairly straight and long north face. There is a large shelf located on the east face starting in the northeast corner, and a lesser shelf about midway along the western face. The land from which the quarry was mined had little natural relief, thus the top of the quarry has very little change in elevation. The bottom of the quarry was excavated generally flat as well. The depth of the quarry, as measured in several places along the east vertical walls, is approximately 22 m. The surface area is approximately 441,000 m² and the volume of the quarry is approximately 9.7 million m³.

The quarry has been known to hold water from rains, however there are no data yet available to determine the depth to groundwater. During the April 1996 site visit, shallow water covered a relatively large area on the floor of the quarry, apparently not more than \( \frac{1}{2} \) m deep. The major consideration for use of the quarry as a landfill include the porous nature of the rock in the quarry floor and walls that was observed during the site visit, uncertainty of the depth to groundwater, and the potential for large volumes of surface run-on during storm events.

Site South of the JLPP

The land area south of the OCP discharge canal between the route and the ocean is characterized by rolling hills. It is not in cultivation due to the rocky soils. Based on observations made in the field, the rock that is exposed to the surface is boulder size or larger and therefore it is improbable that the land can be made arable. Also, the visible mixture of rock and soil creates macro pores which make the rock and soil substrate porous in nature. This plot of land is roughly a parallelogram with the long sides delineated by the route and the beach or bluff. The short sides are delineated by the OCP canal and the bend in Route 121 at the south. The length along the highway is approximately 1200 m and the perpendicular width between the route and the bluff is approximately 375 m. The area of this plot of land is 450,000 m². However, allowing for a buffer and traffic in this area around the landfill itself, the usable parcel for landflling is assumed to be 350 m wide and 900 m long. Therefore, to hold the estimated 6.8 million m³ of ash, with an assumed 3H:1V side slope on the ash pile, the landfill would have to be built to a maximum of approximately 26 m high. This estimate does not account for the valley in the middle of the parcel of land.

The major concerns for consideration of this parcel of land for a landfill, from strictly a technical perspective, include the proximity to the ocean, the visibility of the landfill from the
route, the porous nature of the rock and soil substrate, and the proximity to the groundwater table.

Comparison of the Two Sites
The selection of a landfill site should consider engineering, environmental, economic, and political aspects as presented in Table 7-2. When the two sites are compared against these criteria, the quarry emerges as the preferred site as shown in Table 7-3. Of the 21 specific criteria, the quarry is judged to be "acceptable" for all but six, "moderately acceptable" for five, and only "marginally acceptable" for one. The fields south of the JLPP are relatively less acceptable in several areas.

7.6.2 Description of Specific Landfilling Alternatives
Six specific alternatives are identified and discussed below:

- Quarry fill in conditioned (moist) state using trucks.
- Quarry fill in conditioned state using rail.
- Fill in a slurry that is piped to the quarry with leachate return to JLPP.
- Aboveground fill in conditioned state using trucks.
- Aboveground fill in conditioned state using rail.
- Slurry fill in aboveground impoundment with leachate return to JLPP.

Quarry Fill in Conditioned State Using Trucks
This alternative may be the easiest from the perspective of placing the fill in the quarry, however the most difficult at the point where the ash is accumulated. In this scenario, the ash is transferred to the storage silos as it is now, and the fly ash is moistened (with approximately 20% moisture content) through dustless unloaders into trucks. The trucks then drive to the quarry using 7.5 km of existing roads and dump the ash to be spread and compacted by the landfill operator. The daily generation of ash is estimated to be approximately 620 m³, or approximately 42 trucks per day.
### Table 7-2. General Criteria for Selecting an Ash Landfill

<table>
<thead>
<tr>
<th>Engineering/Environmental Criteria</th>
<th>Physical Size</th>
<th>Proximity</th>
<th>Site Access</th>
<th>Topography</th>
<th>Geology</th>
<th>Soils</th>
<th>Surface Water</th>
<th>Groundwater</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sufficient area must be provided to accommodate the coal combustion by-product material and related facilities for their design life. The active portion of the site should be surrounded by at least 30 m of unoccupied space which serves as a buffer zone between the disposal area and the site boundary.</td>
<td>The landfill site should be as close as possible to the power plant to minimize transportation costs.</td>
<td>The selected site must have sufficient access for construction purposes as well as for delivery of by-product during operation. Using trucks to transport the ash to the landfill site includes consideration of environmental factors such as safety, noise, and fugitive dust emissions. Further, the transportation route must be of adequate width and load capacity.</td>
<td>The site should be able to be developed with a minimum of earthmoving activity by using the natural contour of the land. Minimal site preparation should be required for diverting surface drainage away from the active disposal operations. Small valleys and ravines may be advantageous since they are capable of receiving large volumes without extensive modifications to the natural topography.</td>
<td>Geotechnical hazard areas (such as those prone to slides and faults), as well as areas with underlying, adjacent, or interconnected mines, quarries, sinkholes, or solution cavities should be avoided. The strength of the underlying strata should be capable of supporting any of the necessary surface structures.</td>
<td>There should be an adequate depth of soil between the base of the disposal area and groundwater. The availability of sufficient clay material for use as a low-permeability in situ or remolded liner is also an advantage. Suitable construction materials for dikes, berms, and final cover should be available. The final cover material should be capable of inhibiting water flow and of developing a good stand of vegetation, if growing conditions permit.</td>
<td>The site should be located outside the 100-year flood plain to prevent inundation. Locations near surface water should be avoided whenever possible.</td>
<td>Groundwater contamination is less likely to occur where there is sufficient depth between the bottom of the landfill and the historical seasonal high groundwater table. Preventing contamination is particularly important where the site overlies an aquifer which is either potentially or presently used as a water supply. The potential effect on water supplies, both groundwater and surface water, should be considered in the site location. In addition, the site's effect on groundwater quantity and quality should be minimized by locating away from groundwater recharge areas.</td>
<td>Wind intensity and direction should be considered, particularly with regard to minimizing the effects of fugitive emissions from dry transport and disposal.</td>
</tr>
</tbody>
</table>
Table 7-2. (Continued)

<table>
<thead>
<tr>
<th>Engineering/Environmental Criteria (Continued)</th>
<th>Terrestrial and Aquatic Ecology</th>
<th>Noise</th>
<th>Land Use</th>
<th>Scenic and Aesthetic Effects</th>
<th>Cultural Resources</th>
<th>Economic Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• The alteration of any unique habitat should be avoided. Detrimental effects on any rare or endangered species (resident or migratory) must be prevented.</td>
<td>• The local effects of transportation, construction, and operation should be minimized.</td>
<td>• Populated areas and areas of conflicting land use, such as parks, nature preserves, wilderness areas, and airports, should be avoided. The use of potential farm and timber land should be minimized. The site should have the capability for beneficial land use at the termination of disposal operations.</td>
<td>• Sites should be visually isolated as much as possible. Visual effects should be minimized by maintaining natural barriers such as a ridge of ground or a belt of trees. The presence of such natural barriers may preclude the need for constructing artificial screening devices.</td>
<td>• Unique archaeological, historical, and paleontological areas should be avoided. A thorough archaeological investigation should be performed at each site.</td>
<td>• Transportation Costs</td>
</tr>
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<td></td>
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<td></td>
<td>• Property Acquisition Considerations</td>
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<td>• Site Development Costs</td>
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<td>• Closure Costs</td>
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<td>• Post-Closure Costs</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Salvage Costs</td>
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Table 7-3. Qualitative Analysis of Design Criteria for Two Landfill Sites  
Jorf Lasfar Power Plant, Morocco

<table>
<thead>
<tr>
<th>Engineering/Environmental Criteria</th>
<th>Quarry</th>
<th>Southern Fields</th>
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<tr>
<td>Physical Size</td>
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<td>☐</td>
</tr>
<tr>
<td>Proximity</td>
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<tr>
<td>Site Access</td>
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<td>Topography</td>
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<tr>
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<td>Soils</td>
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<td>Cultural Resources</td>
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<tr>
<th>Economic Criteria</th>
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<tr>
<td>Transportation Costs</td>
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<td>Salvage Costs</td>
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</tbody>
</table>

|= Acceptable
|= Moderate
|= Marginal
The use of the quarry as a fill site, regardless of the method of transport, has an added benefit of the potential reuse of the land for industrial development. The quarry in its current state is not a desirable location for a manufacturing or other industrial operation. However, if the quarry is filled to the original grade, it could be developed for other use. The fill could be staged in 5-year or 10-year cells such that a portion of the quarry could be released for further development at the end of each period, assuming the density of the fill material would meet applicable building codes.

A protective liner and leachate collection system may be required to prevent contamination of the groundwater.

**Quarry Fill in Moistened State Using Rail**
Using this alternative, the ash is transferred from the existing silos into rail cars. This would require the construction of new rail sidings at the plant to route rail cars under the existing hoppers. Furthermore, a rail spur off the existing system leading into the quarry with an ash off-loading system would need to be constructed. Although much is required in capital investments, this alternative is more attractive operationally. There is no increase in automotive traffic, either in the plant or on the road. The ash would need to be transferred at the quarry using heavy equipment to the permanent landfill area.

A protective liner and leachate collection system may be required to prevent contamination of the groundwater.

**Quarry Fill in Slurry State**
In this alternative, the ash is slurred with plant water and pumped up to the quarry. The elevation difference between the plant site and the current bottom of the quarry is approximately 31 m. This represents a significant head requirement and subsequent power requirement to pump the slurry up 31 m and over 5 km. Also, the supernate would need to be collected and returned to the plant for reuse. Capital costs will be greater for this option than hauling but operational costs may be lower.

The leachate that would drain from such an operation is voluminous, therefore a large and elaborate settling basin and leachate collection system would be needed. A liner would need to be
constructed beneath the landfill in order to assure protection of the groundwater from the leachate, which will likely contain heavy metals from the ash.

**Aboveground Fill in Conditioned State**

The disadvantages and advantages of a truck system are no different whether the ash goes to the quarry or to the field south of the plant. However, the distance to the fields south of the plant is much less. Operationally, the fill would be placed in lifts on the existing terrain and compacted in place. It would be necessary to develop haul roads and heavy equipment maintenance facilities. Protection of the surrounding environment would be necessary, such as fugitive dust control and storm water run-on prevention and run-off control. A protective liner and leachate collection system may be required to prevent contamination of the groundwater.

**Aboveground Fill Using Rail**

The requirement for using this site as a landfill with a rail delivery system are no different than using the quarry, except more consideration must be given to preventing dust from wind erosion. The same capital improvements would be required. The rail spur to this site would be required to cross the canal from the OCP, thus requiring a railroad bridge or, at least, a large culvert.

**Aboveground Fill in Slurry State**

Due to proximity to the ocean and the assumed shallow groundwater table, a landfill liner and supernate return system would need to be built to support and collect the large volume of liquid inherent in this system. The retention of solids as the liquid drains out would also need to be considered.

**7.6.3 Selection of a Preferred Landfilling Alternative**

If there are no unforeseen impediments to land acquisition, backfill of the quarry would appear to be the better land disposal alternative based on the site selection criteria and the potential for reuse once the quarry is partially or completely filled. How the ash would be transported is a matter of design and cost. The major advantage for the southern fields site is the shorter transportation distance. The Project Sponsors have initiated activities to determine the availability and detailed technical suitability of both sites.
7.6.4 Identification of Non-landfilling Alternatives

The two primary non-landfilling alternatives are beneficial uses within Morocco and returning the ash to the coal supplier, in the same ships that carry the imported coal, for beneficial use elsewhere.

Return Ash to Coal Supplier

The option of returning the fly ash and bottom ash to the coal supplier may be implemented provided the supplier is willing and able to accept these materials at a cost less than that of other options. Several power plants on the Mediterranean Sea currently have coal supply contracts that provide for this (Odom, 1996). The transporting mechanisms however, may require modification for transferring the ash to the port location and for loading of the ships with the ash. For example, the ash materials (in a dry state) could be transferred from the existing storage silo and into rail cars for transport along the existing rail spur. The ash materials could be pneumatically off-loaded via the ship. A major consideration with this alternative is that the rail cars could be used as the temporary storage mechanism at the seaport when coordinating schedules for off-loading the by-products to the transporting ship. The advantages and disadvantages of this alternative are summarized below.

Advantages:

- future liability associated with disposal is limited,
- dryness of the by-products would be maintained,
- engineering/design modifications to existing structures could be easily retrofitted,
- ash could be batch loaded in bulk shipments, and
- operation and maintenance (O&M) cost for maintaining transfer equipment are expected to be minimal due to limited manpower and maintenance requirements.

Disadvantages include:

- all collected ash material must be kept dry,
- initial capital cost may be required for adding storage capacity dependent on schedule to coordinate ash shipments, and
- emissions during transfer operations will require controls.
Beneficial Use of Ash

The quantity of ash utilized as raw materials or replacement materials has increased over the last two decades. Specifically, high volume uses of fly ash are typified by structure fills, embankments, base courses for road surfaces, soil stabilization, soil amendment and as partial replacement in concrete. Other uses include adding fly ash to flue gas desulfurization processes either as an absorbent or absorbent amendment, and for waste stabilization.

The use and marketability of fly ash in making concrete is predicated on the specification requirements and specific construction codes. The local municipalities and construction codes in Morocco would need to be assessed to determine if the fly ash meets the appropriate specifications and to determine if there are interested vendors within the immediate area. If the market appears to be positive, then an assessment of the quality and quantity of the fly ash needed could be verified.

There are several potential advantages for selecting this alternative, including reduction of disposal liability, reduction of O&M cost, and acceptance by environmental groups and public. The disadvantages include exacting specifications by vendors and the distance to ready-mix concrete and cement plants may result in transportation cost in excess of the value of the ash.

Use in Cement Manufacturing

Fly ash can be used as partial replacement for feedstock to the kiln in the manufacture of Portland cement. For example, cement manufacturers require certain proportions of silica, alumina, calcium, magnesium, iron, and other trace and major elements and oxides. This replacement is acceptable as long as the mineral composition can supplement other feedstocks, such as clay, limestone, shell, or cement rock. The advantages of feeding directly to the kiln, as opposed to adding to the product (admixture), is that specifications for loss on ignition and moisture content are not nearly as stringent.

Agricultural Use

By blending fly ash with compacted soil the pore space between soil particles is increased and surface crusting is diminished. As additional porosity is provided, the soil retains more water and nutrients for plant growth. Also increasing the pore space in the soil enhances plant root growth into the subsurface soil. Other applications where soil amendments have been shown to be beneficial include mixing fly ash to promote growth of turf-grass (e.g., golf courses).

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An assessment of farmlands located within the proximity of the power station would be required to determine if such applications are feasible. For this option to be viable, the farmlands would have to be of sufficient size to support periodic applications of the fly ash to the native soils. An assessment of the soil conditioning requirement for certain crops also would have to be evaluated to ensure that the chemical properties (e.g., pH, metals) of the fly ash would not be detrimental to crop species.

**Beneficial Use in Road Construction and Other Fill Applications**

Recent surveys have shown beneficial use of fly ash and bottom ash for road grade and base foundations to support construction of roads, parking lots, and runways (EPRI, 1988). Fly ash can be used to amend soils and strengthen the subgrade at a relatively low cost. Fly ash as part of base or subbase courses can be used in the following three principal ways: (1) in combination with lime and/or Portland cement; (2) in combination with lime or Portland cement separately; and (3) in combination with on-site borrow soils with or without the inclusion of lime. The formulation of these materials for a subsurface preparation is used as an alternative to a full depth asphalt base course, or an all aggregate base course.

**Fill Use**

Fill application of fly ash has been used successfully as reported by various power companies (DOE, 1990). Fill applications include backfills, embankments, and site fills. The utilization of fly ash as a fill material is a direct result of the physical/engineering properties that the coal combustion by-products offer (e.g., low unit weight, high strength, low compressibility), and cost when compared to natural borrow material. The coal by-products may be conditioned before transporting to allow delivery at a specified moisture content dependent on application. Fill material can be broken down into four general applications: (1) backfills for bridge abutments and utility trenches, (2) roadway embankments, (3) site development fills, and (4) repair or stabilization of landslides.

**Coal Ash Utilization Summary**

In summary combustion byproducts such as fly ash and bottom ash can be a viable resource that offset the use of raw materials and mitigate disposal liability. In many countries, social, economic, and political incentives to avoid disposal of coal ash are present. The avoided cost of disposal weighs heavily in the overall economics, directly fostering utilization of by-products. As a result of these factors, the Europeans, for example, have focused their markets to
use fly ash in production of clay bricks, aerated construction blocks, and synthetic aggregates to be used in a variety of concrete applications.

7.6.5 Ranking of Alternatives and Conclusions

The most advantageous alternative to ocean dumping of the ash by-product material is beneficial reuse. There are basically two general methods for achieving this advantage: returning the ash to the coal supplier for beneficial reuse outside of Morocco, or developing markets within Morocco. In either case, the ash could be put to beneficial use in the cement and concrete industry, in agricultural settings, or in the construction industry. Furthermore, the use of ash as a resource is not restricted to any particular industry but can be put to use in all these areas.

It is currently anticipated that beneficial use of all of the ash will be either impractical or cost-prohibitive. Therefore, the Project Sponsors have initiated activities to determine the availability and detailed technical suitability of two sites which appear to meet generally accepted criteria for siting an ash landfill. The result of these activities will be a preliminary design and cost estimate for developing and using an ash landfill which is protective of the environment and capable of receiving all of the ash anticipated to be generated over the 30 years of the JLPP concession.
8.0 MITIGATION AND ENVIRONMENTAL MANAGEMENT PLAN

This section describes the measures that will be taken to avoid, reduce, or compensate for any potential impacts from the proposed Project. The mitigation measures described below are based on best professional judgments from the environment assessment team and thorough review of mitigation measures recommended by the World Bank (World Bank, 1995).

8.1 Mitigation During Construction

Potential environmental and human health impacts during construction include: increased fugitive dust emissions, soil erosion, storm water runoff and sediment loading, groundwater contamination, and worker health hazards. The mitigation measures are discussed below.

8.1.1 Air Quality

Fugitive dust emissions from excavation, construction, and vehicular traffic at the construction site can affect the air quality of the site. To mitigate increased fugitive dust emissions, dust suppression control methods, such as spraying water on roads or dirt areas will be applied. Trucks carrying fine material may be sprayed or covered as necessary to reduce the generation of dust.

To further reduce dust generation and exhaust emissions, vehicular speeds will be controlled, and buses will be used to transport workers to and from the Project site.

8.1.2 Surface Water Quality

Erosion control measures will be implemented as necessary to prevent storm water runoff from carrying sediment and/or surface water contamination to drainage areas and the Atlantic Ocean. Some typical construction practices which may be used to control storm water runoff and sediment loading from the Project site include:

- Construction of site retention areas or sediment retention ponds to handle storm water runoff;
- Installation of silt curtains, hay bales, or other temporary erosion control measures;
INTERNATIONAL

→ Diversion of runoff from undisturbed areas around construction areas; and

→ Implementation of spill prevention and clean up practices to prevent contamination of storm water runoff (e.g., oil and grease from construction equipment).

8.1.3 Groundwater Quality

During construction, suspended solids and other contaminants (e.g., oil and grease) can infiltrate to the shallow aquiferous zone and impact the groundwater. Spill prevention measures and clean up will be implemented as necessary to prevent groundwater contamination. Also, dewatering methods may be applied to remove surface water and shallow groundwater from pooling in excavation areas and prevent possible contamination or sediment loading from construction activities.

8.1.4 Worker Health and Safety

A health and safety plan incorporating OPIC and Ex-Im safety standards and Moroccan codes for worker health and safety will be implemented for the construction of Units 3 and 4.

8.2 Mitigation During Operation

This section discusses the mitigation measures that will be implemented during operation of the JLPP facility by the Project Sponsors. Potential impacts related to ash disposal, wastewater treatment, surface water quality, groundwater quality, air quality and worker health and safety are addressed below.

8.2.1 Ash Disposal

Ash disposal at sea will be eliminated and replaced with land disposal and/or utilization of the ash once an acceptable option is established by the Project Sponsors. The landfill will be designed and constructed with appropriate groundwater protection systems to prevent leaching into the soil and groundwater. The design of the system will be predicated upon the geology of the site.

If truck transport of coal ash is used, appropriate traffic signals and other controls will be implemented to prevent highway congestion and accidents from increased traffic. Also, measures will be taken to prevent fugitive dust generation while hauling the ash to its destination.
Ash placed in the landfill will be compacted so that the site can be beneficially utilized after it is filled.

