



Jamaica Public Service Company, Ltd.

Environmental Impact Assessment

**120 MW
COMBINED
CYCLE**

BOGUE, MONTEGO BAY



September 2001

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EXECUTIVE SUMMARY

Project Background and Objectives

The Jamaica Public Service Company (JPSCo) intends to install 120 MW over the next two and half years. The installation will be constructed in (in two phases) commencing with 2 x 40 MW in the last quarter of 2001. The suite of projects is to be implemented at Bogue, in St. James in the vicinity of the existing Power Facility on approximately 6.5 hectares of land.

As part of the requirements of the National Environment and Planning Agency an Environmental Impact Assessment of the major impacts (positive and negative) must be conducted for the Proposed project. As part of the assessment, a public consultation meeting will be held and the proceeding recorded and documented. Further mitigation and monitoring plans, which followed the assessment is included in this document. The draft standards and recommendations of NEPA were used in the preliminary design of the projects and as such a number of the impacts will be reduced or eliminated.

The regulations of NEPA/NRCA that will impact on the project are Section 10, Section 17 and Section 9 of the Act, which speaks to the requests for impact assessments, providing information on pollution at facilities and Permit System respectively. Other legislations that impact on environmental matters are the *Office of Utilities Regulation, Factories Act, Town and Country Planning Act (1958), Water Resources Act, and Public Health (1926/1974)* and although not directly impacting on the project the *Montego Bay Marine Park Act*. These regulations will dictate matters relating to Planning and land use, surface and underground water, wastewater disposal and issues of sewage disposal.

Project Location and Description

The proposed site is located in a highly disturbed industrial area – an extension of the existing Bogue Facility.

The existing vegetation consists exclusively of sugar cane. There are a number of ornamental trees bordering the property and the railway line which runs in a north south direction bordering the eastern end of the property. A number of these trees are not on the proposed property or are on the property boundary line.

No terrestrial fauna was observed on the site. The land/area does not support any endangered or threatened species.

Due to the nature of the land use in the area, the land is not known to support and threatened or endangered species. There are no wetlands in the immediate surrounding area of the proposed site.

Sugar cane has been grown on the estate for decades. The current sugar cane crop on site is in ruinate and has no commercial value. As a result of that, there is currently employment for that parcel of land and it was indicated that because of the extended use of the lands and irrigation, no other agricultural crop can be supported on that soil. Information from the previous owners (Jarrett) revealed that the sugar cane on the property can be cut and discarded.

Project Alternatives

Based on previous studies, the urgent requirements for capacity and the fact that all environmental regulations and recommendations were considered, the optimal technical requirements were considered for the projects. The following were considered:

1. Type of fuel
2. NO_x control – the most technical and economical options were selected based on experience and meeting the NEPA draft standards.
3. Ease of implementation of the project in the vicinity of existing facility with

existing infrastructure to reduce the effects of additional construction.

4. Noise Impact and control

Potential Environmental Impacts

In the planning process for all elements of the projects due consideration has been given to the possible environmental impacts that can occur for projects of this nature and magnitude. The activities of both phases (construction and operation) were considered.

In doing so, the major activities of the each project were considered and the possible effects of the activities on the environment. In considering the effects of the projects, the major environmental resources and sub-resources that can be affected were examined by Rapid Ecological Assessment (REP).

The major environmental resources are divided into three major areas and are described below:

Physical environment

? ? Air quality

? ? Land resources (geology, topography, soils)

? ? Water resources

Biological environment

? ? Flora and fauna

? ? Conservation areas, parks, reserves

Socio-economic environment

- ? ? Population/demography/employment/community infrastructure
- ? ? Visual resources
- ? ? Land use
- ? ? Transportation
- ? ? Energy
- ? ? Safety & Public Health
- ? ? Cultural

The possible effects that can occur during the different phases of the project will be summarized below and where applicable detailed assessments will be discussed in the chapters dealing with each of the projects.

Air Quality

All pollutants (sulphur dioxide, SO₂, nitrogen oxides NO_x, and particulate matter PM₁₀.) may have impacts on health and the environment based on ambient concentrations. The concentrations below which health and welfare effects are considered not to occur are reflected in the ambient air quality standards.

The impact analysis of the projected indicated that in addition to the existing facility (based on the capacity factor of the existing units), will not have any adverse impact on the surroundings. With the addition of more efficient units, 20 MW in July 2001 and now the 120 MW, the capacities of the existing, older units will further be reduced. As a result, there will be a reduction in the total emissions of the facility. The modeling of the entire facility's emissions with the new capacity factors, including the new 120 MW plant, has been compared with the modeling performed in July 2001 for the existing units.

Modeling was performed for each pollutant and averaging period for the addition of the

120 MW (simple and combined cycles), including the new capacity factors, utilizing 1995-1998 meteorological data. These results were compared to the existing emissions determined by the modeling in July 2001, with the 20 MW addition and the existing capacity factors.

As outlined in the table above, only the 1998 1-Hour SO₂ ambient air standard was predicted to be exceeded. However, this standard was predicted to be exceeded by the current existing equipment without addition of the new unit and is significantly lower than the existing equipment. For the four years modeled, the standard was exceeded for only one off site receptor during one hour. The hour of exceedance produced a model error due out of range friction velocity. For these reasons, the predicted exceedance is not expected to be reflective of actual site conditions and should not be used for determining compliance with the ambient air quality standard.

The simple and combined cycle modes of the 120 MW plant will have significantly lower emissions per unit of rated capacity than the current existing equipment and is more fuel-efficient. Additionally, due to the reduction of capacity factors for the older units, the average emissions will be significantly lower for all pollutants.

Based on the modeling results presented, JPSCO believes that the installation of the two components will provide significant economic and production benefit, with a reduction of all pollutants emitted to the environment.

Water and Land Resources

In general, impacts to water resources will be minimal and can be reduced by applying appropriate mitigation measures as part of the project design, construction and operation. This has been taken into consideration and treatment systems for each wastewater stream has been recommended and will be a part of the final design. The NEPA trade effluent standards will be adhere to and the treatment scheme will ensure

that all the standards pertinent to the operation will be met.

The potential impacts associated with the proposed project include contamination from the storm water run off, blow down, effluent from the water treatment systems and sewage. Further the potential also exist for contamination from the existing facility based on past practices.

This information has been taken into consideration and appropriate mitigation measures include:

1. Water treatment facility – oil water separators, treatment systems
2. Settling ponds during construction and operation if necessary
3. Connection to the sewage system to the NWC stabilization ponds
4. Remediation projects for the existing site
5. Best Management Practices implemented for the proposed and existing sites
6. Training for the personnel

There are no expected impacts to potable water supply wells.

Based on the existing land use, no serious land resources impact is anticipated for the proposed project during construction and operation. The land is currently in cane and personnel communication with the prior owners, revealed that the canes are in ruinate and have no commercial value.

Ecological Environment

The removal of the vegetation from the proposed site is not considered to be of major ecological consequence since the plants are ruinate sugar cane, grasses and vines. No endangered, protected or otherwise biological significant species were identified on the site.

Social, Economic and Cultural Environment

The increased activities of the project will attract people to the project site. It is not anticipated that any serious impacts relating to vendors will occur. However, the fact that they will be increased activities at the project site, positive impact associated with employment of skilled and unskilled labourers from the area is anticipated.

In general it is anticipated there will be positive impact for the Montego Bay community. With the use of construction materials and equipment, it is also anticipated that the Commercial and Industrial Community will benefit positively from this approximately US\$100 million project.

The impact associated with transportation related to personnel and others accessing the proposed project site are expected to be temporary and limited. No major impact positive or negative is anticipated.

