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# ENVIRONMENTAL ASSESSMENT OF THE USAID/HAITI NORTH PARK POWER PROJECT



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# ENVIRONMENTAL ASSESSMENT OF THE USAID/HAITI NORTH PARK POWER PROJECT

**Submitted to:**

USAID

**Primary Authors:**

Meg Findley, Ph.D., and Martin Côté, AECOM

**DISCLAIMER:**

The authors' views expressed in this document do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

**COVER PHOTO:**

Residents organized by the *Femmes Vaillantes* women's organization of Fleury and Chambert villages near the Industrial Park in Northern Haiti meet to discuss the anticipated impacts of the project.

## ACRONYM LIST

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AIDS	Acquired Immune Deficiency Syndrome
AQGs	Air Quality Guidelines
As(III)	Arsenic (III)
As(v)	Arsenic (v)
BDPA	Bureau for the Development of Agricultural Production ( <i>Bureau pour le Developpement de la Production Agricole</i> )
BEO	Bureau Environmental Officer
CASEC	Board of Directors
CFR	United States Code of Federal Regulations
CO	Carbon monoxide
dB	Decibel
DPF	Diesel Particulate Filter
EA	Environmental Assessment
EDH	Haiti Electric Company ( <i>Electricité d’Haiti</i> )
EIA	Environmental Impact Assessment
ELF	Extremely Low Frequency
EMF	Electromagnetic Field
EMP	Environmental Management Plan
EMMP	Environmental Mitigation and Monitoring Plan
EMPR	Environmental Management Plan and Report
FEWS NET	Famine Early Warning Systems Network
g/kWh	Grams per kilowatt hour
GOH	Government of Haiti
ha	hectare
HFO	Heavy Fuel Oil
HiMSEN	Hyundai Innovative Marine and Stationary Engine
HIV	Human Immunodeficiency Virus
Hz	Hertz
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IDB	Inter-American Development Bank
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IHSI	Haitian Institute of Statistics
IICA	Inter-American Institute for Cooperation in Agriculture
IMO	International Maritime Organization
in	inches
IOM	International Organization for Migration
kg	kilogram
km	Kilometers
kV	Kilovolt
l	liter

LAC	USAID Bureau for Latin America and the Caribbean
lb/hp-hr	Pounds per horsepower hour
MARNDR	Ministry of Agriculture, Natural Resources and Rural Development ( <i>Ministère de l'Agriculture, des Ressources Naturelles et du Développement Rural</i> )
MDE	Ministry of Environment ( <i>Ministère de l'Environnement</i> )
MEO	Mission Environmental Officer
mg	Milligram
MPCE	Ministry of Planning and External Cooperation ( <i>Ministère de la Planification et de la Coopération Externe</i> )
MTPTC	Ministry of Public Works, Transportation and Communication ( <i>Ministère de Travaux Publics, Transports, et Communications</i> )
MW	Megawatt
NGO	Non-governmental Organization
NMHC	Non-Methane Hydro-Carbon
NO <sub>2</sub>	Nitrogen dioxide
NO <sub>x</sub>	Nitrogen Oxides
NPP	North Park Project
PAE	Environmental Action Plan ( <i>Plan d'Action pour l'Environnement</i> )
PM	Particulate Matter
PTDT	Regional Transportation Development Project ( <i>Projet de Transport et de Développement Territorial</i> )
REO	Regional Environmental Officer
RFP	Request for Proposals
Rpm	Revolutions per minute
SCR	Selective Catalytic Reduction
SO <sub>2</sub>	Sulphur dioxide
SO <sub>4</sub>	Sulphate
SONAPI	National Society for Industrial Parks ( <i>Société Nationale des Parcs Industriels</i> )
SO <sub>x</sub>	Sulphur Oxides
STD	Sexually Transmitted Disease
TOC	Total Organic Carbon
ULSD	Ultra-low Sulphur Diesel
US	United States
USG	United States Government
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
UTE	Technical Execution Unit ( <i>Unité Technique d'Exécution</i> )
UTES	Environment Sector Technical Unit ( <i>Unité Technique Environnementale Sectorielle</i> )
V	Volt
V/m	Volts per meter
VOCs	Volatile Organic Compounds
WHO	World Health Organization
µg/m <sup>3</sup>	Micrograms per cubic meter

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## 1. EXECUTIVE SUMMARY

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The Government of Haiti (GOH), in conjunction with the Inter-American Development Bank (IDB) and the United States Government (USG), is developing a 150 hectare industrial park in the northern region of Haiti that will host export-oriented garment manufacturers and other businesses. The North Park Project (NPP) will, in Phase 1 (2012 – 2014) accommodate approximately 18,000 workers in the garment industry, growing to support 65,000 permanent jobs once the Park is fully developed. The industrial park will be owned by the GOH and operated by a private sector management company.

The USG has agreed to provide power to supply the park and settlements serving the workers in the park. The power plant will be owned by GOH but managed by a separate private sector management company. The purpose of the USAID/Haiti North Park Power (NPP) Project is to design the conceptual plan for power plant with an eventual capacity of 25-35 MW. The power facility is needed to provide power all the electrical power needs for the North Industrial Park, including the textile industry, wastewater treatment plant, and residents living within the park. A conceptual engineering plan with general design specifications has been prepared under the guidance of USAID certified engineers.

This EA addresses the anticipated environmental and socioeconomic impacts of the power plant, and provides requirements for environmental monitoring and mitigation. Based on the findings of this Environmental Assessment, Addendum No. 1 and its associated attachments delineates environmental compliance and mitigation requirements to be placed upon the selected contractor during detailed design, construction, testing, commissioning, startup, and turnover period of the power plant in order to comply with the environmental directives of USAID and the Haiti Ministry of the Environment and protect the environment and human health.

Stakeholder consultations during environmental scoping yielded at least twenty-nine different issues associated with the project. These issues represent six major categories of impacts and concerns:

- Impacts on livelihoods and socioeconomic well being;
- Impacts on human health and safety;
- Impacts on the environment;
- Impacts on infrastructure and community development;
- Administrative and local government concerns; and
- Alternative energy sources.

Based on these issues, the following alternatives were analyzed:

1. The Proposed Action to build a 4 MW thermal electric power plant using heavy fuel oil (HFO) by February, 2012 and expanded to 10 MW by 2014, with an eventual capacity of 25-35 MW;
2. The “No Action” alternative, whereby no power plant would be constructed and the North Park would have no power source; and
3. The Diesel Fuel Alternative, whereby a diesel engine using diesel fuel would operate the plant during all phases.

There is an urgent need for the project to help promote economic development in the region through the creation of new industries that create jobs. Analysis of the “No Action” alternative is required in all Environmental Assessments to provide a baseline comparison with action alternatives; however, the “No Action” alternative does not address the purpose and need for the project.

The alternative to utilize diesel fuel during the first phase when the first 4 MW will be running is a viable option that may be considered if the project can reliably supply this type of fuel for the first 1-2 years of the project. The negative impacts on air quality are less with this option. This alternative will also require less maintenance, as moving parts will wear less quickly with diesel than with HFO. All other impacts on quality of life, vegetation, soil and erosion, water and coastal resources, and cumulative impacts are largely the same.

Most of the construction impacts associated with the Proposed Action and Diesel Alternative are minor or moderate, and temporary in duration. Impacts associated with the “No Action” alternative are generally negative and permanent in duration.

Environmental impacts expected to occur during the operation phase of the power plant are generally minor to moderate, and most can be mitigated or avoided following the recommended mitigation measures. This EA includes an Environmental Mitigation and Monitoring Plan (EMMP), which outlines best management practices, most of which are to be undertaken by the power plant construction contractor provided by USAID, in order to mitigate or avoid negative impacts. Some of these measures may even incur positive benefits. Other mitigation measures have been recommended for many indirect impacts on the socioeconomic conditions of the local population throughout the Caracol Commune, but many of these must be implemented by the North Park manager and are beyond the scope of this assessment and EMMP.

Of vital concern are the indirect and cumulative impacts that the provision of electrical power to the industrial park will have on spurring development and the associated influx of outside people coming to the area with hopes of employment and a better life. At the time of this study, no concrete plans were available, or at least discussed with local elected officials and departmental ministries, regarding how infrastructure and public services would be expanded to accommodate rapid population growth. Furthermore, there do not seem to be plans in place to train local residents for jobs in order to enable them to compete for the skilled positions offered by the industrial park.

While the anticipated economic benefits of the industrial park will positively impact quality of life and standard of living for individuals that are employed or their businesses are supported by the park industries, these impacts assume that employment will benefit the local population. If outside workers derive the majority of these benefits, and if they bring their families to live in the area, the pressure on already stretched local budgets and public services and infrastructure will be immense.

## **2. PURPOSE AND NEED**

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The Government of Haiti (GOH), in conjunction with the Inter-American Development Bank (IDB) and the United States Government (USG), is developing a 150-hectare industrial park in the northern region of Haiti that will host export-oriented garment manufacturers and other businesses. The North Park Project (NPP) will, in Phase 1 (2012 – 2014) accommodate approximately 18,000 workers in the garment industry, growing to support 65,000 permanent jobs once the Park is fully developed. A schematic of the park showing the anticipated textile facilities, offices and warehouses, residential buildings, wastewater treatment plant, and power plant to support the industrial park is provided in Figure 1. The industrial park will be owned by the GOH and operated by a private sector management company.

The USG has agreed to provide power to supply the park and settlements serving the workers in the park. The power plant will be owned by GOH but managed by a separate private sector management company from Korea.



The purpose of the USAID/Haiti North Park Power (NPP) Project is to design and build a power plant with an eventual capacity of 25-35 MW. The power facility is needed to provide all the electrical power requirements for the North Industrial Park, including the textile industry, wastewater treatment plant, and residents living within the park. The EA addresses the anticipated environmental and socioeconomic impacts of building and operating the power plant, and provides requirements for environmental monitoring and mitigation.

## 2.1 DESCRIPTION OF PROJECT AND PROPOSED ACTION

The proposed action is to design and construct a power facility to supply the electricity needs of the North Industrial Park and associated residents living on the park. The plant will be located near Caracol, a coastal fishing village approximately 35-40 km southeast of Cap Haitien, as illustrated in Figure 2. The Power facility will occupy a 6 ha footprint in the northeast corner of the proposed park area. The area will include textile industry, a wastewater treatment plant, and some residences within the park.

USAID is issuing a contract for the design, supply, transportation, installation, start-up, testing and commissioning of a 4 MW (expandable to 10 MW) prime capacity HFO power generating facility on a turn-key basis, with a design life of 20 years. The first phase requirement of at least 4 MW will be in operation by February 15, 2012, and the remaining 6 MW by 2013. In designing the plans for the 10 MW power plant, the contractor will make provisions for the possible future expansion of the plant to 25-35 MW. The contractor building the plant will operate the plant for a period of three months after commissioning the first 4 MW, and will supply power to all industrial park customers. After the first three months, the 4 MW will be handed over to a separate management contractor and the building contractor will complete the rest of the plant to a total capacity of 10 MW.

The power plant general arrangement is depicted in Figure 3 on the following page. The proposed action includes generation facilities, HFO systems, associated buildings and structures, building utilities, distribution lines, transformers, and HFO wastewater systems.

Three HFO generator units ranging in capacity from 1-2.5 MW each will initially be installed. These generators are expected to run on HFO as the primary fuel, but will be capable of using diesel fuel oil for start-up, shut-down, and at other times as needed. Additional units will be added to reach the 10 MW capacity by 2013. The units will have a rated output of 4,160 V at 60 Hz. For the initial 4 MW, a substation will be designed with two generator step-up transformer terminals with a high side voltage rated at 23 kV for connection to the distribution system, and with capability for expansion.

An exhaust gas boiler, compressor unit, black start diesel generator, pump station, and control room will also be installed, as necessary. Bulk fuel tanks will be installed to enable fuel storage capacity for 24-hour continuous generation for 15 days.

Associated earthworks will include a leveling of the terrain and a storm water management system for the initial 10 MW power plant block. An access road from the community of Volant on the eastern side of the park is currently under development by the industrial park manager(s) to access the northeast corner of the park where the power plant is to be located. A security fence at a height of 2.5 meters will be installed around the power plant facility associated works, once the construction contractor provided by USAID commences work on the power plant.

Portable latrines will be used by construction workers during construction of the power plant. The power plant will include sanitation facilities connected to a septic field. The IDB and/or the industrial park manager(s) will be responsible for the provision of a full water treatment facility for the North Industrial park, including a 4-inch pipe to deliver water to the power plant for potable water, laboratory, HFO cooling system, fuel conditioning, and emergency fire protection needs.

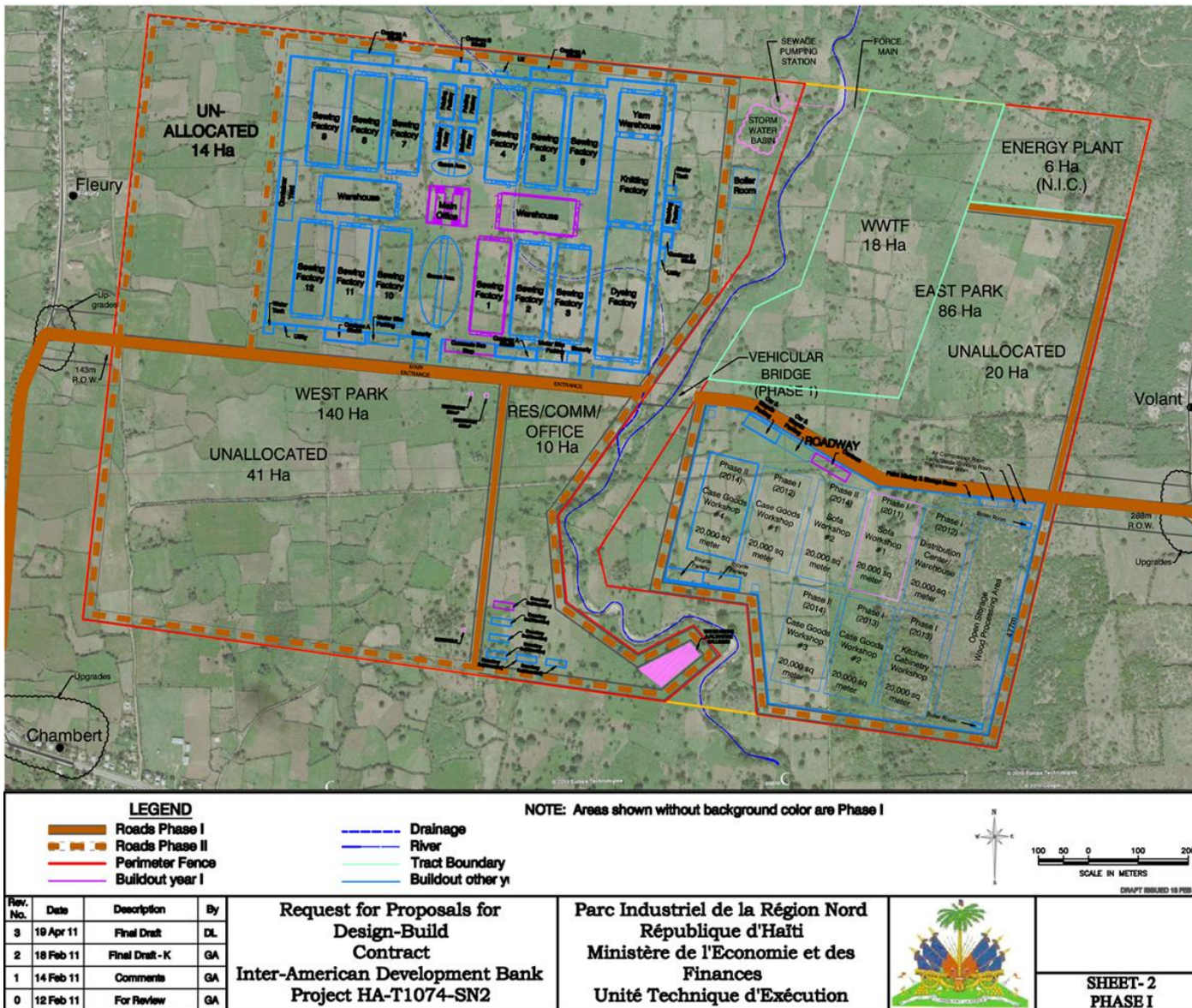


Figure 1. Schematic layout of the Industrial Park

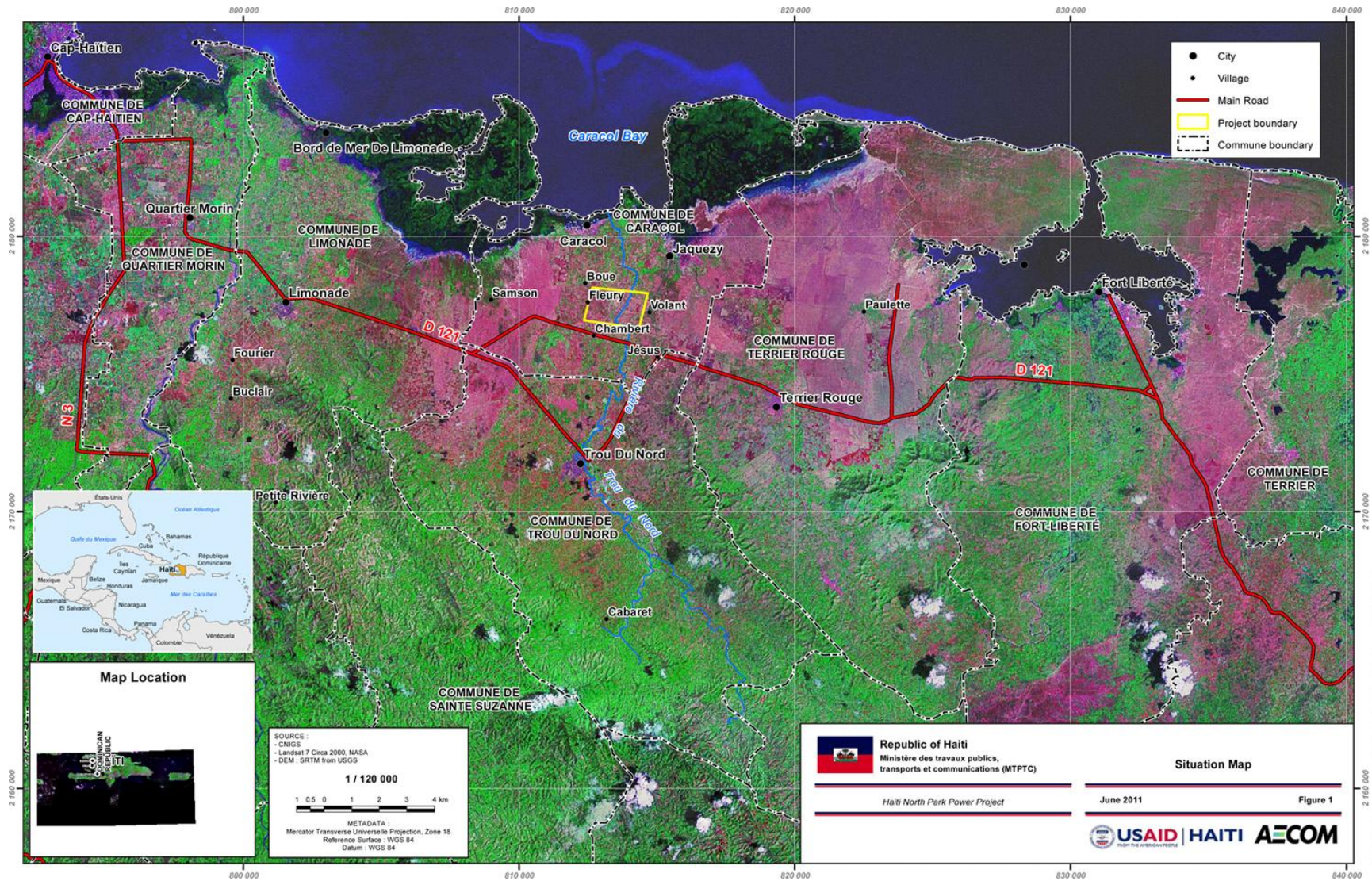


Figure 2. Location of the North Industrial Park in Northern Haiti

## 2.2 ENVIRONMENTAL ASSESSMENT PROCESS

The information for the preparation of this environmental assessment comes from the review of available information from related studies and reports on the project area, and through field investigation and consultation with relevant authorities, organizations, and individuals.

A scoping study was conducted by USAID and included preliminary investigation and consultation with relevant authorities, organizations, and individuals in April, 2011 to gather issues to help identify alternatives. Twenty-nine socioeconomic and environmental issues were raised in the scoping statement (see Section 2.3 below).

USAID is required by law to ensure that environmental and socioeconomic factors and values are integrated into decision making for new development projects. The regulations and procedures that outline these requirements are provided in Title 22 on Foreign Relations of the United States Code of Federal Regulations (CFR), Chapter II (Agency for International Development, Part 216. This EA is prepared in accordance with the procedures established in Section 216.6 of this regulation, and also complies with the environmental requirements set forth by the USAID Bureau for Latin America and the Caribbean Region (LAC) as well as the Government of Haiti (GOH). A conceptual engineering plan with general design specifications has been prepared under the guidance of USAID certified engineers.

Based on the findings of this Environmental Assessment, Addendum No. 1 and its associated attachments delineate environmental compliance and mitigation requirements to be placed upon the selected contractor during detailed design, construction, testing, commissioning, startup, and turnover period of the power plant in order to comply with the environmental directives of USAID and the Haiti Ministry of the Environment and protect the environment and human health.

The USAID/Haiti NPP Project is covered by USAID/Haiti Initial Environmental Examination (IEE) for Pillar A (Part 3): Energy (LAC-IEE-11-16) and received a Positive Determination under the Environmental Threshold Decision. A Positive Determination results from the finding that this activity is likely to have significant cumulative effects on the environment, and thereby requires the development of an Environmental Assessment or Environmental Impact Statement. As part of the EA process, CFR Section 216.2 and 216.3 require to the completion of a Scoping Statement to identify the significant environmental issues relating to the proposed activities and to determine the scope of the issues to be addressed in the EA. It includes consultation with USAID and appropriate stakeholders. The EA is submitted to the Mission Environmental Officer (MEO), the Regional Environmental Officer (REO), and the LAC Bureau Environmental Officer (BEO) for approval.

The environmental assessment for this project includes the following main objectives:

- Describes the physical, natural and social conditions of the study area;
- Evaluates the issues identified during the scoping exercise to determine significant direct and indirect environmental issues and eliminate insignificant issues;
- Determines and compares alternatives for project implementation, including an analysis of the “No Action” alternative; and
- Provides an Environmental Mitigation and Monitoring Plan (EMMP), which shall comprehend all project activities and include realistic mitigation and monitoring measures for construction and operation of the power plant, as well as propose additional measures for the North Park project as a whole that impact the effectiveness of the power plant project.

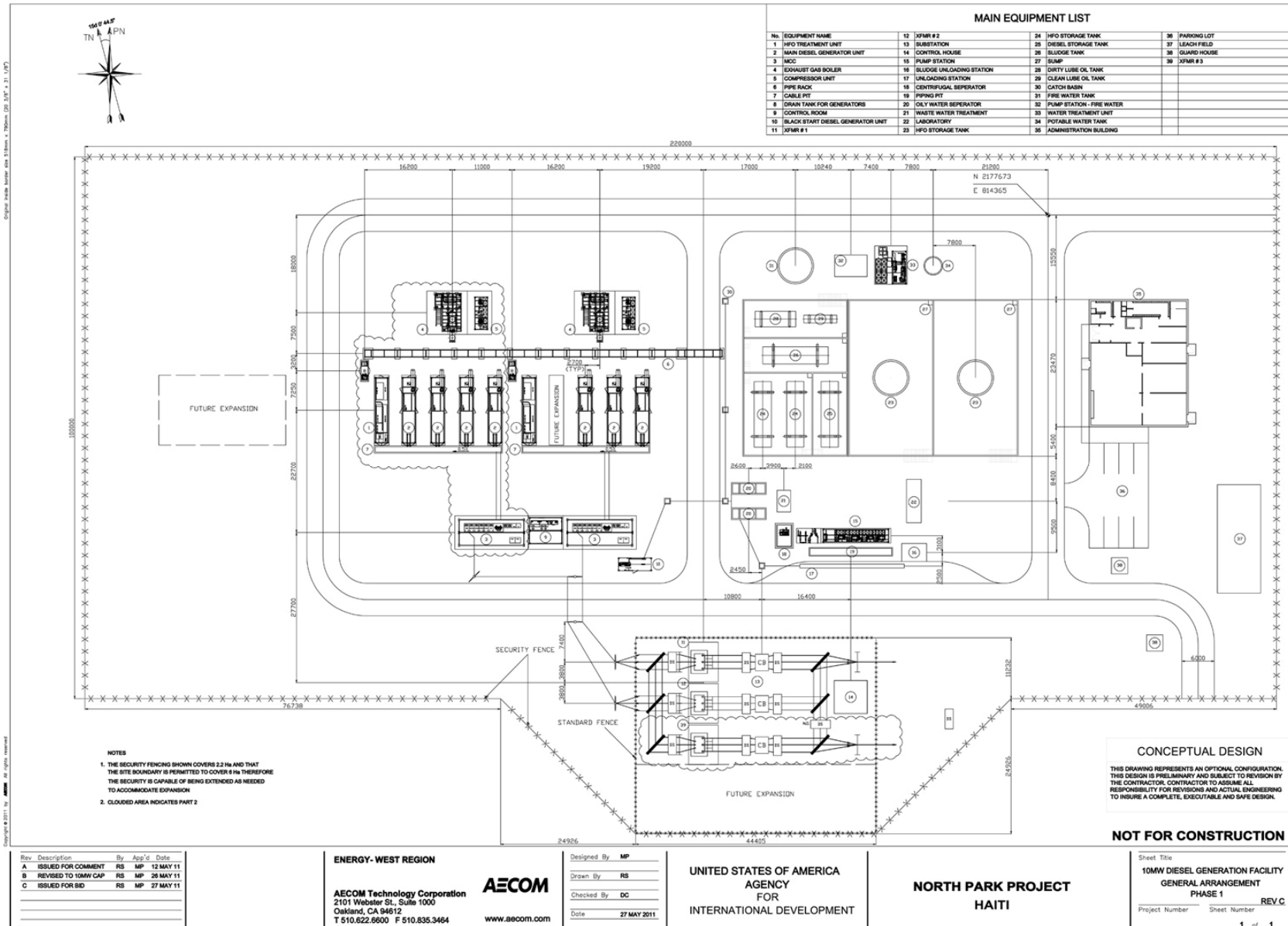


Figure 3. Conceptual design of power plant components

## 2.3 SCOPE OF ENVIRONMENTAL ASSESSMENT

This section discusses significant issues identified during scoping activities and assesses criteria for determining socioeconomic and environmental consequences. For the purpose of the environmental assessment, considerations will be discussed in association with the two different phases of the proposed project: Pre-Construction and Construction Phase, and the Operation Phase.

### 2.3.1 Issues Identified During Scoping Activities

During the scoping process, issues were identified through field study, literature review, and stakeholder consultations. Stakeholder consultations were conducted with relevant institutions at departmental and local levels. A letter was disseminated explaining the objectives of the proposed power plant and requesting participation and comment (Appendices A and B).

Stakeholder consultations yielded 29 different issues associated with the project. These issues represent six major categories of impacts and concerns:

- Impacts on livelihoods and socioeconomic well being;
- Impacts on human health and safety;
- Impacts on the environment;
- Impacts on infrastructure and community development;
- Administrative and local government concerns; and
- Alternative energy sources.

The 29 issues identified during the Scoping process, in addition to other issues identified during environmental analysis, are provided in Table 1 below. Some issues occur in the table under multiple categories. Significant issues having related to positive or negative impacts associated with the proposed action and alternatives are noted by “✓” in the right hand columns.

**Table 1. Issues identified during environmental analysis**

Issue Identified During Scoping	Considered in Analysis of Proposed Action	Considered in Analysis of Alternatives*	Dismissed as Outside EA Scope
<b>Impacts on livelihoods and socioeconomic well being</b>			
Desperate need for employment opportunities for local residents	✓	✓	
Hope that building the power plant will be an economic boost to the area	✓	✓	
Hope that building the power plant will improve quality of life for residents	✓	✓	
Indirect effects from industries served by the power facility	✓	✓	
Gender considerations	✓	✓	
Welfare of children	✓	✓	
Compensation to local residents currently farming land within the industrial park boundary, and on power plant site**	✓	✓	

<b>Impacts on human health and safety</b>			
Potential adverse impacts on air quality	✓	✓	
Effects of power plant noise on the surrounding community	✓	✓	
Power plant fuel handling, transportation, and spill clean-up	✓	✓	
Effects of the power distribution system on local communities (physical as well as socio-economic) and the environment	✓	✓	
Dangers of plant operation and power line maintenance	✓	✓	
Safeguards and contingency plans to protect power plant workers and the local community if there is an accident or malfunction at the power plant	✓	✓	
Management of the power plant and training of power plant workers	✓	✓	
Effects of power plant construction noise and dust on the local community	✓	✓	
Safety of construction workers	✓	✓	
Safety of community during construction (physical risks from construction activities and security risks from influx of outside workers)	✓	✓	
Indirect effects from industries served by the power facility	✓	✓	
<b>Impacts on the environment</b>			
Potential for fuel storage leaks and groundwater contamination	✓	✓	
Project location may be within a proposed Marine Protection Zone	✓	✓	
Cumulative effects from multiple activities being proposed in the area could cause adverse environmental effects not considered significant when analyzed individually	✓	✓	
Marine life in the bay could be adversely affected by: <ul style="list-style-type: none"> <li>a. Sediment;</li> <li>b. Overland migration of liquid pollutants during rains</li> <li>c. Pollution from any point in the watershed entering rivers or streams</li> <li>d. Contamination of groundwater</li> </ul>	✓	✓	
Estuary draining this watershed contains one of the few remaining mangrove sites in Haiti, which is already under pressure from harvesting for charcoal production	✓	✓	
Damage to the near-shore marine ecosystem could cause a loss in livelihood for local fishermen	✓	✓	
Outlet point for the watershed is near the border with the Dominican Republic and adverse environmental impacts could have international consequences	✓	✓	
Environmental justice	✓	✓	
Indirect effects from industries served by the power facility	✓	✓	

<b>Impacts on infrastructure and community development</b>			
Availability and affordability of electric service to local and outlying communities			✓
Dangers and risk of damage associated with moving large generators to the industrial park	✓	✓	
Indirect effects from industries served by the power facility	✓	✓	
<b>Administrative and local government concerns</b>			
Project planning by GOH did not involve all stakeholder GOH Ministries			✓
Planning process needs further review by stakeholders, including local community leaders			✓
Indirect effects from industries served by the power facility	✓	✓	
<b>Alternative energy sources</b>			
Renewable energy options as alternatives to conventional electricity generating methods		✓	
Use of cleaner fuel options		✓	

\*Includes the “No Action” alternative

\*\*Additional issues identified after scoping, during environmental analysis

### 2.3.2 Elimination of Non-significant Issues and Alternatives

Some issues as indicated in Table 1 above were dismissed from the analysis because they are beyond the scope of the NPP Project and associated EA defined in the current Task Order.

The schedule for opening the North Industrial Park is driving the deadline for the power plant to be operational. The accelerated schedule is therefore a fixed variable of the project, and temporal considerations will not be part of the alternatives.