8.2.2 Wastewater Discharge and Surface Water Quality

As described in previous sections, wastewater will be treated and discharged to the Atlantic Ocean. As indicated in Section 9, a wastewater monitoring program will be implemented to monitor discharges. Although all discharges are expected to be within Project guidelines, monitored values outside of those guidelines will be cause for prompt investigation and corrective action.

8.2.3 Air Quality

Emissions of SO₂ and NOₓ from the four JLPP Units are expected to meet Project guidelines for the current coals being considered. The use of low sulfur coals (annual average sulfur content of less than 1.25 wt %) will meet both the stack emissions and ambient air quality Project guidelines. Section 9 details the monitoring methods that will be utilized by the JLPP Operator to assure adherence to the Project guidelines for SO₂ emissions.

NOₓ emissions within the Project guidelines can be maintained through the proper operation and maintenance of coal burners and registers. All four units are designed to achieve the Project guidelines. Therefore, no mitigation is required.

Particulate emissions from Units 3 and 4 are expected to achieve compliance with the Project guidelines at all times for all coals being considered. The ESP supplier has provided a performance guarantee that corresponds to the Project guideline of 50 mg/m³.

Adherence to the Project guidelines for PM emissions on Units 1 and 2 has been demonstrated through stack testing. The Project Sponsors will conduct periodic testing of particulate emissions while burning representative coals to assure that adherence with the Project guideline of 125 mg/m³ will be maintained. In the event that emissions of PM exceed Project guidelines, the Project Sponsors will initiate a study to determine which cost effective alternative PM control measures can be used for mitigation.
In addition to stack discharges, emissions from other sources can be minimized by regularly spraying the coal pile and unpaved roads with water to reduce fugitive dust emissions, and by implementing good housekeeping to minimize VOC emissions from paints, solvents, cleaning fluids, and fuel oil.

8.2.4 Worker Health and Safety

An environmental management plan (as described in Section 8.3) as well as a worker health and safety plan will be implemented to promote and maintain safe and environmentally sound operation practices at JLPP.

8.2.5 Other Operation Impacts

Lighting will be installed as required on stacks for aircraft warning. Additionally, the Project Sponsors will provide landscaping.

Traffic signals and other controls will be installed along roadways to the plant if deemed necessary. Bus transport of JLPP workers is expected to continue after the construction of the new units, which will reduce traffic congestion along Route 121.

Project Sponsors have the incentive to build and operate the JLPP in the most efficient manner possible. Efficient construction and operation will minimize the generation of waste and its adverse effects on the environment.

8.3 Environmental Management and Training

8.3.1 Environmental Management Implementation Plan

A subsidiary of CMS Generation Co., as Operator of the Project, is obligated under the operations and maintenance agreement to operate the JLPP in such a manner that it complies with the JLPP Project guidelines in Table 2-5. In addition to the specific mitigation and monitoring activities to be implemented as described in other sections of this EIA, the Operator has developed a comprehensive environmental management implementation plan (the Plan) which defines generic roles, responsibilities and activities to be implemented at any facility it operates, to assure environmental protection and compliance with requirements. A copy of the
Plan is included in Appendix D. Major elements of the plan, with specific applicability to the Jorf Lasfar project, are described below:

**Environmental Policy Statement**—All CMS environmental activities are based on implementation of this policy. It requires compliance with environmental requirements, planning and actions in support of environmental protection, communication of environmental issues, establishment of responsibility for environmental performance, development of standards and procedures to implement the policy, and regular review of internal conformance with the policy. It is endorsed by the President and Chief Executive Officer of CMS.

- **Organization**—As described in the Plan, CMS has assigned responsibility for environmental management activities throughout the organization. For the day-to-day activities associated with operation of the Project, the Plant Manager or a designated Site Environmental Coordinator will take the lead responsibility for environmental management and protection activities at the site. The CMS Manager of Environmental Affairs will, as needed, provide support to the site and periodic assessment of site environmental management activities.

- **Corporate Standards**—CMS corporate environmental standards establish expectations and responsibilities for the performance of generic environmental management activities. A complete set of these standards is also included in Appendix D. A detailed description of how these standards will be implemented at the Jorf Lasfar site is given in Section 8.3.2 below.

- **Environmental Requirements**—Applicable environmental requirements are required to be documented at each CMS-operated facility. Upon take-over of operations, the Plant Manager or Site Environmental Coordinator will work with the Manager of Environmental Affairs to identify applicable regulatory and permit environmental requirements to assure that they are understood and documented at the site. French and English copies of this EIA will also be maintained at the site to document mitigation and monitoring commitments.

- **Plant Procedures**—The Plant Manager or Site Environmental Coordinator will determine the content of specific plant procedures to implement environmental protection and compliance activities at the site. At a minimum, procedures or plans to be developed during the first year of operation will address the following:

  - an environmental emergency response plan, as described in Corporate Standard ENV-CMS-008;
- a hazardous materials management plan, to assure that hazardous materials and their associated risks are identified, and that appropriate material purchasing, handling, storage, use and disposal controls are in place;

- a waste management plan, to include evaluation of plant waste streams, and procedures for waste handling, storage, labeling, shipping and disposal, with the goal of identifying opportunities to reduce the toxicity or volume of specific wastes, change formulations to less polluting materials, or find beneficial use for plant wastes (e.g., ash);

- operations, maintenance, test and calibration procedures for environmental monitoring and control equipment; and

- bulk chemical and liquid fuel unloading procedures.

Feedback and Improvement - Processes and activities are built into the Plan to assure continuous improvement of the environmental management program. Audits, assessments, reporting, communication and training will provide feedback and improvement, as described in Section 8.3.2 below.

8.3.2 Implementation of Corporate Standards

CMS requires compliance with the Corporate Standards included in Appendix D by each facility it operates. The significance of these standards for the JLPP project is described below.

- **Acquisition and Possession of Permits (ENV-CMS-001)** requires the facility to have a copy of all applicable permits and approvals on-site and to obtain all permits or approvals required for site modifications.

- **Compliance with Requirements (ENV-CMS-002)** requires the facility to comply with all permit and non-permit environmental requirements, and to develop facility-specific procedures as needed to document and implement environmental compliance activities. It also recommends the designation of a Site Environmental Coordinator. This standard ensures that facility management is aware of environmental requirements, and will put in place the organizational and financial resources necessary to assure compliance with permit and regulatory requirements.

- **Commitment Schedule (ENV-CMS-003)** requires the facility to develop an annual schedule describing environmental inspection, monitoring, reporting, notification, training, records management and other similar periodic commitment requirements. This ensures that the facility will have an organized summary of all periodic requirements, including those required by permit, regulation, and
commitments made in this EIA. This schedule will be developed during the first year of operation.

- **Training (ENV-CMS-004)** requires that all employees receive environmental training commensurate with their job responsibilities. This ensures that all employees will have a basic awareness of how their work potentially impacts the environment and of things they can do to minimize those impacts. It also assures that employees whose jobs involve specific environmental compliance or protection activities receive training, as needed, to properly carry out those activities. Initial training on the CMS Generation environmental management implementation plan, CMS Corporate Standards, applicable permit and regulatory environmental requirements and other commitments will be provided to the Plant Manager and Site Environmental Coordinator by the CMS Generation Environmental Affairs Department. The first round of environmental training will be completed during the first year of operation.

- **Environmental Excellence (ENV-CMS-005)** encourages CMS-operated facilities to achieve high levels of compliance with emission and discharge limits, and seek opportunities to minimize waste. Annual awards are given to the top performing facilities, and the Plant Manager will be asked to accept the challenge of operating at the high compliance levels necessary to win an award.

- **Agency Meetings/Discussions (ENV-CMS-006) and Agency Inspections (ENV-CMS-007)** authorize the Plant Manager or other facility staff to communicate directly with representatives of governmental agencies on environmental matters. Significant issues are required to be communicated to CMS management.

- **Response to Environmental Emergencies (ENV-CMS-008)** requires the facility to develop an environmental emergency response plan to guide facility response to an actual or potential significant release (spill, gas leak, explosion, etc.) to the environment, and to notify CMS management if an environmental emergency occurs. The plan will enable plant personnel to take proper actions to prevent, minimize or control and contain releases, to notify the proper authorities as necessary, and to initiate any appropriate clean-up and disposal activities.

- **Periodic Routine Reporting (ENV-CMS-009), Nonroutine Reporting (ENV-CMS-010), and Notice of Violations (NOVs), Citations, Enforcement Actions (ENV-CMS-011)** require the facility to handle routine communication with government environmental agencies and to keep CMS management informed monthly on the status of facility environmental compliance activities. The facility is also required to notify CMS management as soon as possible of any unusual or significant environmental issue or action taken against the facility.
• **Recordkeeping (ENV-CMS-012)** requires the facility to maintain site environmental files for the primary storage of all permits, standards, requirements, procedures, monitoring data, reports, submittals, correspondence, training documentation and other site-related environmental records (such as a copy of this EIA).

• **Audits, Assessments and Appraisals (ENV-CMS-013)** requires that the facility receive periodic internal and independent assessments of its compliance with requirements and commitments and of the quality of its environmental management activities. Such assessments will be scheduled for two out of every three years, and the results will be used to improve site compliance programs.
9.0 MONITORING PLAN

This section describes the proposed activities, methods, and frequencies for monitoring, record keeping, and reporting environmental discharges and potential impacts from the proposed Project. Table 9-1 summarizes the monitoring, record keeping and reporting activities that will occur during the construction phase and during operations of the existing two units and after Units 3 and 4 are completed. As required by the lenders and the Moroccan authorities, the Project Sponsors will develop an annual environmental report which will include the data described below. Records will be maintained at the site for a period of at least five years.

9.1 Monitoring and Reporting of Construction Impacts

During the construction phase of the Project, fugitive dust monitoring will be accomplished via two methods: 1) ongoing ambient air quality sampling being conducted by the Project Sponsors, including PM and PM$_{10}$, will take place until May of 1997; and 2) visual observations of road dust will be made by Project representatives when conditions exist that foster high fugitive dust releases.

Drums, tanks, and hazardous material storage areas will be routinely inspected by Project representatives to confirm that proper housekeeping and hazardous material handling procedures are being followed. Any spills or leaks found during the inspection will be reported to the construction contractor for clean up.

9.2 Monitoring of Operational Impacts

Ongoing monitoring, record keeping and reporting for the operational units will be performed by the Operator. The need for monitoring is delineated in the lenders' guidelines as well as in the CMS Corporate Standards. The subsections below describe the types of monitoring, record keeping and reporting that the Operator will be performing. Table 9-1 summarizes the types of operational monitoring that will occur at JLPP.

9.2.1 Air Quality

Currently, JLPP is conducting ambient air monitoring to determine the baseline NO$_x$, SO$_2$, and PM and PM$_{10}$ concentrations that exist in the vicinity of JLPP. This baseline will include the existing impacts associated with all emission sources of SO$_2$, NO$_x$, and PM in the region, including JLPP Units 1 and 2. After 12 months of monitoring is complete, the Project Sponsors will re-examine the air dispersion modeling analysis performed for this report.
<table>
<thead>
<tr>
<th>Phase</th>
<th>Category</th>
<th>Monitoring Parameters/Frequency</th>
<th>Recordkeeping</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>Fugitive Dust</td>
<td>Ongoing baseline ambient air monitoring will detect construction dust during initial construction phase. Thereafter visual observation of dust.</td>
<td>If excessive fugitive dust is detected, mitigation measure applied and recorded.</td>
<td>Annual report required by lenders and Moroccan government.</td>
</tr>
<tr>
<td>Hazardous materials spills</td>
<td></td>
<td>The condition of tanks and drums containing hazardous material will be routinely inspected.</td>
<td>If spill is noted, describe material, amount, cause, and clean up methods utilized.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Operations</td>
<td>Groundwater</td>
<td>Annual sampling for oil and grease, heavy metals, pH, and conductivity at existing wells.</td>
<td>Maintain laboratory analysis and water table depth for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Waste Water</td>
<td></td>
<td>-Monthly sampling of pH, temperature, residual chlorine.</td>
<td>Maintain logs of sampling dates and laboratory analysis for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Air Emissions</td>
<td></td>
<td>-Annual testing of each unit individually. -Pollutants SO\textsubscript{2}, NO\textsubscript{x}, PM</td>
<td>Include stack test report in annual report. Maintain for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Baseline Ambient Air Quality</td>
<td></td>
<td>-May 1996 - May 1997 (12 months) -Pollutants SO\textsubscript{2}, TSP, PM\textsubscript{10}, NO\textsubscript{x}</td>
<td>Maintain for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Operational Ambient Air Quality</td>
<td></td>
<td>-12 months after Unit 4 becomes operational -Pollutants - SO\textsubscript{2}, TSP, PM\textsubscript{10}, NO\textsubscript{x}</td>
<td>Maintain for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Noise/Source Testing</td>
<td></td>
<td>-One time only -All sources for which contractor guarantees source levels</td>
<td>Maintain for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Noise/Occupational</td>
<td></td>
<td>-Annual measurement -Identify zones 85 dBA</td>
<td>Maintain for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
<tr>
<td>Air quality/Occupational</td>
<td></td>
<td>-Annual measurement -Pollutants - CO NO\textsubscript{x}, PM\textsubscript{10}, SO\textsubscript{2}</td>
<td>Maintain for 5 years at a minimum.</td>
<td>In annual report</td>
</tr>
</tbody>
</table>
Results of the 12 month ambient air quality monitoring will be used to establish the background/baseline air quality. These data will be compared with the project ambient air quality guidelines to determine the following:

- The classification of the region with respect to the project guidelines for each monitored pollutant;
- The allowable World Bank Criterion II incremental impact for \( \text{SO}_2 \);
- The predicted incremental impact of JLPP Units 3 and 4 on ambient air quality for each pollutant monitored; and
- The predicted ambient concentration of monitored pollutants compared with the project ambient air quality guidelines, both long and short term.

The Operator will perform annual stack tests for \( \text{SO}_2 \), \( \text{NO}_x \), and PM for all units, while running at 80% capacity or greater. The results of the stack tests will be reported to the appropriate lending institution annually along with all other environmental monitoring results.

World Bank guidance indicates that additional ambient air quality monitoring should be performed after completion and start-up of Unit 4. The Project Sponsors will use the same equipment that is currently being used to establish the baseline concentrations to perform this post-construction monitoring. The duration of this additional ambient monitoring will be negotiated with the lending institutions after Unit 4 construction is completed.

Occupational air quality testing for CO, \( \text{NO}_x \), PM and \( \text{SO}_2 \) will be performed annually by the Operator to determine potential exposure levels to JLPP workers. Results of this sampling will be included in the annual environmental report.

### 9.2.2 Water Quality

Monthly sampling and analysis of all wastewater outfalls for pH, temperature, oils and grease, and total suspended solids will be performed by the Operator. Total residual chlorine will be monitored once per month in the condenser cooling water discharge and \( \text{BOD}_5 \) will be monitored in the sanitary wastewater outfall.
Annual groundwater sampling of the existing wells will also be conducted and analyzed for oil and grease, heavy metals, pH and conductivity.

The results of all wastewater analysis and groundwater analysis will be summarized and included in the annual environmental report for the lending institutions. All data will be maintained at the site for at least five years.

9.2.3 Noise

Both occupational and source testing will be performed to determine if the facility is producing unacceptable noise levels. The equipment listed in Table 9-2 will be source tested once to determine if it complies with vendor guarantees (also shown in Table 9-2). Occupational testing will occur annually. Based on this testing, the JLPP Operator will identify any areas in the plant that require hearing protection.

<table>
<thead>
<tr>
<th>Table 9-2. Noise Source Performance Guarantees¹ for Specific Equipment at JLPP Units 3 and 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Equipment</strong></td>
</tr>
<tr>
<td>Safety valves (when blowing)</td>
</tr>
<tr>
<td>HP and LP turbine bypass</td>
</tr>
<tr>
<td>Turbine generator</td>
</tr>
<tr>
<td>All other equipment</td>
</tr>
<tr>
<td>Diesel building exterior</td>
</tr>
<tr>
<td>Along site boundary</td>
</tr>
</tbody>
</table>

²All measurements and calculations are according to ANSI SL36, 1979 edition (dBA is A-weighted decibels).

9.2.4 Solid Waste Disposal

The loading and hauling of coal ash, if handled via trucks, may produce an additional source of fugitive dust at the JLPP. Therefore, the handling of coal ash before disposal will be visually monitored to determine if unacceptable levels of fugitive dust are being generated. Mitigative measures such as covering or wetting the ash before being hauled off the facility will be taken to reduce the quantity of dust released.
The Operator will maintain records of the amounts of fly ash and bottom ash that are beneficially re-used and a summary of the amounts and corresponding uses will be reported to the lending institutions in the annual environmental report.
10.0 INTERAGENCY COORDINATION AND PUBLIC PARTICIPATION

The interagency coordination and public participation process included meetings between the Project Sponsors and various Moroccan agencies and discussions with the public and various non-governmental organizations. In addition, this EIA has been reviewed by the Moroccan Ministry of the Environment and several other Moroccan government ministries.

Prior to the preparation of this EIA, the Project Sponsors and Radian met with the following agencies to gather information and establish contacts:

- Office Nationale de l'Electricite (ONE);
- Ministere de l'Environnement (ME);
- Office d'Exploitation des Ports (ODEP);
- Office of the Governor of the Province of El Jadida; and
- Office of the Caid of the Commune of Moulay Abdellah.

The remainder of this section summarizes the two meetings held with public.

Pursuant to the World Bank Operational Directive 4.0, Chapter 7, public and NGO forums to discuss the proposed Project were held in El Jadida and Casablanca on July 11 and July 12, 1996, respectively. The forums were hosted by AFAK, (meaning "Horizon" in Arabic) a Moroccan NGO dedicated to informing the Moroccan public and to improving the quality of life for the people of Morocco.

The purpose of the forums was to: 1) inform the public about the scope of the proposed Project; 2) inform the public of the environmental and socioeconomic impacts associated with the proposed Project; and 3) solicit input from the public concerning the scope of the EIA, the methodologies employed, the data and information presented in the EIA and other concerns. According to AFAK and other NGOs, this was the first forum of its type in Morocco and thus there was strong interest from the Moroccan government, the public, and the participating NGOs.
10.1 Forum Presentation Summary

Both the citizens forum and the NGO forum consisted of a series of presentations by AFAK, ONE, the Project Sponsors, and Radian International, who was the EIA preparer. A brief summary of the presentations by the ONE and the Project Sponsors follows. The presentation of the EIA by Radian is not summarized here as this EIA provides the materials that were presented.

10.1.1 ONE Presentation

The first presentation was made by Mr. Boudlal of ONE who explained the need for additional electrical capacity in Morocco to meet growing industrial and residential electrical demands. A summary of Mr. Boudlal’s comments are as follows:

The importance of JLPP to the ability of ONE to meet the current and future demands of the Moroccan economy and residential demand for electricity was described. The bidding process associated with the privatization of Jorf Lasfar included 34 companies who responded to the request for proposal. Each of the proposals were reviewed by the ONE with assistance from an international consulting firm. The evaluation criteria for the proposals included technical, commercial, and financial competence of each bidder. From the 34 original respondents to the RFP, four were short listed for final evaluations and were asked to provide technical, commercial, and financial proposals. The ABB/CMS proposal was chosen as the finalist and negotiations were begun. The protocol between ABB/CMS and the ONE was signed on April 26, 1996. The ONE will continue to own the land and all the equipment at the JLPP, and will own Units 3 and 4 when construction is complete. ABB/CMS will operate JLPP and have posted a security bond of 500 million dirham. The privatization of JLPP will enable ONE to dedicate its limited resources to continuing their rural electrification program and to meet increasing industrial and residential electrical demand.

10.1.2 ABB Presentation

Mr. Zaoui, the Managing Director of ABB Maroc gave the next presentation which provided an overview of ABB and its qualifications for the proposed Project.
10.1.3 CMS Presentation

Mr. Saheb of CMS Generation Co. provided an overview of CMS and its role in the Project. He also provided a description of the Project as in Section 3.0 of this EIA.