The proposed projects are not anticipated to have any positive or negative cultural, archaeological impacts. Historically the site was a sugar cane plantation and the proposed project will impact on that, as the site will be converted to an Industrial setting, typically of much of the surrounding area.

Management Activities

The construction activities of the project will be supervised by personnel from the JPSCo's Environmental Affairs Department along with the Resident Engineer/Project Manager. The activities during the clearing and earth movement activities as described in Chapter 5 will be carefully supervised.

The operations will also be monitored by the Environmental Affairs Department of JPSCo, reporting to NEPA and other Agencies as required. Monitoring of the emissions and wastewater is proposed. Monitoring according to section 17 (NRCA Act) is also

recommended.

Mitigation

Recommendations for mitigation activities based on the study are outlined below:

1. Treatment of all wastewater from the site, so that effluent quality is within the guidelines of the NEPA/NRCA Trade Effluent Standards.
2. Spill control and handling equipment around oil and chemical filled tanks.
3. Noise evaluation of the site, once the new turbines are commissioned
4. Plant trees or use other options around the perimeter of the site to reduce the impact of any additional noise.
5. Implementation of Remediation measures planned for the existing site.

Additional mitigation measures will be developed if necessary during the final Engineering.

CHAPTER 1 PROJECT OVERVIEW

1.1 Project Objectives

The Jamaica Public Service Company (JPSCo) intends to install 120 MW over the next two and half years. The installation will be constructed in (in two phases) commencing with 2 x 40 MW in the last quarter of 2001. The suite of projects is to be implemented at Bogue, in St. James in the vicinity of the existing Power Facility on 6.5 hectares of land.

The power system expansion is in response to the requirement of the company to meet the demand for electricity on the island, which has been growing at a rate of approximately 4.3% per annum. This growth will warrant that the company expands its production capability by 300 MW over the next 5 years to adequately meet electricity demand.

The present available capacity in Jamaica is 650 MW, 510 provided by JPSCo. Actual peak demand is currently 520 MW and is growing. The reserve margin is currently less than the desired of 25% to take care of maintenance activities and/or emergency shut down.

The requirement for additional capacity is defined through the development of a least cost generation expansion plan. This plan is used by JPSCo to determine the:

- Increment and timing of the requirements for new capacity additions to meet the future demand for electricity with due consideration for the performance and retirement of plants in operation.
- Fuel and Technology preference based on economic factors.

The planning process is influenced by a number of important policy and planning criteria. These are listed below:

- i. The integrated expansion plan is based on benchmark costs, operating modes, performance using best utility practice.
- ii. Demand forecast is based on official projection for economic growth. These economic indicators are obtained from Planning Institute of Jamaica (PIOJ).
- iii. The threshold operating reliability for the system is a Loss of Load Probability equivalent to a maximum of 2 days per year.
- iv. The economic basis of the performance threshold is based on a cost of energy not served (ENS).

These factors all contribute to an economic optimization process, which considers the overall lifecycle cost of each of the alternatives.

This document seeks to provide a comprehensive insight of the different elements of the project as well as address specifically the issues related to environmental compliance.

1.2 Summary of Overall Project

Based on the abovementioned analyses and issues, the company has established the need for a 120 MW of Base load power generating capacity over the next 2 ½ years period 2002 - 2003 to meet the forecasted growth in demand for electricity. The plan calls for the following:

120 MW Combined Cycle Plant (to be implemented/installed in phases)

Phase 1

2002 2 x 40 MW Combustion Turbine

Phase 2

2003 40 MW HRSG & Steam Turbine (to complete the Combined Cycle)

The Bogue site was selected from the existing site based on engineering, environmental factors and economic criteria.

The specific location of the proposed 120 MW Combined Cycle Plant is shown in Figure 1.1 below.

SITE LOCATION MAP

CHAPTER 2 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

Laws & Regulations

Design and Planning Activities

Approach to the EIA Process

2.1 POLICY, LEGAL, ADMINISTRATIVE FRAMEWORK AND PERMIT REQUIREMENTS

Jamaica has a number of statutes dealing with the environment. Fifty-two have been identified which have direct or indirect influence over matters of the environment. These range from public health to physical planning and land use.

The National Environmental Planning Agency (NEPA) formerly known as Natural Resources Conservation Authority (NRCA) is the Agency which executes the NRCA Act of 1991 (NRCA Act). This Act binds the Crown and therefore enforcement can be applied to public sector entities as well as private citizens. The Act of 1991 establishes that NRCA/NEPA has the lead and responsibilities of management, conservation and protection of Jamaica's natural resources and now with the merging of Departments has physical planning functions. The overall function of NEPA is the management of Jamaica's physical environment to ensure, protection, proper management of the resources and conservation.

The regulations of NEPA/NRCA that will impact on the project are Section 10, Section 17 and Section 9 of the Act, which speaks to the requests for impact assessments, providing information on pollution at facilities and Permit System respectively. Other legislations that impact on environmental matters are the *Office of Utilities Regulations Act, 1995*, *Factories Act*, *Town and Country Planning Act (1958)*, *Water Resources Act*, and *Public Health (1926/1974)* and although not directly impacting on the project the *Montego Bay Marine Park Act*. These regulations will dictate matters relating to

Planning and land use, surface and underground water, wastewater disposal and issues of sewage disposal.

The principal environmental laws, policy and legal basis within which these projects will be implemented are those dealing with:

- ? ? surface and underground water,
- ? ? clean air,
- ? ? national heritages sites,
- ? ? wildlife protection,
- ? ? petroleum control
- ? ? protected area.

NEPA/NRCA has a number of draft regulations, which is schedule to be enacted into law in the near future. These regulations will see facilities obtaining licences to emit or discharge emission and effluent from their facilities.

The draft regulations that will govern the operations follow:

- ? ? Air Pollutant Discharge Licence Regulations*
- ? ? Stack emission Monitoring Regulations*
- ? ? Ambient Air Quality Monitoring and Assessment Regulations*
- ? ? Trade Effluent Discharge Regulations*
- ? ? Hazardous Waste Management Regulations*

New facilities will be required to obtain a permit for construction and operation of the facility.

The design, EIA and the projects have been conducted with due consideration of and utilizing all the information available and statutes under the law.

2.1.1 Public Participation

The importance of informed participation by citizenry groups in the consideration and resolution of environmental problems is now becoming a reality in Jamaica. With that, it is important that the community is informed of the plans for all projects and activities. The public participation can be achieved by, public consultation meetings, informing the members of the community, industrial and commercial interest and Non Governmental Organisations by letters or personal contact.

2.2 Regulations and Standards

The regulations and standards that are applicable to the requirements for this project are based on the NEPA guidelines and standards and to some degree on the United States Environmental Protection Agency (USEPA).

This EIA will be conducted utilizing all the requirements of NEPA and other regulations.

2.2.1 Stack Emission Standards

When firing a fuel having composition as detailed in Appendix A and the following Criteria will be met:

Stack Emissions

Specific Station Criteria

a.	Particulate Matter	13 ng/J output	@ 6% O ₂
b.	NO _x , as NO ₂	530 ng/J output	@ 6% O ₂
c.	Carbon monoxide	125 ng/J	@ 6% O ₂
d.	Sulphur dioxide	1% S in the fuel (No. 2)	<i>(To be verified)</i>

2.2.2 Noise Standards

The standards for noise will be 70 decibels at the Plant Perimeter at 10:00 p.m. to 7:00 a.m. Between 7 a.m. to 10 p.m. the noise level requirement is 75 dBA.