#### 2.3.2.1 Alternative Locations

The location of the North Industrial Park and the power facility within has already been determined by the GOH. Consideration of alternative sites is therefore outside of the scope of this EA. Environmental effects deriving from the location of the power plant will be considered; however, the only alternative to the proposed location of the power generating facility is the “No Action” alternative.

#### 2.3.2.2 Drawing Power Originating from Cap Haitien

An alternative to install a power distribution line from the power facility operated by EDH in Cap Haitien was considered, and dismissed. The capacity of the current facility is merely 17 MW, and is therefore insufficient to meet the ultimate needs of 25-35 MW. The cost of installing distribution lines for the transfer of power originating in Cap Haitien to Caracol would be very high. Furthermore, the time required to install the distribution line is beyond the target operation date in February, 2012.

#### 2.3.2.3 Alternative Energy Sources

Alternative energy sources such as wind or solar power were considered but dismissed based on the longer timeframes required to conduct feasibility studies that incorporate wind patterns over many years. The mayors of Cap Haitien and Limonade have been working on developing a new landfill area that may be able to generate methane that could possibly generate electricity in the future. The option, however, is not available within the timeframe for this project.



Cost was also a factor in dismissing this option, particularly with regard to required initial capital costs for the installation of solar panels. A recommendation is included in Section 6 of this report to consider alternative energy sources such as wind, solar, or methane for future power generation needs of the industrial park.

### 3. DESCRIPTION OF ALTERNATIVES

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#### 3.1 “NO ACTION” ALTERNATIVE

The “No Action” alternative considers the impacts of having no power production facility to supply the electricity needs of the North Industrial Park. This alternative implies that there is neither a power plant facility nor any other means to provide power to the textile industry, associated offices, wastewater treatment plant, or residential buildings

#### 3.2 ALTERNATIVE TO USE DIESEL FUEL FOR NORTH PARK POWER FACILITY

To meet the immediate power needs of the industrial park, HFO has been determined to be the fuel of optimal choice. A U.S. Trade Development Agency contractor, Parsons, provided input to this decision based on a desk analysis of energy supply options for the expansion of the power plant to meet the longer term needs of the park and surrounding communities. Renewable energy options are also under consideration for long-term operation (see section 2.3.2 above). The use of diesel generators offers a cleaner fuel option, and the environmental and socioeconomic impacts of this alternative are considered in this assessment. This alternative includes the design and installation of diesel generators during all phases of the power plant.

### 4. ENVIRONMENTAL AND SOCIOECONOMIC BASELINE CONDITIONS

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This section describes the socioeconomic and environmental baseline conditions of the project area. The EA team evaluated the current conditions concerning population demographics and activity, economic development, gender, physical geography and climate, and various coastal and watershed characteristics that may change, either positively or negatively, as a result of project alternatives.

#### 4.1 DIRECT AND INDIRECT INFLUENCED AREAS

The North Industrial Park is located in the Northeast Department of Haiti near the coastal fishing village of Caracol, approximately 35-40 km southeast of Cap Haitien, as illustrated in Figure 2 above. The park occupies a 250 m rectangle with the following coordinates for each corner:

Northwest corner: latitude 19°40.26 N, longitude 72°01.5 W;  
Southwest corner: latitude 19°39.47 N, longitude 72°01.16 W;  
Southeast corner: latitude 19°39.37 N, longitude 72°00.8 W;  
Northeast corner: latitude 19°40.18 N, longitude 7°59.57 W.<sup>1</sup>

The Trou-du-Nord River flows northward through the industrial park and into the Caracol Bay. The power plant will occupy 6 ha in the northeast corner, on the east side of the Trou-du-Nord River. The

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<sup>1</sup> Ministère de l’Economie et des Finances, Direction Générale des Impôts, Certificat No. CDB/03, Port-au-Prince, le 24 Novembre 2010

power plant site and associated downstream river and floodplain environment are considered to be areas of direct environmental influence. Areas downwind of the power plant site are also considered to be under direct environmental influence. Direct socioeconomic impacts are experienced within a broader area of influence that generally covers the commune of Caracol. The economic activity that occurs or is affected by the corridor extending between Ouanaminthe and Cap Haitien is considered an area under the indirect influence of the actions of the proposed project.

## 4.2 Socioeconomic Conditions

### 4.2.1 Demographic Characteristics

The commune of Caracol covers an area of 74.7 km<sup>2</sup>. According to estimates from the Haitian Institute of Statistics, (*l'Institut haïtien de statistique et d'informatique*), the population of Caracol is approximately 7,015, with 3,818 people aged 18 years or older. Population density is estimated at 94 people per square km (Figure 4 below).

The Caracol commune includes the three sections of Caracol, Champin, and Glaudine (Jacquesil), with the population fairly evenly distributed across each. The town of Caracol, situated on Caracol bay, includes 2,690 inhabitants, compared with 2,302 for Glaudine, and 2,023 for Champin. The section of Glaudine encompasses the villages of Jacquesil, Vollant, and Jésus. The village of Fleury, (photo 1), which is situated adjacent to the North Industrial Park, as well as Boue and Chambert make up the section of Champin.

**Table 1: Demographic characteristics of the commune of Caracol, 2009**

Commune Section	Area (km <sup>2</sup> )	Population	Men	Women	18 Years and Older	Density
Caracol Town	0.2	2,690	1,414	1,276	1,480	12,810
Champin Section (Boue, Fleury, Chambert)	30.5	2,023	1,050	973	1,093	66
Glaudine Section (Jacquesil, Vollant, Jésus)	44.2	2,302	1,231	1,071	1,245	52
<b>Total</b>	<b>74.7</b>	<b>7,015</b>	<b>3,695</b>	<b>3,320</b>	<b>3,818</b>	<b>94</b>

Source : Haitian Institute of Statistics, *Population totale, population de 18 ans et plus, ménages et densités estimés en 2009, mars 2009.*

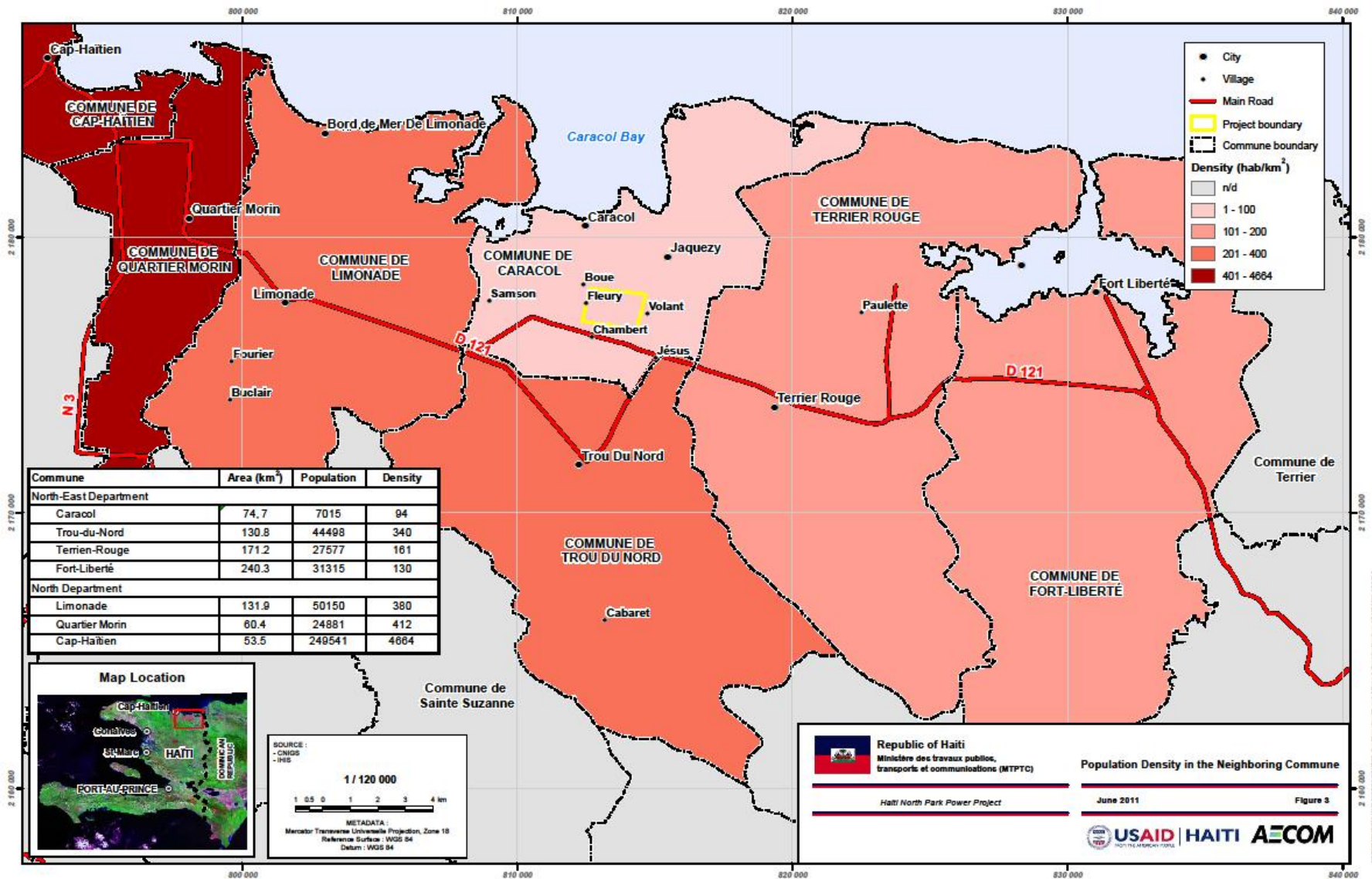


Figure 4. Population density in Northern Haiti

**Photo 1. The village of Fleury**



Source : AECOM, June 2011

The commune of Caracol is located within the Northeast Department of Haiti. It is bordered by the neighboring communes of Trou-du-Nord and Terrier-Rouge, also located within the Northeast Department, and by the commune of Limonade, situated in the North Department. Cap Haitien, considered the economic center of the region, is located approximately 25 km west of Caracol, also in the North Department. Fort-Liberté, the capital city of the Northeast Department, lies approximately 25 km east of Caracol. Census data from the Haitian Institute of Statistics reveals that the population of Caracol is less than other communes in the North and Northeast Departments, with communes adjacent to Caracol remaining four to six times more populated. Population density is also less in Caracol than in the communes of Limonade, Trou-du-Nord and Terrier-Rouge (Table 2).

**Table 2. Demographic characteristics of Caracol and other communes in the North and Northeast Departments, 2009**

Departement and Commune	Area (km <sup>2</sup> )	Population	Men	Women	18 Years and Older	Density
Northeast						
Caracol	74.7	7,015	3,695	3,320	3,818	94
Trou-du-Nord	130.8	44,498	21,821	22,677	23,660	340
Terrier-Rouge	171.2	27,577	13,882	13,695	15,093	161
North						
Limonade	131.9	50,150	25,429	24,721	27,496	380
Quartier Morin	60.4	24,881	12,654	12,227	14,436	412
Cap Haitien	53.5	249,541	115,811	133,730	145,870	4,664
<b>Total</b>	<b>788.1</b>	<b>434,977</b>	<b>208,746</b>	<b>226,231</b>	<b>247,588</b>	<b>552</b>

Source: Haitian Institute of Statistics, March 2009.

#### 4.2.2 Land Use and Land Ownership

The three main ways to farm land in Haiti are through private or public ownership, renting, and tenant farming or sharecropping<sup>2</sup>. Squatting on state property to farm the land or utilize it as pasture for grazing animals is yet another way that land is utilized in Haiti. Land ownership is gained through purchase, inheritance, or by claiming land rights through a long history of occupancy. According to information obtained from the CASEC of Champin, the majority of land owners in the Caracol commune own one *carreau* of land or less<sup>3</sup>. It is also common for farmers to rent their land from private owners. These farmers pay rent in advance, generally for one year at a time. It is not uncommon for farmers to sublet a

<sup>2</sup> Richard A. Haggerty, ed. *Haiti: A Country Study*. Washington: GPO for the Library of Congress, 1989.

<sup>3</sup> One *carreau* of land in Haiti is equivalent to 1.29 hectares.

portion of land to other farmers, thereby creating a more active rental market for farm land. Sharecropping, which is also common in Haiti, generally occurs for short periods of time during the harvest season. In most cases, a sharecropper pays half of his harvest to the land owner.

**Photo 2. Forced entry into the confines of the future industrial park at Caracol**



Source: AECOM, June 2011

Land situated within the boundaries of the industrial park is owned by the GOH. However, information gathered during field visits indicate that the land is occupied and utilized by nearby villagers from Caracol, Glaudine, and Champin. In several places, openings have been created in the fence surrounding the park in order to allow frequent entry by people farming this land (photo 2). During one site visit, numerous cows and goats were observed within the limits of the industrial park, as well as several plots of recently cultivated land. In other places, land appeared to be unmaintained. One house with current occupants (Photo 3), and also equipped with a well, was also located within the western area of the park, near the Baptist church in the village of Fleury. In addition, about a

half dozen of farmers were seen near the site of the power plant, in the process of burning wood for charcoal production. According to the CASEC of Champin, this land has been utilized by villagers for at least the past twenty years. The CASEC estimates that approximately one thousand people regularly exploit the land for agriculture and livestock raising. Active agricultural activity within the industrial park boundaries is evidenced by the patchwork mosaic of tilled land and pastures in Figure 3.

**Photo 3. Inhabited house within the limits of the future industrial park**



Source : AECOM, June 2011.

Agricultural activity in the project area consists of small farm plots scattered throughout the industrial park (Photo 4), and roaming livestock (Photo 5). According to the CASEC, the majority of farmers have not cultivated land within the industrial park in 2011, fearing expulsion and loss of their harvest since the installation of the fence surrounding the park to secure the area. These farmers do, however, continue to allow their livestock to roam on park land while waiting for the park construction works to begin.

**Photo 4. A plot of cultivated land within the perimeter of the future industrial park**



Source : AECOM, June 2011

**Photo 5. Cattle raising is widespread throughout the future industrial park**



Source: AECOM, June 2011

The CASEC of Champin and the *Femmes Vaillantes* women’s association mentioned that the majority of farmers who use industrial park land anticipate compensation for losing future access to this agricultural land once the park development activities commence. Furthermore, according to one farmer encountered within the park limits during a site visit, land clearing activity on the eastern side of the Trou-du-Nord river has angered numerous local farmers. These activities were begun with neither advance notification nor compensation to farmers who lost farmland and valuable fruit trees.

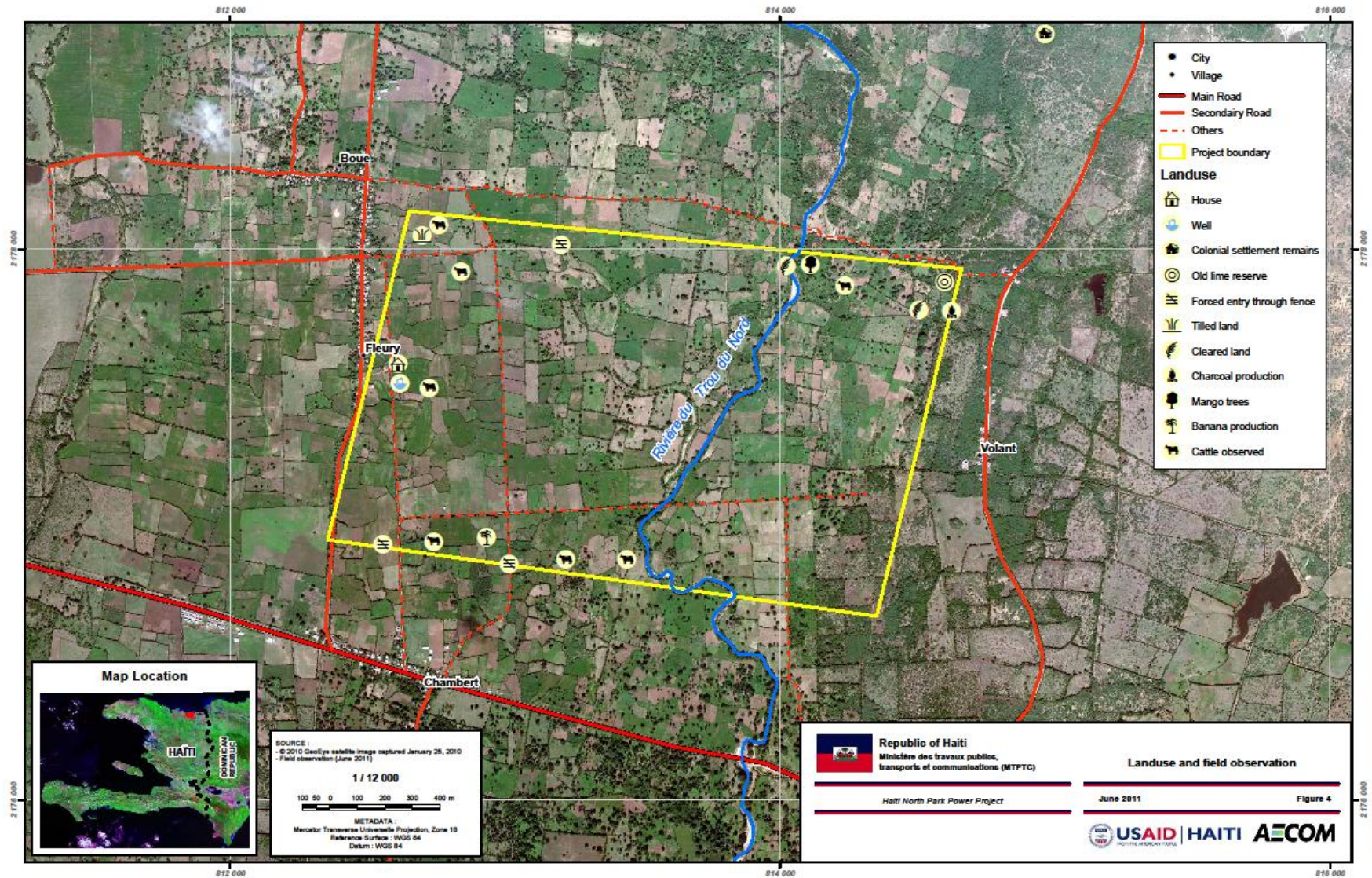


Figure 5. Land use and points of interest within the North Industrial Park

### 4.2.3 Principal Livelihoods, Economic Activities, and Employment

According to a gender assessment conducted by USAID, the majority of Haitians live in extreme poverty (living on one dollar or less per day person). In 2004, this included 56% of the entire Haitian population (67% of the rural population, and 84% of the Northeast Department)<sup>4</sup>.

The labor market in the Northeast Department is described as fragile. According to the Haitian Institute of Statistics, nearly two thirds (63%) of the population of working age (10 years or older) in the Northeast Department do not participate in the work force, while 28% are employed and 9% are officially reported as unemployed. Men (41%) are less active in the job market than women (33%). The working population is comprised of a large proportion of business owners or self-employed workers (87%). Both salaried and unpaid workers comprise a relatively small proportion (5%) of the actively working population.<sup>5</sup>

Agriculture, livestock raising and fisheries provide essential household income in the Caracol Commune, as in the rest of the Northeast Department. However, income generation from these activities is hardly sufficient to meet all of the needs of the population and the region lacks a substantial commercial job market for the agricultural sector, except for a handful of Madame Saras<sup>6</sup> which supply urban markets.

One exception is the free economic zone of the commune of Ouanaminthe, in which a textile industry exists. While the textile industry creates the second sector of economic importance, its impact on the Northeast economy is negligible. With the closing of the jute (sisal) plantations by the Dauphin company in the 1970s, large scale or industrial agriculture are largely absent within the Northeast Department. These old plantations, located near the village of Phaïton, between Caracol and Fort-Liberté, have become immense savannahs or dry grasslands characterized by xerophytic vegetation that hinders agricultural productivity of the region<sup>7</sup>.

The third sector of importance in the Caracol commune involves the transport of agricultural products from Caracol to urban markets within the region. The Madame Saras transport goods to market on Tuesday, Thursday, and Sunday to markets in Cap Haitien, Limonade, and Trou-du-Nord, respectively. In terms of public service provision, this activity is less development and generally very little economic activity<sup>8</sup>. There is a local credit union in Caracol (CAPONET) that offers basic credit and savings services<sup>9</sup>.

#### 4.2.3.1 Agriculture

Small-scale agriculture is widely practiced by most households throughout Caracol. The lack of other market opportunities in the area obviates the need for subsistence level farming or in order to provide needs to local families.

Local farmers cultivate corn, beans, cassava, sweet potato, peanuts, pistachios, bananas, millet, pigeon peas and sugar cane, among others. Other fruits and vegetables growing wild throughout the area are also regularly harvested, such as mangos, papayas, mahogany nuts, spinach, and watercress. Cassava,

<sup>4</sup> USAID, *Gender Assessment, USAID/Haiti*, Juin 2006.

<sup>5</sup> Haitian Institute of Statistics, *Study on livelihood conditions in Haiti*, July 2003.

<sup>6</sup> The *Madames Sara* are women who make frequent trips from the farm to market to sell agricultural goods. Many of them represent familiar images, descending the mountains daily with baskets of vegetables balanced on their heads. A second category is composed of women who purchase produce from local farmers for transport by truck to market to sell. Others cater to Caribbean cruise ships making regional port stops (Source : Alliance Haïti, <http://www.alliance-haiti.com/societe/condition-femme.htm>, June 2011)

<sup>7</sup> Ministère de la Planification et de la Coopération externe, Direction départementale du Nord-Est, *Éléments de problématique départementale du Nord-Est*, mai 1997.

<sup>8</sup> Ibid.

<sup>9</sup> Fondation haïtienne pour le développement intégral latino-américain et caraïbéen, *Rapport diagnostic des associations d'irrigants, zone 5, périmètre Champing AI # 52*, July 2008.



bananas, sweet potato and sugar cane are cultivated throughout the year, while other species are seasonal. According to the CASEC of Champin, approximately 40% of the agricultural production within the commune comes from land within the limits of the industrial park. Table 3 below lists the types of crops cultivated and the planting and harvest seasons in the Northeast Department.

**Table 3. Planting and harvest seasons of major agricultural products cultivated throughout the Northeast Department**

Crop	Planting Season	Harvest Season
Corn	March-April-May August-September	June-July-August December-January
Beans	December-January April-September	February-March June-December
Cassava	Year round	Year round
Sweet potato	Year round	Year round
Peanuts	January-February-March July-August	July-August-September January-February
Bananas	Year round	Year round
Millet	April-May August-September-October	July January
Pigeon peas	April-May-June	February-March
Sugar cane	Year round	Year round

Source : Ministère de la Planification et de la Coopération externe, Direction départementale du Nord-Est, *Éléments de problématique départementale du Nord-Est*, mai 1997.

According to the Ministry of Agriculture's Northeast office, the commune of Caracol includes 500 ha of land having irrigation potential, yet none of this land is currently irrigated<sup>10</sup>. The lack of irrigation and the use of agricultural inputs or machinery prevent farmer of Caracol from gaining maximum agricultural productivity from the land they farm. According to the CASEC of Champin, sales from a half hectare of land can provide annual revenue of approximately US \$1,500. Income can be as high as US \$3,000 per year if the cultivation of bananas is included in the mix. Beans and pistachios are also highly valued in local markets.

#### 4.2.3.2 Livestock Raising

Also a part of agriculture, livestock raising plays an important economic role in Caracol households. Freely roaming animals predominate. Dairy cattle are found in the highest numbers, followed by beef cattle, pigs, horses, sheep, goats, and fowl.

The most recent data on livestock production in the Northeast Department was provided by the Northeast office of the Ministry of Agriculture in 1987. For the Department as a whole, the most common animals raised were chickens (329,602), guinea hens (111,115), goats (67,720), cattle (59,364) and pigs (12,807)<sup>11</sup>. According to representatives of the CASEC of Champin, a typical family in the Caracol commune owns three cows and two goats.

<sup>10</sup> It is important to note that the 250 ha industrial park, includes 30% of land with irrigation potential in the commune of Caracol.

<sup>11</sup> Ministère de la Planification et de la Coopération externe, Direction départementale du Nord-Est, *Éléments de problématique départementale du Nord-Est*, May 1997.

Information provided by the CASEC of Champin indicates that livestock raising helps supplement income earned from cultivation. The sale of one cow, for example, can provide US \$ 600, and one goat can sell for approximately US \$75. In addition, one cow can provide US \$3 per day in milk production. With regard to agricultural productivity, the lack of access to fertilizers, techniques to enhance varieties, and lack of soil conservation practices pose collective challenges to commercial agricultural activity<sup>12</sup>.

#### 4.2.3.3 Fisheries

The northeast coastal zone extends approximately 35 km, and fishing is an important economic activity in this region. The sector is, however, not well organized, and people use artisanal methods such as seine nets, baskets, fishing lines with hooks, and small, wooden, non-motorized boats (photo 6). The fishing

**Photo 6. Fishing boats in Caracol Bay**



Source: AECOM, June 2011

**Photo 7. Fish caught near Caracol**



Source: AECOM, June 2011

sector is, however, beginning to organize itself with the creation of a cooperative (*Koperativ Pechè Karakòl*) and an enforcing body (Brigadier Maritime en Action)<sup>13</sup>.

In Caracol, the fishing industry operates without control over species or size of fish harvested. The *boutou*, sardine, *béquille*, *boute langue*, *carangue*, *barrée*, *zo bleu*, conger eel, *pisquettes*, lobster and shrimp are among the most commonly harvested species (photo 7). Fishermen usually fish in groups of two or three. Commercial fishing is informal and uncommon, limited to local sale. Fishing products are packaged and sold by box for US \$25-100 depending on the size of the box. Fish are preserved by drying and salting. Refrigeration is nonexistent, largely due to the lack of electric power in the commune<sup>14</sup>.

At the time that field visits were made for this study, no information on fishing sites or quantities harvested was available. One fisherman was encountered on the shores of Caracol Bay who mentioned that Haitian fishermen are occasionally victims of harassment or pirating by Dominican fishermen using motorized boats.

#### 4.2.3.4 Other Economic Activities

In addition to agricultural production, livestock raising, and fisheries, the population of the Caracol commune is also engaged in charcoal production (photo 8). Produced primarily from mesquite, charcoal is sold along numerous routes and in local or regional markets. In the absence of electrical power or gas, charcoal is the cooking fuel in the majority of households.

Salt is harvested in the months of July, August and September in Caracol. Several salt marshes are exploited exclusively by the most impoverished women in Caracol. These workers are paid in cash for their work, but they owe 60% of their income to the land owners<sup>15</sup>.

<sup>12</sup> Ibid.

<sup>13</sup> Fondation haïtienne pour le développement intégral latino-américain et caraïbéen, *Rapport diagnostic des associations d'irrigants, zone 5, périmètre Champing AI # 52, Juillet 2008.*

<sup>14</sup> Ibid.

<sup>15</sup> Ibid.

**Photo 8. Charcoal production within the limits of the Industrial Park**



Source: AECOM, June 2011

Sand and gravel is also quarried in the commune of Caracol. These activities are not regulated<sup>16</sup>.

Several persons, almost exclusively men, provide taxi services by motorcycle or van. The price varies according to the mode of transport, between 10 gourdes (motorcycle) and 25 gourdes (van)<sup>17</sup>.

Tourism is very little developed in Caracol. Even though several natural (beach and mangroves) and historic (site of the shipwreck of the Santa Maria) attractions exist, they are visited only occasionally, usually by missionaries.

#### 4.2.4 Gender and Youth

According to a USAID gender assessment, several indicators describe the situation of Haitian women as the worst in the hemisphere: maternal death rate, birth rate, HIV infection, and illiteracy. Moreover, while more women (83%) work in the formal labor force than men (44%), they earn the lowest wages.<sup>18</sup>

Haitian women play a central role in the economy of the country, notably on an informal basis. In rural areas, women work as much as men in agricultural production, but are also the ones responsible for selling goods in local and regional markets. They work in managing household expenses and food supply, and carry out domestic tasks such as cooking, washing, hauling water, and caring for children. Women generally have numerous children, and commonly assume all family responsibilities due to temporary or prolonged absence of their partner.

**Photo 9. Meeting with the members of Femmes Vaillantes Women’s Association**



Source: Eric Auguste, June 2011.

Despite the importance of their contribution to both the informal economic sector and domestic life, women are for the most part marginalized in public life. They are nonetheless active in local associations such as the *Femmes Vaillantes* women’s association (photo 9), which supports women in the communal section of Champin. This association envisions the development of their agricultural activities in local markets, sale of chicks and fish). The women met during this analysis mentioned that the challenges they face in gaining access to credit and necessary farming equipment and tools.

*Femmes Vaillantes* is also concerned with public health conditions of the commune, with infectious diseases, and with malnutrition in children. The women are particularly concerned with the difficulty in accessing

health services and of the prevalence of malaria, typhoid fever, measles, diabetes, high blood pressure, sexually transmitted diseases (STDs), and HIV AIDS. They maintain that children lack educational services and leisure activities as well, which threaten their future and confine them to a fragile socio-

<sup>16</sup> Ibid.

<sup>17</sup> Ibid.

<sup>18</sup> USAID, *Gender Assessment, USAID/Haiti*, Juin 2006.

economic status. In addition, they have observed a large number of orphans within the local population, and this group of children is particularly vulnerable to illness and poverty. According the USAID, half of children under five in Haiti are malnourished.<sup>19</sup>

*Femmes Vaillantes* is optimistic about the development activities of the North Industrial Park, and many women hope to find work in the textile manufacturing industry, while continuing to maintain their current agricultural activities. They see a unique opportunity to improve their economic situation for their family. They anticipate a compensation plan to be put into place to accommodate resettlement or shifting of their agricultural activity to other areas. However, they fear the massive influx of outside workers, mostly single men who will aggravate public health and safety problems. They strongly urge the distribution of condoms to prevent HIV/AIDS transmission and the creation of public health and education services that will favorably support the development of the commune (health clinics, schools, police centers, housing for workers, sport and leisure facilities, potable water, wastewater treatment, and electrical power).

## 4.2.5 Services and Infrastructure

### 4.2.5.1 Health

It is important to note that the primary indicators of health in Haiti are worse than in other countries of Latin America and the Caribbean: a life expectancy of 51 years for women and 50 years for men, an infant mortality rate of children under two of 127 per one thousand, a birth rate of 3.8 children per woman, prevalence of anemia in pregnant women of 63%, and a prevalence rate of HIV/AIDS in persons 15-49 years old of 5.6%<sup>20</sup>.

The Caracol commune has three health clinics, in Caracol, Chambert, and Jacquesil. These clinics treat malaria, typhoid fever, and respiratory infections<sup>21</sup>. Health services are not capable of serving the needs of the entire population. The most severe cases or those that require specialized care are redirected to the hospitals of Trou-du-Nord, Fort-Liberté or Cap-Haïtien.

The health clinic at Caracol employs two nurses and two assistants. It is equipped with a laboratory, but it is inoperable due to the lack of electricity and specialized personnel. Women interviewed during this study reported that the health clinic at Chambert does not offer any services, due to the absence of qualified personnel. No information was available on the status of the health clinic at Jacquesil.

### 4.2.4.2 Education

Illiteracy touches a large part of the Haitian population. According to the Haitian Institute of Statistics, 44% of the population 6 years and older in the Northeast Department has had no schooling, and 88% has not studied past primary school. The Commune of Caracol has 15 schools, of which 13 are primary schools, and 2 are secondary. One of the secondary schools, in the village of Caracol, is fortunate to have 17 teachers who can accommodate 170 students<sup>22</sup>.

In addition, in the commune of Limonade, bordering Route 121, a private university is currently under construction. According to information posted on the side of the road near the construction site, a variety of disciplines will be offered, including agronomy, and business management. The opening of the university is expected in September, 2013.