10.2 Summary of Public Forum

The public forum was held on July 11, 1996 in the auditorium of the ODEP, which is adjacent to JLPP. Public notification was made through the local newspapers and via informational posters announcing the forum. Attendance at the forum was excellent, with over 150 people present representing each of the 30 communes in the Province of El Jadida. The Moroccan and El Jadida provincial government were also well represented. The dignitaries present included the Governor of the Province of El Jadida, the Director of the Center of Observation and Studies in Ministry of the Environment, the Director of the Moroccan LPEE, the President of the Parliament of the Province of El Jadida, and the President of the Association of Dukkala, the specific section of the province in which JLPP is located. The most commonly used language in the Province of El Jadida is Arabic. Although the presentation materials were developed in French, most of the actual verbal presentation was in Arabic.

The public forum was opened by Mr. Hakimi, the Director of LPEE, who introduced the dignitaries and the host/moderator of the forum. Introductory statements concerning the purpose of the forum and the importance of public input into the EIA process were made by the Governor of El Jadida Province, the Director of the Center for Observations and Studies of the Ministry of the Environment, and the President of the Association of Dukkala. The ground rules for the session were discussed by Dr. Iraqi of AFAK, the forum Moderator. Summaries of the opening comments of the government officials and the moderator are provided below.

10.2.1 Comments by the Governor of El Jadida

Summary of the comments from the Governor are as follows:

The Province of El Jadida has entered a new experiment. The investors of the new power plant are reaching out to you for input. The responsibility is on your shoulders to not be afraid of this forum but to take ownership of your community. (The governor then provided a brief explanation of the overall project). The investors would like to present to you the impacts of this project, both good and bad. They want you to provide substantive input...
and for the community to be their partner. In my opinion, this
demonstrates good will and the importance of you taking
ownership of your own destiny. This meeting and your comments
are not merely symbolic.

10.2.2 Comments of the Director of the Center for Observations and Studies of
the Ministry of the Environment

Summary of the Director’s comments are as follows:

This event opens the possibility for the citizens to express and
present their views on the subject of the protection of the
environment at JLPP. This project has local and international
impacts. The Ministry of the Environment and the Province of El
Jadida and the Commune of Moulay Abdellah have developed a
partnership to install a center for the analysis and studies of
pollution. This project is financed by the Mediterranean Action
Plan (METAP) and the center will be built very soon. The
objective is to identify the existing environmental problems. JLPP
impacts are important. The Project guidelines must conform to
international laws including those of the European Union and the
World Health Organization. This plant must be an example to
follow in Morocco.

10.2.3 Comments of the President of the Association of the Region of Dukkala

The Deputy of the Association of the Region of Dukkala thanked AFAK, LPEE, the
World Bank, and ABB/CMS for this event, which is the first of its kind in Morocco.

10.2.4 Comments of the President of the Province of El Jadida

The President of the Parliament of the Province of El Jadida thanked AFAK, LPEE,
ABB/CMS, the World Bank, and Radian. He said, “We want an honest assessment of the
project. There are those who believe that this is a dangerous project. This meeting must be a
working session to adequately address the environmental conditions at JLPP.”
10.2.5 Comments of the Moderator

The forum Moderator stated that this Project is a partnership between the investors and all those who are impacted by this Project. The Moderator said, "The problems of the environment are international. Adequate environmental protection must be achieved via a partnership between the government and the citizens. Holding the first forum of its kind in Morocco here in El Jadida, prior to the Casablanca (NGO) forum, is a statement that the highest priority is the protection of the people in the vicinity of JLPP. The objective of AFAK in hosting this forum is to serve the people."

10.2.6 Comments and Questions from the Public

After the presentations of ONE, ABB, and CMS, the floor was opened to questions and comments from the public. The following summarizes comments/questions that were asked along with the corresponding responses:

**Comment:** The greenery was replaced with cement. What will you do about this?

**Response:** ONE: It was necessary as part of the construction of Units 1 and 2; and the construction contract includes replanting.

**Comment:** A very important aspect is pollution. What is the environmental impact of Units 1 and 2 and then 3 and 4? What are the measures that will be taken to protect the environment?

**Response:** Dr. Iraqi: The answer to this question will be dealt with in the second part of the meeting when Radian makes its presentation.

**Comment:** What is the specific experience of ABB in construction and operation internationally?

**Response:** ABB: ABB was involved with a 5000 MW project in Italy and has 10 years of experience in the U.S. with similar projects. ABB also has contacts with the World Bank and other lenders.

**Comment:** Identify the investments for the protection of the environment.

**Response:** ABB: During construction there will jobs for local people, local materials will be purchased, and there will be an increase in employment (during operation).

**Comment:** The technology of thermal power plants is ancient technology. Why are we not evaluating nuclear power?

**Response:** ONE: ONE has conducted a study for a nuclear plant near Safi and there are other clean fuel projects that are being examined in the country. ONE has expertise in this area.
At this point, Radian presented an overview of the EIA and the anticipated environmental impacts.

Comment: What is the impact of the JLPP on the air quality now and in the future? Please present numbers.

Response: Radian: There is concern about the impacts of air emissions. Particulate and NO\(_x\) are below Project guidelines. Radian has conducted a dispersion modeling study of Units 1 and 2 and of all four units and found that the SO\(_2\) daily average currently exceeds the ambient air quality Project guidelines.

Comment: What are the impacts on the environment of Units 1 and 2 without Units 3 and 4?

Response: Radian: The information is in a report which has been provided to Ministry of the Environment for evaluation. There are many details. One thing that is known is that the baseline measurements of the air near the plant indicate that it is polluted. The international organizations have laws concerning air pollution. If the air is polluted, the new installation will not have the right to increase emissions by more than the amount specified in the guidelines. This is why ABB/CMS will use low sulfur coal even though it is more expensive.

Comment: What is the current condition of the soil?

Response: Radian: Fuel oil pollution was found in the soil. This was immediately relayed to ABB/CMS, who in turn told ONE, and cleanup plans were begun.

Comment: What are the conditions in water discharged from JLPP?

Response: Radian: There is one wastewater stream containing a volume of water (that is small compared to other JLPP discharges) in which the pH increases and decreases. This information was relayed to ABB/CMS and ONE and the problem was resolved. Radian also found that ash is being disposed of in the ocean. Even though international studies on the environmental impact of ash disposal in the ocean were not conclusive, ABB/CMS has decided to discontinue the disposal of ash in the ocean.

Comment: Discuss the Project guidelines.

Response: Radian: The source and the development of the Project guideline numbers are discussed in detail in the EIA. The EIA is at the Ministry of the Environment. All these guidelines are at least as stringent as the international guidelines considered for this report.

Comment: Why do you perform a study if there are no significant impacts as you have reported?

Response: Radian: The study is done to ensure that if there are impacts, they are quantified and methods are explored to minimize that impact. There is a small impact on the air quality but it is still within the Project guidelines. Concerning the water
quality, when ash disposal in the ocean is discontinued, the marine biology and water quality in the ocean will improve.

Comment: How did you decide that this is the best technology?
Response: Radian: When the technology is evaluated, technical feasibility, cost of equipment, cost for environmental protection, and the time available to bring the technology into operation are all considered. For Morocco, to produce additional electricity quickly in the desired time frame, the construction of Units 3 and 4 that are identical to Units 1 and 2 is the best choice.

Comment: Concerning the technology required for environmental protection, what is it, and what is the cost, and who pays for it?
Response: Radian: The quantification of costs is outside of Radian’s mission. The technologies that will be implemented include electrostatic precipitators, low NOx burners, and a water treatment system. There are also strategies that include low sulfur coal use and stopping ash disposal in the ocean. Also there are numerous systems for monitoring of the emissions and there will be a program for the management of hazardous materials. However, cost determination is not in our mission. Mr. Saheb from CMS responded that, in general, all these technologies are in the Project and the Project will respect the guidelines.

Comment: I believe that the session has been excellent. It is obvious that we have choices to make. Development has associated with it environmental dangers. The people are active in improving the environment. We demand that the new investors be loyal guardians in the service of the citizens and the protection of their health.

To conclude the forum a representative of AFAK restated the objectives of the forum, reviewed the events of the day, and thanked everyone for their participation.

10.2.7 Summary of the NGO Forum: Comments and Responses

The NGO forum, hosted and moderated by AFAK, was held on July 12, 1996 at the Sheraton Hotel in Casablanca. It was attended by approximately 120 people. Invitations to NGOs identified by AFAK, ONE, and the Ministry of the Environment were sent to each organization via mail. The list of NGOs who were invited is contained in Appendix C. Additionally, posters and banners were prepared to announce the forum. In addition to the NGOs, several members of the press were present.

The forum was opened by Dr. Haroushi, the president of AFAK, who explained the purpose of the session and the ground rules for public input, questions and comments. All discussions and presentations were in French. A summary of comments and responses follows.
Morning Session

Comment: Why use this technology instead of nuclear power?
Response: ONE: We have evaluated nuclear plants as well as other thermal technologies such as IGCC.

Comment: What do you plan to do to control the price of electricity for the consumers?
Response: ONE: We acknowledge that tariffs are high. The revenues from Jorf Lasfar will be used for rural electrification and the tariffs are being negotiated with the foreign investors.

Comment: Please discuss the solar energy program.
Response: ONE: The solar energy program is being developed. It will be used for the rural electrical grid that we are designing.

Comment: What is the difference in cost between nuclear and thermal power plants?
Response: Mr. Zaoui (ABB): The cost of nuclear plants is four to five times higher than thermal power plants.

Comment: What is the relationship between ABB and ONE?
Response: Mr. Zaoui: At this time, ABB is working with ONE on hydropower plants.

Comment: What about wood as a source of fuel?
Response: Mr. Zaoui: Burning wood would have a very negative impact on the environment.

Comment: Why is there a meeting with the NGOs if the ONE has already made their decisions?
Response: Radian: This is a new forum. Our mission is not to explain the past. Your concerns will be documented in the EIA. The World Bank may include your concerns as conditions of financing. ABB/CMS are committed to listen and to make the effort to address your concerns.

Comment: What studies were done on the epidemiological impacts, or the impact of the Project on the health of the citizens?
Response: Radian: The epidemiological issues are not the responsibility of the power plant. JLPP has the responsibility to document the contaminants in their discharges which have the potential to impact epidemiology. However, the responsibility to do the epidemiological studies rests with the commune of Moulay Abdellah and the region of Dukkala and the Province of El Jadida.

Comment: The communes do not have the resources. Study the impact of the plant’s expansion on the health of the citizens, not with the objective of incriminating the power plant, but document the risk to the citizen.
Response: Radian: Yesterday, we learned that there is financing for a center for environmental protection at Jorf Lasfar (partnership between the Ministry of the Environment and the commune). The JLPP has responsibility to document the contaminants in the discharges that have the potential to impact human health and the environment. For example, if ash disposal in the ocean is stopped, the marine biology will improve. If disposal in the ocean continues, ABB/CMS are responsible for monitoring the water quality and the biology in the vicinity of the ash discharge point.

Comment: Do you know the true baseline conditions?
Response: Radian: We have measured the quality of the air, the water, and the sediments in 1994, prior to operation of Units 1 and 2 and again in 1996 prior to the construction of Units 3 and 4.

Comment: Please repeat and discuss the Project guidelines.
Response: Radian discussed the Project guidelines in greater detail.

Comment: This forum is an excellent initiative, however the EIA alternative technologies analysis should have been done before Units 1 and 2, not after.
Response: Radian: ONE's decision to build JLPP was prudent. Even though there was no formal EIA, ONE did consider environmental impacts.

Comment: Why are you hiding from us a copy of the EIA? You must provide us with a copy of the report in French.
Response: Radian: Everything here is transparent. The EIA is the property of ABB/CMS. They have provided the EIA to the Ministry of the Environment for evaluation. The protocol requires that to obtain copies of the report, a request must be made to the Ministry of the Environment or ABB/CMS.

Comment: Is there a program for the reuse of water at the JLPP?
Response: Radian: ABB/CMS are evaluating a program for reutilization of the water, however no decision has been made at this time. For example, process water can be used to control dust in the transport of the ash. Waste minimization is a science that protects the environment and is profitable.

Comment: Are there any studies of the terrestrial flora and fauna?
Response: Radian: There is no terrestrial biology at the JLPP. The marine biology and the fauna were evaluated. The population diversity and density was found to be very low. This is not surprising in regions with such violent ocean wave action and rock as is found offshore from the JLPP.

Comment: What about a study of the terrestrial biology of the region?
Response: Radian: Our mission was to focus on the immediate area of the JLPP.
Comment: The participation of the NGOs and citizens is temporary. Will there be other forums for the NGOs? The citizens are not informed. Citizen forums have no value. Will you be committing funds for the NGOs and to inform the citizens?
Response: Radian: There will be other forums in the future. These are required by the World Bank. Also, you are responsible to request information according to a protocol. Finally, the population of El Jadida may be poor and uneducated, but they are informed. Yesterday, they posed many very important and relevant questions. ABB/CMS will hold forums to inform the citizens.

Comment: Why are the noise levels measured annually and how would the ash be transported?
Response: CMS responded that the noise levels are continually measured using the equipment at the JLPP according to the Project guidelines. The Moderator indicated that the ash disposal information would be presented later in the afternoon.

Comment: Why is there no impact study on agriculture?
Response: Radian: There are no agricultural activities at the JLPP. The predominant wind direction is towards the ocean. Consequently, the power plant should not have impact on the agriculture in the region. Further, agricultural impact studies are the responsibility of the government.

Comment: Have you participated with the University of El Jadida to analyze the regional marine biology?
Response: Radian: Our studies have documented elevated metals in the water before the first two units were started. Our mission is not to identify the sources of these metals. However, we welcome the opportunity to learn more from any studies by the university.

Comment: You gave the impression that Morocco is ignorant and that there are no other studies except those by JLPP.
Response: Radian: Morocco is a pioneer. This is why the foreigners are investing in Morocco. We have obtained many reports done by Moroccan laboratories. I regret the impression that you have. I assure you that this was not our intention.

Comment: What are the incremental impacts of Units 1 and 2 and then Units 3 and 4 and why did you not do a regional impact study?
Response: Radian: The impacts of Units 1 and 2 and Units 3 and 4 have been evaluated and they will be presented later. To answer your second question, our mission is to evaluate JLPP, not other sources in the region.

Comment: Who worked on this study?
Response: Radian: Approximately 35 people from Radian including engineers, scientists, and support staff were assisted by 20 scientists and support staff from LPEE and 5 Moroccan university faculty members and support from Morocco.

Afternoon Session

Comment: Ash disposal in the quarry will impact groundwater.
Response: Radian: Regardless of where the ash is disposed of, it will be disposed of in a responsible manner that will protect groundwater.

Comment: You need to study, at least four times per year, during each season, the levels of phosphate and contaminants in the water.
Response: Radian: Our mission is the impact of the power plant on the environment only. We have adequately described the air and water conditions and the discharges of the power plant.

Comment: Why do you assess the regional socioeconomic impact but only the local environmental impact?
Response: Radian: There has to be a balance between socioeconomic and environmental impacts.

Comment: The guidelines for the Project are consistent. Further, the principal of causality is respected. These guidelines are applicable in humid, not arid environments. Explain. Also, you are making estimates based on estimates. You must do exhaustive field impact studies.
Response: Radian: The international guidelines are established for humid and arid countries. We have conducted exhaustive field studies. We have used these data to predict the future impacts of JLPP.

Comment: I do not believe in models, you must use extensive data collection.
Response: Radian: Your point of view is noted.

Comment: Will there be continuous monitoring?
Response: Radian: Continuous monitoring is part of the ABB/CMS monitoring plan that is part of the EIA.

Comment: Why do you not use the energy of the waves and the wind to produce electricity?
Response: ONE: We are evaluating alternative technologies in our overall supply strategy.

Comment: You evaluate the levels of each metal. What about the cumulative effects?
Response: Radian: We thank you for expressing your opinion. You are posing very important questions. The debate process in Morocco is mature. ABB/CMS and Radian thank you. With regard to the cumulative effects we have toxicity information in the EIA.
Comment: The JLPP has discharged large levels of contaminants into the region. This is unacceptable.
Response: Radian: The air and water data collected before and after Units 1 and 2 conclusively proves that the power plant has not impacted the environment.

Comment: How would you use the water in the transport of ash?
Response: Radian: It will be used to control dust.

Comment: Where does the pollution for the baseline conditions come from?
Response: Radian: Our objective was to identify the levels of pollution present rather than the source.

Comment: Is JLPP the source of the elevated metal levels?
Response: Radian: These elevated levels existed before Units 1 and 2 and have not changed. The emissions of metals from JLPP are negligible.

Comment: Are these levels natural?
Response: A member of the audience responded that this is not possible. Another member of the audience indicated that the OCP is the source. Radian restated that the objective of the EIA is to evaluate the impact of the power plant only.

Comment: What are the corrective measures?
Response: Radian: The list of corrective measures in the EIA were presented by Radian.

Comment: Will you be committing funds to evaluate the regional impacts?
Response: Radian: The new power plant should not have to pay to study the regional pollution.

Comment: What can you tell us about the use of ash in cement?
Response: ABB: There are 10 cement plants in Morocco and there have been many discussions of this issue. The issue is economic viability.

Comment: The ash disposal in the ocean is not acceptable. If you ship the ash how can you control the disposal?
Response: A member of the audience responded that the investors have decided to stop ash disposal in the ocean. They cannot control the disposal of ash once it has been shipped by boat. Radian responded that the design of disposal of ash in the quarry or on land is under development.

Comment: What are the impacts and recommendations?
Response: The Project impacts comply with the Project guidelines. The water impacts are positive; the air impacts meet the guidelines.
Comment: This EIA is controlled by the terms of reference. This debate is extremely important. It is the first of its kind not only in Morocco but in this region of Africa. Morocco is a model. The NGOs must work together to improve the environmental conditions in the area. The World Bank should not have any reasons to not finance the project as it has been presented. Radian has very well explained that there has to be a balance between the socioeconomic and environmental impacts and that we should find ways to minimize these impacts.

Comment: The ONE is concerned about the environment. Are there studies to include solar energy?

Response: ONE: ONE intends to use solar energy.

Comment: General comments from the audience: “I am very proud to be here representing my NGO. I thank AFAK for their excellent job at this forum. We would like access to the EIA. This project is being done in an environment of openness and we should not be concerned about the impact of this project on our future.”

To conclude the forum a representative of AFAK restated the objectives of the forum, reviewed the events of the day, and thanked everyone for their participation.
Appendix A

Liste of EIA Preparers
List of Preparers

This EIA was prepared by Radian International LLC under a contract from the ABB/CMS Project Sponsors. Radian International LLC subcontracted with the Laboratoire Public d'Essais et d'Etudes (LPEE) in Casablanca, Morocco, for some of the on-site data collection. The following list of preparers is presented in alphabetical order within each of these three groups.

ABB/CMS Personnel

Tony Shea: Role: Overall EIA oversight and review. 
Credentials: Project Engineer, ABB Energy Ventures Inc. One year experience in independent power production.

Mike Weber Role: Overall EIA oversight and review. Responsible for preparation of the section on environmental management and training. 
Credentials: Manager of Environmental Affairs, CMS Generation Co. Total of 22 years experience in meteorology, air quality, and environmental management. Responsible for assuring that CMS Generation has adequate environmental programs in place to assure compliance with corporate policies and external requirements at all facilities it operates.

Radian Personnel

Steve Barnard Role: Responsible for ambient air quality sections and dispersion modeling, including discussions of existing air quality as measured by the ONE and future impact of JLPP operations on air quality as calculated through air quality modeling. 
Credentials: Atmospheric Scientist, Radian International, LLC. Total of 18 years experience in atmospheric research/meteorology, with five years of dispersion modeling experience supporting domestic and international permitting and air quality analyses.

Richard C. Booth Role: Evaluated the impact of firing coals from several potential sources in Units 1 and 2 and the proposed Units 3 and 4 on stack emissions of SO₂, NOₓ, and particulate matter (PM). 
Credentials: Senior Staff Engineer, Radian International LLC. 29 years combustion and emission experience, the last 23 years spent as consultant to electric utilities solving operational combustion and emissions problems.
Tom Calnan  
**Role:** Provided oversight for and participated in the biological and marine water quality baseline investigations (under subcontract to Radian International LLC).

**Credentials:** Coastal Biologist, State of Texas General Land Office. Over 20 years experience in coastal marine biology studies.