2.2.3 Trade Effluent Standards

Process water from the third phase on the implementation will be suitably treated to meet local environmental regulations prior to discharge to an approved location. The standards are shown in Appendix B:

2.2.4 Sewage Effluent Standards

The existing upgraded sewage facility will be used in this project. The sewage system will be connected to the National Water Commission's Bogue Treatment Facility. The sewage standard will therefore not be required for this project. Due consideration however will be taken if there is any additional worker to the plant. The necessary approvals at the local level will be sought.

2.3 Aspects of Environmental Impact Assessment

As outlined above, the site currently comprises 6 Gas Turbines with a total capacity of 103.5 MW.

Gas Turbine	3	21.5	21.5	1973 GE
	6	18.5	14.0	1990 Pratt & Whitney
	7	18.5	14.0	1990 Pratt & Whitney
	8	18.5	14.0	1992 Pratt & Whitney
	9	24.5	20.0	1992 Pratt & Whitney
Emergency	11	25.0	20	Pratt & Whitney

Air quality assessment will be conducted to take into consideration all the elements of the project. The impact prediction on resources or sub-resources (affected & not affected) will be based on the following:

1. The physical and biological characteristics of the surrounding environment
2. The design details of the critical elements of the projects
3. Predicted environmental impacts based on mathematical modeling.

2.4 Objectives

The objectives of the environmental impact assessment are to document details of the following:

1. Description of the Proposed projects and the process of ensuring that all elements of the projects are designed and implemented within the environmental and all other standards related to the projects.
2. Documentation of the Processes used to arrive at the decision to implement the proposed projects/action.
3. Description of the project site
4. Investigation and analysis of the influence of the proposed projects on the surrounding environment.
5. Discuss the implementation and monitoring plans.

Administrative Framework

The following are the requirements established during the planning stage of the projects for the Contractors to adhere to:

Owner has committed to meet or exceed all Jamaican environmental standards. Jamaica at present is operating under “recommendations,” which should become law in the near future. Owner is accepting these “recommendations” as minimum standards and has attached copies of these documents in Attachment A.

Owner has also decided that this project will meet or exceed those standards listed by Jamaica and/or the World Bank. Owner has engaged Parker & Associates to perform preliminary design and environmental permitting work. The summary of the standards from the two entities is attached for reference.

Where the permits require submittal of notices, plans or procedures required for plant operation, the notices, plans or procedures will be developed by Owner. Where the permits require submittal of notices, plans or procedures required for construction, those notices, plans or procedures shall be developed by Contractor and submitted to the Owner. The Owner will submit the notices, plans or procedures required for construction to the relevant Authorities.

All the pertinent regulations, standards, limits and guidelines listed shall be observed for the plant.

Environmental Design Requirements

The plant and equipment shall be designed to comply with the requirements, limits, limitations or restrictions for emissions, trade effluent, noise and vibration as defined by the Natural Resources Conservation Authority (NRCA) which is the environmental

regulatory Agency in Jamaica. Attachment A(not included as reference) is intended to outline those requirements. However, Contractor should refer to the complete document for the full details of compliance.

Air Emissions Limitations

The table on (Attachment A to this Appendix – not included as reference) summarizes the requirements identified in the draft PSD and Title V permits, dated November 14, 2000 and January 12, 2001, respectively. The specific limits as outlined in the attached table are on a per turbine basis and include fuel oil firing.

Water discharge limitations

Water effluent must meet the requirements of the NRCA Trade Effluent Standards prior to discharge to receiving body. The list of parameters and standards for the final effluent quality is provided in (Attachment A of this Appendix not included as reference).

The following summary is intended to provide a listing of major permit requirements.

- 1) The Contractor shall develop a Best Management Practices Plan to prevent or minimize the potential for release of any significant amounts of toxic or hazardous pollutants to the land and waters of the local environment.
- 2) The Contractor must develop procedures for proper solid waste disposal during construction activities

Erosion, Dust and Sediment Control

In addition to erosion, dust and sediment controls, the EPC contractor will also be responsible for installation and maintenance of all erosion, dust and sediment control systems pertaining to site work and/or any storage facility.

Noise emission Limitations

The following discussion contains a summary of the noise requirements for the Project Site. These requirements are based on the acoustic design goals for the project as presented in the Jamaican recommendations. Noise limitations must also be observed during construction the construction phase.

?? All Property Lines Maximum Allowable Sound Level = 70 dBA

Site Clean-up and Waste Disposal

As described in the Terms and Conditions, Contractor shall keep the Facility Site free from waste materials, including, without limitation, paints, chemicals and solutions, rubbish and other debris, resulting from performance of the Works. Where possible Contractor shall recycle and put to good use such waste materials as packaging, office paper, metals and earth. All cleanup and disposal shall be conducted in accordance with all Applicable Laws. The burning of waste materials on site shall not be allowed.

Clearing and Handover

As set forth in the Terms and Conditions, as a condition to Final Completion, Contractor shall remove from site all construction debris and plant and ensure that all surfaces are clean.

Chapter 3 DESCRIPTION OF PROJECT ENVIRONMENT

The proposed site is located adjacent to the existing Bogue Power Plant facility to the south. The land is 6.5 hectares (15 acres).

3.1 Existing Bogue Facility

Bogue Power Plant facility is located to the western part of the island. The facility is located approximately 8 kilometres south west of the Sangster International Airport and approximately 4 kilometres west south west of down town Montego Bay.

The existing Bogue facility is situated on approximately 4.1 hectares (10 acres) of land. The facility houses six (6) gas turbines, 69 kV switchyard and attendant facilities:

- ?? Administrative Building
- ?? Workshop
- ?? Stores

The total electric generating capacity is 83.4 megawatts (MW) and the GT's are fired with No. 2 distillate fuel oil with 0.5% sulphur content. The fuel is stored onsite in large-capacity aboveground storage tanks.

The Power Delivery and Transport Organisations are also located there.

The following considerations were given to siting of the 120 MW.

- i. Economics of preparing the site for the expansion - construction and cost of operation. The economics was influenced by
 - a. Proximity of the site to the load center and the relative cost to move

electricity to the points of demand.

- b. Appropriateness of the site topography and geology and its requirements for site and foundation preparation.
- c. Extent of transmission infrastructure required for connecting the plant to the grid. This is a function of proximity of site to existing transmission network.
- d. Ability of the project to comply with environmental standards.
- e. Ease of fuel supply and cost to establish arrangement for fuel supply.
- f. Available land