<sup>19</sup> Ibid.

<sup>20</sup> Pan American Health Organization, *Gender, Health and Development in the Americas, Basics indicators 2005, 2006*.

<sup>21</sup> Fondation haïtienne pour le développement intégral latino-américain et caraïbéen, *Rapport diagnostique des associations d'irrigants, zone 5, périmètre Champing AI # 52, Juillet 2008*.

<sup>22</sup> Ibid.

#### 4.2.4.3 Access to Potable Water

The village of Caracol and communal sections are fed with potable water with hand pumps and several public water taps. Some people also use unprotected water sources for household water supply. The village of Fleury has a water tank (photo 10) which ensures the provision of water during the dry season.

*Photo 10. Water tank at Fleury*



Source: AECOM, June 2011.

The village of Fleury has a windmill to service a potable water pump for the water tower. The pump is currently broken. Near the water tank, a solar panel powers the only street lamp in the village.

#### 4.2.4.4 Wastewater, Human Sanitation, and Solid Waste Management

The commune of Caracol has no drainage system to divert storm water runoff. During rain events, water floods roads and makes transportation difficult. Houses have simple pit latrines. Solid waste and garbage, which consists largely of bottles and plastic bags, are periodically piled and burned.

#### 4.2.4.5 Energy and Electricity

The commune of Caracol is not connected to an electric power grid. Wood and charcoal constitute the two primary sources of energy for the population. Some households use generators or solar panels.

#### 4.2.6 Transportation System

*Photo 11. Route 121 links the communes between Cap-Haïtien and Fort-Liberté*



Source: AECOM, June 2011.

Route 121 is the only road linking the commune of Caracol with neighboring communes (photo 11). Paved and in good condition, Route 121 is vital to the economic development of the commune. The transportation system in the commune of Caracol consists of dirt roads that are rarely or never maintained. Two dirt roads link Caracol with Route 121 and border the eastern and western edges of the North Industrial Park.

Transportation over short distances is generally managed on foot, by donkey or horse, or by bicycle. Motorcycle taxis and minivans are utilized for longer distances.

#### 4.2.7 Administrative Structure and Civil Society

Caracol commune is composed of the village of the same name and of two communal sections (Champin and Glaudine). In Caracol there is a town hall, a police station, and courthouse. Management of each communal section is assured by an Administrative Council (CASEC) with elected members (photo 12).

Associations organize diverse groups of farmers who wish to share resources in common and register issues and concerns. These organizations are the following: *Femmes Vaillantes*, Organization of Residents for the Development of Jacquesil (*Rasanbleman Peyzan pou Devlopman Jakzi*), Development Committee of Jacquesil (*Komite Developman Jakzy*), Farmers Association of the Jésus Carrefour

(*Asosyasyon Peyzan Kafou Jezi*), Farmers Association Volant (*Asosyasyon Peyzan Volan*), Farmers Group of Champin (*Gwoupman Peyzan Champin*) and the Planters Association of Caracol (*Asosyasyon Plantè Joumou Karakòl*)<sup>23</sup>.

Many non-governmental organizations are active throughout Caracol commune. Plan International implements a diversity of interventions in health, education, and capacity building. It works to provide education for children, construction of latrines and support for agricultural activities. The World Food Program provides support in the production of corn and peas, develops schools, and rehabilitates roads. Le PAPAE (*Programme d'appui à la mise en œuvre du Plan d'action pour l'environnement*) works in mangrove conservation and rehabilitation. Caritas and IICA (Inter-American Institute for Cooperation in Agriculture) offers farm credit for women, micro-credit, and supports the production of salt, fisheries, and irrigation<sup>24</sup>.

**Photo 12. Meeting with the CASEC of Champin**



Source: AECOM, June 2011.

Numerous expectations and desires were expressed by local elected officials and local associations concerning the development of the industrial park. Of particular concern is the absence of a communications plan and lack of involvement of local stakeholders in the decision-making or planning process for the park. Local stakeholders question the selection of the project site, which is highly valued by the local population for agricultural production, and people are concerned about the absence of a management plan to help identify and mitigate or avoid negative impacts on humans and the environment. Stakeholders would like to see local elected officials consulted in order to maximize positive impacts (compensation and enhanced commercial activity) on the local community and to minimize negative effects (massive influx of outside workers, associated public health problems, pollution, and environmental degradation).

**Photo 13. Colonial ruins at Jacquesil**



Source: AECOM, June 2011.

The fears of local representatives and civil society are grounded in previous experiences with industrial parks in Haiti. Some cited the experience of the free trade zone in Ouanaminthe, approximately ten years ago, which has not improved the quality of life of local populations and has degraded local public health conditions. Others mentioned the development of the Dauphin jute plantation which contributed to the poverty of the local population and degraded agricultural life of the north plain. People fear that the development of the industrial park at Caracol will have similar consequences and will lead to the creation of slums.

As a whole, local and departmental authorities, as well as civil society, welcome the economic development that the industrial park will bring. They believe, however, that it is important to put in place a compensation plan for favorable resettlement that will support the continued development of

<sup>23</sup> Ibid.

<sup>24</sup> Ibid.

agricultural activity, as well as preventive or enhancement measures regarding local infrastructure services (health, education, leisure, security, housing, potable water, and electricity).

#### 4.2.8 Cultural Heritage

No cultural or historic sites were identified within the perimeter of the industrial park. During the site visit, one single lime pit was identified near the site of the future power plant. Colonial ruins are located near Jacquesil, approximately 200 m from the northeast perimeter of the park (photo 13).

As mentioned earlier, Caracol Bay is the site of the historic shipwreck of the Santa Maria, the largest ship of Christopher Columbus, which sank in 1492. The community of Chambert hosts colonial wells, ruins, and the burial site of Charlemagne Péralte. In addition, coastal towns in the North and Northeast Departments (Cap-Haïtien, Bord-de-Mer de Limonade, Phaïton, Fort-Liberté) are the homes of forts and quais that witnessed Haiti's colonial past (both Spanish and French) and the period leading up to Haiti's independence.

### 4.3 PHYSICAL AND NATURAL ENVIRONMENT

Characteristics concerning the physical geography and climate, and ecosystems of the Trou-du-Nord watershed and Caracol Bay are discussed below.

The climate in Northern Haiti is tropical humid and the region experiences spatial variation as a function of altitude and direction of trade winds. The trade winds bring storms that generally move from ENE-WSW or NE-SW during the period of December through March, and E-W between April and November. Annual wind data from Cap Haitien show a very predominate wind flow from the east, with a high percentage of wind speeds occurring between 5-10 m/s (11-22 mph)<sup>25</sup>. Mean annual temperatures are generally 25-26°C<sup>26</sup>.

#### 4.3.1 Water Resources and Watershed

The North Industrial Park is located within the Ouanaminthe-Limonade watershed, which occupies an area of 1,065 km<sup>2</sup> along Haiti's northern coastal plain. More specifically, the park is located within the Trou-du-Nord sub-watershed. The Trou-du-Nord River originates in the mountains near St. Suzanne, and snakes its way northward for approximately 35 km, finally emptying its waters in the Caracol Bay (Figure 6).

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<sup>25</sup> Ordonnateur National du FED en République d'Haiti, 2010. Etude des vents dans trois sites en République d'Haiti.

<sup>26</sup> Swartley and Toussaint 2006, USAID 118/119 Assessment

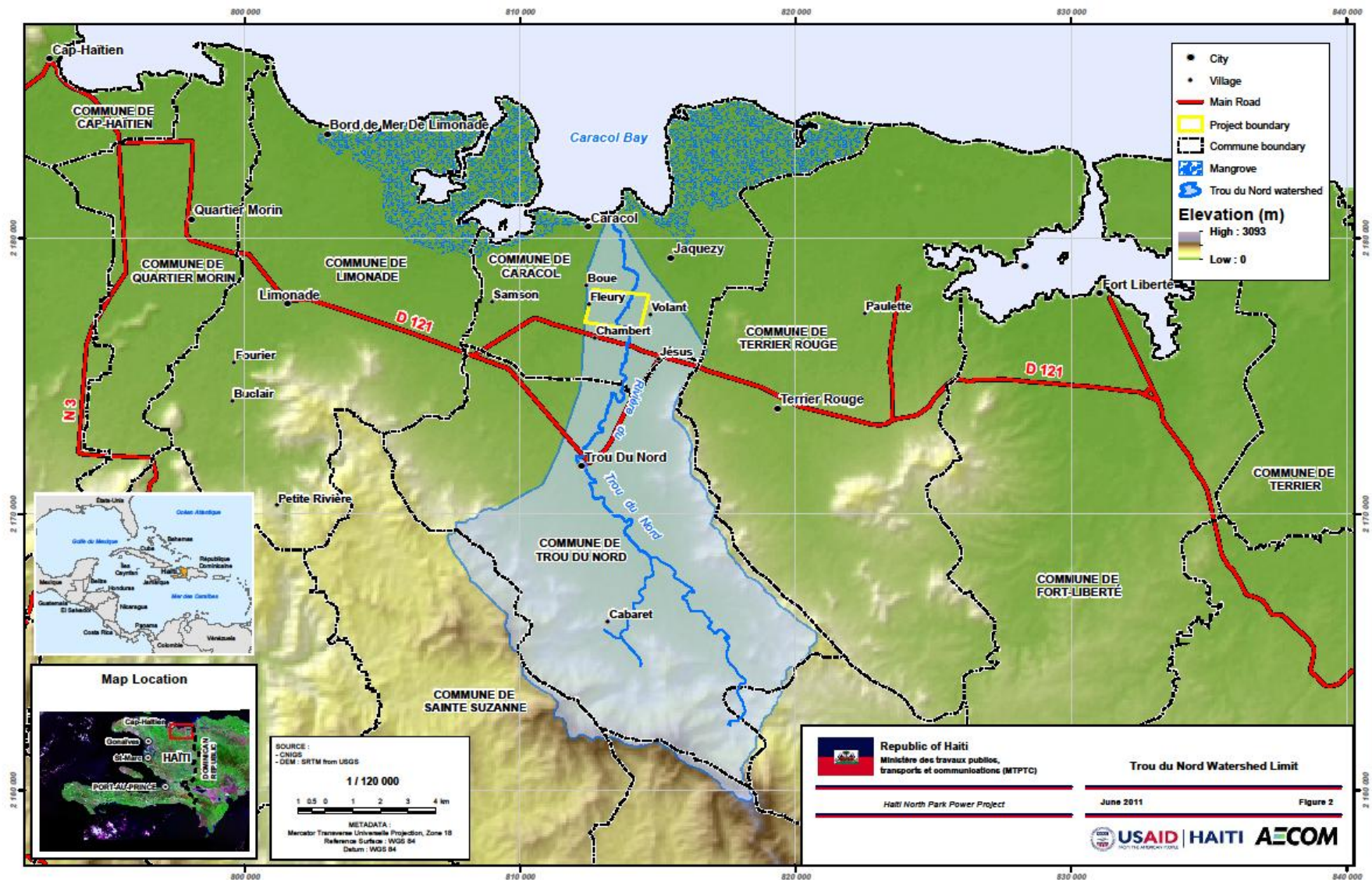


Figure 6. Trou-du-Nord Watershed and associated coastal mangroves in Caracol Bay.



The Trou-du-Nord river is affected by numerous land use and industrial activity, that can negatively impact water quality. The Mont Organisé gold mine is located in the uppermost headwaters of the river, near St. Suzanne on the River Fraiche, a tributary of the Trou-du-Nord river. Sugar cane is processed at a local rum distillery located on the river at the town of Trou-du-Nord. People were also observed driving their vehicles into the river at the Route 121 bridge crossing in order to wash them.

Results of water quality tests recently conducted near the project site are noted in table 4 below.

**Table 4. Water quality parameters from Trou-du-Nord River and Fleury well water samples**

	Unit	Well Water (Fleury)	River Water (Troud du Nord)	WHO Guideline Value	Secondary Standard	Comments
Arsenic	mg/l	1.110	1.030	0.01		Naturally occurring chemical
Barium	mg/l	4.000	4.000	0.7		Naturally occurring chemical
Cadmium	mg/l	<LC	<LC	0.003		From Industrial Sources (steel and plastic industry)
Chromium	mg/l	<LC	<LC	0.05		Naturally occurring chemical
Cyanide	mg/l	0.001	0.003	0.07		From Industrial Sources
Fluoride	mg/l	0.000	0.000	1.5		Naturally occurring chemical
Manganese	mg/l	<LC	<LC	0.4		Naturally occurring chemical
Mercury	mg/l	<LC	<LC	0.006		From Industrial Sources
Nitrate (as No3-)	mg/l	<LC	<LC	50		Agricultural activities
Nitrate (as No2-)	mg/l	<LC	0.05	3		Agricultural activities
Thermotolerant Coliforms	NMP/100ml	2.000	2.4x103	Absence		Evidence of bacterial pollution
pH		7.550	8.130		6.5-9.5	
Turbidity	NTU		12.000		5	Causes Staining
Total Dissolved Solids	mg/l	392.000	262.670		600	
Color	TCU		10.000		15	Between 0-5 TCU for dyeing
Iron	mg/l	<LC	<LC		0.1	Causes Staining
Hardness	mg CaCo3/l	252.700	158.560			Between 100-300 for textile
Dissolved Oxygen	mg/l	1.340	7.590			Additional monitoring parameters to determine water treatability.
Conductivity	µS/cm	551.000	387.000			
Total Organic Carbon	mg/l					
Alkalinity	mg CaCo3/l	317.840	216.310			

The above data indicate the following:

- Two contaminants of concern to human health are Arsenic and Barium, and they were detected in both Trou-du-Nord River water and Fleury well water samples.
- Well water quality in Fleury is adequate for use in the textile industry.
- The turbidity of Trou-du-Nord River water must be reduced to at least 5 NTU for use in the textile industry.
- The remainder (for uses other than potable water and textile industry use) of extracted well water may be used for industrial use without any treatment.

If well water is to be used for human consumption, it will be necessary to reduce the barium and arsenic to WHO guideline levels, and to disinfect the water against bacteria and other microbes. Barium can be

treated through an ion exchange or precipitation softening method, as other conventional processes are ineffective<sup>27</sup>.

There are many options for treating arsenic. Coagulation with ferric sulphate or ferric chloride is one option, however, to determine the exact treatment process it is necessary to know the concentrations of both As(III) and AS(V) in the source water. This will require additional site testing). Another option for arsenic treatment is ion exchange. However, the feasibility of these options is dependent on the SO4 levels in the water. If SO4 is below 50 mg/l, ion exchange is the only option to successfully remove both contaminants.

Turbidity may be removed through conventional processes that include coagulation and filtration. Precipitation softening removes turbidity as well. However, considering that water hardness is not a problem, this treatment option would be excessive, as it requires additional area, uses large quantities of lime and produces large quantities of sludge. The extracted river water should therefore be treated through coagulation assisted filtration for use in the textile industry.

Drinking water by local residents is obtained from dug wells, often 20 feet deep or more. No known water quality testing is performed. The CASEC at Caracol reported that the aquifer is relatively shallow, often just 10 – 30 feet below the surface in many places. Dug latrines often fill up with water, thereby posing pollution risks to drinking water wells. In addition, given that recent water quality tests associated with North Industrial Park planning indicated unsafe levels of arsenic and barium for human consumption, it is highly possible that local residents are drinking unsafe water. It is strongly recommended that as part of a community compensation package, the industrial park authorities conduct well water tests throughout the commune and assist local residents with developing sustainable drinking water options.

Local residents report that the Trou-du-Nord River never runs dry within the confines of the industrial park, and typically runs 5-6 feet deep during the rainy months from May to November. During a site visit in June, 2011, the river was observed to be 3-4 feet deep, with steeply eroded river banks approximately 15-20 feet high (Figure 14 and 15) at a point near the power plant site within the park. The river is reported to flood approximately two times per year at the Route 121 bridge crossing.

**Photo 14. Eastern bank of the Trou-du-Nord River at the power plant site**



Source : AECOM, June 2011

**Photo 15. Western Bank of the Trou-du-Nord River near the power plant site**



Source: AECOM, June 2011

<sup>27</sup> WHO Guidelines for drinking water quality, 2008.

### 4.3.2 Coastal Environment

**Photo 16. Caracol Bay mangrove trees with prop roots**



Source : Eric Auguste, June 2011

Haiti's northern coast is characterized by low-lying alluvial coastal plains. According to satellite imagery from 1998, mangroves occupy 0.6% of Haiti's land area<sup>28</sup>. Many of these are located in Northern Haiti, primarily in pockets in the Bays of Caracol, Fort Liberté, and l'Acul. Mangroves have been heavily exploited in Haiti, particularly over the last 20 years. One of the main threats to mangrove ecosystems is the cutting of trees for firewood and charcoal production (Figure 17 and 18). Charcoal and firewood is used by 90% of urban households throughout Haiti, yet charcoal production offers a low conversion efficiency of only 20%, with 5 kg of wood yielding only 1 kg of charcoal<sup>29</sup>.

Haiti's north coast mangroves provide vital reproduction and nursery grounds for coastal pelagic species of economic importance to the fishing industry, including pike (*Centropomus undecimakis*), prawn (*Penaeus* spp.), Lobster (*Panulirus argus*), and molluscs (*Strombus giga*). At least thirteen coastal pelagic species are currently threatened or in danger of becoming so<sup>30</sup>.

A 2009 study prepared by the *Fondation pour la Protection de la Biodiversité Marine* (FoProBiM) estimates that a 13,000 ha expanse of mangroves, coral reefs, and seagrass beds surrounding Caracol provides \$109,733,000 in ecosystem services (\$105,228,000 for mangroves, and \$4,005,000 for coral reefs). These services include fisheries, dive tourism, and shoreline protection<sup>31</sup>.

With over 1,771km of coastline, Haiti remains the only Caribbean nation without any type of coastal and marine managed area<sup>32</sup>. The Ministry of Environment has proposed a marine protected area that covers between 5,000 – 13,000 hectares in the vicinity of Limonade, Caracol and Fort Liberté, and a Presidential Decree has been drafted. According to the MARDNR, the boundaries of this area have not been defined. The proposed area has generated interest from the Global Environment Fund (GEF), as this area falls within the Caribbean Biological Corridor between Cuba, Haiti and the Dominican Republic.

The coastal shelf of Haiti is relatively narrow and unproductive, having been fished out in many locations<sup>33</sup>.

### 4.3.3 Geology, Soils and Erosion

The parent soils of Northern Haiti are primarily limestone, and are moderately fertile<sup>34</sup>. According to a soil erosion risk map prepared by MPCE in 2002, the alluvial plains surrounding the Bays of Caracol and Fort Liberté were categorized as having relatively low vulnerability to erosion during disaster events such as storms and floods, compared with other areas, particularly in mountainous regions, of Haiti. The

<sup>28</sup> Smucker et al. 2007

<sup>29</sup> Swartley and Toussaint 2006, USAID 118/119 Assessment

<sup>30</sup> Ibid.

<sup>31</sup> FoProBiM 2009, Rapid Assessment of the Economic Value of Ecosystem Services. Prepared for the Organization of American States and the Inter-American Biodiversity Information Network, May 2009.

<sup>32</sup> Ibid.

<sup>33</sup> Ehrlich et al. 1987, cited in Swartley and Toussaint 2006, USAID 118/199 Assessment

<sup>34</sup> Swartley and Toussaint 2006, USAID 118/119 Assessment

MPCE vulnerability classification was based primarily on four factors—slope, soil erodibility, climate erosivity, and vegetative cover. Slope was weighted most heavily in the classification scheme. Smucker et al. (2007) used the MPCE soil erosion risk map as a basis for developing an erosion risk index of major watersheds throughout Haiti. They assigned the index rating of 0 (on a scale of 0 to 100) for the Trou-du-Nord watershed, meaning that the river is less vulnerable to erosion than other river systems in more mountainous regions.

A soil potential map created in 1978<sup>35</sup> classified watersheds based on the capability of soils to support agriculture. The classification system is based primarily on parent soil material, drainage, and erodibility. The Trou-du-Nord watershed received was rated as one of the three top watersheds having high potential to support agricultural productivity.

#### 4.3.4 Flora and Fauna

There are very few studies on avifauna in Haiti. Of the 236 species documented on the island of Hispaniola, ¼ of these are endemic.

**Photo 17. Firewood on the shores of Caracol Bay**



Source : AECOM, June 2011

**Photo 18. Stacked bags of charcoal lining the roads are a common site throughout the communes of Caracol and Fort Liberté**



Source: AECOM, June 2011

Of the 217 species of reptiles and amphibians on Hispaniola, 70% have been recorded in Haiti. Approximately 98% of reptiles and amphibians are endemic to Hispaniola, and one third of these occur only in Haiti<sup>36</sup>. Included among these are the American crocodile (*Crocodylus acutus*) and the Atlantic sea turtle (*Eretmochelys imbricata*). Sea turtles are known to nest in bay areas of Northern Haiti, and Caracol Bay is no exception. Five sea turtles have been inventoried in Haiti.

Abundant flora and fauna appear to exist within the industrial park, despite the fact that the land is currently cultivated and that some areas have been cleared in preparation for park development. Abundance, however, and indicators of biodiversity are difficult to predict in the absence of data. Nonetheless, during a site visit when much of park perimeter was surveyed, more vegetation and fauna were observed in the northeast corner of the property where power plant will be; investigators observed enormous mango trees, egrets and the Mabouya lizard.

Local residents report catching freshwater crayfish and *Bohama* (a small fish about 6 in. long) in the Trou-du-Nord river within the industrial park. These species are harvested for subsistence level consumption.

<sup>35</sup> BDPA 1982

<sup>36</sup> Swartley and Toussaint 2006

Naturally occurring plants in the park, which are locally harvested and important for subsistence include banana, pineapple, millet, sweet potato, peanuts, cashew, *timedsyen* (used for its medicinal properties in women who have had a baby), *croupier*, spinach, pistachios, sorrel, *glucidia* (used in reforestation because it grows quickly), mangos, beans, plaintains, and cassava.

## 4.4 INSTITUTIONAL BACKGROUND

### 4.4.1 Institutions

Haiti's Ministry of Environment (MDE, *Ministère de l'Environnement*) is the primary institution responsible for environmental management and protection. The Ministry of Public Works, Transportation, and Communication (MTPTC, *Ministère des Travaux Publics, Transports, et Communications*) as well as the Ministry of Agriculture and Natural Resources Management (MARDNR, *Ministère de l'Agriculture et des Ressources Naturelles*) also have responsibilities associated with environmental protection.

The MDE is responsible for the development of national policy regarding environmental management, particularly in the establishment of environmental standards, implementation of the Environmental Action Plan (PAE, *Plan d'Action pour l'Environnement*), and the management and regulation of protected areas. The General Inspectorate for the Environment (*Direction Générale*) is the branch that oversees law enforcement and environmental impact assessment (EIA). The General Inspectorate is divided into three departments: the Technical Department, the Administrative Department, and Regional Offices (Northeast, South, and Artibonite). The Technical Department provides numerous services, including regulation and oversight for EIA, biodiversity, erosion control, water quality, and environmental education. To provide EIA oversight and guidance on multi-sectoral development projects, The Technical Department houses the Technical Environment Unit (UTES, *Unité Technique Environnementale Sectorielle*), which includes representatives from numerous ministries concerned with environmental management. The UTES Coordinator facilitates collaboration between the various ministries on environmental regulation and protection.

The MTPTC is responsible for ensuring environmental protection during all public works projects. It includes the MTPTC Environment Unit or Cell (*Cellule du MTPTC*) with the following responsibilities: ensure that sound environmental protection measures are employed by projects; coordinate with the MDE; provide evaluations and recommendations on EIA measures; and insert environmental clauses in public offerings and procurement documents.

Authorities at the departmental, commune, and communal section levels support the central government in protecting the environment and managing natural resources. Principal functions include participation in departmental and communal action plans concerning the environment and sustainable development, implementing land use management plans, maintaining public health services and preserving natural, historic, and cultural resources.

### 4.4.2 Management Structure for the North Park Power Facility

The government agency responsible for the North Industrial Park is the National Society for Industrial Parks (*Société Nationale des Parcs Industriels*, or SONAPI), an autonomous state-owned corporation having responsibility for building and managing industrial parks. An interim report studying the feasibility of the North Industrial Park plan for IDB noted that "SONAPI has limited staff and technical resources, and is likely to require outside technical assistance if it is to act as the agency responsible for

the new park,” and that it will “require substantial expert assistance on reorganization, training, and capacity building, probably funded by one or more donors.”<sup>37</sup>

SONAPI works in collaboration with UTE (*Unité Technique d’Exécution*) to help identify, select, and contract with one or more private companies to act as master developer for the park. A Korean firm has already been selected to build and operate a textile manufacturing facility.

No known compensation, resettlement, or communications plans for local residents living or farming within the park boundaries are available to help the local community make the transition to the development of the industrial park.

#### 4.4.3 Legislation

The General Decree on Environment (*Décret Cadre sur l’Environnement*) was prepared by the MDE with the assistance of the Inter-American Development Bank and approved by the Interim Government in 2005. Chapters in the Decree that are most relevant to EIA include the following:

- Protected areas (Chapter 3, art. 48-55);
- Environmental evaluation (Chapter 4, art 56-61);
- Environmental surveillance (Chapter 5, art 62-67); and
- Common norms (Title 4 and Chapter 1, art 89-93).

#### 4.4.4 Regulatory Authority

The regulatory authority responsible for energy and electricity production and consumption in Haiti is the Ministry of Transportation, Public Works and Communications (*Ministère de Travaux publics, des Transports et des Communications* or MTPTC). The Minister of the MTPTC also presides as the President the Haiti Electric Utility (*Bureau de direction d’Électricité d’Haïti*, or EDH). There are no known regulations or standards for air quality in Haiti.

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<sup>37</sup> KOIOS Associates, Development of the Industrial Park Model to Improve Trade Opportunities for Haiti (HA-T1074-SN2), Interim Report submitted to the Inter-American Development Bank on September 10, 2010, page ix.

## 5. POTENTIAL SOCIAL AND ENVIRONMENTAL IMPACTS

This section describes the impacts identified with each alternative (Table 5). The impacts are organized according to the stage of the project (preconstruction/construction phase or operational phase) in which they are anticipated. Consideration of indirect and cumulative effects is based on the best available information at the time of writing this report. Development activities and plans conducted by donors other than USAID that were revealed at a later date are not included.

**Table 5. Socioeconomic and environmental impacts analyzed**

Socioeconomic Impacts	Environmental Impact
Quality of Life	Soil and Erosion
Standard of Living and Employment Opportunities	Vegetation
Administrative and Social Organization	Wildlife, Wildlife Habitat, and Natural Ecosystems
Infrastructure and Services	Water Quality
Health and Safety	Air Quality
Gender	Noise
Agriculture and Livestock	Landscape and Aesthetics
	Cumulative Effects

### 5.1 IMPACT EVALUATION CRITERIA

Once identified, anticipated impacts are analyzed and evaluated based on available information. The method used for evaluating the overall importance of impacts is based on four fundamental criteria:

1. Nature (positive or negative, and direct or indirect);
2. Duration (temporary or permanent);
3. Areal extent (regional, local, or isolated); and
4. Intensity (low, moderate, or high).

These criteria enable the determination of the overall importance or significance (low, moderate, or strong negative/positive) of each impact identified. Even if a particular evaluation is merely based on a value judgment rather than quantitative data that is not available, the methodology enables the establishment of acceptable levels and defines necessary mitigation and monitoring measures to minimize or eliminate impacts.

#### 5.1.1 Nature of Impact

The nature of the impact can be described as positive or negative. Positive impacts enhance the quality or facilitate access to baseline socioeconomic and environmental elements described above (Section 4), while negative impacts degrade their quality or limit access.

Impacts are also described as direct or indirect. A direct impact appears as an immediate result of a project activity, such as the damage to vegetation caused by the creation of a staging area for equipment storage. An indirect impact arises from a project activity at the secondary level, such as the enhanced opportunities to for economic development enabled by the project.

### 5.1.2 Duration of Impact

The duration of an impact can be temporary or permanent. Careful attention has been made to distinguish between the duration and the source of the impact. For example, a source of impact of short duration (such as turbidity of river water caused by storm runoff from the construction site during construction) can exert an impact of permanent duration on the downstream environment (sedimentation of the riverbed). The presence and operation of the infrastructure works generally impose impacts of permanent duration.

### 5.1.3 Areal Extent of Impact

The areal extent of an impact refers to its area of influence and can be regional, local, or isolated to a particularly small and well defined area. An impact of regional extent exerts an influence far beyond the surroundings of the project area. The local area of influence refers to the communities of the East and North-East Departments affected by the project. And lastly, an isolated impact is limited in extent to a small, readily defined area or experienced by a small number of individuals.

### 5.1.4 Intensity of Impact

The intensity of an impact concerns the scale or size of the impact on socioeconomic and environmental elements such as the productivity of natural habitat, a community, or the utilization of resources. Intensity is evaluated as low, moderate or high. Impacts are evaluated as a function of how they affect the overall integrity of elements and their vulnerability to degradation or loss in value.

### 5.1.5 Mitigation Measures

Recommended mitigation measures associated with anticipated impacts are assigned one of three types of designations in Tables 11 and 12 at the end of this section:

- Those recommended to be incorporated into project design by construction contractor (denoted by \*\*\*\*);
- Those recommended to be implemented during construction and operation by construction contractor (denoted by \*\*); and
- Those outside of the scope of this project, yet recommended to be implemented by Industrial Park Manager (denoted by ++) in order to maximize project success.

## 5.2 IMPACTS OF PROPOSED ACTION

### 5.2.1 Impacts on Quality of Life

#### Pre-construction and construction phase

*Direct Effects.* The transport of generators and construction materials to the project site will cause increased traffic to the local road network which could create inconveniences to the local population, alter traffic patterns, and increase the risk of accidents.

*Indirect Effects.* Construction works at the power plant project site will require the influx of workers from outside the local area, which could create the potential for increased crime.

In addition, the onset of power plant installation will fuel expectations for more employment opportunities provided by the industrial park. If these expectations are not met, local stakeholder support for the project may be jeopardized.



*Cumulative Effects.* The effects from increased potential for crime and expectations for employment opportunities will be intensified when combined with similar effects of other development projects beginning construction in the area at the same time, including other activities within the industrial park, the University, and port development at Fort Liberté and Cap Haitien. Sociopolitical tension could be created as local residents witness the influx of people seeking work in the area.

*Mitigation Measures.* The installation of signage and other means of communication with the local population regarding anticipated impacts and changes that might affect daily routines of local residents will help minimize tension and foster local support and cooperation. The development and implementation of a communications plan by SONAPI or other designated industrial park manager before construction activities begin will help prepare the local community for the changes they will experience<sup>38</sup>, particularly with regard to the cumulative impacts discussed above. With such a plan in place, the negative impacts on quality of life are expected to be minor, especially when weighed against the positive benefits provided by increased employment opportunities.

### **Operation phase**

*Direct Effects.* Under operation, the power plant will produce noise which can disturb the local and population and industrial park workers. Increased traffic associated directly with power plant operation will create additional sources of disturbance and increased risk of traffic accidents to the local population and workers.

Restricted access to the site by those who currently farm the land within the confines of the industrial park will also create a permanent loss of agricultural production on highly valued land having a high soil potential to support productivity.

At the beginning of the pre-construction and construction phase, the local population may experience disappointment if employment expectations are not met. On this point, it is important to note that the Korean manufacturing company that will operate the textile industry within the park, has already initiated training for 150 workers from other countries who are expected to live and work at the industrial park in Caracol. The training of and potential for hire of outside workers is already perceived negatively by the local community, and tension and concern is beginning to mount.