Bob Davis  
**Role:** EIA Task Leader. Directed the organization, preparation, and initial editing of the EIA and had individual writing responsibilities for the noise, socioeconomic, and the executive summary sections. Also wrote portions of the alternatives analysis section.

**Credentials:** Senior Staff Scientist, Radian International LLC. Over 20 years experience directing multimedia, interdisciplinary projects and in U.S. and international EIA methodology and document preparation.

Hollis Flora  
**Role:** Project Manager. Responsible for the daily administration of the project, including other activities associated with gathering data for the EIA, such as ambient air monitoring station, air dispersion modeling, etc.

**Credentials:** Senior Project Manager, Radian International LLC. 19 years experience working with electric utilities. Has previously acted as manager on many and varied Radian projects.

Ardeth Hadley  
**Role:** Performed word processing, formatting, and compilation of the report.

**Credentials:** Support Assistant IV, Radian International LLC. Has worked on numerous risk assessment reports, as well as several other EIA/EDDA reports.

Larry Holcombe  
**Role:** Provided peer review for and consulted on Coal Ash Management feasibility study for the EIA.

**Credentials:** Principal Scientist, Radian International LLC, with 19 years experience at Radian on utility solid waste managements and waste management feasibility assessments.

Robert Legrand  
**Role:** Wrote sections on impacts to surface waters and groundwater, wastewater treatment, and fisheries. Directed the translation of the EIA from English to French. Assisted in water quality and marine biology section preparations.

**Credentials:** Senior Scientist II, Radian International LLC. M.S. in Agronomy (major in hydrobiology), University of Gent, Belgium. M.S. in Environmental Engineering, Cornell University.

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Terry Naulty  
**Role:** Peer reviewer for entire EIA.  
**Credentials:** Senior Project Manager, Radian International LLC. B.S. in environmental engineering, Purdue University. 14 years direct electric utility environmental experience, including Environmental Impact Statements, siting, regulatory analysis, and management.

Holly Prather  
**Role:** Responsible for preparing and designing all graphics and the cover for the report.  
**Credentials:** Specialist, Radian International LLC. Six years experience in graphic design and layout. Past experience in designing logos, covers, posters, newsletters, and other printed materials.

John Reddy  
**Role:** Responsible for evaluating potential options for discontinuing ocean dumping of fly ash and bottom ash.  
**Credentials:** Senior Civil Engineer, Radian International LLC. 15 years experience in civil engineering design, construction management, site investigation, and remediation. Past performance as lead engineer for landfill design projects for U.S. Army Corps of Engineers.

Tony Rizk  
**Role:** Morocco in-country coordinator and task leader for the thermal discharge analysis.  
**Credentials:** Senior Engineer, Radian International LLC. Ph.D. in mechanical engineering. 12 years electric utility experience and experience in power plant thermal discharge analysis. French and Arabic speaker.

Helen Smith  
**Role:** Reviewed sections of document.  
**Credentials:** Scientist, Radian International LLC. M.S. in Toxicology. Experienced in human health screening and baseline risk assessments, toxicity literature reviews, and industrial hygiene assessments (occupational exposure assessments). Has participated in document preparation for RCRA and CERCLA sites for private-sector clients.

Stephanie Smith  
**Role:** Assisted in obtaining maps of site. Assisted in writing, proofreading, and production of document.  
**Credentials:** Associate Scientist, Radian International LLC. B.A. in Environmental Science (pending), Concordia University,
Austin, Texas. Experience assisting with ecological and human health risk assessments.

Barbara Stabeno  Role: Coordinating secretary for this project. Assisted in typing the report and preparing the finished notebooks. Also assisted in coordinating the makeup of the covers with Graphics.

Credentials: Senior Secretary, Radian International LLC. Has assisted in preparation of proposals, reports, and technical correspondence.

Valerie Valderrama  Role: Responsible for researching portions of the socio-economics section of the report. Assisted in translating the EIA from English to French. Reviewed the socio-economic section to ensure that complete information from Moroccan literature was included.


Barry Walker  Role: Prepared sections on project description and air quality control alternatives. Performed air emissions calculations.


Gretchen Welshofer  Role: Summarized and wrote the audit of existing conditions and prepared the mitigation and monitoring sections of the report. Task leader for organizing report production.

Credentials: Scientist, Radian International LLC. Total of five years experience in the areas of NEPA, pollution prevention, environmental compliance, and risk assessment.

LPEE Personnel

Dr. A. Benzekri  Role: Managed LPEE marine biology work for EIA project.

Credentials: Engineer, LPEE. Ph.D. in hydrobiology.
Dr. E. Jabry  Role: Coordinated and supervised LPEE project activities.
Credentials: Director, Centre d'Etudes at de Recherches sur l'Environnement et la Pollution (CEREP). Sc.D.

Mr. A. Karioun  Role: Assisted in noise survey.
Credentials: Engineer, head of Water-Air Services, LPEE.

Mr. S. Lakranbi  Role: Worked with discharge studies and oceanic pollution information for the EIA.
Credentials: Engineer, head of the Marine Pollution and Impact Studies Department, LPEE.

Dr. A. Marzouki  Role: Executed the laboratory measurements and analyses.
Credentials: Engineer in charge of the CEREP laboratories. Ph.D. in biochemistry.
Appendix B

References
References


ABB. Technical documentation received from ABB in May 1996a.


Charef, Abdeslam. Interview with Mr. Abdeslam Charef, Director of the Centre d’Etudes des Matériaux, April 26, 1996, in Casablanca, Morocco. Mr. Charef is primarily concerned with finding a beneficial use for ash generated at power plants in Morocco. 1996.

CMS. Jorf Lasfar O&M Assessment, Section IV, Environmental. February 1996.


Elhaiba. Information provided to Radian by Professor Elhaiba of Casablanca in May 1996.


Laaouina, Abdelmouttalib. Interview with Abdelmouttalib Laaouina, Ph.D., April 24, 1996 in El Jadida, Morocco. (Dr. Laaouina is director of "Societe a Eau-Energie-Environment" of Marrakech, Morocco and a consultant to the government on energy issues).


LPEE. Jorf Lasfar sampling campaign, April - May 1996.


Radian. Data package received from JLPP personnel during site visit on April 22-24 1996.


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Appendix C

Public Participation and Interagency Coordination:
List of NGOs Invited to NGO Forum
PARTICIPANTS OF THE NGO FORUM

The following is a list of NGOs that were invited to the NGO forum held on July 12, 1996 at the Sheraton Hotel in Casablanca.

- Association Club des Jeunes au Service de l'Environnement
- Forum Maghrébin pour l'Environnement et le Développement
- Association Marocaine pour la Protection de l'Environnement (ASPA NA)
- Association des Amis de la Culture, de l'Environnement et du Sport
- Association Ecologique Marocaine
- Groupe d'Études et de Recherches sur les Energies Renouvelables (GERER)
- Association des Alliés de l'Environnement
- Association Marocaine des Sciences de la Mer
- Association Marocaine de Géomorphologie
- Association Marocaine des Sciences du Sol
- Comité Environnement des Associations Régionales et Spécialisées
- Groupement d'Études et de Recherches pour la Protection d'Essaouira (GERPE)
- Mouvement National de l'Environnement
- Organisation du Scoutisme National
- Le Comité de l'Amicale Marocain des Ingénieurs Agronomes Forestiers (AMIAF)
- Association Marocaine d'Études et de Recherches Internationales (AMERI)
- Association du Mouvement Touiza (2 adresses)
- Le Club Marocain d'Éducation en Matière de Population et d'Environnement (CMEPE)
- Association du Bassin de Safi
- Association Sociale Al-Hassania de la Culture et de l'Art
- Association Chantier et Environnement
- Organisation des Jeunes pour le Développement et l'Environnement
- Association pour la Lutte contre l'Erosion, la Sécheresse et la Désertification au Maroc (ALCSEDAM)
- Association des Habitants d'Anfa II pour la Protection de l'Environnement
- Association Marocaine pour l'Environnement et le Développement (bureau national et bureau de Mohammedia)
- Société Marocaine pour le Droit de l'Environnement
Appendix D

Environmental Management Implementation Plan
ENVIRONMENTAL MANAGEMENT IMPLEMENTATION PLAN

Approved

Rodney E. Boulanger
President and CEO

January 4, 1996
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INTRODUCTION

This Environmental Management Implementation Plan describes the elements of CMS Generation's (CMSG or the Company) comprehensive Environmental Management System (EMS) and supporting framework, including organization, resources, and documents. Although the primary focus is on operations-related activities, non-operations activities are addressed as well. The subjects covered by this plan are:

**Policy** - provides the CMSG Environmental Policy Statement,

**Organization** - describes the organization, roles and responsibilities of the various participants in CMSG environmental activities,

**Resources** - describes resources available in support of CMSG environmental activities,

**Corporate Standards** - describes purpose, subjects and general content of generic standards for environmental performance,

**Environmental Requirements** - describes scope and subjects for environmental program-specific requirements,

**Plant Procedures** - describes purpose and recommended subjects for plant procedures,

**Non-Operations Activities** - describes application of the Policy to CMSG activities not related to plant operations,

**Feedback and Improvement** - describes the various vehicles for improving all aspects of the Company's comprehensive EMS, and

**Documents** - describes documents used in support of the Company's comprehensive EMS.
ENVIRONMENTAL POLICY STATEMENT

The life of any business cannot be separated from its impact on the natural environment in which it operates. CMS Generation Co., one of the leading international independent power companies, takes seriously its role in protecting and enhancing the environment of the communities and countries in which it operates. Environmental stewardship is always a primary objective. A secondary goal is to lead the business community and the independent power industry in establishing well-founded environmental policies and backing programs to achieve them. To this end, our activities will be consistent with sound environmental practices in all countries in which we own and/or operate.

In recognizing the Company's diverse role as an owner, sometimes as operator, and always as an advocate for exemplary environmental practices, we will manage our business to:

- Comply with applicable environmental laws and regulations.
- Utilize the World Bank standards in our international business activities to evaluate our environmental practices and new project designs.
- Advocate sound environmental practices in all our diverse partnerships.
- Integrate environmental protection considerations into Company planning and decision making in all phases of our domestic and international business.
- Encourage active employee participation in efforts for environmental protection and ensure open communication among all employees to identify situations where the Company may improve its practices with regard to environmental stewardship.
- Seek opportunities to minimize the generation of waste materials, encourage recycling and ensure proper handling and disposal of wastes.
- Assess potential safety, health and environmental impacts prior to transactions involving the sale, lease, transfer or purchase of real property.
- Work with appropriate environmental agencies and organizations and ensure timely, reasonable and cost-effective solutions to environmental issues.
- Participate through CMS Energy in the development of applicable environmental legislation, regulation and policy issues that may significantly impact our business.
- Establish guidelines and more detailed procedures, when appropriate, for implementation of this Environmental Policy including the designation of individuals accountable for environmental management results.
- Review conformity with this Environmental Policy on a regular basis to ensure compliance throughout the Company.

Rodney E. Boulanger, President and C.E.O.
ORGANIZATION

In support of the Policy, the Company has established and maintains a structured environmental management organization. This organization includes environmental professionals, senior management, staff and support personnel at both the corporate and site level. Each of these individuals have specific responsibilities which are presented throughout the CMSG Environmental Management Manual, and which are summarized below.

Organizational Responsibilities. The current CMSG environmental management organizational structure is shown in Fig. 1. While specific responsibilities of employees involved in environmental management are described in each of the Corporate Standards and Environmental Requirements, general responsibilities of key positions within the organization are as follows:

**CMSG President and C.E.O.** The primary role of the CMSG President and C.E.O. is to establish and require adherence to the Company's Environmental Policy, and to address the organization, human and other resource needs of the Company's comprehensive EMS.

**CMSG Vice President of Operations.** The role of the CMSG Vice President of Operations is to assure that all CMSG-operated facilities are operated in compliance with all applicable environmental requirements, and to assure that an appropriate organization and resources are in place to develop and implement the Company's comprehensive EMS.

**CMSG Manager of Environmental Affairs.** The role of the CMSG Manager of Environmental Affairs is to establish, implement, review and update the Company's comprehensive EMS, and to serve as a resource to CMSG-operated facilities. Typical responsibilities are to:

- maintain the necessary level of competency with existing federal and state environmental laws and regulations and assist CMSG-operated facilities with resolution of site-specific issues,
- work with CMS Governmental Affairs and Legal departments in identifying and analyzing the impact of new or emerging federal and state environmental regulations on operations,
- communicate new or revised federal and state environmental requirements to operating facilities,
- as needed, develop and disseminate program tools and standards for required environmental activities common to CMSG-operated facilities,
FIGURE 1: CMSG ENVIRONMENTAL MANAGEMENT ORGANIZATION

- PRESIDENT
  - OPERATIONS VICE-PRESIDENT
  - OTHER OFFICERS
  - GENERAL MANAGERS
  - MANAGER OF ENVIRONMENTAL HEALTH AND SAFETY
    - PLANT MANAGERS
    - PLANT ENVIRONMENTAL COORDINATOR
  - CMS LEGAL
  - HUMAN RESOURCES
provide or arrange for environmental protection training for site management and environmental coordinators as necessary,

arrange for independent assessment of facility compliance with applicable environmental requirements and regulations, and monitor corrective actions to resolve identified concerns,

engage the services of and receive information from external resources as necessary,

as needed, provide planning information to CMSG-operated facilities on new environmental initiatives,

maintain corporate environmental files,

consult with the CMSG Vice President of Operations, when necessary, to apprise corporate management of outstanding environmental issues, and

assure that appropriate consideration is given to significant environmental issues during the preparation of annual strategic plans and budgets.

**CMSG General Managers.** The role of CMSG General Managers is to assure that CMSG-operated facilities for which they are responsible are operated in compliance with all applicable environmental requirements, and to assure timely resolution of site-specific environmental issues.

**CMSG Plant Managers.** The primary role of CMSG Plant Managers is compliance with all applicable federal, state, local and CMSG-internal environmental requirements. The Plant Manager is responsible for all aspects of administering and implementing the comprehensive EMS at the facility level. If resources allow, the Plant Manager is strongly encouraged to appoint a Site Environmental Coordinator to have primary responsibility for implementation of the site environmental program. Typical responsibilities for the Plant Manager and/or Site Environmental Coordinator are to:

- stress the importance that management attaches to environmental protection and assure that all employees are aware of the CMSG Corporate Environmental Policy,

- ensure employee job descriptions appropriately reflect environmental responsibilities as defined by this document and other site specific procedures,

- ensure environmental issues are integrated appropriately into the annual site operating plan/budget,
environmental Management Implementation Plan

- maintain knowledge of applicable laws, regulations and internal standards relating to environmental protection at the site,
- maintain awareness of any local environmental regulations which could impact facility operations,
- review potential effects of new or revised raw material use, fuel use or power generating activities which may have a significant impact on the environment,
- develop, review and approve standard operating procedures to ensure compliance with applicable environmental requirements and regulations,
- provide or arrange for needed environmental protection training for site employees,
- regularly assess facility compliance with applicable environmental requirements and regulations, and develop corrective actions as necessary,
- assure that pollution monitoring and control devices are functioning properly,
- assure that all required routine and incident reporting is made to environmental agencies and to CMSG corporate offices,
- maintain site environmental records,
- resolve any potential non-compliance concerns and ensure completion of any identified corrective actions, and
- consult with the CMSG Manager of Environmental Affairs and/or the CMS Legal department, as necessary, on outstanding or unresolved environmental issues.

CMS Legal Department. At the request of the CMSG President, Vice President of Operations, Manager of Environmental Affairs, General Managers or Plant Managers, the CMS Legal Department provides legal and regulatory advice to implement and maintain the comprehensive EMS. Typical responsibilities of the CMS Legal Department are to:

- maintain the necessary level of competency with applicable laws, regulations and internal standards relating to environmental protection and liability,
- establish appropriate confidentiality procedures as necessary for documents and activities associated with the comprehensive EMS,
* engage the services of and receive information from external resources as necessary,

* lead in the resolution of findings of potential non-compliance as requested by the Plant Manager, General Manager, Manager of Environmental Affairs, or the CMSG Vice President of Operations,

* review all environmental contracts, permits, notices of violation, and similar documents, to facilitate participation in negotiations as necessary, and

* provide input as necessary to upgrade the comprehensive EMS and associated elements.

**CMS Human Resources Department.** The primary role of CMS Human Resources is the review of the comprehensive EMS to assure consistency with other corporate policies and standards, and to assure that high standards of environmental performance are established and consistently enforced for all CMSG employees.

**Other CMSG Officers.** CMSG Officers are responsible for assuring that employees in their respective areas are aware of the CMSG Environmental Policy, the organization for implementing the comprehensive EMS, and the appropriate non-operations responsibilities described in detail in a subsequent section of this implementation plan.

**Personal Responsibilities.** In addition to the responsibilities of individuals within the company's environmental organization described above, CMSG assigns a certain level of environmental accountability to all employees. Specifically, CMSG expects every employee to understand the company's environmental commitment and recognize that personal success within the company includes a measure of each individual's contribution to that commitment. To encourage employee contribution, CMSG maintains systems to ensure that:

* all employees have access to the CMSG Corporate Standards and Environmental Requirements and supporting procedures which apply to assigned duties,

* employee contributions to the success of the CMSG comprehensive EMS are evaluated and included as part of the annual performance review,

* each employee has access to a confidential reporting system to assure that reports of a suspected non-compliance with any laws or internal requirements can be made without fear of retribution, and

* failure to comply with applicable regulations or internal Company requirements may be cause for disciplinary action, up to and including termination.
CMSG supervisors, managers and officers are encouraged to ask employees to help identify areas of concern and to suggest ideas for improving Company environmental management efforts.
RESOURCES

The organizational and human resources which CMSG has dedicated to environmental management are described in a previous section of this implementation plan. Financial resources for environmental compliance and environmental management activities are allocated in the CMSG annual planning and budgeting process. Audit schedules for operating facilities are determined during this budget process. The consequence of compliance with applicable new laws or regulations is also presented so that the financial impact of future environmental compliance may be assessed.

Pro forma financial analysis of projects during the development stage includes O&M expense for environmental compliance and training, and capital expense for environmental protection systems and equipment required for the plant design. In cases such as international acquisitions, when upgrades to environmental control and monitoring facilities are planned, the cost and scheduling of expenditures are incorporated in financial analysis and financing plans.

Staff from CMS Energy Governmental Affairs and Communications departments are relied upon to assist, as appropriate, in articulating the Company's views concerning projects in development or operation, with respect to the development of environmental legislation, including the writing of rules implementing legislation.

Other resources available for support of the Company's environmental activities include the environmental staff of other CMS companies and qualified environmental consultants.
CORPORATE STANDARDS

CMSG has established corporate standards for how we, as a Company, address a number of generic subjects, as described below:

**Possession of Permits.** Requires CMSG personnel responsible for developing a new project to obtain all necessary environmental permits and approvals, and requires CMSG personnel responsible for operating a facility to have a copy of all such permits and approvals on-site or readily available, and to assure that any new permits, approvals or permit modifications needed for new or modified site equipment, fuels or operations are obtained.

**Compliance with Permit Requirements.** Requires that CMSG personnel responsible for developing or operating a project or facility comply with all applicable permit requirements.

**Commitment Schedule.** Requires CMSG-operated facilities to develop and use an annual schedule or matrix describing environmental inspection, monitoring, reporting, notification and/or similar commitment requirements.

**Training.** Requires that all CMSG employees receive at least a certain minimum level of environmental training appropriate to their job responsibilities.

**Environmental Excellence.** Describes criteria and performance levels expected to be achieved by CMSG-operated facilities to obtain annual awards for environmental excellence.

**Agency Meetings / Discussions.** Establishes guidelines and requirements for CMSG-operated facilities related to communicating and documenting the results of meetings and discussions with federal, state and local environmental agencies.

**Agency Inspections.** Establishes guidelines and requirements for CMSG-operated facilities dealing with a site inspection by personnel from federal, state or local environmental protection/enforcement agencies.

**Response to Environmental Emergencies.** Requires CMSG-operated facilities to notify the Manager of Environmental Affairs (after initiation of other critical response activities) in the event of an emergency which could impact the environment (e.g., oil or chemical spills, toxic gas releases, etc.).

**Periodic Routine Reporting.** Requires monthly reporting by CMSG-operated facilities to CMSG corporate offices, and quarterly reporting by the Manager of Environmental
Affairs to the facilities and CMSG management, and establishes guidelines for routine submittals by CMSG-operated facilities to environmental agencies.