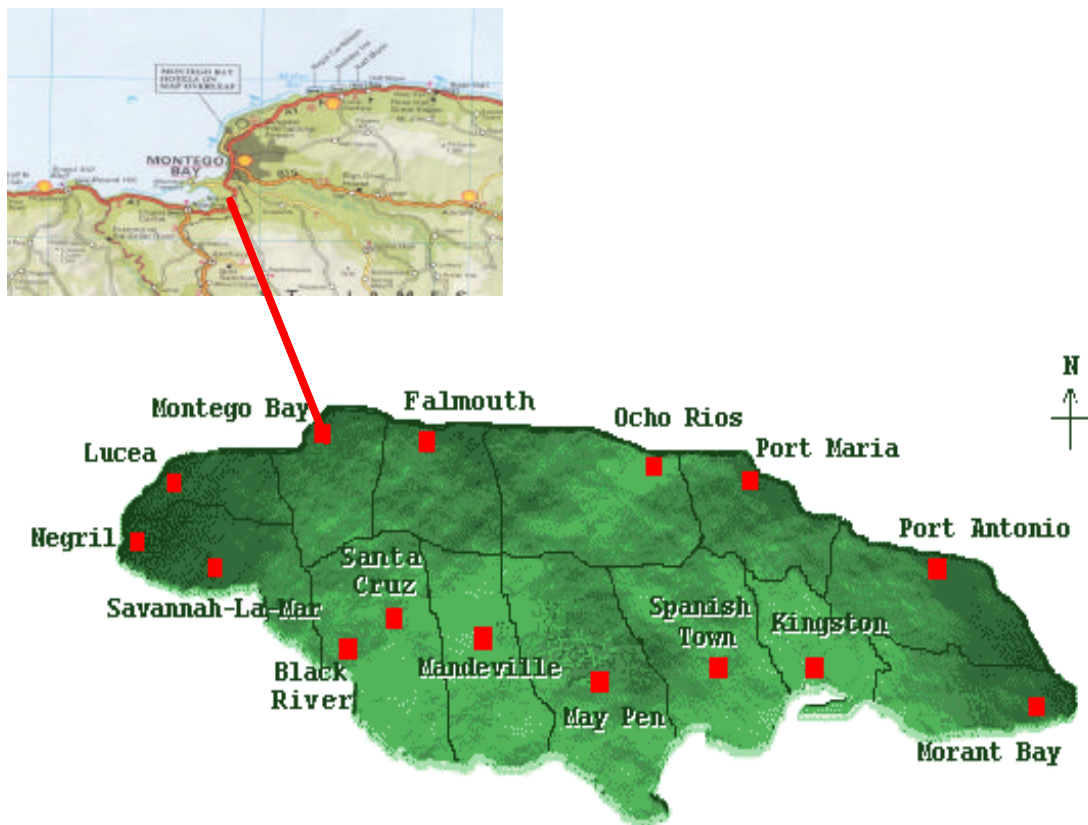
The proposed site for the 120 MW Combined Cycle Plant is to the north and northeast of the existing facility.

3.2 Proposed Site Description and Design Conditions

The project area is located in the parish of St. James, which is in the Northwestern section of Jamaica Fig 3.1. This parish contains the tourist capital Montego Bay, which is the major tourist center of the Island and the main economic base of the parish.

The proposed site is part of the Barnett Estate that has been a large sugarcane plantation for many years. The development around the area has been light industry and commercial operations. Land uses surrounding the JPSCo existing and proposed sites include sugarcane fields, light industry and commercial facilities and a cemetery.

3.1 Location of the Project Site



The project site is located approximately four (4) kilometers from the city of Montego Bay and is bounded by the following:

- ?? Cemetery to the northwest
- ?? Sugar Cane Plantation to the northeast, east and south
- ?? Railway line running north to south along eastern boundary proposed property



North of site along Eastern boundary (railway)

?? Bogue Industrial Complex (JPS, National Water Commission & Cable & Wireless) the main road and NWC Waste Stabilization Ponds to the west.

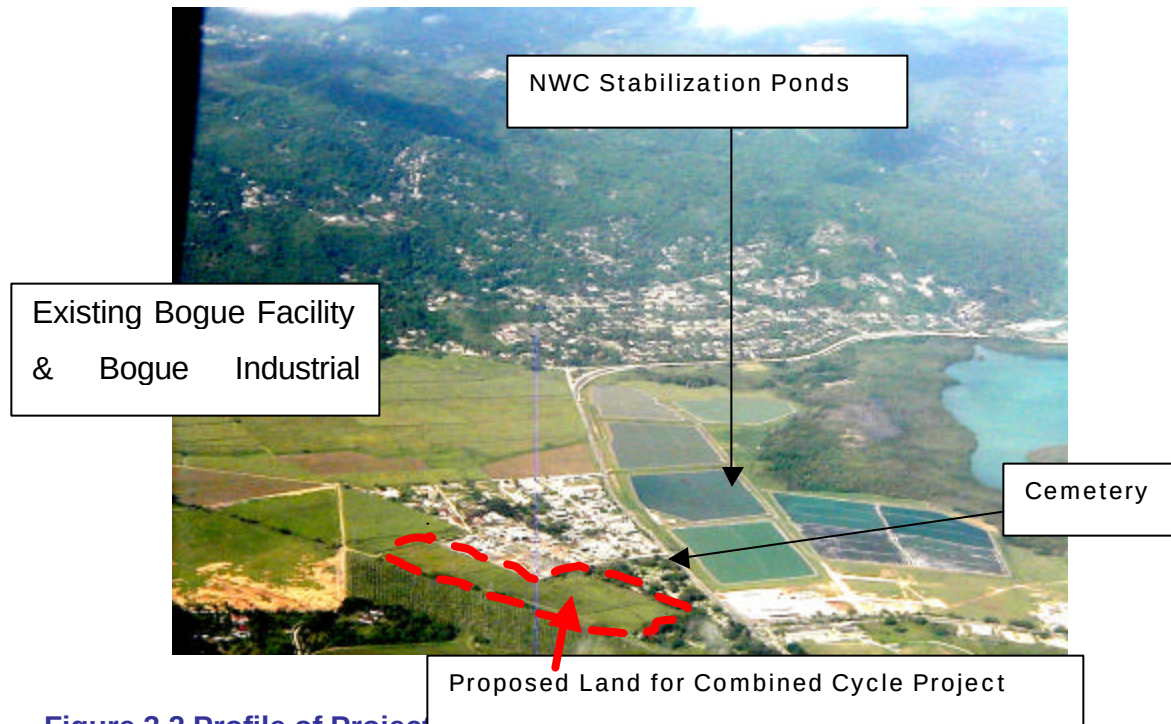


Figure 3.2 Profile of Project Location

The overall project area identified for was 237.9 m (780 ft) by 226.9 m (744 ft) an area of 53,984.3 m² (5.39 ha). Expansion to the transmission corridors 18.3 metres (60 ft) and substation by 94.6 m (310 ft) will require an area of 8.14 ha (20.1 acres).

3.3 PROPOSED PLANT SITE

The proposed site is located in a highly disturbed industrial area - extension of the existing Bogue Facility.

The existing vegetation consists exclusively of sugar cane. A number of ornamental trees bordering the property and the railway line which runs in a north south direction

bordering the eastern end of the property. A number of the trees are located on the boundary proposed property.

No terrestrial fauna was observed on the site. The land/area does not support any endangered or threatened species.

Due to the nature of the land use in the area the land is not known to support and threatened or endangered species. There are no wetlands in the immediate surrounding area of the proposed site.

3.3.1 Plants Species Observed on the Proposed Site

Sugar Cane is the dominant cultivated species on the site. Sugar cane has been grown for decades on the site. Studies have indicated that sugar cane plantations that have been in production for a while become less productive.

Species from the Gramineae family – grasses is seen some areas to the northern end of the proposed property.

Sugar cane has been grown on the estate for decades. The current sugar cane crop on site is in ruinate and has no commercial value. As a result of that, there is no one currently employed to tend to the crop and it was indicated that because of the extended use of the lands for the crop, no other agricultural crop can be supported on that soil. Information from the owners revealed that the sugar cane on the property can be cut and discarded. Further approximately 0.6 m to approximately 1.5 meters of soil may be removed prior to construction activities. The soil removed will be replaced with marl.

The dominant (estimated) landscape zones classification for the immediate area includes the following categories:

Zones	%
Industrial	40
Agriculture – sugar cane	50
Residential	<3

3.3.2 Siting Considerations

The issue of siting for the new power plant is based on the availability of space and the ease of implementation based on technical feasibility and environmental factors. The new plant and subsequent expansion is slated for the areas north to north east of the existing Bogue site – the site of choice.

The following are immediately around the proposed site:

1. Railway line
2. Cemetery bordering the west end of the property
3. Existing power plant
4. Cultivated lands – sugar cane.

3.4 Air Quality and Climate

In consideration of air quality and climate, the tropical maritime climate of Jamaica may be considered as favourable. The prevailing northwesterly winds blowing from the Caribbean Sea onto the land along the north coast, which at time are very strong, ensure as a rule that they will be frequent replacement of air thus providing favourable conditions for the dispersal of fumes and flue gases.