*Indirect Effects.* The arrival of large numbers of outside workers creates the potential for the spontaneous development of informal settlements or slum communities on the periphery of the industrial park, which can cause elevated risks for crime. Such a situation could impose a highly negative impact on the quality of life of the local and even regional population.

*Cumulative Effects.* The intensified effects from increased potential for crime and expectations for employment opportunities when combined with similar effects of other development projects will continue to escalate during operation. Sociopolitical tension could continue or intensify as local residents witness incomers to the area that are actually gaining work they feel should be targeted for the local community.

*Mitigation Measures.* The installation of an insulated engine room to contain the noise and vibrations from the diesel generators will considerably reduce the sound emanated from the power plant. This mitigation measure should limit noise to a maximum of 85 decibels one meter from the exterior wall of the insulated engine room. Ambient noise levels should be no more than 5 decibels at the site boundaries.

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<sup>38</sup> Mitigation measures that are the responsibility of the industrial park manager(s) or implementing partners other than USAID are designated by “++” in Tables 11 and 12 below on impacts and mitigation measures.

The installation of signage and other means of communication will help inform the population of expected changes and help minimize risks to transportation safety from increased traffic patterns associated with power plant and industrial park operation.

The creation of a buffer zone between the outer limit of the industrial park and the park-associated infrastructure within the park boundary will help discourage spontaneous informal settlements on the outskirts of the park. The application of these mitigation measures will help minimize negative direct and indirect impacts from the proposed project on the quality of life of the local community.

The implementation of a communications plan before the commencement of construction works will help prepare the population for anticipated changes. It is recommended that SONAPI collaborate with local and departmental authorities in the implementation of a management plan that emphasizes the integration of migrant workers into the commune of Caracol. Such collaborative actions will essentially provide important information to the local community on power plant and park operations.

## 5.2.2 Impacts on Standard of Living and Employment

### Pre-construction and construction phase

*Direct Effects.* Construction of the power plant and associated work will create approximately 10-20 jobs during a period of two and a half years<sup>39</sup> and a portion of these jobs can be filled by members of the local community. Given the relatively small number of jobs created by construction, the positive impacts will be minor. Additionally, the sale of goods and services to support the construction activities will offer local business opportunities through the provision of food (meat, fruits, and grains) and construction materials (sand, gravel, cement).

*Mitigation Measures.* Considering the expectations of the population with regard to economic benefits derived from the project, it will be important for the construction manager to maximize local employment and the purchase of locally derived goods and services. Before construction begins, the local community should be informed of the available job opportunities, and the requirements for goods and services. The type of skilled workers should be communicated early, and in coordination with local authorities and NGOs, compile a list of qualified local individuals. If possible, worker training should be provided in order to maximize local employment.

### Operation phase

*Direct Effects.* Operation of the power plant will create between 10 and 20 permanent jobs, in addition to the business opportunities related to the provision of locally derived goods and services for operation and maintenance of the plant and needs of the workers.

*Indirect Effects.* The development of other activities in the industrial park following the installation of the power plant will have an indirect positive impact on the quality of life throughout the Caracol commune. The 20,000 to 25,000 jobs that will be created by the park's textile manufacturing industry will enable unemployed and non-working citizens, which comprise nearly three quarters of the population of working age in the Northeast Department, to have the opportunity to earn a regular salary. For workers who maintain a subsistence level of farming or fishing, it is possible that some of them will choose to cease these activities in order to work in the industrial park, if earnings are higher.

*Mitigation Measures.* As in the pre-construction and construction phase, it is important that the power plant manager prioritize the hiring of local workers and the purchase of local goods and services.

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<sup>39</sup> Estimates include 10-20 workers construction et l'installation d'un premier 4 mégawatts pour février 2012. Et de dix à vingt travailleurs pour la construction et l'installation d'une puissance additionnelle de 10 à 30 mégawatts entre février 2012 et décembre 2014.

Furthermore, the implementation of a communications plan prior to commencement of construction for the power plant will enable local stakeholders to understand the available employment and business opportunities and be able to maximize participation in these benefits. With the implementation of these measures, and with consideration of the large number of non-specialized jobs and business opportunities created by the park, it is possible that impacts on the local population will be positive and permanent.

### 5.2.3 Impacts on Administrative and Social Organization

#### Pre-construction and construction phase

*Direct Effects.* A lack of information and communication regarding the construction work will continue to create tension between park and power plant managers and local stakeholders, particularly among local administrative officials.

*Mitigation Measures.* It is recommended that the construction manager for the power plant inform local authorities of the nature and schedule of construction activities. The implementation of a protocol to respond to concerns and complaints registered by local residents is also recommended.

#### Operation phase

*Direct Effects.* The commissioning of the power plant and the development of the industrial park will raise economic, social and environmental issues important to department and local authorities and social organizations.

*Indirect Effects.* An additional indirect social impact may be that as women move from the agricultural field to factories, their children may be left unattended for longer periods of time than when they were engaged in agricultural work. This could cause a negative social impact if children left unattended for long periods of time on their own engage in mischievous activity and form gangs.

*Cumulative Effects.* Ministerial and departmental authorities, notably those from the Ministries of Agriculture and Planning, will be responsible for addressing added pressures on the natural environment (agricultural and water resources). If stakeholders do not have the necessary financial and organizational means to address new problems and issues that arise, it will be difficult to respond and manage additional needs and issues raised by the power plant and associated industrial park. This has the potential to create tension between power plant and industrial park managers and local authorities.

*Mitigation Measures.* Impacts can be minimized by developing a management plan for future development of the commune<sup>40</sup>, creating needed infrastructure and organize the delivery of public services to facilitate integration of workers and possibly their families into the commune.

A potential mitigation for children's risk of being influenced by gang activity is for the garment companies provide a form of day care at the site that could also serve as a hands on teaching ground for children. Such a facility could possibly involving farming organic vegetables in a designated garden area that youth establish and maintain.

In order to minimize negative impacts, the industrial park manager should collaborate with local and departmental authorities by enabling the transparent exchange of information regarding park development plans and maximizing the employment of local residents. If local and departmental authorities have access to sufficient means to improve sorely needed infrastructure and services for the commune, these

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<sup>40</sup> A management plan for the commune of Caracol is currently under preparation, as reported in a report to the IDB by KOIOS Associates, *Development of the Industrial Park Model to Improve Trade : Opportunities for Haiti*, 2010.

stakeholders will be more inclined to provide support to park managers and work with them more collaboratively to help meet their goals.

## 5.2.4 Impacts on Infrastructure and Services

### Pre-construction and construction phase

*Direct Effects.* The transport of generator engines, other machinery and construction materials to the power plant site will temporarily disrupt traffic patterns and cause accelerated wear on local roads providing access to the site.

*Mitigation Measures.* To minimize these effects, the construction manager should inform the community in advance of the anticipated impacts on traffic and roadways. Appropriate measures should be put into place to manage traffic. Maintenance and repairs to local routes utilized for transport should be provided, as well as the management of solid waste and abandoned materials left on site. The implementation of these measures will minimize negative effects during transport and construction.

### Operation phase

*Direct Effects.* A positive, direct impact will be the supply of electricity to the industrial park settlement, thus decreasing the pressure on existing electrical needs for the new communities. The new plant system and electrical lines should ensure a consistent source of electricity for the new settlements and industrial area.

*Indirect Effects.* The anticipated population growth as people are lured by the prospects for employment and new business opportunities will augment traffic and accelerate wear and degradation on transportation infrastructure. This will create added pressure on other infrastructure and services which can hardly meet the current needs of the local and regional population. Of particular concern are health care, schools, drinking water wells and sanitation facilities, and police services. Without appropriate mitigation measures, negative impacts on infrastructure and services will be moderate and permanent.

*Cumulative Effects.* The industrial park alone is expected to attract up to 65,000 workers over the long term. Assuming the average each worker brings a family size of 7 to the area, this corresponds to an additional influx of 455,000 persons requiring food and domestic products, infrastructure, education, public health, and police security services. This will place added pressure on public services that are already stretched thin, and create social tension.

Future expansion of the power plant capacity with possible alternative energy sources utilized could cut down on noise and air pollution while providing more consistent available electricity for additional residences and a larger industrial base from other development projects in the area.

*Mitigation Measures.* The power plant manager is advised to put in place appropriate signage on routes used to transport equipment and workers to the project site. It is recommended that the industrial park manager develop and implement a management plan for the transport of materials and road improvement actions. Also recommended is that the park manager develop a plan to participate in the improvement of infrastructure facilities that workers of the industrial park will utilize. The combined application of these measures will not only minimize negative effects from the influx of a large number of outside workers to Caracol, but will enable the improvement of infrastructure and services important not only to local residents but also to newly arrived industrial park workers. The impacts will then be positive, moderate, and permanent.

### 5.2.5 Impacts on Agriculture and Land Use

#### Pre-construction and construction phase

*Direct Effects.* Restricted access to the site will have a negative short term effect on farmers currently using the land. The majority of farmers have stopped cultivation, for fear of being forced to leave and losing a hard-earned harvest crop. In addition, one inhabited house located on the industrial park will need to have its residents relocated.

*Indirect Effects.* Power plant construction will create food needs for workers. Some farmers can benefit from the sale of necessary goods and services. This positive impact will, however, be minor and temporary, exerting an impact only during the construction phase.

*Cumulative Effects.* The past action of land clearing that has already occurred has pushed farmers off the land they have cultivated for years, and has angered local residents. This social tension could intensify as access to the park becomes even more restricted once the power plant construction begins.

*Mitigation Measures.* The industrial park manager should implement a compensation and resettlement plan for local residents currently working the land within the park boundaries in order to minimize negative impacts associated with the loss of productive use of the land.

#### Operation phase

*Direct Effects.* Power plant operation, as well as activities associated with the industrial park, will create opportunities to sell agriculture and fisheries products that will enhance the development of public markets in Caracol commune.

*Indirect Effects.* The loss of permanent access to farmland within the park boundaries will affect numerous farmers and their families. According to the Champin CASEC, there are approximately 1,000 people who farm the land and raise livestock on areas within the park who will lose access to park land, which will cause a significant loss since this land represents approximately 40% of all the land they farm. This impact will be more significant to subsistence level agricultural production. To further exacerbate the situation, increased population growth as people are attracted to employment opportunities offered by the industrial park will cause an increased demand for land, agricultural and fisheries products in the Caracol commune. A reduction in agricultural potential combined with increased demand will cause food prices to rise, and this will aggravate malnutrition and poverty problems already observed in the community, particularly for children.

*Cumulative Effects.* With regard to the impact of cumulative effects on agricultural production, the University and other new permanent settlements will place an additional negative impact on loss of farm land from the development of the University and settlements, as well as an increased need for additional food (and resulting higher prices for food).

The indirect positive impacts will be that farmers in surrounding communities of the industrial area, University, and new settlements will have access to a much larger market and will be able to set higher prices, especially as agricultural production decreases in the immediate project area due to farmers becoming factory workers and prime agricultural lands are taken by development.

*Mitigation Measures.* To mitigate these problems, the industrial park manager should put into place a resettlement plan with compensation for those individuals living in or farming land within the industrial park. Local elected officials hope for three types of compensation: monetary compensation to individuals for loss of land (short-term), training to enable local residents to have skilled jobs associated with the park in the medium term (6-12 months), and in the long term the relocation of farmers to new

areas to farm. The *Femmes Vaillantes* women's association hopes that a resettlement plan will also include support (such as access to credit and agricultural inputs, improved farming techniques, and public market facilities) to enhance agriculture, livestock raising, and fisheries, the primary income generating activities of the region. The implementation of a comprehensive resettlement package will minimize the significant negative impacts on agricultural activity that are anticipated.

There is an NGO implementing an organic farm near the permanent settlement and University area. This farm could serve as a model for more intensive, organic farming techniques to farmers that have access to land for vegetable gardening in the permanent settlements. As well, the industrial area and associated new development will increase sales for this organic farm.

### 5.2.6 Impacts on Gender and Youth

#### Pre-construction and construction phase

*Direct Effects.* Despite the fact that Haitian women play a vital role in the informal economic sector and domestic affairs, they are often neglected in terms of formal employment, particularly with regard to construction. For the Northeast Department as a whole, there are proportionally fewer women than men who are actively working in the formal jobs sector. Construction of the power plant will offer new employment opportunities for both men and women in Caracol. Employment will offer higher income potential, which can help alleviate economic stress and improve the quality of life for families and children.

*Mitigation Measures.* It is important that the construction manager offer equitable employment opportunities for men and women, which may involve additional encouragement to women who may not otherwise apply. Due to the relatively small number of jobs created by power plant construction, the positive impacts on women, if recommended mitigation measures are followed, will be minor.

#### Operation phase

*Direct Effects.* Operation and maintenance of the power plant will offer employment opportunities to both men and women in the Caracol commune. The positive impact created by these jobs will be minor.

*Indirect Effects.* Increased access to employment has the potential to redefine the economic status of women, and can possibly create new tensions between couples. But on the whole, the indirect impacts on the conditions women face in the Caracol commune will be strongly positive.

*Cumulative Effects.* The indirect positive effects produced by the development of other industrial park activities will be much more important, particularly for women. The thousands of non-specialized jobs to be created in the textile manufacturing industry will likely improve the economic outlook for women, as most of these jobs are traditionally filled by women. Many will choose to abandon agricultural activities to work in the park. Others will benefit from new business opportunities provided by the sale of goods and services needed by industrial park activities.

*Mitigation Measures.* It is recommended that the power plant operator offer equal employment opportunities to men and women. The industrial park manager must also encourage and facilitate equitable hiring of men and women by the other manufacturing industries to be developed within the park.

## 5.2.7 Impacts on Health and Safety

### Pre-construction and Construction Phase

*Direct Effects.* The construction of the power plant, including the transport of generators and supplies to the project site, will increase the risk of traffic and/or worker accidents. With the implementation of an occupational health and safety program and adequate road accident preventive and safety measures, these impacts are minor.

*Indirect Effects.* Transmission of sexually transmitted diseases, including HIV/AIDS, can increase due to the interaction of outside workers with the local population during power plant construction.

*Mitigation Measures.* The power plant construction manager will prepare and implement a Health and Safety Plan (HASP) to ensure health and safety during both construction and operation of the power plant (see Section 7 below). This will also include the provision of training on best practices for plant workers in order to minimize risks, and awareness raising information on STDs and HIV/AIDS. Workers who fail to comply with safety guidelines should be terminated after repeated warnings are issued.

Access to the power plant site will be controlled at all times to prevent entry and possible injury from persons not associated with the project. Security of the site will be the responsibility of the construction contractor. The construction contractor will provide sufficient onsite drinking water, sanitation facilities, and wash and change facilities. All site personnel shall have personal protection equipment, including hard hat, safety glasses, hearing protection and reflective vest.

### Operation Phase

*Direct Effects.* For impacts on water quality and safe water, see Section 5.2.10 below.

The path of the power distribution lines is not known at the time this EA was developed; thus, it is not possible to fully evaluate their impact. However, the discussion below provides a general perspective on anticipated impacts, and suggested guidelines developed by the International Finance Corporation (IFC) and the World Bank to promote environmental, health and safety protection for electric power transmission and distribution lines.

Electric field strength is produced by voltage, and increases in strength as voltage increases. It is measured in volts per meter (V/m). Electric fields are shielded by materials that conduct electricity, and other materials, such as trees and building materials. Magnetic fields result in the flow of electric current and increase as current increases. Magnetic fields pass through most materials and are difficult to shield. Both electric and magnetic fields decrease rapidly with distance. The electromagnetic field (EMF) of power distribution systems typically has a frequency in the range of 50-60 hertz (Hz), and is considered Extremely Low Frequency (ELF).<sup>41</sup>

Although there is public and scientific concern over the potential health effects associated with exposure to EMF, there is no empirical data demonstrating adverse health effects from exposure to typical EMF levels from power transmissions lines and equipment.<sup>42</sup> However, while the evidence of adverse health risks is weak, it is still sufficient to warrant limited concern.

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<sup>41</sup> National Institute of Environmental Health Sciences, 2002, as reported by the IFC and World Bank Group in "Environmental, health, and Safety Guidelines for Electric Power Transmission and Distribution, April 30, 2007.

<sup>42</sup> International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2001; International Agency for Research on Cancer 2002; U.S. National Institute of Health 2002; Advisory Group to the Radiation Protection Board of the UK 2001; and U.S. National Institute of Environmental Health Sciences 1999 (cited in the IFC and World Bank Group in "Environmental, health, and Safety Guidelines for Electric Power Transmission and Distribution, April 30, 2007).

*Mitigation Measures.* Recommendations include the following measures:

- Evaluate the potential exposure to the public against the recommended levels developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and maintain average and peak hours levels below the ICNIRP recommendations for General Public Exposure.
- Consider siting new facilities so as to avoid or minimize exposure to the public.
- Place transmission lines or other high voltage equipment above or adjacent to residential property or other locations intended for highly frequent human occupancy such as schools or offices should be avoided.
- If EMF levels are confirmed or expected to be above the recommend exposure limits, application of engineering techniques should be considered to reduce the EMF produced by power lines, substations, or transformers. Examples include:
  - Shielding with specific metal alloys;
  - Burying transmission lines;
  - Increasing height of transmission towers; and
  - Modifications to size, spacing, and configuration of conductors.

## 5.2.8 Impacts on Soil and Erosion

### Pre-construction and Construction Phase

*Direct Effects.* During construction activities, oil contamination may be caused by oil leakages from heavy equipment, improper handling of petroleum products and fuel spillage during dispensing. Contamination may also occur from the improper disposal of used oils, hydraulic fluids, toxic and empty containers.

Some activities involving site installation, stock piles and fill site preparation, and drainage excavation will temporarily cause soil destabilization.

*Cumulative Effects.* The past action of land clearing within the industrial park by the park manager(s) has left bare soil vulnerable to erosion, and in many cases this is evident near the Trou-du-Nord river bank where a recommended 20 M riparian buffer has not been maintained. This will exacerbate erosion from construction for the power plant.

*Mitigation Measures.* It is recommended that appropriate vegetation be planted along riverbanks within the project area to promote soil stabilization. A vegetated buffer zone of approximately 20 meters (M) will be maintained on either side of the river. Silt screens should be employed in areas of activity near the river to prevent sedimentation. No sand, gravel, rock, or water will be extracted from the river or its channel during construction. Source sites for sand, gravel and rock will be revegetated following construction. The construction contractor will prepare a storm water pollution prevention plan (SWPPP) to mitigate storm runoff and soil erosion throughout the site.

### Operation Phase

*Direct Effects.* Abandoned cement stone aggregated, or gravel littered around stock pile and staging areas after installation of the power facility may change the soil structure. Similarly devegetated areas may increase soil erosion.

*Mitigation Measures.* It is recommended that appropriate vegetation be planted along riverbanks within the project area to promote soil stabilization, as during the construction phase mentioned above. A vegetated buffer zone of approximately 20 M will be maintained on either side of the river. Source sites



for sand, gravel and rock will be revegetated following construction. A barrier of gravel, rock or synthetic sheeting should be placed on the ground under building areas to avoid changes in soil structure.

### 5.2.9 Impacts on Vegetation

#### Pre-construction and Construction Phase

*Direct Effects.* While some shrubs and ground cover remain, all vegetation will likely be removed as the area is resurfaced for drainage, as well as the creation of staging areas, stock piles, and fill sites. Poor disposal of toxic waste and petroleum products may hamper normal growth of vegetation in these areas.

*Cumulative Effects.* The power plant has recently been cleared of most large trees by the industrial park manager(s). Many of these were large fruit (mango) trees that were highly valued by the local community. As mentioned above, in many cases this is evident near the Trou-du-Nord river bank where a recommended 20 M riparian buffer has not been maintained. This will exacerbate erosion from construction for the power plant.

*Mitigation Measures.* Recommendations include the installation of drop pans at petroleum product dispensing points, the storage of potential pollutants such as fuel, oil, and chemicals on sealed surfaces to prevent soil contamination and the collection and recycling used oil and lubricants, where possible, by the construction work team. The construction contractor will maintain a vegetated buffer zone approximately 20 M wide on either side of the Trou-du-Nord River to mitigate the impact to the river and riparian vegetation from construction activities. Large trees should be left along the perimeter of the park boundary.

#### Operation Phase

*Direct Effects.* Few negative impacts on vegetation within the industrial park are anticipated during the operational phase of proposed action. This is largely because at this point, most of the vegetation will have been removed during the pre-construction and construction phases.

*Cumulative Effects.* Cumulative impacts from riparian planting related to all activities within the Trou-du-Nord watershed would have a major positive impact on the coastal mangrove vegetation downstream. The construction of a power plant, industrial area, and permanent settlements will significantly increase the population of the area that in turn would put increased pressure on wood resources for cooking and building materials, mainly the mangroves.

In addition, the increased population anticipated in the area will undoubtedly create additional sewage and solid waste that will threaten the downstream marine and mangrove ecosystem if not managed properly. This issue was also raised by FoProBiM in a recent bulletin published in July, 2011.

**Photo 19. Clearing to provide an access road to the location of the future power plant has already begun**



Source: AECOM, June 2011

**Mitigation Measures.** Any replanting on the site or of riparian plants to stabilize the stream bank may directly benefit local streamside vegetation, but these actions within the 6 ha project site are likely not enough to exert a positive impact on downstream sedimentation in mangroves. The benefits to vegetation and mangroves will improve over a 1 to 5 year period as the vegetation established in mitigation measures for construction become an efficient means of stabilization and water retention. It is strongly recommended that measures be taken to establish the Caracol marine protected area that has been proposed by the Ministry of Environment. Associated protection measures could include stringent requirements for wastewater treatment and solid waste facilities.

A program to purchase propane gas tanks and stoves for the people moving into the industrial plant and permanent settlement, combined with a training program to use them should also be explored. Some other alternative to charcoal and fuelwood for cooking will be needed given that it is estimated that there can be nearly an increase of 400,000 people to the area.

Mitigation measures include a revegetation plan as part of the SWPPP. Large trees will be left along the border of the park to provide shade and fruit for park workers and residents.

### 5.2.10 Impacts on Wildlife, Habitat, and Biodiversity

#### Pre-construction and Construction Phase

**Direct and Indirect Effects.** The impacts on terrestrial wildlife in the project area are considered minor as little to no loss of natural habitat will occur, since the power plant site has recently been cleared (Photo 19). Continued road construction to access the project site will temporarily increase sediment loading to the river environment. However, given that the exposed embankments, are currently contributing sediment loading to the river, the additional amount from construction activities is relatively small.

**Mitigation Measures.** Recommendations previously mentioned to minimize erosion and vegetation loss, and protect river and mangrove environments will help minimize impacts to wildlife, habitat, and biodiversity.

#### Operation Phase

Impacts on terrestrial and aquatic wildlife after construction are considered insignificant.

### 5.2.11 Impacts on Water Quality

#### Pre-construction and Construction Phase

**Direct Effects.** Water quality of the Trou-du-Nord River may be negatively impacted during power plant construction and road construction by contamination from fuel leakages and improper disposal of toxic substances and petroleum products. Erosion from construction activity could cause sedimentation. These impacts are of short duration, since the construction activities are expected to end within less than six

months' time. River or ground water quality could be compromised by inadequate sanitation facilities for construction workers.

*Cumulative Effects.* Past actions to prepare for development of the Industrial Park will exacerbate erosion and sedimentation from power plant construction.

*Mitigation Measures.* To mitigate impacts, the construction contractor will prepare a SWPPP to control storm runoff and soil erosion throughout the site. A buffer zone of at least 20 M will be maintained between construction activity (including worker sanitation facilities) and the river. If necessary, silt screens will be installed to minimize sediment and soil entering the river. Soil-moving activities should take place during the dry season months as much as possible.

All potential pollutants, hazardous materials, petroleum products, lubricants, hydraulic oil, paints, and coatings, shall be stored in an approved container and placed on a sealed surface with containment dikes to prevent soil and water contamination.

A temporary impermeable concrete truck wash out pit will be constructed to preclude wash water from contacting the ground. For this structure, effluent from any concrete pour is contained in a temporary evaporation pond that is lined with a membrane such as visqueen or poly sheeting to prevent seepage into the ground. Material or residue that settles and eventually hardens into an inert substance, after a substantial amount evaporates (similar to laitance that forms from excessive water mixed with cement), can be mechanically broken apart and removed with relative ease.

### Operation Phase

*Direct Effects.* Erosion of bare areas resulting from excavation, drainage channels and construction works may increase runoff which will lead to sedimentation and increased turbidity in surface water. Hazardous materials spilled from transport vehicles and washed into the river may result in water pollution. Bacteria and nutrients may impact water quality in ground or river water from sanitation facilities.

***Photo 20. Unchecked development along coastal and river environments threatens water quality and aquatic life***



Source: AECOM, June 2011

*Cumulative Effects.* Of particular concern are the increased drainage and runoff into the Trou-du-Nord River and downstream mangrove and coastal environment created by the power plant operation, and other industrial park activities, especially the wastewater treatment plant. Increased solid sewage and trash waste will cause soil and water pollution as well as health issues, especially since there is neither properly designed landfills nor sewage treatment plants available. Smucker et al. (2007) aptly note that “rapid population growth and urbanization do not allow aquifers and wetlands to function as a natural storage, filter, and regulator during flood conditions” and that “demographic pressures further aggravate the trend for increased runoff” during flood and storm events. This will be exacerbated as industrial park and other development plans ramp up implementation.

Additional activities impacting the Trou-du-Nord River, such as the rum distillery in Trou-du-Nord and pollution from communities upstream of the park area also contribute to cumulative water quality impacts.

Combined impacts from sanitation facilities at the power plant and other office, industry, and residential buildings within the park could negatively impact ground and river quality.

*Mitigation Measures.* Recommendations include the maintenance of a 20 M buffer area on each side of the river, and the implementation of a SWPPP, as discussed above. Disturbed areas will be revegetated to help prevent harmful runoff entering the river. During construction, waste from portable latrines should be regularly emptied and properly disposed of in a designated landfill area. To manage sanitation impacts during operation, a septic field should be adequately designed and maintained for the power plant sanitation facilities. The septic field should be located as close to or within the power plant site as practical and environmentally sound, but not closer than 20 m from the river, and all potable well water should be tested for bacteria on a regular basis. Other industrial park sanitation facilities should include sewerage connections to the wastewater treatment facility for processing of waste, once the treatment plant is constructed. A biodigester could be designed for the industrial park to capture sewage and produce methane gas for use in generation of electricity. Other recommendations include working with the municipality to construct an official landfill site. It is important to note that the mayors of Limonade and Cap Haitien have already developed plans for an official landfill site.

## 5.2.12 Impacts on Air Quality and Comparison of HFO and Diesel Fuel Options

### Pre-construction and Construction Phase

*Direct Effects.* During construction and improving access roads through the industrial park to the power plant site, large amounts of soil will be excavated, stockpiled, and transported. The machinery used for excavation will generate dust, which can be dispersed by the wind. Emissions in the air from exhaust fumes and dust from vehicle and machines may cause nuisance to surrounding homes, pedestrians and workers. Dust generated from access roads and during transportation of materials will also pollute the air in the immediate local environment.

*Mitigation Measures.* Excavation areas will be watered to limit dust emissions. Limits on the speed of construction vehicles will be established and enforced.

### Operation Phase

*Direct Effects.* The primary risks to air quality concern the emissions from the power plant. Emissions from both the HFO and diesel fuel alternative are discussed below.

Combustion of fossil fuels produces harmful emissions of particulate matter (PM), ozone, nitrogen oxides (NO<sub>x</sub>), sulphur oxides (SO<sub>x</sub>), and carbon monoxide (CO) in the air, which can compromise human health. Ash residues and the dust removed from exhaust gases may contain significant levels of heavy metals and some organic compounds. Important health impacts are discussed below<sup>43</sup>.

The major sources of anthropogenic emissions of NO<sub>x</sub> are combustion processes (heating, power generation, and engines in vehicles and ships). Epidemiological studies have shown that symptoms of bronchitis in asthmatic children increase in association with long-term exposure to nitrogen dioxide (NO<sub>2</sub>). At short-term concentrations exceeding 200 µg/m<sup>3</sup>, it is a toxic gas which causes significant inflammation of the airways. Nitrogen oxides are also precursors for the formation of ground-level ozone.

Ozone is formed by the reaction with sunlight (photochemical reaction) of pollutants such as nitrogen oxides (NO<sub>x</sub>) from vehicle and industry emissions and volatile organic compounds (VOCs) emitted by

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<sup>43</sup> WHO 2008

vehicles, solvents and industry. The precursor VOCs are primarily non-methane hydrocarbons (NMHCs). Exposure to ground-level ozone can cause breathing problems, trigger asthma, reduce lung function and cause lung diseases.

Sulphur oxides are produced from the burning of fossil fuels containing sulphur (coal and oil) for domestic heating, power generation and motor vehicles. SO<sub>2</sub> can affect the respiratory system and the functions of the lungs, and causes irritation of the eyes. Inflammation of the respiratory tract causes coughing, mucus secretion, aggravation of asthma and chronic bronchitis and makes people more prone to infections of the respiratory tract. Hospital admissions for cardiac disease and mortality increase on days with higher SO<sub>2</sub> levels. When SO<sub>2</sub> combines with water, it forms sulphuric acid; this is the main component of acid rain which is a cause of deforestation.

The major components of PM are sulphate, nitrates, ammonia, sodium chloride, carbon, mineral dust and water. Chronic exposure to particles contributes to the risk of developing cardiovascular and respiratory diseases, as well as of lung cancer. As no threshold for PM has been identified below which no damage to health is observed, the recommended value should represent an acceptable and achievable objective to minimize health effects in the context of local constraints, capabilities and public health priorities.

Carbon monoxide (CO) is produced as a combustion by-product from carbon-based fuels. Any combustion process (power production, engines in vehicles and ships, or other fuel burning equipment) has the potential to produce carbon monoxide, an odourless, tasteless, and colorless gas. Inhaled carbon monoxide enters the bloodstream and combines with hemoglobin to form carboxyhemoglobin (COHb), which reduces the blood's ability to deliver oxygen to organs and tissues. People with several types of heart disease already have a reduced capacity for pumping oxygenated blood to the heart. For these people, short-term CO exposure further affects their body's already compromised ability to respond to the increased oxygen demands when exercising or under increased exertion. Healthy individuals are also affected at higher levels of CO exposure. Exposure to elevated outdoor CO levels is associated with fatigue, visual impairment, headache, and reduced manual dexterity. At extremely high concentrations, CO can cause death.

### **Comparing Impacts to USEPA Emissions Standards**

The proposed action specifies the use of heavy fuel oil (HFO) for the power generation facility. Currently there are no relevant Haitian air quality standards for these engines; nor are baseline data on ambient concentrations of PM, sulphur oxides, nitrogen oxides, and ground-level ozone available within the project area. Since the detailed design of the power plant has not been prepared at the time this EA study was conducted, the engine specifications for the generator units to be installed are not known. Therefore, in order to assess air quality impacts, estimated emissions were calculated using available emissions factors and the engine specifications for the installation of a likely engine model to be installed: a series of three 1.6 MW Hyundai Innovative Marine and Stationary Engine (HiMSEN), model 9H21/32, manufactured in 2011. Each engine is capable of operating on diesel (900 rpm) or HFO (1,000 rpm). Three 1.6 MW units will yield a total capacity of 4.8 MW, within the target range of 4 MW during the first phase of the project.