**Nonroutine Reporting.** Requires reporting of nonroutine items such as formal agency information requests, apparent non-compliance, submittals of plans, or requests for agency approvals by CMSG-operated facilities to the Manager of Environmental Affairs, and review of such items by Environmental Affairs and, as necessary, CMS Legal.

**NOVs/LOVs, Citations and Enforcement Actions.** Requires CMSG-operated facilities to respond to official enforcement documents and processes in consultation with the Manager of Environmental Affairs and CMS Legal department.

**Recordkeeping.** Requires CMSG-operated facilities to establish and maintain files for primary storage of all site-related environmental records.

**Audits.** Requires periodic independent compliance audits at CMSG-operated facilities and periodic independent evaluations of the effectiveness of the comprehensive EMS.

Copies of current standards are included in the CMSG Environmental Management Manual. Standards are issued and may be revised from time to time by the Manager of Environmental Affairs in consultation with the General Managers and the Vice President of Operations. Standards will be written in a consistent format and will be reviewed by at least the Plant Managers, General Managers and CMS Legal department prior to approval by the Vice President of Operations.
ENVIRONMENTAL REQUIREMENTS

Program- and site-specific Federal and State environmental requirements are developed for the following areas:

Air Quality. Includes federal, state and/or local air pollution control requirements not otherwise addressed by permits, such as NOx RACT, parts cleaner, and refrigerant recycling requirements.

Hazardous Materials. Includes federal, state and/or local hazardous materials control requirements, such as emergency response planning, and annual inventory and notification requirements.

Spills and Releases. Includes federal, state and/or local spill or release response requirements, such as planning, reporting, and clean-up requirements.

Waste Management. Includes federal, state and/or local solid, liquid, and/or hazardous waste control requirements, such as identification, segregation, testing and tracking requirements.

Water Quality. Includes federal, state and/or local water pollution control requirements not otherwise addressed by permits, such as wastewater, stormwater, and wetlands permitting, and drinking water testing requirements.

Copies of current federal environmental requirements are included in the CMSG Environmental Management Manual. State and/or local requirements (including those applicable to non-US facilities) will be added in 1996. Requirements are issued and may be revised from time to time by the Manager of Environmental Affairs in consultation with the General Managers and CMS Legal department. Requirements will be written in a consistent format and will be reviewed by at least the Plant Managers, General Managers, Vice President of Operations and CMS Legal department prior to approval by the Manager of Environmental Affairs.
PLANT PROCEDURES

The need for site-specific plant implementing procedures is determined on a case-by-case basis by the Plant Manager. The overriding principle is to assure that critical functions could continue to be correctly performed upon the loss of key personnel with specific environmental compliance responsibilities. It is recommended that each facility develop implementing procedures for at least the following areas, as appropriate:

- an emergency response procedure or checklist for use in the event of a spill, accidental release or similar unplanned or emergency situation, if not otherwise addressed by a site emergency or spill plan,
- a materials inventory, material safety data sheets, procedures and/or checklists which constitute the program for management and disposal of hazardous and nonhazardous materials,
- operations, maintenance, test and calibration procedures for environmental monitoring (e.g., CEMs, wastewater) and environmental control equipment, and
- a bulk chemical / liquid fuel unloading and refilling procedure.

Upon development, copies of plant-specific procedures should be included or referenced in the appropriate section of environmental requirements (i.e., air quality, water quality, waste management, spills and releases, or hazardous materials) in the CMSG Environmental Management Manual. Procedures are issued and may be revised from time to time by the Plant Manager in consultation with the Manager of Environmental Affairs and the appropriate General Manager.
NON-OPERATIONS ACTIVITIES

This section of the plan describes environmental management requirements and measures for the following: environmental review of sites and acquisition prospects, selection of EPC contractors and technologies, establishment of environmental requirements for international projects, environmental compliance during construction, establishing environmental files, the construction turn-over and start-up process, sale of existing assets, and projects in which CMS does not have a controlling interest. CMS officers responsible for development, engineering and construction will prepare procedures, issue instructions, and/or conduct training or staff meeting discussions as appropriate to assure that these requirements are implemented.

Development. Development occurs by acquisition of an existing project or by development and construction of a new project. Projects covered by this section are generating plants and related businesses such as fuel supply companies.

Acquisitions of land or existing projects will not be undertaken unless a Phase I Environmental Assessment (and Phase II if needed) is performed prior to the transaction to assess environmental liabilities and risks to development. During a Phase I review, an examination of the site and appropriate records is conducted and the environmental impact of prior uses is assessed, the status of environmental compliance with applicable air, water, waste disposal, and other environmental requirements is assessed, and the impact of nearby activities which could potentially affect environmental conditions at the site is determined.

The review should be performed early enough in the development cycle so that knowledge of environmental issues can be used to assess the risk to development and the ability to secure financing. Phase I (and Phase II if needed) reports will be reviewed by the Manager of Environmental Affairs and CMS Legal department prior to being finalized. The CMSG Project Manager in charge of the development activity will establish timing for the review, and with the input of the CMS Legal department, the Manager of Environmental Affairs, and the Vice President of Engineering and Construction, will determine how the project can address issues and risks, and if there is need for further action by experts familiar with the financial market's current view toward similar environmental risks. In analyzing conclusions from the assessment, distinctions will be made between risks that CMSG would agree to assume and risks that may call for special measures (such as remediation or indemnification) in order to complete financing. The project pro forma will be revised as necessary to reflect the results of the analysis of issues identified by an environmental review.

EPC contractors and equipment suppliers will be selected based on assurance that their designs and equipment include environmental control features required to comply with permit and other environmental requirements for each project. Firms supplying design services and equipment should provide guarantees that the project will meet environmental requirements, and these guarantees should be sufficient for reasonable assurance of meeting requirements.
The guarantees and the requirements are incorporated in the EPC agreement for each project. The CMSG Project Manager assures that the CMS Legal department, the Manager of Environmental Affairs and the Vice President of Engineering and Construction are consulted for this activity.

The CMSG Project Manager is responsible for maintaining environmental files during the development and construction phase of a project.

International Projects. In establishing environmental requirements for international projects, local or World Bank guidelines (whichever are more stringent) which are consistent with competitive power costs in the region are used for new construction. These requirements are incorporated in the project EPC agreement.

In the case of international acquisitions, environmental requirements consistent with power purchase agreement rates are developed using local requirements and World Bank guidelines. The CMSG Project Manager assures that a description of planned environmental improvements is prepared in consultation with the Manager of Environmental Affairs and the Vice President of Engineering and Construction. The project pro forma is updated as necessary to include financial impacts of improvements.

If an international project does not conform to the latest guidelines of the World Bank due to the desire of project partners and/or the host country to proceed along a path which permits other, less costly but otherwise effective environmental control measures, the CMSG Project Manager will consult with the CMS Legal department, the Manager of Environmental Affairs and the Vice President of Engineering and Construction to direct the completion of an assessment which states the basis for environmental requirements for the project. The assessment will be part of the review and the decision to proceed with the project by responsible Officers of CMSG.

Construction. Responsibility for environmental performance and risk management during construction authorized by CMSG rests with the contractor. The contractor will be required by the Vice President of Engineering and Construction to provide notice to the Company of spills, accidental releases or other environmental anomalies which occur during the construction period. The notice requirement will be incorporated in the construction contract as appropriate. The CMSG Construction Manager at the site monitors the contractor's performance. When CMSG does not manage construction, it will advocate that the owner's representative and contractors fulfill similar responsibilities.

Turn-over and Start-up. The CMSG Site Construction Manager and Plant Manager work together to oversee the contractor's work to properly handle and remove general and hazardous waste materials during and at the end of construction. They also work with the contractor, equipment suppliers and regulators to establish procedures, conduct tests and report results concerning the environmental control and monitoring equipment.
As part of the turn-over and start-up program, the CMSG Site Construction Manager and Plant Manager will consult with the Manager of Environmental Affairs to provide assurance that all reasonable steps have been taken to enable the project to conform with environmental requirements. Start-up related permit requirements should be reviewed at least 90 days prior to anticipated first use of combustion equipment, to assure that appropriate notifications are made. It is also recommended that permit requirements be reviewed with regulators to confirm that there is agreement as to interpretation and that the interpretations have been reflected in plant procedures, instructions to operations personnel, and training.

After financial closing and commencement of commercial operation, environmental files from development and closing activity are transferred to those responsible for asset management.

**Divestiture.** An environmental review of an asset may be performed prior to its sale or transfer where there is a need to establish a more complete record of environmental performance by CMSG. The CMS Legal department and the CMSG Officer responsible for the transaction make the judgement on the need to conduct a review.

**Limited Partnership / Non-controlling Interest.** This Environmental Management Implementation Plan indicates actions which will be undertaken by CMSG employees when the Company controls or performs development or operations activities for a particular project. When CMSG is an investor but is not controlling or performing these functions, it will advocate environmental management measures which parallel and meet the intent of those presented here.
FEEDBACK AND IMPROVEMENT

The comprehensive EMS is not just a book of requirements stuck on a shelf, but an evolving program, with built-in vehicles for improvement. Audits, assessments, reporting, communications and training are all designed to provide continuous improvement.

Audits. As described in the corporate standard on audits and assessments, audits of operating facilities and of the other aspects of the environmental management program are conducted on a regular basis. Information from the audits is used to pinpoint areas for improvement and to identify changes to the environmental management program which may be needed.

An environmental compliance audit is an evaluation of the current state of compliance of a particular facility with all applicable environmental requirements identified for the audit. To assure that CMSG can perform such detailed self-examination while minimizing exposure to enforcement risk associated with discovery of apparent discrepancies with requirements, the documents associated with an audit are communicated to and from CMS Legal department, for the purpose of gathering facts to render legal advice. Control of audit documents in this manner is to preserve attorney-client privilege. Compliance audits are conducted at least once every three years at each facility, are performed by an independent third-party auditor, and as a practical matter, are scheduled and managed by the Manager of Environmental Affairs.

An environmental operational assessment is that portion of a formal internal assessment of compliance with CMSG operational standards which deals specifically with environmental issues. The purpose of an internal operational assessment is to review plant methods and practices, with the goal of identifying best practices to be shared with other facilities, and areas for improvement to be addressed by the assessed facility. Operational assessments are conducted by plant and/or CMSG corporate personnel at least once every three years.

The goal of these formal facility evaluations is to have reviews performed two out of every three years. The need for more or less frequent formal reviews for a specific facility may be recommended by the Manager of Environmental Affairs after consultation with the appropriate Plant and General Managers and CMS Legal department. Informal assessments may be conducted from time to time by the Plant Manager, the Manager of Environmental Affairs, or other corporate or plant staff, as needed.

An audit or appraisal of the comprehensive EMS is an evaluation of the adequacy and efficiency of the elements of that system in carrying out the CMSG environmental policy and assuring all CMSG stakeholders that the Company takes appropriate actions to protect the environment while remaining competitive. The appraisal provides an assessment of whether the appropriate tools, resources, training and documentation are in place to assure compliance with the Company's environmental policy. In addition, the appraisal examines compliance with corporate standards and non-operations requirements described in this Environmental Management Implementation Plan applicable to individuals and groups not covered by facility compli-
Appraisals of the comprehensive EMS's effectiveness should be conducted at least once every three years. The audit is conducted under the direction of the President of CMSG who will appoint an employee of the Company to coordinate the audit and follow up actions.

**Reporting and Communications.** As described in corporate standards on reporting, plants are required to provide monthly reporting of environmental performance measures to the Manager of Environmental Affairs. These measures are used to track and trend facility environmental performance, and to determine recipients of awards for environmental excellence. Reporting on trends of these measures and trends in environmental regulation is provided to the plants and CMSG officers by the Manager of Environmental Affairs on a quarterly basis.

Both existing and new environmental requirements applicable to specific facilities operated by CMSG are communicated to employees at their respective locations. The Manager of Environmental Affairs is responsible for such communication to General and Plant Managers. Each Plant Manager is responsible for assuring that such information is communicated to employees at the plant. Requirements for projects in the development stage are communicated to employees working on those projects by the Manager of Environmental Affairs.

Every employee is encouraged to work through his or her Supervisor and/or Plant Manager to identify and resolve specific facility environmental compliance concerns. If the nature of the concern prevents such communication, the employee may contact the Manager of Environmental Affairs or CMS Legal department directly.

**Training.** As described in the corporate standard on training, all CMSG employees are expected to receive a level of environmental training commensurate with their job responsibilities. Additional training needs for improved performance are identified through audits, assessments and appraisals.
In addition to this Environmental Management Implementation Plan, major documents which make up the written portion of the Company's comprehensive EMS include the Environmental Policy Statement, Corporate Standards, Environmental Requirements, and Plant Procedures. Together, these documents comprise the CMSG Environmental Management Manual, which compiles the major written elements of Company's comprehensive EMS into one location. Except for Plant Procedures, which are generated/updated by the Plant Manager or his or her designee, the Manager of Environmental Affairs (EA) is responsible for generating draft (new or revised) versions of these documents. Responsibilities for review and approval of these documents are summarized below:

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The purpose of the Environmental Management Manual is to have a specific location for current descriptions of all facility-related environmental requirements, corporate standards and other EMS program elements. The Manual may be distributed in paper and/or electronic form, and it is the responsibility of the Manager of Environmental Affairs to maintain a list of Manual holders and the most current version of each document, and to assure that the most current version of each document is distributed to the appropriate Manual holders.
CORPORATE STANDARDS
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STANDARD: CMSGC personnel responsible for developing a new project will assure that all necessary environmental permits and approvals are obtained.

CMSGC personnel responsible for operating a facility will have a copy of all applicable permits and approvals on-site or readily available, and will assure that any new permits, approvals or permit modifications needed for new or modified site equipment, fuels or operations are obtained.

CMSGC Environmental Affairs will assure that a system is in place to provide CMSGC-operated facilities with documentation of other applicable (non-permit) environmental requirements.

ACTION: DEVELOPMENT PROJECT MANAGER

- consult with Environmental Affairs to determine applicable environmental requirements and permitting needs for new projects early in project activities.

- hire and administer contracts with outside environmental service providers.

- assure that all required permits are obtained prior to contingent project activities.

- provide a copy of each environmental permit application, draft permit and final permit to Environmental Affairs, and upon appointment, the new Plant Manager.

- transfer environmental files to facility no later than commercial startup.
ACTION (cont):  FACILITY

- consult with Environmental Affairs to determine applicable environmental requirements and permitting needs for new or modified site operations or equipment early in project activities.

- hire and administer contracts of outside environmental service providers as needed.

- assure that all required permits are obtained prior to contingent project activities.

- provide a copy of each environmental permit application, draft permit and final permit to Environmental Affairs, and maintain a copy of each at the facility.

ENVIRONMENTAL AFFAIRS

- review plans for new development projects and new or revised site operations or equipment, and provide recommendations for approaches to significant issues, permitting strategies, and/or outside service providers, as requested by the Development Project Manager or Plant Manager.

- provide technical review and/or management of outside environmental service providers as requested.

- review permit applications and draft permits, and consult as necessary with CMS Legal, CMSGC Plant Support, and/or the Development Project Manager or Plant Manager on any significant issues.

- provide (or assure the provision of) copies of applicable (non-permit) Federal and state environmental requirements to each CMSGC-operated facility.

CMS LEGAL

- advise Environmental Affairs as requested on legal or regulatory issues associated with permit applications or draft permits.

- review applicable (non-permit) Federal and state environmental requirements developed by Environmental Affairs, prior to issuance to CMSGC-operated facilities.
ACTION (cont):  PLANT SUPPORT

- advise Environmental Affairs as requested on operations issues associated with permit applications or draft permits.

RECORDS:  DEVELOPMENT PROJECT MANAGER

- copies of all permit applications and final permits during development and construction.

FACILITY

- copies of all permit applications, final permits and other environmental requirements during operation, for life of facility.

BASIS:  CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

DETAIL:  Compliance with environmental requirements begins with knowledge of what those requirements are. CMSGC Environmental Affairs can review proposed new projects and changes in fuels, equipment or operations which could impact the environment at existing facilities, and assist development or operations managers in determining applicable environmental requirements and developing strategies to address those requirements. Environmental Affairs can also review permit applications and draft permits received from environmental agencies to assure that commitments made are consistent with applicable requirements, CMSGC environmental policy, and CMSGC operational practices. Finally, Environmental Affairs has the tools and mandate to track applicable Federal and state environmental regulations, and to assure that operating facilities are provided with copies of applicable requirements.

It is important that persons responsible for current activities on a project (whether in development or operation) have available to them the current version of any applicable permits and other applicable environmental requirements as a reference document and a reminder of commitments. Therefore, maintaining current copies of applicable permits is the responsibility of the appropriate (development or operations) manager (see also ENV-CMS-012).

CONTACTS:  Questions on this standard may be directed to the Manager of Environmental Affairs.

☆☆☆☆
STANDARD: CMSGC personnel responsible for developing, managing construction of, or operating a project or facility have primary responsibility for assuring compliance with all applicable permit and other (non-permit) environmental requirements.

ACTION: DEVELOPMENT PROJECT MANAGER

- request CMS Legal review of construction contracts to assure that they contain appropriate language to require contractor compliance with all environmental requirements.

- request Environmental Affairs review of construction contracts for technical and regulatory aspects of environmental control and monitoring equipment.

CONSTRUCTION MANAGER

- monitor construction contractor environmental compliance performance.

- request support from Environmental Affairs and/or CMS Legal as needed to resolve questions on permit and other environmental requirements.

- consult with Environmental Affairs and the Plant Manager at least 90 days prior to turn-over and startup, to establish list of responsibilities and schedule for startup-related environmental requirements (notification, testing, etc.).

FACILITY

- consult with Environmental Affairs and the Construction Manager at least 90 days prior to turn-over and startup, to establish list of responsibilities and schedule for startup-related environmental requirements (notification, testing, etc.).
ACTION (cont): FACILITY (cont)

- put into place the organizational and financial resources necessary to assure compliance with all permit and other environmental requirements (see also ENV-CMS-003).

- develop facility-specific procedures as needed to implement environmental compliance activities, and provide to Environmental Affairs for review (see CMSG Environmental Management Implementation Plan for recommended procedure subjects).

ENVIRONMENTAL AFFAIRS

- advise Development Project Manager as requested on technical and regulatory aspects of environmental control and monitoring equipment.

- advise Construction Manager as requested on environmental requirements during construction, turn-over and startup.

- advise Plant Manager as requested on environmental requirements during turn-over, startup and operation.

- review plant procedures developed to implement environmental compliance activities.

CMS LEGAL

- review and approve construction contracts prior to CMSGC signing.

- review construction contractor submittals during turn-over and startup, as requested.

- advise Construction Manager as requested on legal or regulatory requirements during construction, turn-over and startup.

- advise Plant Manager as requested on legal and regulatory requirements during turn-over, startup and operation.

RECORDS: None

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan
DETAIL: Ongoing compliance with environmental requirements requires that persons responsible for current activities on a project (whether in development, construction or operation) take the lead role in assuring that those activities are done correctly. If resources allow, Plant Managers are urged to assign responsibility for monitoring and assuring plant environmental compliance to a site environmental coordinator. Environmental Affairs can provide technical and regulatory advice and support and CMS Legal can provide regulatory and legal advice and support.

CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

***
STANDARD: CMSGC-operated facilities will develop and use an annual schedule or matrix describing environmental inspection, monitoring, reporting, notification, training, records management and/or similar commitment requirements.

ACTION: FACILITY

- develop an annual schedule or matrix describing environmental inspection, monitoring, reporting, notification, training, records management and/or similar commitment requirements, and provide a copy to Environmental Affairs.

ENVIRONMENTAL AFFAIRS

- review facility commitment schedule for completeness and accuracy, and periodically review facility status against the schedule.

CMS LEGAL

- review facility commitment schedule for completeness and accuracy.

RECORDS: None

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

DETAIL: An annual schedule or matrix describing periodic environmental commitments is a useful tool for assuring that persons responsible for environmental compliance activities act on all of those commitments (especially the ones which occur less frequently than monthly or quarterly). The format of the schedule or its location (e.g., a wall chart, pages in a planner, part of a computerized tracking system, etc.) is not particularly important, as long as the tool is easily accessible to those who need to refer to it. Sources for commitment requirements may include such things as permits, spill and/or pollution prevention plans, consent orders, monitoring plans, Federal, state, or local regulations, etc.
CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

★★★
STANDARD: All CMSGC employees will receive a level of environmental training appropriate to their job responsibilities.