The air temperature averages annually almost 28°C with a range of 3°C. The higher temperatures occur during the months of June through August with lower temperatures occurring during the months of December through March.

Air quality in the vicinity of the plant is expected to be fairly good due to the rural setting along the coast with no other major industrial activity near the existing Power Plant site. At the proposed site the dominant wind direction is north-west and occurs during the day at a speed of approximately 28 m/s. The air quality in the immediate area is essentially influenced by the JPSCo's existing Bogue, Power Station. No other major facility is located within a 5 kilometres radius of the site (NEPA).

This area is currently used for commercial/industrial activities. The standards of the NRCA/NEPA are mainly for the protection of human health and as such the areas where there is human settlements within the area of influence will be studied.

3.5 LAND USE AND ECONOMIC ACTIVITIES

The proposed site is largely flat land with clay type soils with site elevation based on the contour lines varying from 9.2 m to 15.3 m (30 to 50 ft contour lines). The Project site is located approximately four kilometers (2.5 miles) from the city of Montego Bay. The immediate environs of the site however has no direct tourist interests. The site accommodates:

1. The Bogue Industrial Complex which houses operating facilities for all three major utilities on the island (water, telephone and power) as well as other light manufacturing facilities and job shops.
2. Major tracts of land in the immediate environs are in cane cultivation.
3. The Pie River cemetery is adjacent to the existing and proposed sites.

3.6 Facilities and Services

The social infrastructure in the Montego Bay area is well developed. The Montego Bay area is served by the following public facilities:

- ?? Police – The Police Station is located 3 kilometers from the proposed site.
- ?? Fire - The Montego Bay Fire Brigade Station serves the area in which the proposed plant will be constructed
- ?? Health Care – The Cornwall Regional Hospital is the closest public hospital. There are other private health care facilities in Montego Bay.
- ?? Schools – There are number of primary and secondary level institution in the area. The closest school is a primary school and it is located approximately 1.8 kilometers from the proposed site.

3.7 Hydrological Feature of the Area

Jamaica is divided into ten hydrological basins. St. James is located in the Great River basin as defined in the Water Resources Development Plan. The Parish of St. James receives seasonal distribution of rainfall due to its uneven geography and other climatic conditions.

The typical monthly rainfall for the Great River Basin shows a low of 48 mm in February and a high of 309 mm in May with a total annual rainfall of approximately 1785 mm.

3.8 Geology

The three main groups of rock types comprising the surface of Jamaica, follows:

1. Quaternary alluvium of generally moderate permeability, which occupy approximately 15% of land area – mainly in the coastal plains and in the floors of the valleys.
2. Tertiary Limestone with variable developed karstification and moderate to high permeabilities, which occupy about 60% of the land area
3. Cretaceous volcanoclastics of low permeability that occupy approximately 25% of the land area mainly in inliers along upland axis.

The general review of the geological formation map shows St. James to have a significant cretaceous volcanoclastic formation. The parish of St. James has a long coastal strip and then moves inland to a hilly terrain.

3.9 Water Resources

3.9.1 Surface Water

Surface water features are present on the site. A drain flows through the property at the western border. The site surface is relatively flat with an elevation of approximately 15.3 metres or less.



Drain running along Western boundary of site.



Pye River approximately 3,000 metres North of Northeastern corner

Water Resources within the general vicinity of the site include the Pies and Montego Rivers which runs north and west of the Bogue site. The Pier River is located approximately 6,100 metres northwest boundary and approximately 3,100 metres from the north east boundary. The earthen drain, drains into the Pie River. The Retirement River runs south of the site.

3.9.2 Ground water Resources

The ground water resources in the area are restricted to a deep limestone aquifer. The flow is in an east to west direction, towards Montego Bay (UWA). No shallow acquifers are known to exist in the area. All potable water is obtained from a single deep limestone aquifer.

One potable water well is currently located on the facility.

3.10 Sewage and Wastewater

Sewage for the existing facility is managed via two septic systems located on the property. The plan is to convert and tie into the National Water Commission Bogue Sewage treatment system as part of the site development exercise being proposed over the next 3 years.

Existing storm water drains will facility stormwater runoff during the rainy period. No major impact is anticipated in this area.

3.11 Ecological Environment

The existing facility is in a zoned industrial site and does not contain any ecologically important flora or supports noticeable fauna. The site contains no ornamental trees. Ornamental trees are seen on the fringe of the property along the railway line. The land on adjacent property west and south of the existing site contains sugarcane.



Because of the nature of the project no impact in this area anticipated during construction and operation of the proposed facility.

Bordering the property on three of the four sides are sugar cane plantation with the Bogue Cemetery bordering the northwest.

3.12 Population

The population of the area of Montego Bay is approximately 82,000 (Population Census 1991). The estimated annual increase of population for 2000 was approximately 86,500.

3.13 Socio Economic & Cultural Activities of the Area

The main socio-economic activity in the area is Tourism. Also within the area there are a number of Commercial and Industrial operations. This include the other utilities telephone and water – Cable and Wireless Jamaica and National Water Commission. South of the proposed site there are machine shops and Engineering operations. The immediate surrounding land is slated for industrial and commercial operations.

In construction near the NWC stabilization ponds is a new supermarket. Also adjacent there a pharmacy planned for that location. This is west north west of the proposed site.