To estimate impacts on air quality, emissions estimates were then compared with U.S. Environmental Protection Agency (USEPA) air emissions standards. The U.S. emission standards for diesel-fired nonroad engines manufactured after January 1, 2011, driving generator sets greater than 560 kW would be U.S. Environmental Protection Agency (USEPA) "Tier 4" standards. These standards are based on the use ultra low sulphur diesel (ULSD) with a sulphur content of 15 ppmw (or 0.00015% by weight). ULSD is required by the USEPA Tier 4 standards to protect catalytic traps needed to meet low particulate matter (PM) emission limits. The fuel specification for the proposed action is HFO, which has a sulphur content

four orders of magnitude higher than ULSD, up to approximately 3% by weight. Therefore, the use of USEPA Tier 4 emission standards would not be applicable in this analysis.

Generators manufactured between 2006 and 2011 are normally subject to USEPA Tier 2 nonroad engine emission standards. However, these emission standards assume the use of distillate fuels (No. 2 fuel oil), with a typical sulphur content of approximately 0.3% by weight. This sulphur content is lower than that of HFO by an order of magnitude. As a point of reference, these USEPA Tier 2 emission standards for nonroad engines and generators greater than 560 kW are provided in Table 6 below.

**Table 6. USEPA Tier 2 emission standards for nonroad diesel engines and generators (g/kWh)**

Component	Tier 2 Emission Standard
Carbon monoxide (CO)	3.5 g/kWh
Nonmethane hydrocarbons + nitrogen oxides (NMHC+NOx)	6.4 g/kWh
Particulate matter (PM)	0.2 g/kWh

Since HFO (No. 6 fuel oil) is not distillate oil and has a high sulphur content, it is recognized the above USEPA Tier 2 emission levels are not likely to be achievable without emission controls using selective catalytic reduction (SCR) for NOx, and a scrubbing technology for NOx and PM. While Tier 2 emission standards would also not be directly applicable for the HFO engines specified in the proposed action, a comparison of estimated emissions with and without emission control devices against Tier 2 standards can provide context for anticipated emissions (Table 7 below). In this analysis, Tier 2 standards are expected to be met only for CO without a selective catalytic reduction device for NOx, and a scrubber for SOx and PM reduction. Using both SCR and scrubber, Tier 2 standards may be met.

Air pollutant emission factors are published values that attempt to relate the quantity of a pollutant released to the ambient air with an activity associated with the release of that pollutant. It should be noted that there are no available emission factors on which to base estimates for the intended engine model to be installed by the NPP project using HFO. Therefore, the estimates below have been made using published AP-42 emissions factors for diesel fuel. A comparison of how this relates to anticipated HFO emissions for the Proposed Action follows.

**Table 7. Approximate emission calculations for industrial diesel engines (using emission factors from US EPA, Section 3.4, Table 3.4-1)**

Pollutant	AP-42 EF lb/hp-hr	Uncontrolled AP-42 EF g/kW-hr	USEPA Tier 2 Standards <sup>d</sup> g/kW-hr	USEPA Tier 4 Standards g/kW-hr	Emission Control on AP-42 Factors (EF)		Approx EF from Controls on AP-42 EF g/kW-hr <sup>f</sup>
Nitrogen oxides (NOx) (uncontrolled) <sup>a</sup>	0.024	14.59	6.4	0.4	Hyundai SCR	90%	2.19
CO	0.0055	3.34	3.5	3.5			3.34
SOx	0.0243	14.75	--	--	Hyundai Scrubber <sup>e</sup>	90%	1.48
Particulate Matter (PM) <sup>b</sup>	0.0007	0.43	0.2	0.10	Hyundai Scrubber <sup>e</sup>	50%	0.21
NMHC <sup>c</sup>	0.000705	0.43	Note d	0.4			0.43

Notes for Table 7 above:

- a - AP-42 controlled factor of 0.013 lb/hp-hr assumes ignition timing retard.
- b - All PM from diesel combustion is essentially PM10 (PM less than 10 micrometers in diameter)
- c - Assumes total organic compound (TOC) emission factor, and based on one engine test, 9% methane/91% nonmethane.
- d - For engines above 560 kW. NOx standards shown are for NOx + NMHC. This allows for play between NOx and NMHC emissions in controlling combustion, since these trade off in rich-burn/lean-burn combustion options. Rough rule of thumb is diesel combustion has approx 95% NOx, 5% NMHC.
- e - Typical NOx reduction for Hyundai SCR unit and engineering judgment for SOx and PM control by caustic scrubber. PM control also possible by diesel particulate filter (DPF) -- various designs, depends on fuel properties and other factors. NOx estimate in reasonable agreement with IMO Tier III NOx 2016 standard on Page 17 of Hyundai HiMSEN Engine Catalogue.

**Mitigation Measures.** The corresponding estimates for maximum emissions using three 1.6 MW generators (representing the 4 MW phase) with and without controls are provided in Table 8 below. With the moderate easterly winds experienced in the region, these values for both HFO or diesel fuel are not expected to impose a strong negative impact on the population. However, a 25 MW expansion using HFO, would exert 5.2 times more emissions, which would likely violate QHO AQ standards, thereby creating strong negative impacts on air quality and human health.

**Table 8. Estimated total emissions using three 1.6 MW generators (representing the 4 MW phase)**

Pollutant	Uncontrolled Maximum Emissions (AP-42 EFs)		Emission Control on AP-42 Factors		Emission Control on AP-42 Factors	
	lb/hr	tons/ year			lb/hr	tons/ year
Nitrogen oxides (NOx) (uncontrolled) <sup>a</sup>	154.4	676.1	Hyundai SCR	90%	15.4	67.6
CO	35.4	154.9			35.4	154.9
SOx	156.1	683.7	Hyundai Scrubber <sup>d</sup>	90%	15.6	68.4
Particulate Matter (PM) <sup>c</sup>	4.5	19.7	Hyundai Scrubber <sup>d</sup>	50%	2.3	9.9
NMHC <sup>b</sup>	4.5	19.9			4.5	19.9

Notes:

- a - AP-42 controlled factor of 0.013 lb/hp-hr assumes ignition timing retard.
- b - Assumes total organic compound (TOC) emission factor, and based on one engine test, 9% methane/91% nonmethane.
- c - For engines above 560 kW. NOx standards shown are for NOx + NMHC. This allows for play between NOx and NMHC emissions in controlling combustion, since these trade off in rich-burn/lean-burn combustion options. Rough rule of thumb is diesel combustion has approx 95% NOx, 5% NMHC.
- d - Typical NOx reduction for Hyundai SCR unit and engineering judgment for SOx and PM control by caustic scrubber. PM control also possible by diesel particulate filter (DPF) -- various designs, depends on fuel properties and other factors.

### WHO Ambient Air Quality Guidelines

Given that the above U.S. engine standards are not directly applicable for HFO engines, relevant World Health Organization (WHO) air quality guidelines (AQGs) are most applicable for this project. The WHO AQGs provide widely accepted and up-to-date assessments of health effects of air pollution, and recommend targets for air quality at which the health risks are significantly reduced.

The WHO AQGs<sup>44</sup> include ambient air concentrations for PM less than 10 micrometers in aerodynamic diameter (PM<sub>10</sub>), PM less than 2.5 micrometers in aerodynamic diameter (PM<sub>2.5</sub>), sulphur dioxide (SO<sub>2</sub>), and nitrogen dioxide (NO<sub>2</sub>) as follows in Table 9 below.

<sup>44</sup> WHO 2008.

**Table 9. WHO air quality guidelines (AQGs)**

Air Quality Contaminant	WHO Air Quality Guideline
<b>NO<sub>2</sub></b>	40 µg/m <sup>3</sup> annual mean 200 µg/m <sup>3</sup> 1-hour mean
<b>SO<sub>2</sub></b>	20 µg/m <sup>3</sup> 24-hour mean 500 µg/m <sup>3</sup> 10-minute mean
<b>PM<sub>10</sub></b>	20 µg/m <sup>3</sup> annual mean 50 µg/m <sup>3</sup> 24-hour mean
<b>PM<sub>2.5</sub></b>	10 µg/m <sup>3</sup> annual mean 25 µg/m <sup>3</sup> 24-hour mean
<b>Ozone</b>	100 µg/m <sup>3</sup> 8-hour mean

Note the WHO AQGs also have an ozone (O<sub>3</sub>) standard, which would not be relevant in this single emission source application. The assessment of atmospheric ozone concentrations resulting from a single source of NO<sub>x</sub> and/or VOC emissions cannot be meaningfully determined with available modeling tools. Ozone modeling is performed by complex computer programs considering overall regional emission sources, available daily atmospheric mixing height and temperature data, and regional wind flow patterns that consider the transport of those pollutants while they undergo

photochemical reactions. Given the low level of industrial activity on Haiti and good prevailing atmospheric ventilation, the proposed project is not expected to be a significant contributor to elevated ground-level ozone concentrations.

Compliance with the WHO AQGs can only be determined by air dispersion modeling using the detailed design specifications of the specific engines to be installed by the construction contractor, provided that adequate meteorological data are available for the area and assuming the following emission factors derived from the USEPA “AP-42” document (Table 10), in order to ascertain the potential level of emissions control that may be required to achieve the WHO AQGs. Modeling could also include assessments at various alternative exhaust stack heights in order to determine stack heights that would contribute to lowering ground level concentrations.

**Table 10. USEPA AP-42 emission factors for diesel fired engines for use in assessing HFO fired engines (AP-42, Section 3.4, Table 3.4-1)**

Air Quality Contaminant	Emission Factor
<b>O</b>	3.3 g/kWh*
<b>NO<sub>x</sub>:</b>	14.6 g/kWh
<b>SO<sub>2</sub>:</b>	14.8 g/kWh**
<b>PM</b>	0.4 g/kWh

As illustrated above, the emissions for the diesel 4MW power facility should be within the range characterized between the USEPA AP-42 emission factors and the USEPA Tier 2 nonroad diesel engine standards. Therefore, impacts on air quality with emissions control devices are minor. Results from dispersion modeling could be factored into the final diesel specifications utilized by the power plant construction contractor in order to achieve the WHO AQGs.

Notes:

\*For CO, there is no WHO AQG; however, the AP-42 level is close to the USEPA Tier 2 (and Tier 4) standard.

\*\*Assumes 3% sulphur content by weight. The SO<sub>2</sub> emission factor for alternative sulphur contents would be in direct ratio with the 3% sulphur assumption.

**Summary of HFO Impacts**

The current design of the power plant involves the use of HFO for power production and diesel as necessary for start-up or for shut-down. This approach was determined by USAID as the viable alternative to meet the implementation schedule of the power plant.



For HFO, one can expect that NO<sub>x</sub> will most likely be higher since HFO burns hotter, and NO<sub>x</sub> emissions are a function of combustion temperature. SO<sub>x</sub> and PM will also be higher with higher sulphur and ash-forming content in the HFO. For the 4 MW and 10 MW facility, impacts on air quality with the use of emissions control devices will be more negative than with diesel fuel, but may still yield acceptable ambient air quality results. However, this is an estimate, and dispersion modeling using actual ambient air quality and wind data at the power plant site is required to make a quantitative determination. In addition, it is anticipated that impacts on air quality using HFO for a 25-35MW facility will exert strongly negative impacts on air quality, and the use of diesel fuel or alternative energy sources should be considered for future expansion phases.

### 5.2.13 Impacts of Noise

*Direct Effects.* During construction, heavy equipment will be used that will generate noise, thereby causing a nuisance to the surrounding population and environment. The noise levels vary widely and depend on the type of activity performed. For example, a front end loader will generate noise on the level of 100 decibels (dB), while that of a truck will be approximately 85 dB. To put these noise levels in perspective, acceptable levels of noise are generally regarded to be 40 dB during the night (to avoid sleep disturbance) and 50 dB during the day (higher than 50 dB causes annoyance and interference with communication<sup>45</sup>).

*Mitigation Measures.* Construction should therefore take place only during the day, and protective ear wear should be provided to all workers. Workers who fail to comply with safety guidelines should be terminated after repeated warnings are issued.

### 5.2.14 Impacts on Landscape and Aesthetics

#### Pre-construction and Construction Phase

*Direct Effects.* Construction activities may give rise to landscape and visual impacts. The presence of construction activities, heavy machinery and earthmoving equipment, presence of stockpiles and staging areas, staging of large generator machines and large tanks of fuel may all degrade the overall appearance of the quiet, pastoral landscape.

*Mitigation Measures.* Construction material, as well as rebar and other solid waste will be disposed of in appropriate landfill areas designated by Caracol Commune and Departmental officials.

#### Operation Phase

*Direct Effects.* Abandoned construction materials and construction or staging areas denuded of vegetation may affect the quality of the aesthetic environment. These should be removed and properly disposed of in designated and approved landfill areas. The construction management team should inspect the area to ensure removal of all construction materials and debris following the completion of construction activity.

*Mitigation Measures.* Revegetation and landscaping of the power plant grounds will not only impede runoff and improve drainage, but will also enhance the visual appearance of the pastoral landscape.

### 5.2.15 Impacts of Construction Camps

#### Pre-construction, Construction and Operation Phase

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<sup>45</sup> Sheladia and Associates 2009

*Direct Effects.* The 10-20 workers required to install the power plant facility, and an additionally equal number to operate and maintain the facility will likely stay on site.

*Mitigation Measures.* Drinking water should be tested for bacteria, arsenic and barium, and treated accordingly to arrive at WHO drinking water quality guidelines. Latrines should be constructed at least 20 m from the river, and properly maintained. Toilets and running water should be connected to the industrial park's wastewater treatment system (which is to be covered under a separate EA study). Refuse should be collected in designated locations and disposed of accordingly.

### 5.2.16 Cumulative Impacts

Connected activities within the industrial park include road construction, housing development, textile industry, wastewater treatment facilities, and drinking water treatment. All of these actions will commence following construction of the power plant, and will exert considerable collective impacts. These have been noted in the relevant sections above.

Some of these actions have already occurred, and will contribute to impacts caused by the construction of the power plant. And looking toward the future, implementing the proposed action concurrently with other future development projects within the Industrial Park and elsewhere will contribute to cumulative impacts. For example, the industrial park alone is expected to attract up to 65,000 workers over the long term. Assuming the average each worker brings a family size of 7 to the area, this corresponds to an additional influx of 455,000 persons requiring food and domestic products, infrastructure, education, public health, and police security services. Others will likely follow the mass migration to the Caracol Bay area in anticipation of seeking other related informal means of employment and business opportunities. Unchecked population growth and spontaneous development of informal communities can cause degradation and associated health risks to coastal and river environments, as evidenced elsewhere in Haiti (Photo 19). An integrated development plan to help manage the growth and associated demands on local services and resources, in addition to other mitigation measures discussed above under relative impacts sections of this report, can help avoid such problems.

Other future developments will also contribute to the impacts described herein. For example, a university (the *Limonde Centre d'Education Supérieur*) is currently being built on Route 121 between Cap Haitien and Caracol. Expected to accommodate 7,000 students, it will provide numerous educational, leisure services for Northern Haiti. Expected to be open in September 2012, the university will undoubtedly draw additional migrants to the area.

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
<b>Quality of Life</b>			
Transport of generators and construction materials to the project site	<p>Increase in traffic may create disturbance to the local population and alter local traffic patterns in the project area</p> <p>Risk of accidents and fatalities from using the road during the transportation</p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>moderate</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<ul style="list-style-type: none"> <li>• Install signage to alert communities to the transport of heavy equipment and machinery**</li> <li>• Inform communities of the anticipated changes in traffic patterns due to the construction activity**</li> <li>• Develop and disseminate a communications plan to the community prior to construction**</li> </ul>
Construction works and related activities	Unmet expectation of the potential for new jobs and employment opportunities may create tension within the community, erode local support for the project	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>moderate negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<ul style="list-style-type: none"> <li>• Develop and disseminate a communications plan to the community prior to construction**</li> </ul>
Construction works and related activities	Influx of new people settling in the area to benefit from employment and commerce activities associated with the project may create tension within the community, erode local support for the project, and cause security risks and increased crime	<p><i>Nature:</i> <b>indirect negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<ul style="list-style-type: none"> <li>• Develop and disseminate a communications plan to the community prior to construction**</li> </ul>
Restricting access to the Industrial Park by the local population	Loss of a site valued by the local population (cultural impact)	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<ul style="list-style-type: none"> <li>• Develop and disseminate a communications plan to the community prior to construction**</li> </ul>

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
<b>Standard of Living and Employment</b>			
Creation of employment and business opportunities to support construction activities	Creation of 10-20 jobs associated with construction and installation of facilities, as well as new business opportunities arising from supplying needs of the project and the employees during a 2 ½ year period (July 2011 – December 2014)	<p><i>Nature: direct positive</i>  <i>Duration: temporary</i>  <i>Extent: local</i>  <i>Intensity: low</i>  <i>Overall importance: minor positive</i></p>	<ul style="list-style-type: none"> <li>Maximize employment of local people with the necessary skills for the project works**</li> <li>Before the construction phase, inform the population of the employment and business opportunities**</li> <li>Identify the skilled jobs required by the project which could be filled by local labor. Ask the local authorities and local NGO to dress a list of local skilled laborers with their experience**</li> <li>Encourage local employment and provide, if possible, adequate training to increase local employment**</li> <li>Promote the purchase of local goods and services**</li> </ul>
<b>Administrative and Social Organization</b>			
Construction works and related activities	A lack of communication and information during the pre-construction and construction phases may cause social tension between the stakeholders, particularly between the local authorities and construction firm	<p><i>Nature: direct negative</i>  <i>Duration: temporary</i>  <i>Extent: local</i>  <i>Intensity: moderate</i>  <i>Overall importance: moderate negative</i>  <i>Overall importance with mitigation : minor negative</i></p>	<ul style="list-style-type: none"> <li>Plan a process to address complaints from stakeholders**</li> <li>Inform local authorities about the nature and the scheduling of the construction activities**</li> </ul>
<b>Infrastructure and Services</b>			
Transport of construction materials	Disruption of the road traffic during the pre-construction and construction phases	<p><i>Nature: direct negative</i>  <i>Duration: temporary</i>  <i>Extent: local</i>  <i>Intensity: moderate</i>  <i>Overall importance: minor negative</i>  <i>Overall importance with mitigation : minor negative</i></p>	<ul style="list-style-type: none"> <li>Inform in advance the road users of the land and road and plan the traffic control in order to minimize impacts to road traffic**</li> </ul>

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
Transport of construction materials	Damages to the road traffic during the pre-construction and construction phases	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation :</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Regular maintenance of the road in order to minimize impacts to road damages**</li> </ul>
Construction works and related activities	Production of waste materials near the construction site	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation :</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Waste management plan in order to minimize impacts of waste production**</li> <li>All construction waste materials will be removed and transported to an official landfill site to be properly disposed of</li> <li>Reclamation of waste materials site will be done after construction is complete</li> </ul>
<b>Health and Safety</b>			
Influx of new workers in project area	Casual sex and higher risk of transmission of sexually transmitted diseases due to interaction of project workers with local population	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>low</b> <i>Overall importance:</i> <b>minor/moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Provide a Health and Safety Plan (HASP) that includes awareness and education both to the local population and workers about STDs and HIV/AIDS**</li> <li>Make condoms and information freely available to project employees**</li> </ul>
Construction works and related activities	Potential accidents of project workers	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Plan a work safety program as part of the HASP and provide worker training on best practices to minimize health and safety risks**</li> </ul>
	Potential accidents of local population due to unauthorized	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b>	<ul style="list-style-type: none"> <li>Develop, communicate and implement accident preventive and safety measures</li> </ul>

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
	use of the project area	<i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	to the local population** <ul style="list-style-type: none"> <li>Control access to construction areas**</li> <li>Develop and disseminate a communications plan to the community prior to construction</li> </ul>
Restricting access to the Industrial Park by the local population	Potential malnutrition caused by the loss of subsistence food production by individuals currently cultivating the project area	<i>Nature:</i> <b>indirect negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Implement a compensation plan for local farmers**</li> </ul>
<b>Gender</b>			
Creation of employment and business opportunities supporting construction activities	Improved access to economic opportunities for women  Reduced stress within the family unit	<i>Nature:</i> <b>direct positive</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>low</b> <i>Overall importance:</i> <b>minor positive</b> <i>Overall importance with mitigation:</i> <b>minor positive</b>	<ul style="list-style-type: none"> <li>Offer the same opportunities of employment to men and women and encourage women to apply in order to benefit from business opportunities**</li> </ul>
<b>Agriculture and Livestock</b>			
Creation of employment and business opportunities supporting construction activities	Project needs for goods and services may enhance the sale of local agricultural products	<i>Nature:</i> <b>direct positive</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor positive</b> <i>Overall importance with mitigation:</i> <b>minor positive</b>	<ul style="list-style-type: none"> <li>Inform the local population of food products and services required by the project**</li> </ul>
Restricting access to the Industrial Park by the local population	Limitation of grazing and farming land as construction occupies land currently used by local farmers	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b>	<ul style="list-style-type: none"> <li>Implement a compensation plan for local farmers**</li> </ul>

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	
<b>Soil and Erosion</b>			
Improper storage and/or disposal of materials and fuels	Soil contamination	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Install drip pans at petroleum products dispensing points**</li> <li>• Store potential pollutants such as fuel, oil and chemicals on sealed surfaces to prevent soil contamination**</li> <li>• Collect and recycle used oil and lubricants**</li> </ul>
Exposed soil from construction activity, excavation, or stockpiling	Erosion and resulting soil loss and degradation	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Cover and protect susceptible soil surfaces**</li> <li>• Install silt screens to prevent sedimentation in the Trou-du-Nord River during construction**</li> </ul>
Soil erosion of riverbanks	Erosion and resulting soil loss from construction activity	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Provide a vegetated buffer strip by replanting vegetation in riverbank areas impacted by construction**</li> <li>• Install rip rap where appropriate**</li> <li>• Install silt screens to prevent sedimentation during construction**</li> </ul>
<b>Vegetation</b>			
Site clearing and construction activity	Loss of vegetation	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b>	<ul style="list-style-type: none"> <li>• Minimize impacted area of activity**</li> <li>• Provide revegetation and landscaping with endemic plants in areas impacted by construction**</li> </ul>

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>	
Contamination from improper disposal of construction materials and fuels	Retardation of vegetation growth	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Install drip pans at petroleum products dispensing points**</li> <li>• Store potential pollutants such as fuel, oil and chemicals on sealed surfaces to prevent soil contamination**</li> <li>• Contain and clean up spills as soon as possible**</li> <li>• Collect and recycle, if possible, used oil and lubricants**</li> </ul>
<b>Wildlife, Wildlife Habitat, and Natural Ecosystems</b>			
Sedimentation in river due to runoff from exposed areas and construction activity	Degradation of aquatic life, such as fish and crayfish habitat in Trou-du-Nord River	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Provide a vegetated buffer strip by replanting vegetation in riverbank areas impacted by construction**</li> <li>• Install rip rap where appropriate**</li> <li>• Install silt screens to prevent sedimentation during construction**</li> </ul>
Disturbance of nesting sites and habitat for birds, reptiles, and other small animals from construction activity	Loss of habitat for birds and reptiles, and other small animals	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>minor</b> Overall importance: <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Establish and provide enforcement for a marine protected area within the Caracol commune to serve as a refuge for wildlife displaced from power plant facility and increased population migration due to the prospect of jobs created by the project**</li> <li>• Prepare and implement a regional development plan to manage increased pressure on land and natural resources**</li> </ul>
<b>Water Quality</b>			
Improper storage and/or disposal of materials and fuels	Soil contamination	Nature: <b>direct negative</b> Duration: <b>temporary</b>	<ul style="list-style-type: none"> <li>• Install drip pans at petroleum products dispensing points**</li> <li>• Store potential pollutants such as fuel, oil</li> </ul>



**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		<i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	and chemicals on sealed surfaces to prevent soil contamination** <ul style="list-style-type: none"> <li>Collect and recycle used oil and lubricants**</li> </ul>
Improper storage and/or disposal of materials and fuels	Water contamination from runoff	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>Install drip pans at petroleum products dispensing points**</li> <li>Store potential pollutants such as fuel, oil and chemicals on sealed surfaces to prevent soil contamination**</li> <li>Collect and recycle used oil and lubricants**</li> <li>House fuel tanks in a spill containment structure with a capacity to hold 110% of the capacity of all the fuel tanks****</li> </ul>
Exposed soil from construction activity, excavation, or stockpiling	Sedimentation in river, and possibly affecting downstream mangrove environment	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>Cover and protect susceptible soil surfaces**</li> <li>Install silt screens to prevent sedimentation in the Trou-du-Nord River during construction**</li> </ul>
Soil erosion of riverbanks	Sedimentation in river, and possible affecting downstream mangrove environment	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>Cover and protect susceptible soil surfaces**</li> <li>Install silt screens to prevent sedimentation in the Trou-du-Nord River during construction**</li> </ul>
Inadequate or unmaintained sanitation facilities for workers	Contamination of river water and groundwater	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i>	<ul style="list-style-type: none"> <li>Choose appropriate sites for portable sanitation facilities, situated at least 20 M from river**</li> </ul>

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		<i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>• Provide proper maintenance and hygiene of sanitation facilities**</li> <li>• Regularly empty latrines and properly dispose of waste in a designated landfill area</li> </ul>
<b>Air Quality</b>			
Air pollution from diesel fumes and dust from construction vehicles	Air pollution may affect human health	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>• Control dust by application of water**</li> <li>• Limit speed of hauling trucks**</li> <li>• Provide regular maintenance of construction vehicles**</li> </ul>
Inadequate or unmaintained sanitation facilities for workers	Unpleasant odors	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>• Provide proper maintenance and cleaning of sanitation facilities**</li> </ul>
<b>Noise</b>			
Excessive noise from machinery and vehicles	Disturbance to local residents and workers	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i>	<ul style="list-style-type: none"> <li>• Limit working period to daylight hours only**</li> <li>• Provide protective gear for workers**</li> </ul>
<b>Landscape and Aesthetics</b>			
Construction works and disposal of waste and material from construction and installation of facility	Degraded quality of natural landscape	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate</i>	<ul style="list-style-type: none"> <li>• Provide proper cleanup and control of construction site**</li> <li>• Provide proper disposal of waste from construction and unused equipment**</li> </ul>

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		<b>negative</b> Overall importance with mitigation: <b>minor negative</b>	
<b>Cumulative Impacts</b>			
Past action of land clearing throughout the Industrial Park combined with construction activities for the power plant	Increased erosion and sedimentation from runoff over exposed construction areas will degrade water quality	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Maintain a vegetated buffer strip approximately 20 M wide on either side of the river along its entire length within the Industrial Park by replanting vegetation<sup>++</sup></li> <li>• Install rip rap where appropriate<sup>**</sup></li> <li>• Install silt screens to prevent sedimentation during construction<sup>**</sup></li> <li>• Cover and protect all susceptible soil surfaces<sup>**</sup></li> </ul>
Combined construction activities of housing, roadworks, and textile facility within the Industrial Park	Increased erosion and sedimentation from runoff over exposed construction areas will degrade water quality	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Maintain a vegetated buffer strip approximately 20 M wide on either side of the river along its entire length within the Industrial Park by replanting vegetation<sup>++</sup></li> <li>• Install rip rap where appropriate<sup>**</sup></li> <li>• Install silt screens to prevent sedimentation during construction<sup>**</sup></li> <li>• Cover and protect all susceptible soil surfaces<sup>**</sup></li> </ul>
Combined construction activities of housing, roadworks, and textile facility within the Industrial Park	Increased solid sewage and trash waste will cause soil and water pollution as well as health issues, especially since there is no official or properly designed landfill available nor sewage treatment plants	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor positive</b>	<ul style="list-style-type: none"> <li>• Design biodigester for industrial area to capture sewage and produce methane gas electricity<sup>++</sup></li> <li>• Work with municipalities of Cap Haitien, Limonade and others to construct an official landfill site <sup>++</sup></li> </ul>
Combined construction activities of housing, roadworks, and textile facility within the Industrial Park	Increased construction activity will diminish available natural vegetation and habitat for wildlife	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b>	<ul style="list-style-type: none"> <li>• Maintain a vegetated buffer strip approximately 20 M wide on either side of the river along its entire length within the Industrial Park by replanting vegetation<sup>++</sup></li> </ul>

**Table 11. Potential socioeconomic and environmental impacts of the proposed action during the pre-construction and construction phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		<p><i>Overall importance: moderate negative</i></p> <p><i>Overall importance with mitigation: minor negative</i></p>	<ul style="list-style-type: none"> <li>Minimize disturbance and clearing**</li> </ul>
Combined construction activities of the University of Haiti, port development and expansion at Cap Haitien, Fort Liberté and elsewhere	Increased erosion and sedimentation from runoff over exposed construction areas will degrade water quality	<p><i>Nature: direct negative</i></p> <p><i>Duration: temporary</i></p> <p><i>Extent: local</i></p> <p><i>Intensity: moderate</i></p> <p><i>Overall importance: moderate negative</i></p> <p><i>Overall importance with mitigation: minor negative</i></p>	<ul style="list-style-type: none"> <li>Maintain a vegetated buffer strip approximately 20 M wide on either side of the river along its entire length within the Industrial Park by replanting vegetation**</li> <li>Install rip rap where appropriate**</li> <li>Install silt screens to prevent sedimentation during construction**</li> <li>Cover and protect all susceptible soil surfaces**</li> </ul>
Combined construction activities of the University of Haiti, port development and expansion at Cap Haitien, Fort Liberté and elsewhere	Increased construction activity will diminish available natural vegetation and habitat for wildlife	<p><i>Nature: direct negative</i></p> <p><i>Duration: temporary</i></p> <p><i>Extent: local</i></p> <p><i>Intensity: moderate</i></p> <p><i>Overall importance: moderate negative</i></p> <p><i>Overall importance with mitigation: minor negative</i></p>	<ul style="list-style-type: none"> <li>Create and maintain a vegetated buffer strips approximately 20 M wide on either side of impacted rivers by replanting vegetation**</li> <li>Minimize disturbance and clearing**</li> </ul>

\*\* Recommended mitigation measure to be implemented by Industrial Park Manager

\*\* Recommended mitigation measure to be implemented during construction and operation by construction contractor

\*\*\*\* Recommended mitigation measure to be incorporated into project design by construction contractor