ACTION:

FACILITY

- include environmental awareness training as part of new employee orientation, and provide annual environmental awareness refresher training to all employees, as needed.

- assure that employees with specific environmental compliance responsibilities receive initial training appropriate to those responsibilities.

- assure that training required by specific environmental regulation, program, permit condition, etc., is conducted at the required intervals.

MANAGER OF TRAINING

- assist the facility with training needs analysis, conducting training, and/or recommending outside training resources, as needed.

- develop or obtain an environmental awareness training program for use by facilities.

- assess ongoing facility environmental training effectiveness and assist with updating or improving training programs and materials as needed.

ENVIRONMENTAL AFFAIRS

- assure that Plant Managers (and, if applicable, site environmental coordinators) receive initial training on CMSGC, Federal and state environmental requirements.

- assist the Manager of Training with specification of the scope and content of an environmental awareness training program.
ENV-CMS-004

RECORDS: FACILITY

- documentation of environmental training provided to each employee, for 3 years.

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

DETAIL: There are three levels of facility environmental training:

- **Environmental awareness training.** Basic environmental awareness training is an introduction to the various environmental media, and plant equipment and operations which could have a direct impact on those media. It can be an effective tool in preventing the escalation of minor equipment or operational problems into major environmental concerns. As such, initial environmental awareness training is required for each new facility employee, and annual refresher training is recommended for all facility employees. This training is developed by the Manager of Training and delivered by facility staff.

- **Job-specific environmental training.** This is training which is not necessarily required by statute or regulation, but is necessary for employees with specific environmental compliance responsibilities to carry out those responsibilities in an efficient manner while ensuring compliance. The training may consist of on-the-job training (e.g., CEMS operations, maintenance, and/or calibration) and/or training provided by outside experts (e.g., individual training for Plant Managers and site environmental coordinators on CMSGC and applicable Federal and state environmental regulations by Environmental Affairs, seminars on environmental regulations by outside firms, etc.). Job-specific training is required initially when a person takes on a new job or new responsibilities involving environmental compliance activities, or when changes in environmental requirements dictate the need for changes in the way those activities are performed.

- **Required environmental training.** Unlike OSHA requirements, few environmental statutes require training as a program element. Those that do (e.g., spill plans, maintenance and repair of CFC-containing refrigeration equipment, etc.) may or may not be applicable to a particular facility. It is the Plant Manager’s responsibility to review the environmental requirements applicable to his/her
DETAIL (cont): particular facility provided as part of the CMSGC comprehensive Environmental Management System for specific training requirements, and to assure that those requirements are met. Training requirements for OSHA programs are addressed in the CMSGC comprehensive Safety & Health Reference Manual and the CMSGC Safety Training Manual.

The Manager of Training can assess the effectiveness of facility environmental training and assist with updating or improving training programs and materials as needed.

CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

Questions on training needs, content or resources may be directed to the Manager of Training.

◆◆◆
**STANDARD:** CMSGC-operated facilities may qualify for annual awards for environmental excellence, based on criteria and performance levels described below.

**ACTION:**

**ENVIRONMENTAL AFFAIRS**

- establish criteria for annual Environmental Excellence Awards for CMSGC-operated facilities (see DETAIL below).

- establish criteria for Environmental Manager’s Special Award for CMSGC-operated facilities (see DETAIL below).

- evaluate facility performance against award criteria and recommend award recipients to General Managers and Vice-President of Operations.

**FACILITY**

- comply with permit and other environmental requirements to qualify for annual Environmental Excellence Awards (see DETAIL below).

- reduce emissions, discharges, and/or waste generation, or take other proactive steps to improve or enhance facility environmental performance to qualify for the Environmental Manager’s Special Award (see DETAIL below).

**GENERAL MANAGERS**

- review Environmental Affairs’ evaluation of facility performance against award criteria and recommend award recipients to the Vice-President of Operations.

**VICE PRESIDENT OF OPERATIONS**

- select award recipients based on recommendations received from Environmental Affairs and General Managers.

*01/09/96*
ACTION (cont): CMS COMMUNICATIONS

* communicate information on award recipients and basis for awards to appropriate news media.

RECORDS: None.

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

DETAIL: Environmental Excellence Awards. CMSGC recognizes exceptional environmental performance of the facilities it operates through annual Environmental Excellence Awards. Awards are given to facilities achieving outstanding compliance records, according to the following criteria:

**Thermal Plants**

* 99% or greater annual average compliance with all applicable air emission limits combined (e.g., SO\textsubscript{2}, NO\textsubscript{x}, CO, opacity, etc.). [NOTE: "compliance with all applicable ... limits combined" means average compliance for all parameters measured (e.g., 100% annual compliance with applicable SO\textsubscript{2}, NO\textsubscript{x}, and CO limits, combined with 96% annual average compliance with an opacity limit would average to 99% overall). In addition, compliance is measured against all applicable requirements (i.e., if emission exceedences are exempted during startup or shutdown by regulation or permit condition, such exceedences are not counted against compliance percentage).]

* 99% or greater annual average compliance with all applicable water discharge limits combined (e.g., pH, temperature, suspended or dissolved solids, chemical or metal concentration limits, toxicity, etc.).

* 95% or greater annual average CEMS availability (all parameters combined).

* conduct environmental awareness training for all employees at least once per year.

* no federally reportable spills or releases (see ENV-SPL-US02 and ENV-SPL-US03).
DETAIL (cont):

- no letters of violation (LOVs), notices of violation (NOVs),
citations or other enforcement actions received which result in a
fine, consent or other administrative order, or any other sanc-
tion against the facility or its employees.

*Hydro Plants*

- 99% or greater annual average compliance with all applicable
water quality requirements combined (e.g., dissolved oxygen,
clarity, thermal limits, and associated response activities).

- 99% or greater annual average compliance with all applicable
fish passage, biological monitoring, river flow or other related
facility-specific requirements combined.

- conduct environmental awareness training for all employees at
least once per year.

- no federally reportable spills or releases (see ENV-SPL-US02
and ENV-SPL-US03).

- no letters of violation (LOVs), notices of violation (NOVs),
citations or other enforcement actions received which result in a
fine, consent or other administrative order, or any other sanc-
tion against the facility or its employees.

*Fuel Processing and Other Facilities*

- 99% or greater annual compliance with all inspection, monitor-
ing, notification, reporting and recordkeeping requirements
contained in permits or plans (spill plans, emergency response
plans, stormwater pollution prevention plans, etc.) combined.

- conduct environmental awareness training for all employees at
least once per year

- no federally reportable spills or releases (see ENV-SPL-US02
and ENV-SPL-US03).

- no letters of violation (LOVs), notices of violation (NOVs),
citations or other enforcement actions received which result in a
fine, consent or other administrative order, or any other sanc-
tion against the facility or its employees.
Documentation of facility performance is provided to CMS corporate offices on a monthly basis, as described in ENV-CMS-009 and in the operating standard on plant reporting. Every facility which meets the applicable criteria above on a calendar-year basis receives an award.

Environmental Manager’s Special Awards. CMSGC also recognizes exceptional environmental performance of the facilities it operates through Environmental Manager’s Special Awards. These awards are given to facilities that go beyond compliance to develop and implement a proactive environmental ethic at the site. Kinds of activities which enable a facility to qualify for this award include, but are not limited to:

- reductions in emissions, discharges and/or solid waste on a mass per unit of production (tons/MWhr) basis, resulting from changes in fuel, treatment, equipment, or operating practices.

- reductions in annual volume (cu yd) or mass (tons) of solid and/or hazardous waste generated due to changes to less polluting materials, reuse of materials or wastes, or recycling of material previously considered waste (used oil, office paper, cardboard, metal, plastic, glass, etc.).

- environmental enhancement activities, such as establishing habitats on otherwise unused site land, or working with state or private conservation groups to protect or enhance local environmentally sensitive areas not on the immediate plant site.

- training, education and/or community outreach activities designed to improve or enhance environmental awareness of site employees, local schools and/or community groups.

Reductions in emissions, discharges, and waste generated will be calculated by Environmental Affairs. However, documentation on specific activities or measures which contributed to such reductions, and documentation on other site environmental enhancement or outreach activities, should be sent to the Manager of Environmental Affairs no later than January 31 following the calendar year during which the activity began or took place. General Managers, Plant Managers, site environmental coordinators or other site employees involved in environmental enhancement activities are encouraged to provide a brief written description of the activity and resulting benefits. Although ongoing activities will be considered for the Special Award, new or innovative activities will be more heavily weighted. An award will be made to each facility that, in the opinion of the Manager of Environmental Affairs, exhibits
DETAIL (cont): outstanding environmental leadership through activities that meet the intent of the criteria described above.

CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

● ● ●
STANDARD: CMSGC-operated facilities are authorized to communicate directly with federal, state and local environmental agencies. Significant results of meetings and discussions with such agencies will be reported to Environmental Affairs, following the guidelines provided below.

ACTION: FACILITY

- when possible, inform Environmental Affairs at least one week in advance of meetings with environmental agencies at which significant issues are expected to be discussed.

- after face-to-face or telephone discussions with environmental agencies, contact Environmental Affairs within one business day by phone or fax, if significant issues were discussed or specific commitments made.

ENVIRONMENTAL AFFAIRS

- provide assistance to facility, as requested, in preparing for, participating in, and/or following up on meetings with environmental agencies.

- determine need for additional follow-up or legal support.

GENERAL MANAGER

- assist Environmental Affairs, as necessary, to assure timely completion of follow-up activities.

RECORDS: FACILITY

- documentation / summary of significant issues and/or commitments made in discussions with environmental agencies, for life of facility.

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

01/08/96
Meetings or discussions with personnel from environmental agencies can occur at any time, and are most appropriately handled by facility staff most directly involved in facility environmental compliance activities. Environmental Affairs can provide technical and regulatory advice and support to assist the facility in developing approaches to significant issues or strategies for dealing with agency staff.

It is not necessary to contact Environmental Affairs for every meeting or telephone call with an environmental agency. However, those at which significant issues (Plant Manager's judgement) are discussed or specific commitments made should be documented both to file and to Environmental Affairs.

Depending on the nature of the issues involved, Environmental Affairs may review the need to involve CMS Legal, the appropriate General Manager, and/or others, as needed.

Questions on this standard may be directed to the Manager of Environmental Affairs.
STANDARD: CMSGC-operated facilities dealing with a site inspection by personnel from federal, state or local environmental protection or enforcement agencies will attempt to cooperate with the inspector(s), following the guidelines provided below.

**ACTION:**

**FACILITY**

- upon arrival of an inspector from an environmental agency, determine the purpose of the visit, indicate willingness to cooperate, and arrange for a knowledgeable escort (see DETAIL below).

- as a general rule, provide samples and copies of records requested (see DETAIL below).

- determine whether any follow-up action is required.

- provide a brief written summary of the visit to Environmental Affairs and the appropriate General Manager within one week (see DETAIL below).

**ENVIRONMENTAL AFFAIRS**

- review inspection report summary and determine need for additional follow-up or legal support.

**GENERAL MANAGER**

- assist Environmental Affairs, as necessary, to assure timely completion of follow-up activities.

**CMS LEGAL**

- assist facility with immediate response to search warrants and criminal investigations (see DETAIL below).

**RECORDS:**

**FACILITY**

- copies of records provided to environmental inspectors, for 3 years.

01/09/96
BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

DETAIL: Site inspections by personnel from environmental protection or enforcement agencies can occur at any time, although many environmental regulations specify that they happen at "reasonable" times (e.g., normal business hours). Sometimes visits are scheduled in advance, while at other times they may be unannounced. They may be targeted towards a site-specific issue (e.g., reported exceedences of permit limits; neighbor complaints, etc.), but more often, they are simply general or routine. Frequently, they cover one environmental program area (e.g., air, water, waste management, etc.), but they can cover multiple areas (multi-media inspections).

As a general rule, indicate willingness to cooperate. There is rarely, if ever, anything to be gained by refusing reasonable requests or antagonizing the inspector. Cooperation generally leads to greater flexibility and discretion on the part of the inspector, which can result in a better inspection outcome. Be responsive to questions, but be focused. There is no need to volunteer unrequested information.

Determine the purpose of the visit. Usually, this will be explained by the inspector up-front, but if not, ask. Unless the inspector indicates that the inspection is part of a criminal investigation, s/he will not have a search warrant, nor should s/he be asked to produce one. However, if the inspector does produce a search warrant, the facility has no choice but to cooperate within the specific scope of that warrant, and should immediately contact Bob Schroder at (313) 441-0276 or (810) 229-8401 (home), or Neil Fellows at (313) 436-9250.

Inspection content. An inspection usually consists of: an initial meeting for introductions and to explain the purpose and scope of the visit; a tour of the facility (or key areas related to the scope of the visit); examination of key records; and a closing meeting to discuss observations and follow-up actions.

Arrange for a knowledgeable escort. The plant manager should, if at all possible, participate in at least the opening and closing meetings.
DETAIL (cont.): Appropriately facility environmental, engineering and/or operations management staff should accompany the inspector throughout the inspection.

Inspector Requests. In some cases, the inspector may request fuel, other raw material, or waste samples. These should be obtained according to plant and/or EPA-approved sampling procedures, and the facility should request split samples for its own use later, should the results of the inspector's sampling and analysis indicate problems.

Copies of records are also frequently requested. In general, provide requested copies of records related to the scope of the inspection, unless they are marked "Confidential" or "Attorney-Client Privilege." Make two copies of everything - one for the inspector, and one for plant files, so that a separate file record is made of exactly what was provided. In some cases, the amount of information requested will be so voluminous as to require considerable time to compile and copy. Usually, a reasonable inspector will allow those copies to be provided in a follow-up transmittal within the next week or so.

Determine whether any follow-up action is required. At the conclusion of the inspection, facility staff should have an idea of the inspector's impressions and whether s/he expects any follow-up activities. Although a written report will probably not be provided at that time (if ever), the inspector should be able to explain what (if anything) to expect next, and who to contact for follow-up.

Summary Report. After completion of the visit, provide a narrative summary of the visit to Environmental Affairs and the appropriate General Manager. Include the inspector's name, the agency represented, the date, time and duration of the inspection, the scope of the inspection, facility personnel involved in meetings and acting as escorts, a description of any samples taken and records provided, an evaluation of the results of the inspection, and a description of any requested follow-up activities.

CONTACTS: It is not necessary to contact Environmental Affairs before or during an inspection; however, the Manager of Environmental Affairs may be contacted if questions arise or support is needed.

Questions related to protection of documents, criminal inspections or investigations should be directed to CMS Legal.

01/09/96
ENVIRONMENTAL AFFAIRS

- copies of quarterly status reports, for two years.

DETAIL: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

Compliance and communication are two of the cornerstones of the CMSGC environmental policy. Periodic reporting is used to keep management informed on the status of facility compliance, performance trends, and the outlook for changes which could impact corporate assets or operations. Periodic reporting is also used to keep operating facilities informed as to current and changing environmental requirements.

Periodic reporting required by permit or other commitment (see ENV-CMS-003) is submitted by the facility directly to the appropriate environmental agency. Unless the report meets the criteria for nonroutine reporting (see ENV-CMS-010), no prior review of the report by Environmental Affairs and no copying of the report to Environmental Affairs is required. For example, routine monthly or quarterly monitoring reports, including those which show exceedences of permit limits (e.g., excess emission reports), are not required to be sent to Environmental Affairs. Note, however, that the transmittal letters for such reports should avoid use of the term "violation" in reporting operations or data outside of permit limits. Phrases such as "excess emissions", "discharge in exceedence of permit limits" or the like, are preferable ways of expressing the same concept.

Monthly Reports. Each facility provides a monthly hard copy or electronic report to the CMSGC corporate office summarizing facility operations, as described in the CMSGC operational standard on plant reporting. This report includes summary information on emissions, discharges, CEMS availability, spills, and LOV/NOVs, and is used to track compliance trends and calculate annual compliance percentages for environmental excellence awards (see ENV-CMS-005).

Quarterly Report. Environmental Affairs provides a quarterly report to the facilities and CMSGC management summarizing the information
DETAIL (cont): provided by the facilities, identifying trends, and describing anticipated or actual changes in environmental requirements, as follows:

- **Compliance Summary.** Summary of monthly numerical data on emission and discharge monitoring, number of spills and NOVs. Includes an analysis of trends, as applicable.

- **Regulatory Outlook.** Brief description of emerging issues slated for or having recently had regulatory action, and potential impact on assets and facility operations.

- **Other.** Other significant information, such as successes, "Best Practices", lessons learned, and status of environmental management system implementation.

CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

- - -
STANDARD: CMSGC-operated facilities will report significant nonroutine items such as formal agency information requests, apparent noncompliance, submittals of plans, or requests for agency approvals to Environmental Affairs.

CMSGC Environmental Affairs and, as necessary, CMS Legal, will provide counsel and advice on appropriate response.

ACTION: FACILITY

- report agency written and significant verbal information requests, potentially reportable spills, and conditions which appear to be inconsistent with site environmental requirements to Environmental Affairs and the appropriate General Manager by the end of the first business day following the event or its discovery.

- copy Environmental Affairs on time-critical nonroutine agency written reporting such as excess emission incident reports, spill reports, requests for variance, etc.

- provide a copy of other nonroutine agency submittals such as notifications, plans (e.g., fugitive dust control plans, monitoring plans, etc.) or requests for agency approvals to Environmental Affairs for review at least one week prior to scheduled submittal.

ENVIROMENTAL AFFAIRS

- review nonroutine reporting from facilities and consult with CMS Legal and the appropriate General Manager on any significant issues.

- provide technical and regulatory guidance to assist facilities with response to agencies.
ACTION (cont):  GENERAL MANAGER

- assist Environmental Affairs, as necessary, to assure timely resolution of issues.

CMS LEGAL

- provide regulatory and legal guidance as requested to assist facilities with response to agencies.

RECORDS: FACILITY

- copies of all correspondence with environmental agencies, for life of facility or until expiration of retention period associated with a specific requirement.

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

DETAIL: Nonroutine reporting involves actual or potential communication with environmental agencies regarding significant issues of an unusual or nonrecurring nature. Environmental Affairs can provide technical and regulatory advice and support and CMS Legal can provide regulatory and legal advice and support in the review of such issues and associated communications, and assist facility managers in reviewing applicable environmental requirements and developing appropriate responses.

Nonroutine reports of a time-critical nature required to be sent to environmental agencies within a short period of time after an event (spill, exceedence, etc.), are not required to be reviewed by Environmental Affairs in advance, but should be copied to Environmental Affairs. Transmittal letters for such reports should avoid use of the term "violation" in reporting operations or data outside of permit limits. Phrases such as "excess emissions", "discharge in exceedence of permit limits" or the like, are preferable ways of expressing the same concept.

CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

* * *
STANDARD: CMSGC-operated facilities will respond to official enforcement documents and processes only after consultation with CMS Legal and Environmental Affairs.

ACTION: FACILITY

- report any written agency Notice of Violation (NOV), Letter of Violation (LOV), citation or other enforcement document alleging actual or possible violation of or noncompliance with environmental requirements to CMS Legal, Environmental Affairs and the appropriate General Manager as soon as possible (no later than the end of the first business day following receipt of the document).

CMS LEGAL

- review documents provided by facility and develop response strategy in consultation with the facility, General Manager and Environmental Affairs.

ENVIRONMENTAL AFFAIRS

- assist CMS Legal and the facility, as requested, in the development, review and implementation of appropriate response activities.

GENERAL MANAGER

- assist CMS Legal and the facility in the development, review and implementation of appropriate response activities.

RECORDS: FACILITY

- copies of all correspondence with environmental agencies, for life of facility or until expiration of retention period associated with a specific requirement.
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<th>BASIS:</th>
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<tr>
<td>DETAIL:</td>
<td>Official notices from environmental agencies alleging violation of environmental statutes, regulations, and/or permit conditions are always taken seriously. Prompt and appropriate review and response can frequently minimize or eliminate potential associated penalties. CMS Legal can provide regulatory and legal advice and support in the review of the issues and associated communications, and assist facility managers in reviewing applicable environmental requirements and developing appropriate responses.</td>
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<tr>
<td>CONTACTS:</td>
<td>Questions on enforcement authorities, penalties, and any other legal issue may be directed to CMS Legal department.</td>
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Any other questions on this standard may be directed to the Manager of Environmental Affairs.