Below: Proposed project site – looking south south east

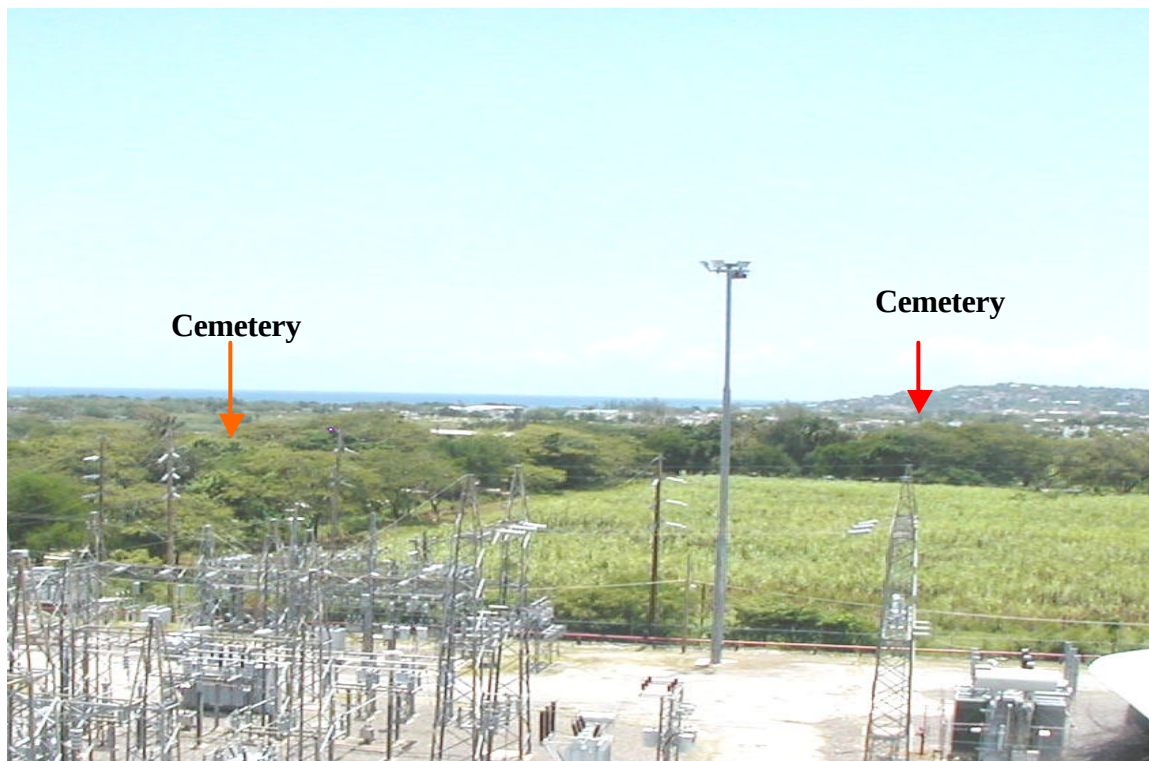


Above: Proposed project site – looking east

Proposed project site – looking north/northeast



Below: Proposed project site – looking north



Chapter 4. PROJECT DESCRIPTION/CONCEPT

4.0 APPROACH TO THE DESIGN AND PLANNING STAGES OF THE PROJECTS

Jamaica Public Service Company and Mirant Corporation in planning and negotiation stages with the Contractor(s) for the Projects, stipulated that all works (design and implementation) must be implemented in conformance to all Local Standards and particularly the environmental guidance, standards and policy. Where local standards do not exist, EPA and World Bank Standards should be adopted.

The project will consider all elements that are important to the environmental stability of the area. Particularly the physical, biological and social aspects of the environment were considered and discussed during the process of negotiation for the basic design of the Projects.

The standards for air emissions, effluent, sewage, noise and any other disturbance anticipated, therefore will form part of the Contractual agreement. All likely impact anticipated for the construction and the operation of each facility was considered during the process.

The following are common design standards and parameters that will be applicable to all elements of the projects. Other standards and controls are discussed under the specific project description.

4.0.1 Hydrology and Water Resources

Fresh water for the power plant will be obtained from two sources – potable water and effluent from the sewage treatment facility – stabilization ponds. The effluent from the sewage treatment facility will be treated before it is used in the process.

Approximately 4.5 million litres per day (one million gallons) will be used in the second phase of the project, scheduled to be commissioned in 2003.

4.0.2 Natural Hazard Vulnerability (Geo-technical Designs and Seismic Requirements)

Jamaica is located in a high intensity earthquake zone. As a result, particular attention will be paid to the civil designs in respect of earthquake resistance. In this regard, the design will meet or exceed the requirements as established in the latest updates to the National Building Code (NBC) and Caribbean Uniform Building Code (CUBC).

Based on this, the civil structures for the power plant project will be designed to meet the requirement for Ground Acceleration of 0.4 g with a 10% probability of occurrence over a 50 years period. By law, all engineering civil designs are subject to the regulation of the Professional Engineers Regulations Act (PERA) and approved by the appropriate Jamaica Building Authority Board.

4.0.3 Site Meteorological Conditions

The plant designs and performance guarantee will be established for local site conditions as it relates to temperature, wind speed, and precipitation. Full cognisance has been taken of design standards for hurricane mitigation that is required for Jamaica. The basic parameters and standards are outlined below:

a. Air Temperature

Maximum Design Temperature	36 °C
Design	28 °C
Minimum Design Temperature	17 °C

b. Humidity

Design Relative Humidity	75%
Minimum Relative Humidity	60%
Maximum Relative Humidity	95%
Jamaican Datum = A.M.S.L. (Datum Level for existing topographical maps)	

c. Hazard Mitigation

Maximum Hurricane Intensity Wind Speed 240 km/h (150 mph) with 3 sec interval on 50 years return cycle.

4.04 Environmental Standards

The plants are being designed to conform to the draft environmental standards for emissions, effluent, noise and vibration standards etc. as defined by National Environment and Planning Agency (NEPA), which is the environmental regulatory agency in Jamaica. The summary outlined in Chapter 2 section 2.2, includes the critical standards, which is not meant to represent a complete listing of the local environmental standards as stipulated by the local environmental agency (NRCA/NEPA).

4.1 General Description

The Project is a new addition to Jamaica Public Service Company existing plant at Bogue, Jamaica. It is a liquid fuel burning combined cycle power plant **consisting of two GE PG6551B combustion turbines, two vertical Heat Recovery HRSG's and one steam turbine resulting in a 2 x 2x 1 arrangement (figure 4.1)**. The liquid fuel is No. 2 distillate. The plant nominal output would be approximately 122 MW. There is no evaporative cooling or steam injection for power augmentation. NO_x abatement will be

achieved with water injection that will also slightly enhance the power output. The HRSGs will not be provided with duct burners.

The Combined Cycle Plant will be constructed in phases. The extension of the plant will be built sequentially:

Phase 1: Two combustion turbine/generator construction to commence in 2001 for operation in mid 2002 and then;

Phase 2: Steam Turbine for 2003

Both combustion turbines will be built to operate in simple cycle mode first and in combined cycle mode later with the addition of the HRSG's, steam turbine/generator and the cooling tower in 2003.

The two units will be converted to combined-cycle mode operation by mid 2003 with final construction of phase 2 the steam turbine.

4.2 DETAILED DESCRIPTION

Phase 1 – Implementation (construction to begin in end of 2001)

The two gas turbines (GE PG 6551B) for phase 1 will be installed outdoors. The combustion turbines (CT) will be equipped with water injection for NO_x abatement. The CT generator package will include fin-fan coolers for the removal of all CT related heat loads thus eliminating the need for cooling water.

The combustion turbines will use dual fuel (primary fuel is #2 distillate and secondary fuel natural gas. The CT will be enclosed in weather-proof acoustical enclosures. The CT generators and auxiliary modules will be however located outdoors. The CTs will

have an outdoor waterproof, lighted and ventilated enclosure to limit the noise.

A control building, an administrative building and a maintenance shop/warehouse will be constructed.

The specification of the combustion turbines follows:

1. Exhaust gas flow temperature
2. Stack heights of 25 metres.
3. Inlet temperature of C
4. Water injection system for NO_x control to 85 ppm.
5. Fire detection by thermic detectors and protection systems
6. Vibration sensor for seismic type for protection
7. Combined lube and control oil system and oil cleaning system.
8. Spill control systems for storage sites

4.3 Environmental Concerns Associated with Power Plant expansion

1. Air Emission and Quality Control
2. Noise emission
3. Spill Control Management
4. Fire Protection
5. Water Management - supply and disposal
 - ?? Industrial waste water (Phase 2)
 - ?? Sewage treatment
6. Socio-economic

In the design stages of the Power plant and associated facilities, all potential environmental aspect were considered. The following description of component of the

plant and facilities will demonstrate that the design features were specifically geared to eliminate or reduce any potential environmental effects as outlined above 1-6.

The details of the design measures will be included here.

Fuel Oil Delivery, Storage and Handling

4.3.1.1 Storage

The existing storage will be expanded to accommodate two additional fuel oil storage tanks. The total capacity for the new tank is 5.5 million litres of No. 2 fuel oil. The tank will be constructed with 0.635 centimetre carbon steel with retaining wall. The requirements as outlined by NEPA should be given to the Contractor so that all requirements are met as shown in Appendix D.

4.3.1.2 Tank Foundations

Foundations for storage tanks will be provided with either a ring wall design or individual footings as appropriate. Containment will be provided for the appropriate application.

4.3.1.3 Pipe Supports

Miscellaneous structural steel framing will be provided as required for the support of piping systems within the buildings and enclosures and outdoor. Painting specifications for pipe-support steel will be the same as for the building structure. For above ground pipe supports, concrete sleepers with steel inserts will be provided as required by final design.

4.3.1.4 Operation – Delivery and Handling

During operation, the fuel oil will be delivered via the existing pipeline or new pipeline. The interface for the fuel lines from the supplier will be at the Bogue fence line. As such, issues relating to the impact during the laying of the fuel line will be the responsibility of the supplier. Fuel will be pumped, metered and filtered to the final condition required by the combustion turbine manufacturer. The storage tanks capacity will be 5.5 million liters.