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
<b>Quality of Life</b>			
Anticipation by the local community of the new project	Unmet expectation of the potential for new jobs and employment opportunities	<i>Nature: direct negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: minor</i> <i>Overall importance: minor negative</i>	<ul style="list-style-type: none"> <li>Develop and disseminate a communications plan to the community prior to construction<sup>++</sup></li> </ul>
Excessive noise from generators	Disturbance to local residents and workers	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i>	<ul style="list-style-type: none"> <li>Provide noise attenuation to limit the noise output to a maximum of 85 dB (A) at 1 meter from the external wall of the generator container or enclosure, and not more than 5dB (A) above the ambient noises at the site boundary<sup>****</sup></li> <li>Design engine room to contain a heavy, vibrating diesel engine with a high noise level<sup>****</sup></li> </ul>
Increased traffic associated with power plant operation	<p>Increase in traffic may create disturbance to the local population and alter local traffic patterns in the project area</p> <p>Risk of accidents and fatalities from using the road during the transportation</p>	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>Install signage to alert communities to the transport of heavy equipment and machinery<sup>**</sup></li> <li>Inform communities of the anticipated changes in traffic patterns due to the construction activity<sup>**</sup></li> <li>Develop and disseminate a communications plan to the community prior to construction<sup>++</sup></li> </ul>
Restricting access to the Industrial Park by the local population	Loss of a site valued by the local population (cultural impact)	<i>Nature: direct negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>Develop and disseminate a communications plan to the community prior to construction<sup>++</sup></li> </ul>
Arrival of thousands of new workers in the commune of Caracol attracted by the Industrial Park job	Risk of slum development around the industrial park and deterioration of the	<i>Nature: indirect negative</i> <i>Duration: permanent</i>	<ul style="list-style-type: none"> <li>Develop and disseminate a communications plan to the community prior to construction<sup>++</sup></li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
opportunities	quality of life of the local population	<i>Extent: local</i> <i>Intensity: high</i> <i>Overall importance: major negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>• Create a buffer zone around the industrial zone<sup>++</sup></li> <li>• Collaborate with local and regional authorities in the implementation of a land management plan <sup>++</sup></li> </ul>
<b>Standard of Living and Employment</b>			
Operation of the power plant	Creation of 10-20 jobs associated with the operation of facilities, as well as new business opportunities arising from supplying needs of the maintenance of the site and the employees	<i>Nature: direct positive</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor positive</i> <i>Overall importance with mitigation : minor positive</i>	<ul style="list-style-type: none"> <li>• Maximize employment of local people with the necessary skills for the operation of the facilities<sup>**</sup></li> <li>• Before the construction phase, inform the population of the employment and business opportunities<sup>**</sup></li> <li>• Identify the skilled jobs required by the project which could be filled by local labor. Ask the local authorities and local NGO to dress a list of local skilled laborers with their experience<sup>**</sup></li> <li>• Encourage local employment and provide, if possible, adequate training to increase local employment<sup>**</sup></li> <li>• Promote the purchase of local goods and services<sup>**</sup></li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
Creation of employment and business opportunities associated with the industrial park activities	<p>Creation of thousands of jobs associated with operation of the facility, as well as new business opportunities arising from supplying needs of the industrial park facilities</p> <p>Improvement of the individual and family incomes</p> <p>Possible switch from agriculture or fisheries activities to industrial wage labor</p>	<p><i>Nature:</i> <b>indirect positive</b></p> <p><i>Duration :</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local and regional</b></p> <p><i>Intensity:</i> <b>high</b></p> <p><i>Overall importance:</i> <b>moderate positive</b></p> <p><i>Overall importance with mitigation :</i> <b>major positive</b></p>	<ul style="list-style-type: none"> <li>• Maximize employment of local people with the necessary skills for the project works**</li> <li>• Before the construction phase, inform the population of the employment and business opportunities**</li> <li>• Identify the skilled jobs required by the project which could be filled by local labor. Ask the local authorities and local NGO to dress a list of local skilled laborers with their experience**</li> <li>• Encourage local employment and provide, if possible, adequate training to increase local employment**</li> <li>• Promote the purchase of local goods and services**</li> </ul>
<b>Administrative and Social Organization</b>			
Operation of the power plant	A lack of communication and information during operation phase may cause social tension between the stakeholders, particularly between the local authorities and industrial park manager	<p><i>Nature:</i> <b>direct negative</b></p> <p><i>Duration:</i> <b>temporary</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p> <p><i>Overall importance with mitigation :</i> <b>minor negative</b></p>	<ul style="list-style-type: none"> <li>• Develop and disseminate a communications plan to the community prior to construction**</li> <li>• Collaborate with local and regional authorities in the implementation of a land management plan **</li> </ul>
Shift from agriculture to factory labor	Children left unattended for long periods of time may be influenced by or participate in gang activity	<p><i>Nature:</i> <b>indirect negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local/regional</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p> <p><i>Overall importance with mitigation :</i> <b>moderate positive</b></p>	<ul style="list-style-type: none"> <li>• Garment industry provides daycare and youth activities on site, possibly involving organic farming activities **</li> </ul>
<b>Infrastructure and Services</b>			

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
Population growth due to the opportunity for increased economic activity from the power plant	Increase in traffic and degradation of transportation infrastructure	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	<ul style="list-style-type: none"> <li>• Provide appropriate signage along affected route**</li> <li>• Prepare and implement a plan for operations and maintenance and necessary upgrades of affected routes in order to accommodate the increase in traffic**</li> </ul>
Population growth due to the opportunity for increased economic activity from the power plant	Pressure on infrastructure services (water and sanitation, hospitals, schools, police security) and resulting decrease in quality of life and health and safety	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	<ul style="list-style-type: none"> <li>• Prepare and implement a plan for additional infrastructure services (hospitals, schools, police security) to accommodate the increase in population growth and associated need for these services**</li> </ul>
<b>Health and Safety</b>			
Population growth due to the opportunity for increased economic activity from the power plant	Casual sex and higher risk of transmission of sexually transmitted diseases	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor/moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>• Provide awareness and education both to the local population and workers about STDs and HIV/AIDS**</li> <li>• Provide condoms to project employees at the power plant**</li> </ul>
Population growth due to the opportunity for increased economic activity from the power plant	Pressure on well being and health-related infrastructure services (water and sanitation, hospitals, police security) and resulting decrease in quality of life and health and safety	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	<ul style="list-style-type: none"> <li>• Prepare and implement a plan for additional infrastructure services (water and sanitation, hospitals, police security) to accommodate the increase in population growth and associated need for these services**</li> </ul>



**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
Power plant operation	Potential accidents of project workers	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Plan a work safety program and provide worker training on best practices to minimize health and safety risks**</li> <li>Implement a policy that terminates employees failing to wear personal protective equipment after receiving a warning for the first infraction**</li> <li>Institute a monitoring program to detect and address unsafe conditions</li> </ul>
	Potential accidents of local population due to unauthorized use of the project area	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Develop, communicate and implement accident preventive and safety measures to the local population**</li> <li>Control access to power plant facility and grounds**</li> <li>Develop and disseminate a communications plan to the community prior to operation**</li> </ul>
Restricting access to the Industrial Park by the local population	Potential malnutrition caused by the loss of subsistence food production by individuals currently cultivating the project area	<i>Nature:</i> <b>indirect negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Implement a compensation plan for local farmers**</li> </ul>
Improper handling or storage of adhesives, cleaners, solvents, and chemicals	Risk of injury to workers	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>minor</b> <i>Overall importance:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>Apply and store adhesives, cleaners, solvents, and chemicals in a ventilated area**</li> <li>Provide training to workers in proper handling, use and storage**</li> </ul>
Drinking water quality of well established on project site to provide drinking and bathing water to workers and plant operators	Harmful effects from elevated levels of Arsenic and Barium in drinking water supply source (groundwater)	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>severe</b>	<ul style="list-style-type: none"> <li>Treat water using recommended WHO treatment measures to meet WHO guideline values for arsenic and barium, or use bottled water for drinking and cooking, use well water for bathing and</li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		Overall importance: <b>strong negative</b> Overall importance with mitigation: <b>strong positive</b>	cleaning** <ul style="list-style-type: none"> <li>Monitor water quality with regular monthly testing using WHO recommended surveillance methods**</li> </ul>
Tampering with wellhead or pump, or infiltration of surface runoff into well	Risk of bacterial or chemical contamination of drinking water	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>severe</b> Overall importance: <b>strong negative</b> Overall importance with mitigation: <b>strong positive</b>	<ul style="list-style-type: none"> <li>Provide site security at all times**</li> <li>Install wellhead protection during construction**</li> <li>Monitor water quality with regular monthly testing using WHO recommended surveillance methods**</li> </ul>
Inadequate ventilation within the building where the generators are housed	Risk of explosion and injury or death to workers due to build-up of explosive gases within the power facility	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>severe</b> Overall importance: <b>strong negative</b> Overall importance with mitigation: <b>moderate positive</b>	<ul style="list-style-type: none"> <li>Provide adequate ventilation in engine room****</li> <li>Consider the installation of sensors to detect unsafe levels of carbon monoxide or explosive gases****</li> <li>Institute a monitoring program to detect and address unsafe conditions**</li> </ul>
Overheating of the generators leaking/fractured pipe work, fuel or oil system pipe work is in contact with hot surfaces	Risk of fire or explosion and injury or death to workers	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>severe</b> Overall importance: <b>strong negative</b> Overall importance with mitigation: <b>moderate positive</b>	<ul style="list-style-type: none"> <li>Install a fire detection system****</li> <li>Avoid laying fuel or oil system pipe work over hot surfaces****</li> </ul>
Emissions from power plant smokestacks	Respiratory ailments of community and workers	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local/regional</b> Intensity: <b>moderate/strong</b> Overall importance: <b>moderate negative for 4 MW phase; moderate/strong negative for 10 MW; strong negative for 25-35 MW</b>	<ul style="list-style-type: none"> <li>Design generators and smokestacks with available emissions control devices for maximum emissions reduction for sulphur oxides, nitrogen oxides, particulate matter, carbon monoxide, and non-methane hydrocarbons (includes scrubber, selective catalytic reduction device, and particulate filter). Utilize BACT in the design****</li> <li>Contractor shall provide any price</li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		<p><b>phase</b>  <i>Overall importance with mitigation:</i>  <b>minor negative for 4 MW phase;</b>  <b>Minor/moderate negative for 10 MW;</b>  <b>strong negative for 25-35 MW phase</b></p>	<p>difference associated with normal design vs. design to implement the above measures****</p>
<b>Gender</b>			
Creation of employment and business opportunities from power plant operation	<p>Improved access to economic opportunities for women</p> <p>Reduced stress within the family unit</p>	<p><i>Nature:</i> <b>direct positive</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor positive</b>  <i>_Overall importance with mitigation:</i>  <b>minor positive</b></p>	<ul style="list-style-type: none"> <li>Offer the same opportunities of employment to men and women and encourage women to apply in order to benefit from business opportunities**</li> </ul>
Creation of employment and business opportunities associated with the industrial park activities	<p>Improved access to economic opportunities for women</p> <p>Reduced stress within the family unit</p>	<p><i>Nature:</i> <b>indirect positive</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>moderate positive</b>  <i>_Overall importance with mitigation:</i>  <b>major positive</b></p>	<ul style="list-style-type: none"> <li>Make sensitive the employers of the industrial park to the importance of gender equity in the hiring process **</li> </ul>
<b>Agriculture and Livestock</b>			
Operation of the power plant	<p>Industrial activities will create needs for goods and services and may enhance the sale of local agricultural products</p> <p>Development of local market for agricultural and fishing products</p>	<p><i>Nature:</i> <b>indirect positive</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>moderate</b>  <i>Overall importance:</i> <b>minor positive</b></p>	
Restricting access to the Industrial	Loss of grazing and farming	<i>Nature:</i> <b>direct negative</b>	<ul style="list-style-type: none"> <li>Implement a compensation plan for local</li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
Park by the local population	land as power plant occupies land currently used by local farmers	<i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	farmers <sup>++</sup> <ul style="list-style-type: none"> <li>Work with municipality to identify lands for agricultural production<sup>++</sup></li> <li>Set aside some industrial land area or surrounding area for agricultural production<sup>++</sup></li> </ul>
Increase in population growth due to anticipated economic and livelihood opportunities	Increased pressure on agricultural land and fishing grounds	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>Prepare and implement a regional development plan to manage increased pressure on land and natural resources<sup>++</sup></li> </ul>
<b>Soil and Erosion</b>			
Improper storage and/or disposal of materials and fuels during plant operation	Soil contamination	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	<ul style="list-style-type: none"> <li>Install drip pans at petroleum products dispensing points<sup>**</sup></li> <li>Store potential pollutants such as lubricating oil and chemicals on sealed surfaces to prevent soil contamination<sup>**</sup></li> <li>Collect and recycle, where possible, used oil and lubricants<sup>**</sup></li> <li>House fuel tanks in a spill containment structure with a capacity to hold 110% of the capacity of all the fuel tanks<sup>****</sup></li> </ul>
Vegetation planting to maintain a permanent vegetated buffer zone, 20 M wide, on each side of the river	Increase in riparian vegetation and soil stability	<i>Nature: direct positive</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate positive</i> <i>Overall importance with mitigation: moderate positive</i>	
<b>Vegetation</b>			

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
Vegetation planting and for riverbank stabilization works	Increase in riparian vegetation and soil stability	<i>Nature:</i> <b>indirect positive</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate positive</b>	
Lack of vegetation regrowth from clearing of site for power plant installation and operation	Lack of natural vegetation	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>moderate positive</b>	<ul style="list-style-type: none"> <li>• Provide revegetation and landscaping with endemic plants in areas impacted by construction**</li> </ul>
<b>Wildlife, Wildlife Habitat, and Natural Ecosystems</b>			
Disturbance of nesting sites and habitat for birds, reptiles, and other small animals due to power plant operation	Loss of habitat for birds and reptiles, and other small animals	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>minor</b> <i>Overall importance:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Establish and provide enforcement for a marine protected area within the Caracol commune to serve as a refuge for wildlife displaced from power plant facility and increased population migration due to the prospect of jobs created by the project**</li> <li>• Prepare and implement a regional development plan to manage increased pressure on land and natural resources**</li> </ul>
Pollution and encroachment of project activities on natural habitat due to increased population growth in area	Loss of wildlife and fisheries  Loss of mangroves due to encroachment and deforestation (for settlement and/or charcoal production)	<i>Nature:</i> <b>indirect negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local and regional</b> <i>Intensity:</i> <b>moderate to high</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Minimize disturbance and clearing**</li> <li>• Replant vegetation where appropriate**</li> <li>• Establish and enforce a marine protected area that includes the Trou-du-Nord estuary and associated mangroves**</li> <li>• Prepare and implement a regional development plan to manage increased pressure on land and natural resources**</li> </ul>
<b>Water Quality</b>			

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
Inadequate drainage and site runoff from plant operation	Contamination and sedimentation of Trou-du-Nord River and downstream mangrove ecosystem	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local and regional</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Vegetate embankments impacted by construction to maximize contaminant retention and eliminate entry into water**</li> <li>• Treat oily water in a separator**</li> <li>• Provide adequate drainage of the plant site to drain water away from the area in a controlled manner, away from the river. Divert water away from structures and associated roads, without causing harm to other planned facilities within the industrial park, and to people living or working adjacent to the site boundary****</li> <li>• Provide a drainage system for the plant site to follow natural drainage patterns, if possible****</li> <li>• Provide a drainage system or tranches around the perimeter of the plant site****</li> <li>• Provide a separate drainage system for the fuel tank containment area to separate and collect oily water****</li> <li>• Line storm drains with rip-rap**</li> </ul>
Erosion of bare and exposed areas resulting from activity of workers	Sedimentation and increased turbidity	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>low</b> <i>Overall importance:</i> <b>moderate negative</b>	<ul style="list-style-type: none"> <li>• Replant vegetation as part of riverbank stabilization works where appropriate**</li> <li>• Install rip rap where appropriate**</li> </ul>
Poorly designed or inadequate sanitation facilities	River and ground water contamination	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Install and maintain a properly designed septic field for the power plant sanitation facilities</li> <li>• Install the septic field at least 20 m from the Trou-du-Nord River;</li> <li>• Test potable well water for bacteria on a regular basis</li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
Improper storage and/or disposal of materials and fuels during plant operation	River and ground water contamination	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Install drip pans at petroleum products dispensing points**</li> <li>• Store potential pollutants such as lubricating oil and chemicals on sealed surfaces to prevent soil contamination**</li> <li>• Collect and recycle, where possible, used oil and lubricants**</li> <li>• House fuel tanks in a spill containment structure with a capacity to hold 110% of the capacity of all the fuel tanks****</li> </ul>
<b>Air Quality</b>			
Emissions from power plant smokestacks	Respiratory ailments of community and workers	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local/regional</b> <i>Intensity:</i> <b>moderate/strong</b> <i>Overall importance:</i> <b>moderate negative for 4 MW phase; moderate/strong negative for 10 MW;</b> <b>strong negative for 25-35 MW phase</b> <i>Overall importance with mitigation:</i> <b>minor negative for 4 MW phase; Minor/moderate negative for 10 MW;</b> <b>strong negative for 25-35 MW phase</b>	<ul style="list-style-type: none"> <li>• Design generators and smokestacks with available emissions control devices for maximum emissions reduction for sulphur oxides, nitrogen oxides, particulate matter, carbon monoxide, and non-methane hydrocarbons (includes scrubber, selective catalytic reduction device, and particulate filter). Utilize BACT in the design****</li> <li>• Contractor shall provide any price difference associated with normal design vs. design to implement the above measures****</li> <li>• Consider the use of diesel fuel or explore alternative energy options for the 25-35 MW phase</li> </ul>
<b>Noise</b>			
Excessive noise from generators	Disturbance to local residents and workers	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>low</b> <i>Overall importance:</i> <b>minor negative</b>	<ul style="list-style-type: none"> <li>• Provide noise attenuation to limit the noise output to a maximum of 85 dB (A) at 1 meter from the external wall of the generator container or enclosure, and not more than 5dB (A) above the ambient noises at the site boundary**</li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
			<ul style="list-style-type: none"> <li>• Design engine room to contain a heavy, vibrating diesel engine with a high noise level****</li> <li>• Provide ear protection gear for workers**</li> <li>• Include signage in maximum visibility locations to advise the use of ear protection**</li> <li>• Plant trees around power plant facility, ensuring that trees are far enough away from the plant to minimize risk of fire**</li> </ul>
<b>Landscape and Aesthetics</b>			
Abandoned construction materials and structures	Degraded quality of natural landscape	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i>	<ul style="list-style-type: none"> <li>• Proper cleanup and disposal of waste and construction materials**</li> </ul>
<b>Cumulative Impacts</b>			
Erosion and sedimentation from the collective development of activities within the Trou-du-Nord watershed, particularly activities adjacent to the river	Widening of the river and shifting of the river bed over time	<i>Nature: direct positive</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	<ul style="list-style-type: none"> <li>• Maintain a vegetated buffer strips approximately 20 M wide on either side of impacted rivers by replanting vegetation**</li> <li>• Minimize disturbance and clearing during implementation**</li> </ul>
Combined housing, and textile facility developments and associated sanitation facilities within the Industrial Park and from the University and other settlements	Increased sewage and trash waste will cause soil and water pollution as well as health issues, especially since there is no official or properly designed landfill available nor sewage treatment plants	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor positive</i>	<ul style="list-style-type: none"> <li>• Include sewerage connections from other industrial park sanitation facilities to the wastewater treatment plant for processing of waste, once the treatment plant is constructed**</li> <li>• Test potable well water for bacteria on a regular basis**</li> <li>• Design biodigester for industrial area to capture sewage and produce methane</li> </ul>



**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
			gas electricity <sup>++</sup> <ul style="list-style-type: none"> <li>Work with municipalities of Cap Haitien, Limonade and others to construct an official landfill site <sup>++</sup></li> </ul>
Combined impacts of power plant operation with other Industrial Park activities (housing, textile factory, etc.)	Increase in traffic and degradation of transportation infrastructure	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	<ul style="list-style-type: none"> <li>Provide appropriate signage along affected route<sup>**</sup></li> <li>Prepare and implement a plan for operations and maintenance and necessary upgrades of affected routes in order to accommodate the increase in traffic<sup>++</sup></li> </ul>
Future development of alternative energy sources to meet energy needs of power plant during expansion phases	Cleaner alternative energy sources with fewer air quality impacts	<i>Nature: direct positive</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate/strong</i> <i>Overall importance: moderate positive</i>	
Combined impacts of power plant operation with other Industrial Park activities (housing, textile factory, etc.)	Pressure on infrastructure services (water and sanitation, hospitals, schools, police security) and resulting decrease in quality of life and health and safety	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	<ul style="list-style-type: none"> <li>Prepare and implement a plan for additional infrastructure services (water and sanitation, hospitals, schools, police security) to accommodate the increase in population growth and associated need for these services<sup>++</sup></li> </ul>
Combined impacts of power plant operation with other Industrial Park activities (housing, textile factory, etc.)	Degradation of Trou-du-Nord River water quality and downstream mangrove ecosystem due increased sedimentation and contamination from runoff and activity	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate to high</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation:</i>	<ul style="list-style-type: none"> <li>Maintain a vegetated buffer strips approximately 20 M wide on either side of impacted rivers by replanting vegetation<sup>++</sup></li> <li>Minimize disturbance and clearing<sup>**</sup></li> <li>Replant vegetation as part of riverbank stabilization works where appropriate<sup>**</sup></li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
		<b>minor positive</b>	<ul style="list-style-type: none"> <li>• Install rip rap where appropriate**</li> <li>• Provide adequate drainage as necessary**</li> </ul>
Combined impacts of power plant operation with other Industrial Park activities (housing, textile factory, etc.)	<p>Loss of wildlife and fisheries due to pollution and encroachment of activities on natural habitat</p> <p>Loss of mangroves due to encroachment and deforestation (for settlement and/or charcoal production) from increased population growth</p>	<p><i>Nature:</i> <b>indirect negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local and regional</b></p> <p><i>Intensity:</i> <b>moderate to high</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p> <p><i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<ul style="list-style-type: none"> <li>• Minimize disturbance and clearing**</li> <li>• Replant vegetation where appropriate**</li> <li>• Establish and enforce a marine protection area that includes the Trou-du-Nord estuary and associated mangroves<sup>++</sup></li> <li>• Prepare and implement a regional development plan to manage increased pressure on land and natural resources<sup>++</sup></li> </ul>
Combined impacts of power plant operation with other Industrial Park activities (housing, textile factory, etc.)	Degradation of air quality	<p><i>Nature:</i> <b>indirect negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local and regional</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p> <p><i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<ul style="list-style-type: none"> <li>• Design generators and smokestacks with available emissions control devices for maximum emissions reduction for sulphur oxides, nitrogen oxides, particulate matter, carbon monoxide, and non-methane hydrocarbons (includes scrubber, selective catalytic reduction device, and particulate filter). Utilize BACT in the design****</li> <li>• Contractor shall provide any price difference associated with normal design vs. design to implement the above measures****</li> </ul>
Combined impacts of power plant operation with other Industrial Park activities (housing, textile factory, etc.)	Increase in economic opportunity and quality of life due to jobs creation	<p><i>Nature:</i> <b>indirect positive</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local and regional</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate positive</b></p>	
Combined impacts of power plant operation with other development activities within the region spanning from Cap Haitien to Ouanaminthe	Increase in traffic and degradation of transportation infrastructure	<p><i>Nature:</i> <b>indirect negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>regional</b></p>	<ul style="list-style-type: none"> <li>• Provide appropriate signage along affected route**</li> <li>• Prepare and implement a plan for</li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
(new University of Haiti, and port development and expansion at Fort Liberté and Cap Haitien, etc.)		<i>Nature: indirect negative</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: moderate positive</i>	operations and maintenance and necessary upgrades of affected routes in order to accommodate the increase in traffic <sup>++</sup>
Combined impacts of power plant operation with other development activities within the region spanning from Cap Haitien to Ouanaminthe (new University of Haiti, and port development and expansion at Fort Liberté and Cap Haitien, etc.)	Pressure on infrastructure services (water and sanitation, hospitals, schools, police security) and resulting decrease in quality of life and health and safety	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: moderate positive</i>	<ul style="list-style-type: none"> <li>• Prepare and implement a plan for additional infrastructure services (water and sanitation, hospitals, schools, police security) to accommodate the increase in population growth and associated need for these services<sup>++</sup></li> </ul>
Combined impacts of power plant operation with other development activities within the region spanning from Cap Haitien to Ouanaminthe (new University of Haiti, and port development and expansion at Fort Liberté and Cap Haitien, etc.)	Degradation of Trou-du-Nord River water quality and downstream mangrove ecosystem due increased sedimentation and contamination from runoff and activity	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: minor positive</i>	<ul style="list-style-type: none"> <li>• Maintain a vegetated buffer strips approximately 20 M wide on either side of impacted rivers by replanting vegetation<sup>++</sup></li> <li>• Minimize disturbance and clearing<sup>**</sup></li> <li>• Replant vegetation as part of riverbank stabilization works where appropriate<sup>**</sup></li> <li>• Install rip rap where appropriate<sup>**</sup></li> <li>• Provide adequate drainage as necessary<sup>**</sup></li> </ul>
Combined impacts of power plant operation with other development activities within the region spanning from Cap Haitien to Ouanaminthe (new University of Haiti, and port development and expansion at Fort Liberté and Cap Haitien, etc.)	Loss of wildlife and fisheries due to pollution and encroachment of activities on natural habitat  Loss of mangroves due to encroachment and deforestation (for settlement and/or charcoal production) from increased population growth	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: minor to moderate negative</i>	<ul style="list-style-type: none"> <li>• Minimize disturbance and clearing<sup>**</sup></li> <li>• Replant vegetation where appropriate<sup>**</sup></li> <li>• Establish and enforce a marine protection area that includes the Trou-du-Nord estuary and associated mangroves<sup>++</sup></li> <li>• Prepare and implement a regional development plan to manage increased pressure on land and natural resources<sup>++</sup></li> </ul>
Combined impacts of power plant operation with other development activities within the region spanning from Cap Haitien to Ouanaminthe	Degradation of air quality	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i>	<ul style="list-style-type: none"> <li>• Design generators and smokestacks with available emissions control devices for maximum emissions reduction for sulphur oxides, nitrogen oxides,</li> </ul>

**Table 12. Potential socioeconomic and environmental impacts of the proposed action during the operational phase**

Source of Impact	Description of Impact	Importance	Mitigation Measures
(new University of Haiti, and port development and expansion at Fort Liberté and Cap Haitien, etc.)		<i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	particulate matter, carbon monoxide, and non-methane hydrocarbons (includes scrubber, selective catalytic reduction device, and particulate filter). Utilize BACT in the design**** <ul style="list-style-type: none"> <li>Contractor shall provide any price difference associated with normal design vs. design to implement the above measures****</li> </ul>
Combined impacts of power plant operation with other development activities within the region spanning from Cap Haitien to Ouanaminthe (new University of Haiti, and port development and expansion at Fort Liberté and Cap Haitien, etc.)	Increase in economic opportunity and quality of life due to jobs creation	<i>Nature: indirect positive</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong positive</i>	

++Recommended mitigation measure to be implemented by Industrial Park Manager

\*\*Recommended mitigation measure to be implemented during construction and operation by construction contractor

\*\*\*\* Recommended mitigation measure to be incorporated into project design by construction contractor

### 5.3 IMPACTS OF “NO ACTION” ALTERNATIVE

This section describes the impacts that can be anticipated in no action is taken. The power plant would not be constructed, and no electrical power would be generated to fuel the energy needs of the planned industrial park activities. The “no action” alternative also considers the indirect impacts associated with the inability of the industrial park to develop the planned textile manufacturing industry due to a lack of power. As part of the “No Action” alternative, mitigation measures would not be implemented for potential impacts.

#### 5.3.1 Impacts on Quality of Life

The population of the Caracol commune expects that the closure of the industrial park limits will be accompanied by a compensation and resettlement plan. If the power plant construction project does not proceed, the local population, which has already begun to limit agricultural activities in the park, will have neither a full harvest nor financial compensation.

In addition, residents expect that industrial park development will lead to improvements in infrastructure and public services (health, education, security, drinking water and wastewater management, food, and power) in the commune, which would be a significant positive impact on the quality of life of local residents. If the project is not realized, the local population will not benefit from these improvements.

#### 5.3.2 Impacts on Land Use

As mentioned above, local residents using the land within the limits of the park have already cut back on agricultural production, particularly of grains and legumes. If the power plant and industrial park are not realized, it is likely that farmers will return to the park area to continue farming at the same intensity as before.

#### 5.3.3 Impacts on Standard of Living and Economic Opportunities

Thousands of jobs are expected to be created by the industrial park in Caracol, of which less than 10 % of the population has regular salaried jobs. Without the project, these opportunities will not be realized. In the case that the industrial park project is not realized, the expected economic development will not occur and the local population will feel discouraged and disappointed. In order to ensure a subsistence livelihood, many local farms will pursue agriculture, livestock raising and fishing.

### 5.4 IMPACTS OF DIESEL FUEL SOURCE ALTERNATIVE

The impacts associated with installing diesel generators requiring clean diesel fuel are summarized in Tables 14 and 15 below, in comparison with the Proposed Action and “No Action” alternatives. Most of the impacts will be the same as for the HFO used in the Proposed Action. The differences relate to Air Quality, and these are discussed in Section 5.4.11 above.

## 6. RECOMMENDATIONS

As discussed previously in Section 2 above, the purpose of the USAID/Haiti NPP Project is to design the conceptual plan for power plant with an eventual capacity of 25-35 MW. The power facility is needed to provide all the electrical power needs of the North Industrial Park, including the textile industry, wastewater treatment plant, and residents living within the park. The proposed action is the only alternative that meets the purpose and need of the project (Table 13). Provided that the EMMP in this report is followed, the proposed action enables the creation of 18,000 jobs in northern Haiti by providing a safe, reliable and environmentally sound means of power supply to the North Industrial Park. The machines will use HFO for power production during the initial phases, as determined by USAID. Diesel fuel will be available for startup and shut down. The machines are designed, however, to run on diesel fuel, if necessary. By installing HFO generators that are also capable of operating on diesel fuel, the proposed action also offers the flexibility of switching to cleaner diesel fuel options that can be further explored if and when the power plant is expanded to a capacity of 25-35 MW. The exploration of other fuel options for future expansion phases beyond 10 MW should be considered, since it is anticipated that using HFO for a 25-35MW facility will exert strongly negative impacts on air quality. Alternative energy sources should also be explored for use in future expansion phases of the power plant.

**Table 13. Ability of the proposed action and alternatives to meet the purpose and need of the project**

Requirements to Meet Purpose and Need	Proposed Action	“No Action” Alternative	Diesel Fuel Alternative
<b>Provides power and electrical needs for the North Industrial Park</b>	<b>Yes;</b> the project will supply power for the textile industries, and associated settlements of the industrial park	<b>No</b>	<b>Yes</b>
<b>Provides a safe and environmentally sound means of power supply</b>	<b>Yes;</b> provided the recommended mitigation measures are followed	<b>Not applicable</b>	<b>Yes;</b> this alternative has fewer negative impacts on air quality and therefore human health than the proposed action
<b>Enables the provision of 18,000 jobs to industrial park workers by 2014, and up to 65,000 over the long term</b>	<b>Yes;</b> by providing power to the Industrial Park, the park plans will proceed	<b>No</b>	<b>Yes</b>
<b>Provides a financially viable means of power supply to the industrial park over the long term</b>	<b>Yes;</b> it is anticipated that HFO will be more affordable with lower security costs, and machines are available to meet critical Phase 1 operational schedules; however, during future expansion phases, diesel or alternative energy options should be explored	<b>No</b>	<b>No;</b> diesel fuel is currently more expensive and requires higher security costs to transport and keep on site

There is an urgent need for the project to help promote economic development in the region through the creation of new industries that create jobs. Therefore, the “No Action” alternative is rejected because it does not address the purpose and need for the project.

The alternative to utilize diesel fuel during the first phase would be a viable option to consider if the project could reliably supply this type of fuel for the first 1-2 years of the project. The negative impacts

on air quality are less with this option. Diesel machines also require less maintenance, as moving parts will wear less quickly with diesel than with HFO. All other impacts on quality of life, vegetation, soil and erosion, water and coastal resources, and cumulative impacts are largely the same.

A summary comparison of potential impacts from the Proposed Action and alternatives for the pre-construction/construction and operation phases are provided below in Tables 14 and 15, respectively. Most of the construction impacts are minor or moderate, and temporary in duration. Impacts associated with the “No Action” alternative are generally negative and permanent in duration.

Environmental impacts expected to occur during the operation phase of the power plant are generally minor to moderate, and most can be mitigated or avoided following the recommended mitigation measures. This EA includes an Environmental Mitigation and Monitoring Plan (EMMP), which outlines best management practices, most of which are to be undertaken by the power plant construction contractor provided by USAID, in order to mitigate or avoid negative impacts. Some of these measures may even incur positive benefits. Other mitigation measures have been recommended for indirect impacts on the socioeconomic conditions of the local population throughout the Caracol Commune, but many of these must be implemented by the North Park manager and are beyond the scope of this assessment and EMMP.