***
STANDARD: CMSGC-operated facilities will establish and maintain site environmental files for primary storage of all site-related environmental records.

ACTION: DEVELOPMENT PROJECT MANAGER

- establish and maintain project environmental files for primary storage of all permits, requirements, reports, submittals, correspondence, and other project-related environmental records during the development and construction phases of a project.

FACILITY

- establish and maintain site environmental files for primary storage of all permits, standards, requirements, procedures, monitoring data, reports, submittals, correspondence, training documentation, and other site-related environmental records.

- establish and maintain a separate file for documents covered by attorney-client privilege, according to guidance provided by CMS Legal.

- annually purge files of records for which the retention period has expired.

ENVIRONMENTAL AFFAIRS

- establish and maintain corporate environmental files for duplicate storage of permits, standards, requirements, procedures, and other site-related environmental records, as needed to support site activities.

CMS LEGAL

- assist facilities with developing a process for applying attorney-client privilege to specific records, and with determination of which documents might require such privilege.
RECORDS: DEVELOPMENT PROJECT MANAGER

- as described above and in any other applicable corporate standard or environmental requirement.

FACILITY

- as described above and in any other applicable corporate standard or environmental requirement.

ENVIRONMENTAL AFFAIRS

- as described above and in any other applicable corporate standard or environmental requirement.

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan.

DETAIL: Most records associated with site environmental compliance activities are either essential as reference documents or required by regulation to be kept on-site. Many required records, such as monitoring data, have specific retention periods. To conserve file space and assure that only necessary records are maintained, records which have exceeded their required retention period should be purged from site files at least once per year.

For security, it is strongly recommended that environmental records be stored in a fireproof lockable cabinet.

Transfer of environmental files from development to operations is covered in the CMSGC Environmental Management Implementation Plan and ENV-CMS-001.

CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

Questions on what kinds of records might require attorney-client privilege and how to handle those records may be directed to CMS Legal department.

◆◆◆
STANDARD: Formal evaluation of CMSGC environmental management systems and CMSGC-operated facility environmental compliance programs will be performed on a periodic basis. Results will be used to provide CMSGC management and the affected facilities the opportunity to improve the performance of these environmental management systems and programs.

ACTION: ENVIROMENTAL AFFAIRS

- in consultation with CMS Legal and the General Managers, develop and update as necessary, a schedule for conducting environmental compliance audits and operational assessments, so that at least one audit and one assessment is completed for each facility every three years.

- finalize, by May 15 of each year, the list of specific facilities to have environmental compliance audits completed during that calendar year, and develop a list of those facilities expected to have audits completed during the following calendar year.

- define the scope of each audit and select independent third-party auditors familiar with environmental regulations and facility operations to perform the audits.

- schedule individual audits, based on availability of key facility staff and auditors.

- review draft audit reports and coordinate resolution of comments.

- as needed, assist the facility with the identification and evaluation of appropriate corrective actions.

- use the final audit report to identify areas of particular strength and areas for improvement for sharing with other facilities.

- track progress on completion of corrective actions and work with the appropriate General Manager to assure timely resolution.
ACTION (cont): ENVIRONMENTAL AFFAIRS (cont)

- assure that an appraisal of the adequacy of the complete environmental management system is conducted at least once every three years. Take on the actions assigned to "Facility" below during such an appraisal (see DETAIL below).

FACILITY

- work with Environmental Affairs to determine suitable dates for a scheduled audit.

- review and comment on draft audit reports

- develop proposed corrective actions and schedule to address audit findings.

- use the final audit report as a guide to identification of and action on areas for improvement.

- update the General Manager and Manager of Environmental Affairs on a monthly basis on the status of unresolved audit findings.

- complete corrective actions according to schedule, and return the final audit report to CMS Legal upon completion of all corrective actions.

GENERAL MANAGER

- assist with obtaining approval from project partners, as necessary, for expenses associated with audits.

- assist the facility and Environmental Affairs, as needed, to assure timely scheduling of audits and completion of corrective actions.

CMS LEGAL

- after consultation with Environmental Affairs and the appropriate General Manager, send a formal letter requesting the third-party auditor to conduct an environmental compliance audit of a specific facility.
ACTION (cont): CMS LEGAL (cont)

- receive the formal transmittal of the draft audit report from the third-party auditor, and distribute to the facility and Environmental Affairs for review and comment.

- request the return of all draft audit reports and transmit comments and description of proposed corrective actions to the third-party auditor for incorporation in the final audit report.

- assist the facility in addressing any potential noncompliance issues.

- receive the final audit report from the third-party auditor, and transmit to the CMSGC President, Vice President of Operations, Manager of Environmental Affairs, and the appropriate General Manager and facility manager.

- request the return of all outstanding copies of final audit reports upon completion of all corrective actions.

RECORDS: CMS LEGAL

- copies of all final audit reports and documentation of completed corrective actions, for life of facility.

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

DETAIL: In order to assure that the environmental compliance program is both effective and provides for continuous improvement, CMSGC management has included a program evaluation element in its environmental policy.

Evaluation Type. This standard identifies three kinds of environmental evaluations:

- an environmental compliance audit is an evaluation of the current state of compliance of a particular facility with all applicable environmental requirements identified for the audit. To assure that CMSGC can perform such detailed self-examination while minimizing exposure to enforcement risk associated with discovery of apparent discrepancies with requirements, the documents associated with an audit are communicated to and from CMS Legal, for the
DETAIL (cont): The purpose of gathering facts to render legal advice. Control of audit documents in this manner is to preserve attorney-client privilege.

- an environmental operational assessment is that portion of a formal internal assessment of compliance with CMSGC operational standards which deals specifically with environmental issues. The conduct of operational assessments is described in the CMSGC standard on Operational Assessments.

- an appraisal of the environmental management system is an evaluation of the adequacy and efficiency of the elements of that system in carrying out the CMSGC environmental policy and assuring all CMSGC stakeholders that the Company takes appropriate actions to protect the environment while remaining competitive. The conduct of an appraisal is described at the end of this DETAIL section.

Scheduling. Scheduling of facilities to be audited is dictated primarily by the amount of time since the previous audit and the number of current or recent compliance issues.

Scope. In most situations, an audit will usually be a full-scope evaluation of compliance with environmental requirements, as described in written corporate standards and all applicable federal, state and local laws, regulations and permits. In some cases, an audit may seek less detail in some areas (e.g., if recent evaluations or compliance history show strengths in those areas) and/or more detail in others (e.g., complete evaluation of waste streams for initial or reassessment of hazardous waste generator classification and/or pollution prevention and waste minimization opportunities). Other areas for evaluation may include adequacy of training, tools, communications, resources, and/or attitudes and commitment. In all cases, the auditors are expected to examine appropriate records, procedures, equipment and facilities, and to interview facility staff having environmental responsibilities.

Site Preliminary Draft Report. The auditors will be asked to compile the results of their assessment into a site preliminary draft report to be discussed with facility management before the auditors leave the site. The site preliminary draft report contains a narrative summary of strengths and areas without findings, followed by individual findings. Each finding includes a simple statement of the specific requirement and reference, the condition as found by the auditors, and a ranking of Priority Action, Action Required, or Action Recommended, based on
the auditors' professional evaluation of the severity and risk of the specific finding, as follows:

- **Priority Action.** The condition is ongoing, and if allowed to continue, represents significant exposure to enforcement and/or risk of environmental damage (e.g., lack of a required spill prevention plan). Corrective action should begin immediately and be completed as soon as possible, not to exceed 30 days (may be extended by the General Manager and/or Manager of Environmental Affairs as circumstances dictate).

- **Action Required.** The condition appears to be isolated or does not represent significant exposure to enforcement or risk of environmental damage (generally applies to reporting or recordkeeping discrepancies). Corrective action is necessary, and should be completed as soon as possible, not to exceed 60 days.

- **Action Recommended.** The condition does not currently involve noncompliance, but if allowed to continue, could lead to exposure to enforcement or risk of environmental damage (e.g., lack of a non-mandatory spill prevention plan). Corrective action is recommended, and should be implemented as soon as time and resources allow.

The auditors will also be asked to develop and present to the facility one or more possible actions to correct each finding. The facility is encouraged to discuss its options with the auditors and, if possible, commit to or complete appropriate corrective actions before the auditors leave the site.

**Draft Audit Report.** The auditors will be asked to provide a draft audit report to CMS Legal within 14 days of the end of the on-site audit. This report contains the information developed for the site preliminary draft report and any response actions or commitments already made by the facility, in the following format:

- **Executive Summary.** No more than a half-page summary of significant findings and corrective actions.

- **Audit Scope and Team.** A brief description of the regulatory program areas covered by the audit and the names and experience of the audit team members.
DETAIL (cont):

- **Facility and Contacts.** A brief description of the facility audited and the names and positions of the facility staff who provided information used during the audit.

- **Audit Areas Without Findings.** A brief description of areas which appear to be in compliance with all applicable requirements. Note any areas of particular strength or innovative approach which may be transferable to other facilities.

- **Audit Findings and Corrective Actions.** As written for the site preliminary draft report. Include any actions already carried out or committed to by the facility to correct the finding (if none, include a recommended corrective action).

Report Review. The focus of the review is on the accuracy of the report, the ranking of findings, and the corrective actions. All Priority Action or Action Required findings must have an associated corrective action and schedule for completion to be included in the final report. In no case will CMSGC ask the auditors to change observations or accurate statements of fact, regardless how damaging such statements might appear to be. However, the reviewing parties may determine that editorial, emphasis, or content changes would improve report accuracy or that a finding should be ranked higher or lower, or not included at all. Environmental Affairs coordinates the resolution of comments, and CMS Legal then assists the auditors in making corrections to the report that are deemed necessary to accurately represent the audit results.

Final Audit Report. The auditors will be asked to return to CMS Legal, within 14 days of receipt of comments on the draft report from CMS Legal, three copies of the final audit report incorporating those comments. CMS Legal retains one copy for file, provides one copy to the facility manager, and routes one copy to the Manager of Environmental Affairs, the General Manager, the Vice President of Operations, and the CMSGC President.

Corrective Action Completion. Environmental Affairs and CMS Legal assist the facility as needed to address any potential noncompliance issues. Corrective actions are implemented in as timely a manner as possible, consistent with the ranking of the finding. If a scheduled commitment cannot be met, it should be discussed with the appropriate General Manager and the Manager of Environmental Affairs, for establishment of an alternate schedule. The facility provides an update on the status of open corrective actions to the appropriate General Manager and Manager of Environmental Affairs at the end of each month, until all
DETAIL (cont): corrective actions are complete. At that time, all copies of the final audit report are returned to CMS Legal.

Appraisals. An appraisal evaluates the effectiveness of the various elements of the environmental management system (standards, procedures, training, communication, tools, etc) in supporting the Company’s environmental policy statement and minimizing risk. Since the entity audited is primarily Environmental Affairs, this audit is directed by the Vice President of Operations. Since the scope of an appraisal is to evaluate management systems, it is not expected that attorney-client privilege protection is necessary.

CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

***
STANDARD: CMSGC-operated facilities will notify the appropriate General Manager, CMS Communications department and Environmental Affairs in the event of an emergency which has actual or potential impact on the environment.

ACTION:

FACILITY

- if not developed as part of another plan (e.g., spill plan, emergency response plan, etc.), develop a plan for responding to environmental emergencies (e.g., oil or chemical spills, toxic gas releases, etc.).

- report any environmental emergency to the appropriate General Manager, CMS Communications department and Environmental Affairs, as soon as possible (after initiation of other critical response activities, but no later than the end of the first business day following the event).

GENERAL MANAGER

- assist the facility with response to an environmental emergency and consult with CMSGC senior management and/or CMS Legal department, as needed.

CMS COMMUNICATIONS

- assist the facility with response to news media regarding an environmental emergency.

ENVIRONMENTAL AFFAIRS

- assist the facility with identifying appropriate response actions and resources for an environmental emergency.

MANAGER OF TRAINING

- assist the facility with initial, refresher, or follow-up training on response actions, as needed.
ENV-CMS-008
RESPONSE TO ENVIRONMENTAL EMERGENCIES

RECORDS: FACILITY

- copies of current plans and procedures for response to environmental emergencies, for life of facility or until superseded by updates.
- copies of all correspondence with environmental agencies, for life of facility or until expiration of retention period associated with a specific requirement.

BASIS: CMSGC Environmental Policy Statement and Environmental Management Implementation Plan

DETAIL: An environmental emergency involves a sudden or unexpected release of raw material, product, or waste to the air, water, or ground. Depending on the nature and amount of material released and the receiving medium, the release may or may not be reportable to environmental agencies (see ENV-SPL-US02, ENV-SPL-US03 and applicable ENV-SPL state requirements). An environmental emergency response plan should be available on-site, either as a stand-alone document, or as part of another response plan (spill plan, general emergency action plan, etc.), to guide facility response to environmental emergencies with an actual or potential significant release to the environment. At a minimum, the plan should identify:

- the materials on-site with potential for significant release
- the locations of tanks, drums and large containers of materials
- the equipment and structures available on-site to contain or slow the spread of a release
- responsibilities of any employee discovering a release
- the primary release response coordinator and his/her responsibilities
- the names of reputable clean-up contractors available for fast response
- notification and follow-up reporting requirements, including information on reportable quantities for on-site materials, as applicable

Training on environmental emergency response actions should be part of general environmental awareness training provided to all employees (see 201/09/96
DETAIL (cont): ENV-CMS-004. It is recommended that the plan be tested via a drill or simulation at least once per year.

CONTACTS: Questions on this standard may be directed to the Manager of Environmental Affairs.

Questions on training may be directed to the Manager of Training.

***
STANDARD: CMSGC-operated facilities will make periodic routine reports to environmental agencies as required by permit or other environmental requirement, and will provide a monthly summary report on the status of facility environmental compliance programs to CMSGC corporate offices.

CMSGC Environmental Affairs will provide quarterly reports of facility environmental compliance and other elements of the environmental management system to facilities and CMSGC senior management.

ACTION: FACILITY

- provide all required routine periodic reports directly to appropriate environmental agencies according to commitment schedule (see ENV-CMS-003 and DETAIL below).

- provide a monthly report to the CMSGC corporate office, summarizing the status of facility environmental compliance, within 3 business days after the end of each calendar month (included in the monthly summary of operations report - see DETAIL below).

ENVIRONMENTAL AFFAIRS

- review facility compliance reports monthly.

- provide a quarterly report summarizing the status of facility environmental compliance and new or revised environmental requirements to the CMSGC President, Vice President of Operations, General Managers and facility managers, within 30 days after the end of each calendar quarter (see DETAIL section for report content).
Appendix E

Photo Log
Figure 1. Existing JLPP Units 1 and 2.

Looking east northeast from a berm (left foreground) separating the Atlantic from the JLPP site, Unit 1 is at (1): Unit 2 is at (2). The cleared area (3) is site of two new units. Between the cleared area and the security fence (4) is debris from original construction. The ash disposal pipelines are at (5).
Figure 2. Site of New Units.

Looking northwest across future site of Units 3 and 4 (1) from partway up the escarpment. The nearest residence is in lower right (2). Other features include: the main gate (3), the security fence (4), the cooling water discharge canal (5), the ash disposal pipelines (6), the cooling water intake area (7), Units 1 and 2 (8), the switchyard and substation (9) and the two fuel oil tanks (10).
Figure 3. South Part of JLPP Site.

Looking southwest from the same location as Figures 4. The cooling water discharge canal (1) flows more than 1 km to its discharge (2) in the Atlantic. The road (3) leads right to the plant gate and left up the escarpment to the main coastal highway (Route 121). The ash discharge pipeline (4) enters the Atlantic near (2).
Figure 4. Sites of Units 3 and 4.

Looking north from the southeast corner of JLPP. Main gate is at (1), cooling water discharge is at (2), site of proposed Units 3 and 4 is at (3), existing units are at (4), cooling water intake structure and pumphouse is at (5), 220 kV substation is at (6), and transmission lines are at (7).
Figure 5. East side of JLPP.

Looking northeast from a point southeast of JLPP (same location as in Figure 3). The 220 kV transmission lines (1) lead east up the bluff. The nearest residence (2) is a four family compound that is outside the fenceline and will not be directly affected by the JLPP expansion. The nearest off-site residence is beyond the crest of the bluff. Point (3) is where nearest-residential area noise survey monitoring was conducted.
Figure 6. Center Part of JLPP.

Looking west across area south of the coal storage area and north of Units 1 and 2. Rail spur connecting port with rail network above the bluff is at (1). Security fence is at (2). Space reserved for future fuel oil tank is at (3). Conveyor bringing coal from storage pile is at (4). Fuel oil unloading area (5) for transferring oil from train cars to tanks. The Atlantic Ocean is in the background.
Figure 7. North Part of JLPP.

Looking north from escarpment above JLPP. One of two fuel oil tanks is at (1). Coal ship being unloaded at the port is at (2). Existing (3) and future (4) coal storage areas. Main breakwater jetty at the port is at (5). The berm protecting the coal yard from the Atlantic Ocean is at (6). The 12-month baseline ambient air quality monitoring station is also located at this point (6).
Figure 8. Coal Storage Area at Far North End of JLPP.

Coal stacking and storage operations at the far north end of JLPP. Port is to the right (north) of photo.
Figure 9.

Rocky shoreline north of JLPP and north of the port. Wave action (1) with cliffs of Jorf Lasfar (2) in background illustrates high energy shoreline.
Figures 10 through 12. Marine Biology and Water Quality Study

Marine biology and water quality study. Wildco benthic grab sampler in Figure 10. Niskin water sampler in Figure 11. Fish catch displayed in Figure 12.
Figures 13 and 14.
Figure 13 looks south on the concrete-lined channel of the cooling water discharge (1), temporary bottom ash disposal area (2) used because ocean ash disposal lines had become clogged, OCP discharge (3). Figure 14 looks north across east edge of 22-meter high quarry walls. The quarry is a potential ash disposal site.
Figure 15 looks west from the crest of the bluff across part of the port area. Coal is being unloaded at the pier to the left (1). Sulfur is being unloaded at the pier to the right (2), where it is melted at the port and transported by steam-jacketed lines to storage tanks in Figure 16.
Figures 17 and 18.

Figure 17 looks north along the coastal highway about 6km south of JLPP. The village of Sidi Al 'Abed is typical of traditional scenes around JLPP where the society appears to be unaffected by nearby industrial development. Figure 18 shows a hotel and restaurant a few km south of JLPP where rocky beach begins to give way to sandy beaches.
Appendix F

Air Emissions Calculations
Stac’- Emission Calculations Methodology

Method of calculations for estimated stack particulate matter (PM) emissions from Units 1 or 2:

(1.) Using the coal ultimate analysis, heating value, and the boiler original equipment manufacturer’s (OEM’s) predicted operating characteristics (i.e., heat rate and excess O₂), combustion calculations were made for full load to determine the flue gas flow and moisture content at the electrostatic precipitator (ESP) inlet.

(2.) The heat rate and fuel analysis were used to determine the total ash being generated during full load operation. The flyash was assumed to be 80% of the total ash being generated. This enabled the dust loading at the ESP inlet to be estimated.

(3.) The ESP OEM (Walther) provided a series of correction curves to correct the predicted ESP collection efficiency based on deviations from design of: coal sulfur, flue gas temperature, inlet dust loading, unburned carbon, flue gas moisture, and flue gas flow. Flue gas temperature and unburned carbon were assumed to be unchanged for all cases since there was no means to assess the impact of various coals on these parameters.