The fuel oil management system will be equipped with the following:

- ?? Fuel shut-off valve
- ?? Sump tank and sump pump
- ?? Spill containment structures – including secondary structures
- ?? Oil-water separator(s) where necessary

The implementation of the above strategies is to eliminate and reduce any likely impact that may occur during the transfer and storage of the fuel oil.

The potential impacts associated with this method of delivery will be mitigated based on the risk. The following will be the mitigation plan:

1. All flanges, valves and pipeline will be managed to reduce the potential of spills during unloading to the tank.
2. A spill control plan for the site will be documented and available to all parties.

4.3.1.5 Fuel Systems

The fuel system will be a single fuel, liquid fuel system and will be designed to operate the combustion turbines through out the full range of operation. The fuel oil No. 2 data

sheets are given in Appendix A.

The liquid fuel system will include the following:

- ?? The existing and future fuel oil storage tank(s)
- ?? Fuel shut-off valve
- ?? 2 x 100% fuel-oil forwarding pumps
- ?? One fuel heating station (viscosity heating only)
- ?? One pressure regulation station
- ?? 2 x 100% capacity duplex filter/separators with a fuel accumulator
- ?? One volumetric flow meter with totalizer
- ?? Sump tank and sump pump
- ?? Fuel atomizing air system

All components of the liquid fuel system will be designed to meet the requirements of the gas turbine manufacturer. Control and monitoring of the pressure regulation station and the full heater will be integrated with the DCS.

The pressure regulation station, the duplex filter/separators and the flow meter will be provided on the same skid and be placed outdoors.

The interconnection piping between the fuel system components will be of carbon steel, whereas the piping downstream at the filter separators to the combustion turbine fuel module will be of stainless steel.

The sump tank allows the drawing of liquid fuel from the combustion turbine fuel module and from exhaust plenum in case of a false start. This will reduce the risk of oil spill

around the turbines.

The fuel atomizing air will be extracted from the combustion turbine compressor discharge, will be conditioned in the air pre-cooler and pressurized more in the main atomizing air compressor. The main atomizing air compressor will be a centrifugal type driven by the accessory gear. A booster compressor, driven by the diesel engine will provide atomizing air during start-up and acceleration.

4.3.1.6 Oil-Filled Transformer Foundations

These foundations will have an integral reinforced concrete spill containment area.

4.3.2 Fire Protection Systems

Fire Protection System will be provided for the turbine and gas compartment areas of the accessory module, lube and hydraulic area. The system will meet the Local and National Fire Protection Association code requirements. The automatic operating system will include the carbon dioxide storage and detector system.

The fire protection system for the units will include detection, alarm, actuation and signaling systems. The firewater pumps will consist of 2 X 100% capacity (one AC motor driven and one standby diesel driven) pumps supplemented with a jockey pump. The firewater loop will be a minimum of 250 mm diameter.

All fire trouble and water flow alarms will sound in the control room.

An automatic FM200 gas fire protection system will be provided for the electrical equipment and control rooms. Automatic fire detection (heat and smoke) will be provided in the electrical equipment and rack room, control room and chemical feed enclosure in addition to hand held fire extinguishers. The fire protection and monitoring

panel will be placed in the control room.

The combustion turbines (phase 1) will be protected by their own low-pressure carbon dioxide fire protection system.

Transformer fire protection will be designed to meet the requirements of the local fire department and the carrier of the Insurance policy. The transformer deluge system will be designed to operate automatically, actuated by a heat sensitive (thermal) pneumatic pilot system. Firewalls will be designed in accordance with the requirements of NFPA 850 3-1.4.

The fuel oil storage tanks will be protected with a double ring deluge spray system on the outside and with foam/water spray on the inside. Similarly the steam turbine (phase 2) lube oil system and the cooling tower will be protected with deluge spray systems.

The administration building, the office space in the control building, the maintenance shop and the chemical feed enclosure will have wet pipe sprinkler systems.

Fire hydrants will be installed and will be protected if subject to mechanical damage. The means of protection will be arranged in a manner that will not interfere with the connection and operation of the hydrants. Hydrant connections will be compatible with the local fire department hoses.

The preliminary capacity of the firewater storage tank will be 682,000 litres (150,000 gallons).

4.3.3 Emission Controls

4.3.3.1 Sulphur Dioxide (SO₂)

The two gas turbines will use No. 2 fuel oil with 0.5% sulphur content which is the

required (recommended) standard for sulphur content in light (nos. 1 or 2) fuel oils.

4.3.3.2 Nitrogen Dioxide (NO₂)

Nitrogen oxides (NO_x) emission from combustion of fossil fuels consists of thermal NO_x and fuel-bound NO_x. Thermal NO_x is formed from the reaction of oxygen and nitrogen in the combustion air at combustion temperatures. Formation of thermal NO_x depends on the flame temperature the residence time, combustion pressure and the air-to-fuel ratios in the primary combustion zone. The design and operation of the combustion chamber dictates these conditions. Fuel-bound NO_x is created by the oxidation of volatilized nitrogen in the fuel. Nitrogen content in the fuel is the primary factor in fuel bound nitrogen (FBN) formation.

4.3.3.2.1 Technologies for NO_x emission reduction

Six main types of engine or process modification have been recognized as technically viable for reducing NO_x emissions from stationary engines:

1. Wet injection
2. Water emulsification of fuel
3. Air-to-fuel ratio changes
4. Retarded ignition timing
5. Derating power output, and
6. Exhaust gas recirculation

The effectiveness of engine modifications is highly dependent on the specific type of engine and its fuel.

The two combustion turbines (phase 1) will be equipped with NO_x control system to reduce the NO_x emission to within the limits of the prescribed standards. The gas turbines will be equipped with one, water injection skid each for NO_x level reduction.

The NO_x control will be by water injection to reduce the NO_x emission to 85 ppmv. Demineralised water will be injected into the combustion chamber of the unit to reduce the temperature of the gases. No change in pressure of the gases from the stack will result from this control technology. The process of water injection will be a closed system and water will be returned to storage via an outlet flange on the skid.

The general concept of the control focuses on controlling the combustion temperature in the primary combustion zone since thermal NO_x generally increases as combustion temperature increases. This type of system can achieve about 30 – 45 percent reduction in NO_x emissions using demineralised water. Favourable conditions for thermal oxidation of molecular nitrogen can be reduced, by spraying the flame temperature with water. In this method water is injected at a location downstream from the combustion zone inside each firing cylinder.

Based on the manufacturers information and the adjustments made for local conditions the NO₂ emission for each of the unit is 85 ppmv. The two combustion turbines will have independent stacks. The NO_x control without the NO_x emission control will be approximately 225 ppmv. The regulation (draft) has made provision of maintenance or emergency activities for the control technology. With that in mind a return period of maximum of 24 – 36 hours for control equipment will form part of the requirement to be adhered to.

4.3.4 Noise Emission

The severity of noise impacts is related to the magnitude and duration of the noise. The level of noise is normally measured as sound pressure level in decibels. Decibels are calculated as a logarithmic function of SPL in air to a reference effective pressure, which is considered the hearing threshold. To account for the effect of how the human ear perceives sound pressure, sound pressure level is adjusted for frequency. This is

referred to the A-weighting, which adjusts measurements for the approximated response of human ear to low-frequency SPLs.