Of vital concern are the indirect and cumulative impacts that the provision of electrical power to the industrial park will have on spurring development and the associated influx of outside people coming to the area with hopes of employment and a better life. At the time of this study, no concrete plans were available, or at least discussed with local elected officials and departmental ministries, regarding how infrastructure and public services would be expanded to accommodate rapid population growth. Furthermore, there do not seem to be plans in place to train local residents for jobs in order to enable them to compete for the skilled positions offered by the industrial park.

While the anticipated economic benefits of the industrial park will positively impact quality of life and standard of living for individuals that are employed or their businesses are supported by the park industries, these impacts assume that employment will benefit the local population. If outside workers derive the majority of these benefits, and if they bring their families to live in the area, the pressure on already stretched local budgets and public services and infrastructure will be immense.

**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
<b>Quality of Life</b>			
<p>Increase in traffic may create disturbance to the local population and alter local traffic patterns in the project area</p> <p>Risk of accidents and fatalities from using the road during the transportation</p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>moderate</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<p><b>Not applicable</b></p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>moderate</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>
<p>Unmet expectation of the potential for new jobs and employment opportunities may create tension within the community, erode local support for the project</p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>moderate negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>moderate negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>moderate negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>
<p>Influx of new people settling in the area to benefit from employment and commerce activities associated with the project may create tension within the community, erode local support for the project, and cause security risks and increased crime</p>	<p><i>Nature:</i> <b>indirect negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<p><b>Not applicable</b></p>	<p><i>Nature:</i> <b>indirect negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>
<p>Loss of a site valued by the local population (cultural impact)</p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<p><b>Not applicable</b></p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i> <b>minor negative</b></p>
<b>Standard of Living and Employment</b>			



**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
<p><b>Creation or lack of creation</b> of 10-20 jobs associated with construction and installation of facilities, as well as new business opportunities arising from supplying needs of the project and the employees during a 2 ½ year period (July 2011 – December 2014)</p>	<p>Nature: <b>direct positive</b>                      Duration: <b>temporary</b>                      Extent: <b>local</b>                      Intensity: <b>low</b>                      Overall importance: <b>minor positive</b></p>	<p>Nature: <b>indirect negative</b>                      Duration: <b>permanent</b>                      Extent: <b>local and regional</b>                      Intensity: <b>minor</b>                      Overall importance: <b>minor negative</b></p>	<p>Nature: <b>direct positive</b>                      Duration: <b>temporary</b>                      Extent: <b>local</b>                      Intensity: <b>low</b>                      Overall importance: <b>minor positive</b></p>
<b>Administrative and Social Organization</b>			
<p>A lack of communication and information during the pre-construction and construction phases may cause social tension between the stakeholders, particularly between the local authorities and construction firm</p>	<p>Nature: <b>direct negative</b>                      Duration: <b>temporary</b>                      Extent: <b>local</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>moderate negative</b>                      Overall importance with mitigation : <b>minor negative</b></p>	<p><b>Not applicable</b></p>	<p>Nature: <b>direct negative</b>                      Duration: <b>temporary</b>                      Extent: <b>local</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>moderate negative</b>                      Overall importance with mitigation : <b>minor negative</b></p>
<b>Infrastructure and Services</b>			
<p>Disruption of the road traffic during the pre-construction and construction phases</p>	<p>Nature: <b>direct negative</b>                      Duration: <b>temporary</b>                      Extent: <b>local</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>minor negative</b>                      Overall importance with mitigation : <b>minor negative</b></p>	<p><b>Not applicable</b></p>	<p>Nature: <b>direct negative</b>                      Duration: <b>temporary</b>                      Extent: <b>local</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>minor negative</b>                      Overall importance with mitigation : <b>minor negative</b></p>
<p>Damages to the road traffic during</p>	<p>Nature: <b>direct negative</b></p>	<p><b>Not applicable</b></p>	<p>Nature: <b>direct negative</b></p>

**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
the pre-construction and construction phases	<i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation : minor negative</i>		<i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation : minor negative</i>
Production of waste materials near the construction site	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation : minor negative</i>	Not applicable	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation : minor negative</i>
<b>Health and Safety</b>			
Casual sex and higher risk of transmission of sexually transmitted diseases due to interaction of project workers with local population	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor/moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	Not applicable	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor/moderate negative</i> <i>Overall importance with mitigation: minor negative</i>
Potential accidents of project workers Potential accidents of local population due to unauthorized use of the project area	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	Not applicable	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>
	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i>	Not applicable	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i>

**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>		Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>
Potential malnutrition caused by the loss of subsistence food production by individuals currently cultivating the project area	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>
<b>Gender</b>			
Improved access to economic opportunities for women  Reduced stress within the family unit	Nature: <b>direct positive</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>low</b> Overall importance: <b>minor positive</b> Overall importance with mitigation: <b>minor positive</b>	<b>Not applicable</b>	Nature: <b>direct positive</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>low</b> Overall importance: <b>minor positive</b> Overall importance with mitigation: <b>minor positive</b>
<b>Agriculture and Livestock</b>			
Project needs for goods and services may enhance the sale of local agricultural products	Nature: <b>direct positive</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>minor positive</b> Overall importance with mitigation: <b>minor positive</b>	<b>Not applicable</b>	Nature: <b>direct positive</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>minor positive</b> Overall importance with mitigation: <b>minor positive</b>
Limitation of grazing and farming land as construction occupies land currently used by local farmers	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation:	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>

**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	<b>minor negative</b>		
<b>Soil and Erosion</b>			
Soil contamination	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<b>Not applicable</b>	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>
Erosion and resulting soil loss and degradation	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	<b>Not applicable</b>	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>
Erosion and resulting soil loss from construction activity	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>	<b>Not applicable</b>	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>
<b>Vegetation</b>			
Loss of vegetation	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<b>Not applicable</b>	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>

**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
Retardation of vegetation growth	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>
<b>Wildlife, Wildlife Habitat, and Natural Ecosystems</b>			
Degradation of aquatic life, such as fish and crayfish habitat in Trou-du-Nord River	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>
Loss of habitat for birds and reptiles, and other small animals	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>minor</b> <i>Overall importance:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>minor</b> <i>Overall importance:</i> <b>minor negative</b>
<b>Water Quality</b>			
Soil contamination	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>minor negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>
Water contamination from runoff	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b>

**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>		Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>
Sedimentation in river, and possibly affecting downstream mangrove environment	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>
Sedimentation in river, and possible affecting downstream mangrove environment	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>
Contamination of river water and groundwater	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>temporary</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>
<b>Air Quality</b>			
Air pollution may affect human health	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local/regional</b> Intensity: <b>moderate/strong</b> Overall importance:	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local/regional</b> Intensity: <b>moderate/strong</b> Overall importance:

**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	<p><b>moderate negative for 4 MW phase;</b>  <b>moderate/strong negative for 10 MW;</b>  <b>strong negative for 25-35 MW phase</b>  <i>Overall importance with mitigation:</i>  <b>minor negative for 4 MW phase;</b>  <b>minor/moderate negative for 10 MW;</b>  <b>strong negative for 25-35 MW phase</b></p>		<p><b>minor negative for 4 MW phase;</b>  <b>minor/moderate negative for 10 MW;</b>  <b>strong negative for 25-35 MW phase</b>  <i>Overall importance with mitigation:</i>  <b>minor negative for 4 MW phase;</b>  <b>minor negative for 10 MW;</b>  <b>minor/moderate negative for 25-35 MW phase</b></p>
Unpleasant odors	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i>  <b>minor negative</b></p>	<b>Not applicable</b>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b>  <i>Overall importance with mitigation:</i>  <b>minor negative</b></p>
<b>Noise</b>			
Disturbance to local residents and workers	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b></p>	<b>Not applicable</b>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>low</b>  <i>Overall importance:</i> <b>minor negative</b></p>
<b>Landscape and Aesthetics</b>			
Degraded quality of natural landscape	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>moderate</b>  <i>Overall importance:</i> <b>moderate negative</b>  <i>Overall importance with mitigation:</i>  <b>minor negative</b></p>	<b>Not applicable</b>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>temporary</b>  <i>Extent:</i> <b>local</b>  <i>Intensity:</i> <b>moderate</b>  <i>Overall importance:</i> <b>moderate negative</b>  <i>Overall importance with mitigation:</i>  <b>minor negative</b></p>

**Table 14. Summary comparison of potential socioeconomic and environmental impacts of the proposed action and alternatives during pre-construction and construction phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
<b>Cumulative Impacts</b>			
Increased erosion and sedimentation from runoff over exposed construction areas will degrade water quality	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>
Increased construction activity will diminish available natural vegetation and habitat for wildlife	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>
Increased erosion and sedimentation from runoff over exposed construction areas will degrade water quality	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>
Increased construction activity will diminish available natural vegetation and habitat for wildlife	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>



**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
<b>Quality of Life</b>			
Unmet expectation of the potential for new jobs and employment opportunities	<i>Nature: direct negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: minor</i> <i>Overall importance: minor negative</i>	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i>	<i>Nature: direct negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: minor</i> <i>Overall importance: minor negative</i>
Disturbance to local residents and workers	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i>	<b>Not applicable</b>	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i>
Increase in traffic may create disturbance to the local population and alter local traffic patterns in the project area  Risk of accidents and fatalities from using the road during the transportation	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<b>Not applicable</b>	<i>Nature: direct negative</i> <i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>
Loss of a site valued by the local population (cultural impact)	<i>Nature: direct negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>	<b>Not applicable</b>	<i>Nature: direct negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: low</i> <i>Overall importance: minor negative</i> <i>Overall importance with mitigation: minor negative</i>
Risk of slum development around the industrial park and deterioration of the quality of life of the local population	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: high</i> <i>Overall importance: major negative</i> <i>Overall importance with mitigation: minor negative</i>	<b>Not applicable</b>	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: high</i> <i>Overall importance: major negative</i> <i>Overall importance with mitigation: minor negative</i>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
<b>Standard of Living and Employment</b>			
<p><b>Creation or lack of creation</b> of 10-20 jobs associated with the operation of facilities, as well as new business opportunities arising from supplying needs of the maintenance of the site and the employees</p>	<p>Nature: <b>direct positive</b>                      Duration: <b>permanent</b>                      Extent: <b>local</b>                      Intensity: <b>low</b>                      Overall importance: <b>minor positive</b>                      Overall importance with mitigation : <b>minor positive</b></p>	<p>Nature: <b>indirect negative</b>                      Duration: <b>permanent</b>                      Extent: <b>local or regional</b>                      Intensity: <b>minor</b>                      Overall importance: <b>minor negative</b></p>	<p>Nature: <b>direct positive</b>                      Duration: <b>permanent</b>                      Extent: <b>local</b>                      Intensity: <b>low</b>                      Overall importance: <b>minor positive</b>                      Overall importance with mitigation : <b>minor positive</b></p>
<p>Creation or lack of creation of thousands of jobs associated with operation of the facility, as well as new business opportunities arising from supplying needs of the industrial park facilities</p> <p>Improvement of the individual and family incomes</p>	<p>Nature: <b>indirect positive</b>                      Duration : <b>permanent</b>                      Extent: <b>local and regional</b>                      Intensity: <b>high</b>                      Overall importance: <b>moderate positive</b>                      Overall importance with mitigation : <b>major positive</b></p>	<p>Nature: <b>indirect negative</b>                      Duration: <b>permanent</b>                      Extent: <b>local or regional</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>moderate negative</b></p>	<p>Nature: <b>indirect positive</b>                      Duration : <b>permanent</b>                      Extent: <b>local and regional</b>                      Intensity: <b>high</b>                      Overall importance: <b>moderate positive</b>                      Overall importance with mitigation : <b>major positive</b></p>
<b>Administrative and Social Organization</b>			
<p>Increased gang activity as children of parents working in the garment industry are left unattended for long periods of time</p>	<p>Nature: <b>indirect negative</b>                      Duration: <b>permanent</b>                      Extent: <b>local/regional</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>moderate negative</b>                      Overall importance with mitigation : <b>minor positive</b></p>	<p style="text-align: center;"><b>Not applicable</b></p>	<p>Nature: <b>indirect negative</b>                      Duration: <b>permanent</b>                      Extent: <b>local/regional</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>moderate negative</b>                      Overall importance with mitigation : <b>minor positive</b></p>
<p>A lack of communication and information during operation phase may cause social tension between the stakeholders, particularly between the local authorities and industrial park manager</p>	<p>Nature: <b>direct negative</b>                      Duration: <b>temporary</b>                      Extent: <b>local</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>moderate negative</b></p>	<p style="text-align: center;"><b>Not applicable</b></p>	<p>Nature: <b>direct negative</b>                      Duration: <b>temporary</b>                      Extent: <b>local</b>                      Intensity: <b>moderate</b>                      Overall importance: <b>moderate</b></p>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	Overall importance with mitigation : <b>minor negative</b>		<b>negative</b> Overall importance with mitigation : <b>minor negative</b>
<b>Infrastructure and Services</b>			
Increase in traffic and degradation of transportation infrastructure	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local and regional</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>moderate positive</b>	<b>Not applicable</b>	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local and regional</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>moderate positive</b>
Pressure on infrastructure services (water and sanitation, hospitals, schools, police security) and resulting decrease in quality of life and health and safety	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local and regional</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>moderate positive</b>	<b>Not applicable</b>	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local and regional</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>moderate positive</b>
<b>Health and Safety</b>			
Casual sex and higher risk of transmission of sexually transmitted diseases	Nature: <b>direct negative</b> Duration: <b>temporary/permanent</b> Extent: <b>local</b> Intensity: <b>low</b> Overall importance: <b>minor/moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>temporary/permanent</b> Extent: <b>local</b> Intensity: <b>low</b> Overall importance: <b>minor/moderate negative</b> Overall importance with mitigation: <b>minor negative</b>
Pressure on well being and health-related infrastructure services (water and sanitation, hospitals, police security) and resulting decrease in quality of life and health and safety	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local and regional</b> Intensity: <b>moderate</b>	<b>Not applicable</b>	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local and regional</b> Intensity: <b>moderate</b>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>moderate positive</b>		Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>moderate positive</b>
Potential accidents of project workers Potential accidents of local population due to unauthorized use of the project area	Nature: <b>direct negative</b> Duration: <b>temporary/permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>temporary/permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>
	Nature: <b>direct negative</b> Duration: <b>temporary/permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>temporary/permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>minor negative</b> Overall importance with mitigation: <b>minor negative</b>
Potential malnutrition caused by the loss of subsistence food production by individuals currently cultivating the project area	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>indirect negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>moderate</b> Overall importance: <b>moderate negative</b> Overall importance with mitigation: <b>minor negative</b>
Risk of injury to workers	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>minor</b> Overall importance: <b>minor negative</b>	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b> Intensity: <b>minor</b> Overall importance: <b>minor negative</b>
Harmful effects from elevated levels of arsenic and barium in drinking water supply source (groundwater)	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b>	<b>Not applicable</b>	Nature: <b>direct negative</b> Duration: <b>permanent</b> Extent: <b>local</b>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	<i>Intensity: <b>severe</b></i> <i>Overall importance: <b>strong negative</b></i> <i>Overall importance with mitigation: <b>strong positive</b></i>		<i>Intensity: <b>severe</b></i> <i>Overall importance: <b>strong negative</b></i> <i>Overall importance with mitigation: <b>strong positive</b></i>
Risk of bacterial or chemical contamination of drinking water	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>severe</b></i> <i>Overall importance: <b>strong negative</b></i> <i>Overall importance with mitigation: <b>strong positive</b></i>	<b>Not applicable</b>	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>severe</b></i> <i>Overall importance: <b>strong negative</b></i> <i>Overall importance with mitigation: <b>strong positive</b></i>
Risk of explosion and injury or death to workers due to build-up of explosive gases within the power facility	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>severe</b></i> <i>Overall importance: <b>strong negative</b></i> <i>Overall importance with mitigation: <b>moderate positive</b></i>	<b>Not applicable</b>	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>severe</b></i> <i>Overall importance: <b>strong negative</b></i> <i>Overall importance with mitigation: <b>moderate positive</b></i>
Risk of fire or explosion and injury or death to workers	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>severe</b></i> <i>Overall importance: <b>strong negative</b></i> <i>Overall importance with mitigation: <b>moderate positive</b></i>	<b>Not applicable</b>	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>severe</b></i> <i>Overall importance: <b>strong negative</b></i> <i>Overall importance with mitigation: <b>moderate positive</b></i>
<b>Gender</b>			
Improved access to economic opportunities for women  Reduced stress within the family unit	<i>Nature: <b>direct positive</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>low</b></i> <i>Overall importance: <b>minor positive</b></i> <i>Overall importance with mitigation: <b>minor positive</b></i>	<i>Nature: <b>indirect negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local or regional</b></i> <i>Intensity: <b>moderate</b></i> <i>Overall importance: <b>moderate negative</b></i>	<i>Nature: <b>direct positive</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>low</b></i> <i>Overall importance: <b>minor positive</b></i> <i>Overall importance with mitigation: <b>minor positive</b></i>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
<p>Improved access to economic opportunities for women</p> <p>Reduced stress within the family unit</p>	<p><i>Nature:</i> <b>indirect positive</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>low</b></p> <p><i>Overall importance:</i> <b>moderate positive</b></p> <p><i>Overall importance with mitigation:</i> <b>major positive</b></p>	<p><i>Nature:</i> <b>indirect negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local or regional</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p>	<p><i>Nature:</i> <b>indirect positive</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>low</b></p> <p><i>Overall importance:</i> <b>moderate positive</b></p> <p><i>Overall importance with mitigation:</i> <b>major positive</b></p>
<b>Agriculture and Livestock</b>			
<p>Industrial activities will create needs for goods and services and may enhance the sale of local agricultural products</p> <p>Development of local market for agricultural and fishing products</p>	<p><i>Nature:</i> <b>indirect positive</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>minor positive</b></p>	<p><i>Nature:</i> <b>indirect negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local or regional</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p>	<p><i>Nature:</i> <b>indirect positive</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>minor positive</b></p>
<p>Limitation of grazing and farming land as power plant occupies land currently used by local farmers</p>	<p><i>Nature:</i> <b>direct negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p> <p><i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<p><b>Not applicable</b></p>	<p><i>Nature:</i> <b>direct negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p> <p><i>Overall importance with mitigation:</i> <b>minor negative</b></p>
<p>Increased pressure on agricultural land and fishing grounds</p>	<p><i>Nature:</i> <b>indirect negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p> <p><i>Overall importance with mitigation:</i> <b>minor negative</b></p>	<p><b>Not applicable</b></p>	<p><i>Nature:</i> <b>indirect negative</b></p> <p><i>Duration:</i> <b>permanent</b></p> <p><i>Extent:</i> <b>local</b></p> <p><i>Intensity:</i> <b>moderate</b></p> <p><i>Overall importance:</i> <b>moderate negative</b></p> <p><i>Overall importance with mitigation:</i> <b>minor negative</b></p>
<b>Soil and Erosion</b>			
<p>Soil contamination</p>	<p><i>Nature:</i> <b>direct negative</b></p>	<p><b>Not applicable</b></p>	<p><i>Nature:</i> <b>direct negative</b></p>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	<i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>		<i>Duration: temporary</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>
Increase in riparian vegetation and soil stability	<i>Nature: direct positive</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate positive</i> <i>Overall importance with mitigation: moderate positive</i>	Not applicable	<i>Nature: direct positive</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate positive</i> <i>Overall importance with mitigation: moderate positive</i>
<b>Vegetation</b>			
Increase in riparian vegetation and soil stability	<i>Nature: indirect positive</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate positive</i>	Not applicable	<i>Nature: indirect positive</i> <i>Duration: permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate positive</i>
Lack of natural vegetation	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	Not applicable	<i>Nature: direct negative</i> <i>Duration: temporary/permanent</i> <i>Extent: local</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>
<b>Wildlife, Wildlife Habitat, and Natural Ecosystems</b>			
Loss of habitat for birds and reptiles, and other small animals	<i>Nature: direct negative</i> <i>Duration: temporary</i>	Not applicable	<i>Nature: direct negative</i> <i>Duration: temporary</i>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	<i>Extent: local</i> <i>Intensity: minor</i> <i>Overall importance: <b>minor negative</b></i>		<i>Extent: local</i> <i>Intensity: minor</i> <i>Overall importance: <b>minor negative</b></i>
Loss of wildlife and fisheries  Loss of mangroves due to encroachment and deforestation (for settlement and/or charcoal production)	<i>Nature: <b>indirect negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local and regional</b></i> <i>Intensity: <b>moderate to high</b></i> <i>Overall importance: <b>moderate negative</b></i> <i>Overall importance with mitigation: <b>minor negative</b></i>	<b>Not applicable</b>	<i>Nature: <b>indirect negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local and regional</b></i> <i>Intensity: <b>moderate to high</b></i> <i>Overall importance: <b>moderate negative</b></i> <i>Overall importance with mitigation: <b>minor negative</b></i>
<b>Water Quality</b>			
Contamination and sedimentation of Trou-du-Nord River and downstream mangrove ecosystem	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local and regional</b></i> <i>Intensity: <b>moderate</b></i> <i>Overall importance: <b>moderate</b></i> <i>Overall importance with mitigation: <b>minor negative</b></i>	<b>Not applicable</b>	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>permanent</b></i> <i>Extent: <b>local and regional</b></i> <i>Intensity: <b>moderate</b></i> <i>Overall importance: <b>moderate</b></i> <i>Overall importance with mitigation: <b>minor negative</b></i>
Sedimentation and increased turbidity	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>temporary/permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>low</b></i> <i>Overall importance: <b>moderate negative</b></i>	<b>Not applicable</b>	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>temporary/permanent</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>low</b></i> <i>Overall importance: <b>moderate negative</b></i>
Water contamination	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>temporary</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>moderate</b></i> <i>Overall importance: <b>moderate negative</b></i> <i>Overall importance with mitigation: <b>minor negative</b></i>	<b>Not applicable</b>	<i>Nature: <b>direct negative</b></i> <i>Duration: <b>temporary</b></i> <i>Extent: <b>local</b></i> <i>Intensity: <b>moderate</b></i> <i>Overall importance: <b>moderate negative</b></i> <i>Overall importance with mitigation: <b>minor negative</b></i>



**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
<b>Air Quality</b>			
Respiratory ailments of community and workers	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local/regional</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local/regional</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>minor negative</b>
<b>Noise</b>			
Disturbance to local residents and workers	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>low</b> <i>Overall importance:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>low</b> <i>Overall importance:</i> <b>minor negative</b>
<b>Landscape and Aesthetics</b>			
Degraded quality of natural landscape	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>low</b> <i>Overall importance:</i> <b>minor negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct negative</b> <i>Duration:</i> <b>temporary/permanent</b> <i>Extent:</i> <b>local</b> <i>Intensity:</i> <b>low</b> <i>Overall importance:</i> <b>minor negative</b>
<b>Cumulative Impacts from the collective development of activities within the Trou-du-Nord watershed, particularly activities adjacent to the river</b>			
Widening of the river and shifting of the river bed over time from the collective development of activities within the Trou-du-Nord watershed, particularly activities adjacent to the river	<i>Nature:</i> <b>direct positive</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local and regional</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>moderate positive</b>	<b>Not applicable</b>	<i>Nature:</i> <b>direct positive</b> <i>Duration:</i> <b>permanent</b> <i>Extent:</i> <b>local and regional</b> <i>Intensity:</i> <b>moderate</b> <i>Overall importance:</i> <b>moderate negative</b> <i>Overall importance with mitigation:</i> <b>moderate positive</b>
<b>Cumulative Impacts from the combined impacts of power plant operation with other Industrial Park activities (housing, textile factory, etc.)</b>			
Increase in traffic and degradation of	<i>Nature:</i> <b>indirect negative</b>	<b>Not applicable</b>	<i>Nature:</i> <b>indirect negative</b>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
transportation infrastructure	<i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>		<i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>
Increase in traffic and degradation of transportation infrastructure	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	Not applicable	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>
Pressure on infrastructure services (water and sanitation, hospitals, schools, police security) and resulting decrease in quality of life and health and safety	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>	Not applicable	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: moderate positive</i>
Degradation of Trou-du-Nord River water quality and downstream mangrove ecosystem due increased sedimentation and contamination from runoff and activity	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate to high</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor positive</i>	Not applicable	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate to high</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor positive</i>
Loss of wildlife and fisheries due to pollution and encroachment of activities on natural habitat	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i>	Not applicable	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
Loss of mangroves due to encroachment and deforestation (for settlement and/or charcoal production) from increased population growth	<i>Intensity: moderate to high</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>		<i>Intensity: moderate to high</i> <i>Overall importance: moderate negative</i> <i>Overall importance with mitigation: minor negative</i>
Degradation of air quality	<i>Nature: direct negative</i> <i>Duration: permanent</i> <i>Extent: local/regional</i> <i>Intensity: moderate/strong</i> <i>Overall importance: moderate negative for 4 MW phase; moderate/strong negative for 10 MW; strong negative for 25-35 MW phase</i> <i>Overall importance with mitigation: minor negative for 4 MW phase; minor/moderate negative for 10 MW; strong negative for 25-35 MW phase</i>	Not applicable	<i>Nature: direct negative</i> <i>Duration: permanent</i> <i>Extent: local/regional</i> <i>Intensity: moderate/strong</i> <i>Overall importance: minor negative for 4 MW phase; minor/moderate negative for 10 MW; strong negative for 25-35 MW phase</i> <i>Overall importance with mitigation: minor negative for 4 MW phase; minor negative for 10 MW; minor/moderate negative for 25-35 MW phase</i>
Increase in economic opportunity and quality of life due to jobs creation	<i>Nature: indirect positive</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate positive</i>	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate negative</i>	<i>Nature: indirect positive</i> <i>Duration: permanent</i> <i>Extent: local and regional</i> <i>Intensity: moderate</i> <i>Overall importance: moderate positive</i>
<b>Cumulative Impacts from the combined impacts of power plant operation with other development activities within the region spanning from Cap Haitien to Quinaminthe (new University of Haiti, and port development and expansion at Fort Liberté and Cap Haitien, etc.)</b>			
Increase in traffic and degradation of transportation infrastructure	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation:</i>	Not applicable	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation:</i>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
	<b>moderate positive</b>		<b>moderate positive</b>
Pressure on infrastructure services (water and sanitation, hospitals, schools, police security) and resulting decrease in quality of life and health and safety	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: moderate positive</i>	<b>Not applicable</b>	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: moderate positive</i>
Degradation of Trou-du-Nord River water quality and downstream mangrove ecosystem due increased sedimentation and contamination from runoff and activity	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: minor positive</i>	<b>Not applicable</b>	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: minor positive</i>
Loss of wildlife and fisheries due to pollution and encroachment of activities on natural habitat  Loss of mangroves due to encroachment and deforestation (for settlement and/or charcoal production) from increased population growth	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: minor to moderate negative</i>	<b>Not applicable</b>	<i>Nature: indirect negative</i> <i>Duration: permanent</i> <i>Extent: regional</i> <i>Intensity: high</i> <i>Overall importance: strong negative</i> <i>Overall importance with mitigation: minor to moderate negative</i>

**Table 15. Summary comparison of potential socioeconomic and environmental impacts of proposed action and alternatives during the operational phase**

Impacts	Proposed Action	“No Action” Alternative	Diesel Alternative
Degradation of air quality	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local/regional</b>  <i>Intensity:</i> <b>moderate/strong</b>  <i>Overall importance:</i>  <b>moderate negative for 4 MW phase;</b>  <b>moderate/strong negative for 10 MW;</b>  <b>strong negative for 25-35 MW phase</b>  <i>Overall importance with mitigation:</i>  <b>minor negative for 4 MW phase;</b>  <b>minor/moderate negative for 10 MW;</b>  <b>strong negative for 25-35 MW phase</b></p>	<p style="text-align: center;"><b>Not applicable</b></p>	<p><i>Nature:</i> <b>direct negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>local/regional</b>  <i>Intensity:</i> <b>moderate/strong</b>  <i>Overall importance:</i>  <b>minor negative for 4 MW phase;</b>  <b>minor/moderate negative for 10 MW;</b>  <b>strong negative for 25-35 MW phase</b>  <i>Overall importance with mitigation:</i>  <b>minor negative for 4 MW phase;</b>  <b>minor/moderate negative for 10 MW;</b>  <b>minor/moderate negative for 25-35 MW phase</b></p>
Increase in economic opportunity and quality of life due to jobs creation	<p><i>Nature:</i> <b>indirect positive</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>regional</b>  <i>Intensity:</i> <b>high</b>  <i>Overall importance:</i> <b>strong positive</b></p>	<p><i>Nature:</i> <b>indirect negative</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>regional</b>  <i>Intensity:</i> <b>moderate</b>  <i>Overall importance:</i> <b>moderate negative</b></p>	<p><i>Nature:</i> <b>indirect positive</b>  <i>Duration:</i> <b>permanent</b>  <i>Extent:</i> <b>regional</b>  <i>Intensity:</i> <b>high</b>  <i>Overall importance:</i> <b>strong positive</b></p>

## 7. ENVIRONMENTAL MITIGATION AND MONITORING PLAN

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The Environmental Mitigation and Monitoring Plan (EMMP) for power plant construction, testing, start-up and turnover activities is outlined in Table 16 below. It includes recommended mitigation measures, indicators to evaluate their effectiveness, monitoring schedule, and responsible authorities.

Several aspects of this environmental assessment have been determined to have consequences that must be mitigated / diminished during the period of construction, testing, commissioning, startup, turnover, and operation. This environmental mitigation and monitoring plan delineates the requirements that shall be placed upon the selected Contractor during construction, testing, commissioning, startup, and turnover period of the power plant to comply with the directives of the USAID and the Haiti Ministry of the Environment in order to maintain the environment and mitigate impact to the population, quality of life, flora and fauna.

This document requires the Contractor to provide several plans, mitigation and written policy directives. These documents shall be submitted to USAID for approval. All plans shall have USAID approval prior to commencement of construction or any substantial soil disturbance or excavation. The contractor shall be responsible to implement these requirements. AECOM will provide Owner's Construction Oversight services and shall in conjunction with the client and the Ministry of Environment have responsibility and authority for enforcement.

The overall requirements to be implemented by the contractor during construction, testing, commissioning, startup, and turnover period of the power plant is described below. Specific requirements are included in the impacts and mitigations table of the Proposed Action and form an integral part of this addendum.

### 7.1 HEALTH AND SAFETY PLAN (HASP)

1. The contractor shall prepare and implement a HASP to ensure worker health and safety while on the project and provide training on best practices to minimize risks. The HASP will include a communications plan to workers on the risks associated with socially transmitted diseases and HIV/AIDS, and the contractor will implement this plan, and make condoms and information freely available to all workers. First aid facilities shall be available on site.
2. Access into the construction site shall be controlled. Security of the site at all times is the responsibility of the Contractor.
3. The Contractor shall provide sufficient onsite drinking water, portable toilets, wash and change facilities for all craft. No onsite disposal of sanitary waste is allowed.
4. The Contractor shall provide Personal Protection Equipment (PPE) for all personnel and shall as a minimum include: hard hat, safety glasses, hearing protection and reflective vests. Other PPE concomitant with the specific activity shall also be provided.
5. Institute a monitoring program to detect and address unsafe conditions.
6. Implement a policy that terminates employees failing to wear personal protective equipment after receiving a warning for the first infraction.