(4.) Once each correction factor was determined, ESP efficiency was calculated using the following formula:

\[ \eta_{ESP} = 1 - e^{-k} \]

and: \[ k = K_1 \cdot C_1 \cdot C_2 \cdot C_3 \cdot C_4 \cdot C_5 \]

where: \[ K_1 = -5.21673738 \]
\[ C_1, C_2, C_3, C_4, C_5 = \text{correction factors} \]
(5.) The stack particulate emissions were calculated by:

\[
\text{PM Emissions} \left( \frac{\text{mg}}{\text{Nm}^3} \right) = \\
\text{(Rated Power Output of Units (MW))} \times \text{(Capacity Factor)} \times \left( \text{Specific Heat Rate} \left( \frac{\text{Kcal}}{\text{Kwh}} \right) \right) \\
\times \left( \frac{1}{\text{Lower Heat Value} \left( \frac{\text{Kcal}}{\text{kg} - \text{coal}} \right)} \right) \\
\times \left( \frac{\text{kg} - \text{Ash}}{\text{kg} - \text{coal}} \right) \times (0.80) \times \left( \frac{1000 \text{ kW}}{\text{MW}} \right) \\
\times \left( \frac{10^6 \text{ mg}}{\text{kg}} \right) \times (1 - \eta_{\text{ESP}}) \\
\text{Dry Gas Flow} \left( \frac{\text{m}^3}{\text{hr}} \right)
\]

(6.) The PM emissions per day were calculated by:

\[
\text{Stack PM (Tonne/day)} = \text{Stack PM (mg/Nm}^3) \times \text{Gas Flow m}^3/\text{hr} \times 24 \text{ hr/day} \times 1 \text{ Tonne/10}^6 \text{ mg}
\]
SO₂ Emissions

Emissions of SO₂ are calculated based on the conversion of all coal sulfur to sulfur dioxide (SO₂) and an average anticipated future composition. In the future it is anticipated that coal will come from the United States, Colombia, and South Africa. Using the average ultimate analyses of each of these coals, a composite ultimate coal analysis was computed and is presented in Table F-1.

Table F-1. Ultimate Analysis of Composite Coal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% By Weight</td>
<td></td>
</tr>
<tr>
<td>-Sulfur</td>
<td>1.25</td>
</tr>
<tr>
<td>-Ash</td>
<td>10.75</td>
</tr>
<tr>
<td>-Moisture</td>
<td>9.21</td>
</tr>
<tr>
<td>-Volatiles</td>
<td>30.89</td>
</tr>
<tr>
<td>-Carbon</td>
<td>66.67</td>
</tr>
<tr>
<td>-Hydrogen</td>
<td>4.50</td>
</tr>
<tr>
<td>-Nitrogen</td>
<td>1.29</td>
</tr>
<tr>
<td>-Oxygen</td>
<td>6.48</td>
</tr>
<tr>
<td>-Chlorine</td>
<td>0.10</td>
</tr>
<tr>
<td>Higher Heating Value (Kcal/kg)</td>
<td>6,574</td>
</tr>
<tr>
<td>Lower Heating Value (Kcal/kg)</td>
<td>6,302</td>
</tr>
</tbody>
</table>

SO₂ Emissions \(\text{tonne} \text{ day}^{-1} \text{MW}^{-1}\) = \[\text{Specific Heat Rate} \left(\frac{\text{Kcal}}{\text{kw} \cdot \text{hr}}\right) \times \left[24 \text{ hrs} / \text{day}\right] \times \left[\text{Coal Sulfur Content} \left(\frac{\text{kg} \cdot \text{sulfur}}{\text{kg} \cdot \text{coal}}\right)\right] \times \left(\frac{2 \text{ kg} \cdot \text{SO}_2}{\text{kg} \cdot \text{sulfur}}\right)\]

\[
\times \left(\frac{1 \text{ tonne}}{1000 \text{ kg}}\right) \times \left(\frac{1000 \text{ kW}}{\text{MW}}\right) \times \left(\frac{\text{Kcal}}{\text{kg} \cdot \text{Coal}}\right) \times \left(\frac{\text{Lower Heating Value}}{\text{Kcal} / \text{kg} \cdot \text{Coal}}\right)
\]
Scenario #1 - “Base Coal”

For Units 1 & 2 Firing “Base Coal”

\[
\text{SO}_2 \text{ Emissions} \left( \frac{\text{tonne}}{\text{day-MW}} \right) = \left( \frac{2,065 \text{ Kcal}}{\text{Kwh}} \right) \times \left( \frac{24 \text{ hr}}{\text{day}} \right) \times \left( \frac{0.0125 \text{ kg - sulfur}}{\text{kg - coal}} \right) \times \frac{2 \text{ kg - SO}_2}{\text{1 tonne}} \times \frac{1000 \text{ kg}}{1000 \text{ kg}} \times \frac{1000 \text{ kW}}{\text{MW}} \times \frac{6,302 \text{ Kcal}}{\text{kg - coal}}
\]

= 0.20 \text{ tonne - SO}_2\text{ day - MW}

For Units 3 & 4 Firing “Base Coal”

\[
\text{SO}_2 \text{ Emissions} \left( \frac{\text{tonne}}{\text{day-MW}} \right) = \left( \frac{2,080 \text{ Kcal}}{\text{Kwh}} \right) \times \left( \frac{24 \text{ hr}}{\text{day}} \right) \times \left( \frac{0.0125 \text{ kg - sulfur}}{\text{kg - coal}} \right) \times \frac{2 \text{ kg - SO}_2}{\text{1 tonne}} \times \frac{1000 \text{ kg}}{1000 \text{ kg}} \times \frac{1000 \text{ kW}}{\text{MW}} \times \frac{6,302 \text{ Kcal}}{\text{kg - coal}}
\]

= 0.20 \text{ tonne - SO}_2\text{ day - MW}

Scenario #2 “Ultra-Low” Sulfur Coal

For Units 1 & 2 Firing “Ultra-Low” Sulfur Coal

\[
\text{SO}_2 \text{ Emissions} \left( \frac{\text{tonne}}{\text{day-MW}} \right) = \left( \frac{2,065 \text{ Kcal}}{\text{Kwh}} \right) \times \left( \frac{24 \text{ hr}}{\text{day}} \right) \times \left( \frac{0.0020 \text{ kg - sulfur}}{\text{kg - coal}} \right) \times \frac{2 \text{ kg - SO}_2}{\text{1 tonne}} \times \frac{1000 \text{ kg}}{1000 \text{ kg}} \times \frac{1000 \text{ kW}}{\text{MW}} \times \frac{6,835 \text{ Kcal}}{\text{kg - coal}}
\]

= 0.029 \text{ tonne - SO}_2\text{ day - MW}
For Units 3 & 4 Firing “Ultra-Low” Sulfur Coal

\[
\text{SO}_2 \text{ Emissions} \left( \frac{\text{tonne}}{\text{day-MW}} \right) = \left( \frac{2,080 \text{ Kcal}}{\text{Kwh}} \right) \times \left( \frac{24 \text{ hr}}{\text{day}} \right) \times \left( \frac{0.0020 \text{ kg - sulfur}}{\text{kg - coal}} \right) \times \left( \frac{2 \text{ kg - SO}_2}{\text{kg - sulfur}} \right) \times \left( \frac{\text{tonne}}{1000 \text{ kg}} \right) \times \left( \frac{1000 \text{ kW}}{\text{MW}} \right) \times \left( \frac{6,835 \text{ Kcal}}{\text{kg - coal}} \right)
\]

\[= 0.029 \frac{\text{tonne - SO}_2}{\text{day - MW}}\]
Appendix G

Thermal Discharge Compliance of the Jorf Lasfar Power Plant
THERMAL DISCHARGE COMPLIANCE OF
THE JORF LASFAR POWER PLANT

G1.0 INTRODUCTION

The objective of this activity is to evaluate the impacts of the Jorf Lasfar Power Plant (JLPP) thermal discharges onto the Atlantic Ocean. The analysis focuses on the impact of the thermal discharges while all four units are in operation and at full load. The analysis results are evaluated to assess compliance with the World Bank (WB), United States Overseas Private Investment Corporation (OPIC) and the Export Import Bank of the United States (Ex-Im) Guidelines.

The waste thermal energy of fossil fuel power plants range from 50% to 67% of the total fuel energy input. Approximately 10% of the waste thermal releases are emitted through the stack. The remainder is typically released through condenser cooling. The preferable condenser design and the cooling medium depend largely on the particular fuel of choice, the site geographic location and proximity to water sources, estuaries, or sea water. The proper condenser design is particularly important to optimize power plant operation and minimize environmental impacts. The United States Electric Power Research Institute has identified the condenser cooling design and performance as the single largest source impacting the performance efficiency of the power plant. The increases to the ambient water temperature caused by condenser cooling water may adversely impact the local marine biology. Releases of chemicals employed to treat the cooling water may also impact the biological environment. Thus, proper operation of the condenser cooling system is critical to power plant efficiency as well as environmental protection. Proper operation of the condenser consists of efficient heat transfer to the cooling water and targeted use of chemical water treatment.

The following are general guidelines required to ensure optimum condenser performance and minimum environmental impact of the thermal discharges and the cooling water chemical treatment:

EIA G-1 August 1, 1996
Use of targeted chlorination in the treatment of cooling water;
Continuous monitoring of condenser tube fouling rate;
periodic condenser maintenance program; and
Cooling water temperature increase not exceeding 10 degrees Celsius (°C) across the condenser.

These guidelines have been demonstrated to optimize the power plant performance and to minimize the environmental impacts of the cooling water releases.
G2.0 PROJECT DESCRIPTION

The JLPP Units 1 through 4 use sea water to cool the plant condensers. Units 1 and 2 generate 348 MW each at full load. Units 3 and 4 are designed to generate 350 MW each at full load. Each of the condensers is a single shell, single pass condenser with multiple tube bundles. The tubes are made of titanium. The tube sheets are made of carbon steel with titanium cladding. Each tube bundle is equipped with a set of air coolers for deaeration and venting of incondensible gases. Each condenser is equipped with 2 inlet and 2 outlet waterboxes. The condenser design rejected heat load is 363,470 kJ/s for Units 1 and 2. At this load, the predicted condenser pressure is 0.049 bar at a cooling water inlet temperature of 20°C and a cooling water volume flow of 11.4 m³/s. At this flow rate, the design cooling water pressure drop between cooling water inlet and outlet nozzles is 0.37 bar.

Each condenser cooling water is discharged into a common open channel constructed from concrete. Its width is about 12 meters (m) at the condenser discharge point and increases to 26 m at the discharge point into the Atlantic Ocean. The channel length is approximately 1.5 km. A serrated cascade weir is constructed at about the midpoint along the channel length. The JLPP cooling water drop height at the weir can be up to 4 m in elevation.

The channel water temperature profile (with two units operating at full load) was measured in September 1995 and later during April 1996. Temperature data for the receiving waters was taken in April 1996. The September, 1995 data was reported in the Phase II report. The April data for the channel and the receiving waters is shown in Table G-1. The condenser cooling water net temperature increase is measured to be less than 9°C. The aggregate impacts of the JLPP Units 3 and 4 are determined via modeling techniques in the following sections.
Table G-1. Measured Thermal Conditions with two units at full load in April, 1996

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condenser exit</td>
<td>Immediately after discharge from the boiler condensers</td>
<td>26</td>
</tr>
<tr>
<td>Mid point</td>
<td>Halfway down the 1.5 km concrete channel</td>
<td>26</td>
</tr>
<tr>
<td>Channel exit</td>
<td>At channel exit into the concrete pool</td>
<td>26</td>
</tr>
<tr>
<td>Concrete pool</td>
<td>Immediately prior to entering the receiving waters</td>
<td>25.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from Shore (m)</th>
<th>Water Depth (m)</th>
<th>Temperature (°C)</th>
<th>Surface</th>
<th>Center</th>
<th>Bottom</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>4</td>
<td>18.7</td>
<td>18.2</td>
<td>17.6</td>
<td>18.2</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>5.3</td>
<td>18.7</td>
<td>18.2</td>
<td>17.5</td>
<td>18.1</td>
<td></td>
</tr>
<tr>
<td>140</td>
<td>6</td>
<td>18.6</td>
<td>17.8</td>
<td>17.5</td>
<td>18.0</td>
<td></td>
</tr>
<tr>
<td>240</td>
<td>8</td>
<td>18.6</td>
<td>17.6</td>
<td>17.2</td>
<td>17.8</td>
<td></td>
</tr>
<tr>
<td>440</td>
<td>12</td>
<td>18.6</td>
<td>17.6</td>
<td>17.2</td>
<td>17.8</td>
<td></td>
</tr>
</tbody>
</table>

The cooling water is chlorinated to control mussels and mollusks. The JLPP personnel continuously monitor the chlorine levels at the condenser discharge and at the Atlantic Ocean discharge points. The JLPP records indicate that the chlorine content at both locations does not exceed 0.23 mg/l. This free chlorine level is well below the WB Guidelines.

In summary, the condenser cooling water system data indicates that the system is within the general guidelines required for good performance and adequate protection of the environment. The following sections provide analysis of the net thermal impact of the cooling water on the receiving ocean. The objective of the analysis is to determine the net ocean water temperature increase at 100 m away from shore, with all 4 boilers operating at full load.
G3.0 TECHNICAL APPROACH

G3.1 Fundamentals

A basic, but extremely important factor in the consideration of thermal discharges is that the discharge plume disperses in the receiving ocean waters in a nonlinear manner. The plume dispersion field is normally divided into three regions.

Near Field (A Zone): The A zone is in the vicinity of the discharge point. The dispersion rate is minimal in this zone and is dominated by the plume (or jet) discharge momentum. The length of the A zone ranges from 2 channel diameters to several hundred meters, depending on the geometry of the plume and the receiving water.

Intermediate field (B Zone): The B zone domain extends from the edge of the A zone into the receiving water. The B zone mixing rate is controlled by the plume geometry, momentum and thermal energy, as well as the receiving water currents, thermal stratification, and depth. The length of the B zone can be determined for deep bodies of water via scaling techniques (Jirka and Doneker, 1991). However, if the receiving water depth is not uniform as well as in the presence of land jetties and rocky obstructions, the analytical techniques yield large errors. Advanced computational techniques are required for successful analysis. The B zone can be very short or up to several kilometers long depending upon the flow characteristics.

Far Field (C zone): The C zone region extends from the edge of the B zone. The plume in this zone is fully dispersed. The residual plume thermal energy dissipation rate is dominated by the receiving water temperatures and currents.

G3.2 Application to JLPP

The thermal discharge analysis for JLPP consists of an integrated field testing and mathematical modeling of the thermal discharges. The implementing tasks included gathering of data describing the ocean bottom, ocean currents, and the water and air temperatures. The model simulations cover reasonable thermal discharge scenarios. The simulation results are then examined in light of the WB and the Ex-Im Guidelines—specifically, the temperature of the
receiving water at the edge of the mixing zone is determined. The WB defines the edge of the mixing zone for open bodies of water to be 100 m away from shore. The WB definition is followed throughout the EIA document.

As can be deduced from the previous section, the JLPP thermal discharge analysis depends on the use of computational fluid dynamics (CFD) techniques. Order of magnitude analysis of the JLPP discharges has indicated that the following factors dominate the cooling water dispersion rate:

- Ocean bottom depth and gradient;
- Mean ocean water currents velocity;
- Geometric shape of the discharge channel;
- Maximum discharge plume mass flow rate;
- Mean discharge plume water temperature; and
- Mean ocean water temperature.

The accuracy of the discharge water thermal analysis depends on the level of detail available on the above controlling parameters. Field activities have been carried out to quantify these parameters. Where field data was not available, conservative estimates are made. These estimates were chosen to ensure that the actual temperature increase at the edge of the mixing zone is smaller than the predicted temperature increase to ensure compliance with the WB Guidelines. The controlling parameters are summarized in Table G-2.
Table G-2. Controlling Parameters for Thermal Discharge Analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ocean Bottom Depth</td>
<td>Distance from shore (m)</td>
</tr>
<tr>
<td>Depth (m)</td>
<td>4</td>
</tr>
<tr>
<td>2. Mean ocean wave motion and mean ocean currents velocity</td>
<td>Tides</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Currents at the surface</td>
<td>The currents are facing south with velocities ranging from 0.05 m/s to 0.5 m/s. In the shallow water, currents could attain 1m/s generated by reflection against the cliff.</td>
</tr>
<tr>
<td>Wave motion</td>
<td>Highly turbulent with strong wave motion.</td>
</tr>
<tr>
<td>3. Geometric shape of the discharge channel</td>
<td>The channel at the discharge point is a rectangular concrete open channel with a width of 26 m.</td>
</tr>
<tr>
<td>4. Maximum discharge plume mass flow rate</td>
<td>83,880 m³/hr for units 1 and 2, and 171,360 m³/hr when all four units are in operation.</td>
</tr>
<tr>
<td>5. Mean discharge plume water temperature</td>
<td>26°C</td>
</tr>
<tr>
<td>6. Mean ocean water temperature</td>
<td>17.8 °C</td>
</tr>
</tbody>
</table>

Other Background and Calibration Data

The ocean current is from the North to the South. The Jorf Lasfar Technical Specifications document have reported that the ocean current velocity ranges from 0.05 to 0.5 m/s. The minimum velocity is typically near the ocean bottom. This class of flow is fully...
turbulent. The velocity profile typically follows the logarithmic law at the wall (White, 1975). The mean velocity is typically 67% to 85% of the maximum velocity. As a conservative estimate, and in light of the transient nature of this problem, the mean velocity component along the shore was chosen to be 0.5 m/s (or 50% of the maximum velocity).

The wind roses indicate that regardless of wind direction, the normal wind velocity can be as high as 40 kph. The ocean bottom from the shoreline and up to 200 m away from land is rocky. The ocean waves are highly turbulent, with strong wave motions. The region is not amenable to recreational swimming and diving.

The measured water temperature profile indicates that, with 2 units in operation, the cooling water is fully mixed (C zone) within 50 m from the shore line. The temperature increase at 100 m away from shore is about 0.3 ºC. This data is the cornerstone of the model development and it is used to calibrate the model. The calibrated model is then used to predict the impact of all 4 units in operation.

G3.3 Model Development

The dissipation of the thermal discharges into the ocean are evaluated using a full capability computational fluid dynamics (CFD) simulation. The CFD code of choice is the PHOENICS code developed by Combustion, Heat and Mass Transfer (CHAM) based in London, United Kingdom. The PHOENICS code is a control volume based finite difference algorithm. The code has been extensively validated in the applications of environmental hydraulics. Specific environmental flow applications include ocean thermal discharges (Markatos and Simitovic, 1983), waste water discharges into reservoirs (Rizk, 1992), and flow over aerating weirs (Hadjeriouah, 1993). PHOENICS solves the full capability Navier Stokes equations and generalized transport equations in the solution of fluid flow, heat and mass transfer.

G3.4 Model Calibration

A graphic summary of the model calibration parameters, computational grid, problem geometry, and input parameters for the modeling runs are shown in Figure G-1.
The ocean bottom gradient of 1:20 is based on the field data which Radian gathered. The cooling water is discharged into a pool which is about 4 m deep bounded by concrete walls diagrammed in Figure G-1.

The wave current velocities are a strong function of the prevailing winds, the tidal movements, and the proximity to the shoreline. This parameter is transient with a wide range of varying values. The most conservative assumption is a time averaged forward (toward the shoreline) wave velocity. This velocity is used to calibrate the model to the field data at 80 m from the shoreline. An optimal wave current velocity was determined to be about 0.2 m/s toward the shoreline.
G3.5 Model Results

Calibrated model runs simulating full-load operation of all four units indicate that the impact of the condenser cooling water is within WB Guidelines. Figures G-2 and G-3 show the modeled net temperature increase along the centerline of the plume at increasing distance from the shore for 2-unit and 4-unit operation, respectively. The net temperature increases modeled in Figure G-2 are confirmed by the actual water temperature testing conducted during the Environmental Assessment. Figure G-3 shows that at 102 m from the shore, the modeled net temperature increase for 4-unit operation is about 2.2°C. This falls well within even the most stringent WB Guidelines of 3°C for receiving waters with ambient temperatures greater than 28°C.

Figures G-4 and G-5 show the modeled temperature increases at various downstream locations as a function of distance from shore for 2-unit and 4-unit operation, respectively.
Figure G-2. Net Temperature Increase at Plume Centerline for Z-Unit Operation
Figure G-3. Net Temperature Increase at Plume Centerline for 4-Unit Operation
OFF-SHORE DISTANCE (2-UNIT OPERATION)

FIGURE G-4. NET TEMPERATURE INCREASE AS A FUNCTION OF DOWNSPOUT DISTANCE AND

TEMPERATURE PROFILE
**G3.6 Conclusions**

The Phoenics model was calibrated with field data to reflect the field temperature data collected for 2-unit, full-load operation at 80 m from the shoreline. When the input parameters were adjusted for 4-unit operation, the modeled results showed that the maximum net thermal increase from ambient conditions at 100 m from the shoreline was about 2.2°C. This falls within the most stringent WB Guideline of 3°C for receiving waters with ambient conditions of greater than 28°C.