## 7.2 STORM WATER POLLUTION PREVENTION PLAN (SWPPP)

1. The contractor shall prepare a SWPPP to mitigate storm runoff and soil erosion throughout the site. Protection from runoff and sedimentation into the Trou-du-Nord River shall be considered. Silt screens and sedimentation control devices shall be implemented.
2. Maintain a vegetated buffer zone approximately 10M wide on either side of streams or river banks if required to mitigate the impact to the river from the power plant construction activities. Rip rap is allowed where appropriate.
3. Replanting of vegetation where disturbed during construction is required.
4. A temporary impermeable concrete truck wash out pit shall be constructed to preclude wash water from contacting the ground.

## 7.3 DUST CONTROL

1. Contractor shall implement a plan for dust control. Watering of excavation areas to limit dust emissions is required.
2. Limits on the speed of construction vehicles shall be established and enforced.

## 7.4 WORK HOURS

Work hours shall be limited to daylight hours only.

## 7.5 WASTE DISPOSAL

Contractor shall maintain daily the site in an orderly fashion. Waste receptacles shall be positioned about the site to maintain a clean facility. All waste shall be collected and disposed of offsite at a qualified waste facility.

## 7.6 STORAGE OF CHEMICALS AND HAZARDOUS MATERIALS

1. All potential pollutants, hazardous materials, petroleum products, lubricants, hydraulic oil, paints, coatings etc. shall be stored in an approved container and placed on a sealed surface with containment dikes to prevent soil contamination. HAZMAT Spill Kits shall be placed nearby storage areas as needed.
2. Drip pans / pads shall be installed at petroleum dispensing locations i.e., truck refueling and maintenance locations and under temporary generators and portable equipment.
3. Used oil, lubricants, hydraulic oil and like products shall be collected and disposed of offsite at an approved facility. Collected oily water shall be properly treated or disposed of at an approved facility.

## 7.7 PUBLIC NOTIFICATION AND SIGNAGE

1. Contractor is responsible to devise and maintain orderly traffic patterns into and out of the site to minimize disruption to the community. The contractor shall install signage to alert the communities of construction activities and the transport of heavy equipment on the public roads. Site security will be maintained to prevent entry and possible injury from persons not associated with the project.
2. There shall be a public awareness program promulgated by the contractor to the communities prior to the commencement of construction.
3. Contractor shall inform local authorities about the nature and scheduling of construction activities.

4. Contractor shall implement a public complaint and notification program.

## **7.8 LOCAL EMPLOYMENT**

1. Prior to construction, contractor shall inform local communities of project employment and business opportunities.
2. Contractor shall maximize the local procurement of supplies and services, and employment of local individuals with the necessary skills currently residing in the North or North-East Departments for construction works (primarily the communities of Fleury, Volant, and Caracol, and secondarily the towns of Fort Liberté, Limonade, and Trou-du-Nord) where applicable.

## **7.9 MONITORING, RECORDING AND REPORTING**

1. Contractor shall be responsible for monitoring, recording and reporting all environmental activities performed during the construction testing, commissioning, startup and turnover activities.
2. Contractor shall maintain daily logs of these activities and provide weekly reports for review by AECOM and the Client. Environmental compliance infringements shall be reported expeditiously together with the measure implemented to mitigate any adverse environmental consequences.
3. All daily logs, reports and other environmental documentation shall be part of the permanent records maintained by the contractor, copies of which shall be included in the final turnover package submitted to the client.



**Table 16. Environmental Mitigation and Monitoring Plan (EMMP) for the construction, testing, start-up, and turnover of the North Park Power Facility**

Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
<b>Quality of Life</b>			
<p>Increase in traffic from transport of generators and construction materials to the project site may create disturbance to the local population and alter local traffic patterns in the project area</p> <p>Risk of accidents and fatalities from using the road during the transportation</p>	<p>Objective: to avoid or minimize disturbance</p> <ul style="list-style-type: none"> <li>• Set limits for time of construction operations to occur each day</li> <li>• Install signage to alert communities to the transport of heavy equipment and machinery</li> <li>• Assist client to inform communities of the anticipated changes in traffic patterns due to the construction activity</li> <li>• Apply water when appropriate to minimize dust</li> </ul>	<ul style="list-style-type: none"> <li>• Document time and schedule of construction activity (daily)</li> <li>• Document proper application of water to minimize dust and measures to manage traffic at construction site (daily)</li> <li>• Inspect vehicles weekly and maintain as necessary (weekly log of number of vehicles and equipment maintained)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>
<b>Standard of Living and Employment</b>			
<p>Creation of 10-20 jobs associated with construction and installation of facilities, as well as new business opportunities arising from supplying needs of the project and the employees during the construction period (July 2011 – February 2012)</p>	<ul style="list-style-type: none"> <li>• Maximize employment of local people with the necessary skills for the project works</li> <li>• Where possible, adequate training to increase local employment</li> <li>• Before the construction phase, inform the population of the employment and business opportunities</li> <li>• Promote the purchase of local goods and services where applicable</li> </ul>	<ul style="list-style-type: none"> <li>• Document employment and payroll activity (weekly log of number of jobs filled by local people; target of 90% of unskilled employees should come from local communities in Northern Haiti)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>
<b>Administrative and Social Organization</b>			
<p>A lack of communication and information of construction works and related activities may cause social tension between the stakeholders, particularly between the local authorities and construction firm</p>	<p>Objective: Maintain positive relationship and cooperation with local population</p> <ul style="list-style-type: none"> <li>• Plan a process to address complaints from stakeholders</li> <li>• Assist client to inform local authorities about the nature and the scheduling of the construction activities (included as part of the project communications)</li> </ul>	<ul style="list-style-type: none"> <li>• Track issues and complaints (Monthly log of number of complaints registered, including actions taken to address the issues)</li> <li>• Conduct and document meetings with local representatives, documenting issues raised (monthly log, including the target of at least one meeting at onset of project)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>

Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
plan)			
<b>Infrastructure and Services</b>			
Transport of construction materials may cause disruption to road traffic during the pre-construction and construction phases	Objective: Minimize perturbation to local traffic <ul style="list-style-type: none"> <li>Inform in advance the road users of the land and road and plan the traffic control in order to minimize impacts to road traffic</li> </ul>	<ul style="list-style-type: none"> <li>Document delays in traffic and record any traffic incidents (Monthly log of number and duration of traffic delays)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
Transport of construction materials may cause damage to roadways	Objective: Minimize damage to transportation infrastructure <ul style="list-style-type: none"> <li>Identify areas of road damage</li> </ul>	<ul style="list-style-type: none"> <li>Document road damage and required reparations (Monthly log of observed road damage)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM, during the life of AECOM contract only</li> </ul>
Transport of construction materials may cause damage to roadways	Objective: Minimize damage to transportation infrastructure <ul style="list-style-type: none"> <li>Provide regular maintenance of the road in order to minimize road damage</li> </ul>	<ul style="list-style-type: none"> <li>Document road reparations (Monthly log of reparations)</li> </ul>	<ul style="list-style-type: none"> <li>Implementation – IDB/SONAPI</li> <li>Monitoring – USAID and IDB/SONAPI/SONAPI/SONAPI</li> <li>Oversight – USAID and IDB/SONAPI/SONAPI</li> </ul>
<b>Health and Safety</b>			
Risk of injury to workers from improper handling or storage of adhesives, cleaners, solvents, and chemicals	Objective: Minimize risk of injury from chemicals and solvents <ul style="list-style-type: none"> <li>Apply and store adhesives, cleaners, solvents, and chemicals in a ventilated area</li> <li>Provide training to workers in proper handling, use and storage</li> </ul>	<ul style="list-style-type: none"> <li>Develop and gain review/approval of worker Health and Safety Plan (HASP)</li> <li>Document training provided (Start-up documentation of training)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight (including review and approval of HASP) – USAID and AECOM, during the life of AECOM contract only</li> </ul>
Harmful effects from elevated levels of Arsenic and Barium in drinking water supply source (groundwater)	Objective: Provide safe water for drinking and bathing <ul style="list-style-type: none"> <li>Treat water using recommended WHO treatment measures to meet WHO guideline values for arsenic and barium, or use bottled water for drinking and cooking, use well water</li> </ul>	<ul style="list-style-type: none"> <li>Document water treatment methods (Weekly log)</li> <li>Develop and gain review/approval of water quality monitoring plan</li> <li>Document water quality monitoring results using WHO surveillance methods (Weekly log)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight (including review and approval of water quality monitoring plan) – USAID and</li> </ul>

Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
	for bathing and cleaning <ul style="list-style-type: none"> <li>Monitor water quality with regular monthly testing using WHO recommended surveillance methods</li> </ul>	of water quality results)	AECOM, during the life of AECOM contract only
Risk of bacterial or chemical contamination of drinking water from tampering with construction site wellhead or pump, or infiltration of surface runoff into well	Objective: Provide safe water for drinking and bathing <ul style="list-style-type: none"> <li>Provide site security</li> <li>Install wellhead protection during construction</li> <li>Monitor water quality with regular monthly testing using WHO recommended surveillance methods</li> </ul>	<ul style="list-style-type: none"> <li>Conduct site security inspections (Weekly log of security checks)</li> <li>Regularly inspect the integrity and effectiveness of wellhead protection measures</li> <li>Document water treatment methods (Weekly log)</li> <li>Develop and gain review/approval of water quality monitoring plan</li> <li>Document water quality monitoring results using WHO surveillance methods (Weekly log of water quality results)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight (including review and approval of water quality monitoring plan) – USAID and AECOM</li> </ul>
Risk of explosion and injury or death to workers due to build-up of explosive gases within the power facility, caused by inadequate ventilation within the building where the generators are housed	Objective: Minimize risk to explosion during power plant operation <ul style="list-style-type: none"> <li>Provide adequate ventilation in engine room</li> <li>Consider the installation of sensors to detect unsafe levels of carbon monoxide or explosive gases</li> <li>Institute a monitoring program to detect and address unsafe conditions</li> </ul>	<ul style="list-style-type: none"> <li>Conduct regular inspections of carbon monoxide and explosive gas sensors (Daily log of working condition)</li> <li>Document monitoring and measures taken to address unsafe conditions, and include in HASP (Daily log)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight (including review and approval of monitoring plan) – USAID and AECOM</li> </ul>
Risk of fire or explosion and injury or death to workers from overheating of the generators leaking/fractured pipe work, fuel or oil system pipe work is in contact with hot surfaces	Objective: Minimize risk to explosion during power plant operation <ul style="list-style-type: none"> <li>Install a fire detection system</li> <li>Avoid laying fuel or oil system pipe work over hot surfaces</li> </ul>	<ul style="list-style-type: none"> <li>Conduct regular inspections of leaking/fractured pipe work and fuel oil system in contact with any hot surfaces (Daily log of working condition)</li> <li>Document monitoring and measures taken to address unsafe conditions, and include in HASP (Daily log)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight (including review and approval of monitoring plan) – USAID and AECOM</li> </ul>
Casual sex and higher risk of transmission of sexually transmitted diseases due to interaction of project workers with local population	Objective: Minimize or prevent the spread of STDs and HIV/AIDS <ul style="list-style-type: none"> <li>Provide a Health and Safety Plan (HASP) that includes awareness and education for workers about STDs and HIV/AIDS</li> </ul>	<ul style="list-style-type: none"> <li>Develop and gain review/approval of worker Health and Safety Plan (HASP)</li> <li>Document the free availability of condoms to project workers (Daily log)</li> <li>Document training provided (Start-up documentation of training)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight (including review and approval of HASP) – USAID and AECOM</li> </ul>

Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
	<ul style="list-style-type: none"> <li>• Make condoms and information freely available to project employees</li> <li>• Provide information to community representatives on the risks of STDs and HIV/AIDS and prevention measures</li> </ul>	<ul style="list-style-type: none"> <li>• Conduct and document meetings with local representatives, documenting issues raised (monthly log, including the target of at least one meeting at onset of project)</li> </ul>	
Construction works and related activities cause potential accidents to project workers	<p>Objective: Minimize risk of accidents to project workers</p> <ul style="list-style-type: none"> <li>• Develop HASP and provide worker training on best practices to minimize health and safety risks</li> </ul>	<ul style="list-style-type: none"> <li>• Develop and gain review/approval of HASP</li> <li>• Document training provided (Start-up documentation of training)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight (including review and approval of HASP) – USAID and AECOM</li> </ul>
Construction works and related activities cause potential accidents to local population due to unauthorized use of the project area	<p>Objective: Minimize risk of accidents to local residents</p> <ul style="list-style-type: none"> <li>• Develop, communicate and implement accident preventive and safety measures Control access to construction areas</li> <li>• Develop a communications plan and assist client to disseminate to the community prior to construction</li> </ul>	<ul style="list-style-type: none"> <li>• Develop and gain review/approval of HASP</li> <li>• Document training provided (Start-up documentation of training)</li> <li>• Conduct site security inspections (Weekly log of security checks)</li> <li>• Conduct and document meetings with local representatives, documenting issues raised (monthly log, including the target of at least one meeting at onset of project)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight (including review and approval of HASP) – USAID and AECOM</li> </ul>
<b>Gender</b>			
Creation of employment and business opportunities supporting construction activities enables improved access to economic opportunities for women and reduced stress within the family unit	<p>Objective: Promote equitable access to project benefits for men and women</p> <ul style="list-style-type: none"> <li>• Offer the same opportunities of employment to men and women and encourage women to apply in order to benefit from business opportunities</li> </ul>	<ul style="list-style-type: none"> <li>• Document employment and payroll activity (weekly log of number of jobs filled by women)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>
<b>Agriculture and Livestock</b>			
Creation of employment and business opportunities	<p>Objective: Enhance the sale of local</p>	<ul style="list-style-type: none"> <li>• Conduct and document meetings with local</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid</li> </ul>

Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
supporting construction activities	agricultural products <ul style="list-style-type: none"> <li>• Inform the local population of food products and services required by the project</li> </ul>	representatives, documenting issues raised (monthly log, including the target of at least one meeting at onset of project)	documents) – USAID <ul style="list-style-type: none"> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>
<b>Soil and Erosion</b>			
Improper storage and/or disposal of materials and fuels causes soil contamination	Objective: Reduce soil contamination by preventing spills <ul style="list-style-type: none"> <li>• Install drip pans at petroleum products dispensing points</li> <li>• Store potential pollutants such as fuel, oil and chemicals on sealed surfaces to prevent soil contamination</li> <li>• Collect and recycle used oil and lubricants</li> </ul>	<ul style="list-style-type: none"> <li>• Document the storage location, disposal, and recycling of all hazardous chemicals (Weekly log of chemicals and quantity involved)</li> <li>• Document the installation and use of drip pans and sealed surfaces (Weekly log)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>
Exposed soil from construction activity, excavation, or stockpiling causes erosion and associated soil loss and degradation	Objective: Minimize soil erosion <ul style="list-style-type: none"> <li>• Cover and protect susceptible soil surfaces</li> <li>• Install silt screens to prevent sedimentation in the Trou-du-Nord River during construction</li> <li>• Maintain large trees on the perimeter of the park boundaries</li> </ul>	<ul style="list-style-type: none"> <li>• Survey and document exposed soils and formation of gullies, as well as measures taken to address problems (Weekly log documenting inspections)</li> <li>• Revisit treated areas to verify improvement (Weekly log documenting inspections)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>
Soil loss and vegetation from construction activity causes soil erosion of riverbanks	Objective: Protect Trou-du-Nord riverbanks from erosion <ul style="list-style-type: none"> <li>• Provide a vegetated buffer strip by replanting vegetation in riverbank areas impacted by construction</li> <li>• Install rip rap where appropriate</li> <li>• Install silt screens to prevent sedimentation during construction</li> </ul>	<ul style="list-style-type: none"> <li>• Survey and document exposed soils and formation of gullies, as well as measures taken to address problems (Weekly log documenting inspections)</li> <li>• Revisit treated areas to verify improvement (Weekly log documenting inspections)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>
<b>Vegetation</b>			
Loss of vegetation due to site clearing and construction activity	Objective: Protect Trou-du-Nord riverbanks from erosion <ul style="list-style-type: none"> <li>• Minimize impacted area of activity</li> <li>• Provide revegetation and landscaping</li> </ul>	<ul style="list-style-type: none"> <li>• Survey and document exposed soils and formation of gullies, as well as measures taken to address problems (Weekly log documenting inspections)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> </ul>

Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
	with endemic plants in areas impacted by construction	<ul style="list-style-type: none"> <li>Revisit treated areas to verify improvement (Weekly log documenting inspections)</li> </ul>	<ul style="list-style-type: none"> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
Contamination from improper disposal of construction materials and fuels retards healthy vegetation growth	<p>Objective: Prevent spills and contamination</p> <ul style="list-style-type: none"> <li>Install drip pans at petroleum products dispensing points</li> <li>Store potential pollutants such as fuel, oil and chemicals on sealed surfaces to prevent soil contamination</li> <li>Contain and clean up spills as soon as possible</li> <li>Collect and recycle, if possible, used oil and lubricants</li> </ul>	<ul style="list-style-type: none"> <li>Document the storage location, disposal, and recycling of all hazardous chemicals (Weekly log of chemicals and quantity involved)</li> <li>Document the installation and use of drip pans and sealed surfaces (Weekly log)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
<b>Wildlife, Wildlife Habitat, and Natural Ecosystems</b>			
Sedimentation in river due to runoff from exposed areas and construction activity degrades aquatic life and habitat, such as fish and crayfish habitat in Trou-du-Nord River	<p>Objective: Minimize disturbance to habitat</p> <ul style="list-style-type: none"> <li>Provide a vegetated buffer strip by replanting vegetation in riverbank areas impacted by construction</li> <li>Install rip rap where appropriate</li> <li>Install silt screens to prevent sedimentation during construction</li> </ul>	<ul style="list-style-type: none"> <li>Document the date and length of time of construction activities impacting the aquatic environment and review to verify that activities involving soil disturbance are confined to the dry season (Weekly log)</li> <li>Inspect and document integrity of rip rap, silt screens (Daily log documenting inspections and condition of protective barriers)</li> <li>Survey and document exposed soils and formation of gullies, as well as measures taken to address problems (Weekly log documenting inspections)</li> <li>Revisit treated areas to verify improvement (Weekly log documenting inspections)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
<b>Water Quality</b>			
Inadequate drainage and site runoff from plant causes contamination and sedimentation of Trou-du-Nord River and downstream mangrove ecosystem	<p>Objective: Eliminate erosion and siltation</p> <ul style="list-style-type: none"> <li>Vegetate embankments impacted by construction to maximize contaminant retention and eliminate entry into water</li> <li>Treat oily water in a separator</li> <li>Provide adequate drainage of the plant site to drain water away from the</li> </ul>	<ul style="list-style-type: none"> <li>Develop and gain review/approval of Storm Water Pollution Prevention Plan (SWPPP)</li> <li>Survey and document exposed soils and formation of gullies, as well as measures taken to address problems (Weekly log documenting inspections)</li> <li>Revisit treated areas to verify improvement (Weekly log documenting inspections)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight (including review and approval of SWPPP) – USAID and AECOM</li> </ul>

Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
	<p>area in a controlled manner, away from the river. Divert water away from structures and associated roads, without causing harm to other planned facilities within the industrial park, and to people living or working adjacent to the site boundary</p> <ul style="list-style-type: none"> <li>• Provide a drainage system for the plant site to follow natural drainage patterns, if possible</li> <li>• Provide a drainage system or trenches around the perimeter of the plant site</li> <li>• Provide a separate drainage system for the fuel tank containment area to separate and collect oily water</li> <li>• Line storm drains with rip-rap</li> </ul>	<ul style="list-style-type: none"> <li>• Inspect and document integrity of rip rap, silt screens, and drainage systems (Daily log documenting inspections and condition of protective barriers)</li> </ul>	
<p>Water contamination from improper storage and/or disposal of materials and fuels</p>	<p>Objective: Prevent spills and contamination</p> <ul style="list-style-type: none"> <li>• Install drip pans at petroleum products dispensing points</li> <li>• Store potential pollutants such as fuel, oil and chemicals on sealed surfaces to prevent soil contamination</li> <li>• Collect and recycle used oil and lubricants, where possible</li> <li>• House fuel tanks in a spill containment structure with a capacity to hold 110% of the capacity of all the fuel tanks</li> </ul>	<ul style="list-style-type: none"> <li>• Document the storage location, disposal, and recycling of all hazardous chemicals (Weekly log of chemicals and quantity involved)</li> <li>• Document the installation and use of drip pans and sealed surfaces (Weekly log)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight – USAID and AECOM</li> </ul>
<p>Exposed soil from construction activity, excavation, or stockpiling causes sedimentation in river, and possibly affecting downstream mangrove environment</p>	<p>Objective: Minimize sedimentation</p> <ul style="list-style-type: none"> <li>• Cover and protect susceptible soil surfaces</li> <li>• Install silt screens to prevent sedimentation in the Trou-du-Nord River during construction</li> </ul>	<ul style="list-style-type: none"> <li>• Develop and gain review/approval of Storm Water Pollution Prevention Plan (SWPPP)</li> <li>• Survey and document exposed soils and formation of gullies, as well as measures taken to address problems (Weekly log documenting inspections)</li> <li>• Revisit treated areas to verify improvement (Weekly log documenting inspections)</li> </ul>	<ul style="list-style-type: none"> <li>• Tendering (include requirement in bid documents) – USAID</li> <li>• Implementation – Contractor</li> <li>• Monitoring – Contractor</li> <li>• Oversight (including review and approval of SWPPP) – USAID and AECOM</li> </ul>

Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
		<ul style="list-style-type: none"> <li>Inspect and document integrity of rip rap, silt screens, and drainage systems (Daily log documenting inspections and condition of protective barriers)</li> </ul>	
<p>Inadequate or unmaintained sanitation facilities for workers causes contamination of river water and groundwater</p>	<p>Objective: Groundwater quality protection</p> <ul style="list-style-type: none"> <li>Choose appropriate sites for sanitation facilities, situated at least 50 m from river</li> <li>Provide proper maintenance and hygiene of sanitation facilities</li> </ul>	<ul style="list-style-type: none"> <li>Document and verify location of sanitation facilities away from stream</li> <li>Document daily cleaning and maintenance of facilities (Daily log)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
<b>Air Quality</b>			
<p>Emissions from power plant smokestacks cause respiratory ailments of community and workers</p>	<p>Objective: Minimize air pollution</p> <ul style="list-style-type: none"> <li>Design generators and smokestacks with available emissions control devices for maximum emissions reduction for sulfur oxides, nitrogen oxides, particulate matter, carbon monoxide, and non-methane hydrocarbons (includes scrubber, selective catalytic reduction device, and particulate filter). Utilize BACT in the design</li> <li>Contractor shall provide any price difference associated with normal design vs. design to implement the above measures</li> </ul>	<ul style="list-style-type: none"> <li>Provide emissions monitoring (Weekly log)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
<p>Air pollution from diesel fumes and dust from construction vehicles may adversely affect human health</p>	<p>Objective: Minimize harmful emissions and dust from construction vehicles</p> <ul style="list-style-type: none"> <li>Control dust by application of water</li> <li>Limit speed of hauling trucks</li> <li>Provide regular maintenance of construction vehicles</li> </ul>	<ul style="list-style-type: none"> <li>Document proper application of water to minimize dust and measures to manage traffic at construction site (daily)</li> <li>Inspect vehicles weekly and maintain as necessary (weekly log of number of vehicles and equipment maintained)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
<p>Inadequate or unmaintained sanitation facilities for workers create unpleasant odors</p>	<p>Objective: Eliminate unpleasant odors</p> <ul style="list-style-type: none"> <li>Provide proper maintenance and cleaning of sanitation facilities</li> </ul>	<ul style="list-style-type: none"> <li>Document and verify location of sanitation facilities away from stream</li> <li>Document daily cleaning and maintenance of</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> </ul>



Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority
		facilities (Daily log)	<ul style="list-style-type: none"> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
<b>Noise</b>			
Excessive noise from generators creates disturbance to local residents and workers	<p>Objective: Minimize noise</p> <ul style="list-style-type: none"> <li>Provide noise attenuation to limit the noise output to a maximum of 85 dB (A) at 1 meter from the external wall of the generator container or enclosure, and not more than 5dB (A) above the ambient noises at the site boundary</li> <li>Design engine room to contain a heavy, vibrating diesel engine with a high noise level</li> <li>Provide ear protection gear for workers</li> <li>Include signage in maximum visibility locations to advise the use of ear protection</li> <li>Plant trees around power plant facility, ensuring that trees are far enough away from the plant to minimize risk of fire</li> </ul>	<ul style="list-style-type: none"> <li>Monitor and document noise levels at 1 m from the external wall of the generator container, and at the site boundary (Daily log)</li> <li>Monitor use of ear protection gear (Daily log)</li> <li>Document the installation of signage</li> <li>Document trees planted</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
Excessive noise from construction machinery and vehicles creates disturbance to local residents and workers	<p>Objective: Minimize noise</p> <ul style="list-style-type: none"> <li>Limit working period to daylight hours only</li> <li>Provide protective gear for workers</li> </ul>	<ul style="list-style-type: none"> <li>Document time and schedule of construction activity (daily)</li> <li>Inspect vehicles weekly and maintain as necessary (weekly log of number of vehicles and equipment maintained)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>
<b>Landscape and Aesthetics</b>			
Construction works and disposal of waste and material from construction and installation of facility degrades quality of natural landscape	<p>Objective: Minimize degradation of natural landscape</p> <ul style="list-style-type: none"> <li>Provide proper cleanup and control of construction site</li> <li>Provide proper disposal of waste from construction and unused equipment</li> </ul>	<ul style="list-style-type: none"> <li>Document cleanup, control, and disposal (Weekly log)</li> </ul>	<ul style="list-style-type: none"> <li>Tendering (include requirement in bid documents) – USAID</li> <li>Implementation – Contractor</li> <li>Monitoring – Contractor</li> <li>Oversight – USAID and AECOM</li> </ul>



Source and Description of Impact	Mitigation Measures	Monitoring Methodology and Indicators	Responsible Authority

## APPENDIX A – SCOPING LETTER (ENGLISH)

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Dear \_\_\_\_\_:

You may be aware that the creation of an Industrial Park has been proposed for an area between Fleury and Volant, near Caracol, in the North of Haiti. As a part of this Industrial Park, the United States Government, through its Agency for International Development (USAID), plans to construct a power plant with power distribution system to serve the Industrial Park and some nearby communities.

We would like to hear from you about any concerns you may have about the impact this power plant could have on the natural environment or on the people who live in the surrounding area. The most efficient method of contributing your views on this subject is through e-mail. For this purpose, we have set up a special e-mail address: [papusaidpcps@usaid.gov](mailto:papusaidpcps@usaid.gov). Please include “Caracol Power Plant” on the subject line of your message so it is routed to the correct office. Including your name and title is optional, but if included, they will assist us in understanding if our outreach has been effective. If sending your comments by surface mail is more convenient, address them to: Mission Environmental Officer, USAID, P.O. Box 1634, Port-au-Prince, Haiti.

As a starting point, examples of potential issues we have identified include:

1. Will the power plant have an adverse impact on air quality?
2. Will the noise of the plant affect the surrounding community?
3. If an oil spill were to occur during unloading or transportation of the fuel, what would be the effect and how would the spill be cleaned up?
4. If the fuel storage tanks leak, will there be an effect on the groundwater?
5. Are there alternative ways to generate electricity using renewable options?
6. Will the power distribution system have an intrusive effect on the community?
7. Will the distribution system be dangerous? Who will maintain the power lines?
8. What safeguards will be in place to protect workers and the local community if something goes wrong at the plant?
9. Who will manage the power plant? Will they be properly trained?
10. Will the communities that receive electricity be able to afford it?

These next series of questions are related to the construction period:

1. Will there be much noise and dust during construction?
2. Will the workers be safe?
3. The generators are very big, will it be dangerous to move them to the industrial park and will it damage the new road?
4. Will the construction be properly managed to make sure everybody remains safe?

Thank you very much for your attention to this matter. Please pass this letter to other individuals that you think would like to respond. We look forward to hearing from you. Please reply by March 14, 2010.  
Thank you.

Sincerely,

Debra Allen-Reid  
USAID/Haiti Mission Environmental Officer

## APPENDIX B : SCOPING LETTER (FRENCH)

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Monsieur, Madame \_\_\_\_\_ :  
Adresse.....

L'Agence Américaine pour le Développement International en Haiti (USAID/Haiti), vous présente ses compliments et profite de l'occasion pour vous informer plus amplement du projet de création d'un Park Industriel dans le Département du Nord Est entre les localités de Fleury et Volant dans les environs de Caracol. Le Gouvernement des Etats-Unis d'Amérique, à travers l'USAID/Haiti, prévoit, en complément au Park Industriel, la construction d'une Usine Electrique ainsi que des lignes de distribution qui alimenteront en énergie le Park et certaines communautés voisines.

Nous vous saurions gré de partager avec nous vos appréhensions potentielles quant à l'impact de cette usine sur l'environnement ou sur les habitants de la région, à l'adresse électronique spécialement créée pour ce type d'échanges : [papusaiddpcps@usaid.gov](mailto:papusaiddpcps@usaid.gov). Veuillez bien indiquer « Caracol Power Plant » comme sujet de l'e-mail et mentionner également votre nom et votre titre, pour nous aider à mieux diriger votre requête. Vous pouvez également, nous adresser un courrier à l'adresse suivante : Mission Environmental Officer - USAID, P.O. Box 1634 - Port-au-Prince, Haiti.

Ci-dessous, nous vous faisons part d'une série de questions déjà identifiées.

Questions concernant l'environnement :

1. Est-ce que l'usine électrique aura un impact négatif sur la qualité de l'air ambiant ?
2. Est-ce que le bruit produit par les machines de l'usine affectera la communauté environnante ?
3. Dans le cas d'épandage de produit pétrolier lors du débarquement ou le transport de carburant, quels seront ses impacts and de quelle façon pourrait –t-on les nettoyer ?
4. Dans le cas où les citernes de stockage présenteraient des fuites, auront-ils un effet sur la nappe phréatique ?
5. Est-ce qu'il existe des moyens alternatifs de production de courant électrique par l'utilisation de l'énergie renouvelable ?
6. Est-ce que le système de distribution du courant électrique aura en effet gênant sur la communauté ?
7. Le système de distribution du courant électrique peut-il être dangereux ? Qui aura la charge de son entretien ?
8. Quels sont les systèmes de sécurité qui seront mis en place pour protéger les travailleurs et la communauté locale dans le cas où l'usine aurait de problèmes ?
9. Qui aura la gestion de l'usine ? Sera-t-il bien entraîné ?
10. Est-ce que la communauté qui aura le bénéfice de l'énergie électrique sera en mesure de le supporter financièrement ?

Questions liées à la période de construction :

1. Y aura-t-il beaucoup de bruits et de poussières pendant la construction ?
2. Les travailleurs seront-ils en sécurité ?
3. Les générateurs d'électricité sont de très grosses machines, sera-t-il dangereux de les transporter au Park Industriel et leur transport détériorera –t-il la chaussé ?
4. La construction sera-t-elle bien gérée afin de garantir la sécurité de tout le monde ?

Tout en espérant recevoir votre réaction à la présente, nous vous prions de ne pas hésiter à partager cette correspondance avec toute personne appropriée.



Dans l'attente de votre réponse d'ici au 14 mars 2011, veuillez recevoir, Monsieur, Madame, nos salutations distinguées.

Debra Allen-Reid  
USAID/Haiti Mission Environmental Officer

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