Baseline noise levels taken for JPSCo ear protection programme shows that at the Administrative building sound levels reading is

The units will be equipped with 10- foot silencer. Equipment sound levels on an A weighted basis will not exceed 90 dBA at any point 1 m from the equipment, 1.5 meter above the elevation of the turbine deck and appurtenances including motor drives under any operating conditions. Insulation, lagging and other methods will be provided to meet the specified sound levels necessary to meet the guidelines at the boundary of the property.

The existing ear protection programme for the existing facility will be extended to the proposed facility.

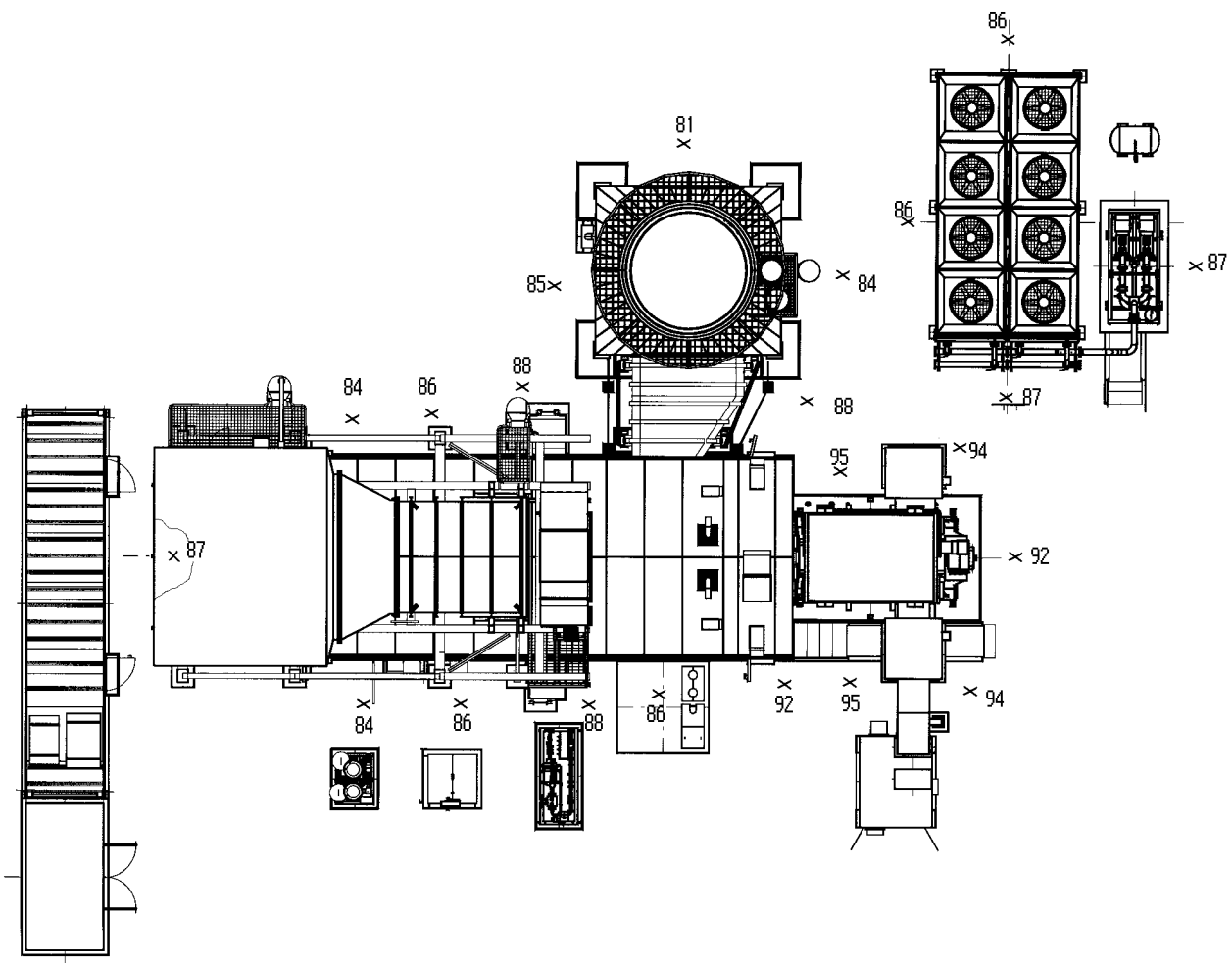
The expected sound pressure level around the unit is shown below in figure 4.2.

Figure 4.2

**BOGUE STATION
JAMAICA**

2 TG 6BEv

**EXPECTED SOUND PRESSURE LEVEL AT 1 METRE (3 ft) AROUND THE UNIT AND
1.5 METRE (5 ft) HIGH IN THE FREE FIELD
(reference : 2×10^{-5} Pa)**



Average sound pressure level ($\overline{SPL}$) at 1m around the unit

$$\overline{SPL} \approx 10 \log \left(\frac{1}{22} \right) + 22 \log \left(10^{\overline{SPL}/10} \right)$$

Expected averaged value : **90 ± 3 dB(A)** at one metre around the unit and 1.5 metre from ground.

Relevant standard : ANSI B133.8 : Gas Turbine Installation - Sound Emissions

4.3.5 Water Management – Supply & Disposal

4.3.5.1 Water System

A water treatment system will be provided for producing high quality boiler make-up water and high quality injection water for the combustion turbines for NO_x abatement. Water supply to the boiler make-up water will be from the 2.3 million litres (500,000 gallon) effluent (raw) water tank.

The water treatment system will have 2 x 100% capacity trains to treat 456.6 – 909.2 lpm of raw water. Each train will consist of a mixed media filter, strong acid cation unit, decarbonator, a strong base anion unit followed by a mixed bed unit. The decarbonator will be common to both trains. A neutralization system will be provided.

The floor of the demineralization area will be cement to a smooth finish. The cured cement floor will be sealed with an acid/caustic resistant resin or epoxy.

For safety an emergency eye wash station as well as a shower station will be placed in the area at suitable location.

4.3.5.2 Potable Water

The potable water will be supplied from the existing water supply system from the NWC. The potable water will supply safety and eyewash showers.

4.3.5.3 Raw Water System

The raw water system will come from effluent water from Bogue Sewage Treatment Facility that is approximately 2.5 kilometres away from the plant. The process effluent water will be pump to site via 250 mm coated carbon steel pipe. The effluent will be

processed through microfiltration system and chlorinated before it is discharged to a 2.3 million litres raw water storage tank at the plant. The effluent (raw) water storage tank will supply water to the demineralized water system. The water will serve the cooling water and service water for plant use.

4.3.5.4 Service Water System

Service water will be supplied from a new raw water system from the Bogue Sewage treatment facility.

4.3.5.6 Wastewater System – Phase 1

4.3.5.1 Process – Wastewater streams

The two combustion turbines will not have wastewater treatment facilities because the process does not require water for any other process other than the NO_x control. The water skid system as discussed above is a closed system.

A water treatment system will be provided for producing high quality boiler make-up water for the HRSG and high quality injection water for the combustion turbines for NO_x abatement.

Complete two stage R.O. system with 2x100% mixed-bed demineralizers and 2x100% regeneration pumps (suction from demineralization storage tank), two 100% softeners, two mixed-media filters with 2 x100% backwash pumps (suction from demineralization storage tank), a demineralization feed (surge tank) upstream of mixed-bed demineralizer. RO rejects can be discharged to the cooling tower blow down because of high pressure and do not require any pumping of the rejects. However, the mixed-media filter back wash and softener rejects may have to be pumped to the cooling tower

blow down depending upon equipment and discharge location, and any treatment required for cooling tower blow down.

Water treatment system will have 2 x 100% capacity trains to treat 454.6-681.9 lpm (100-150 gpm) of raw water. Pre-filter will be designed for manual backwash. Each train will be designed to operate for 24 hours between regenerations.

The decarbonator will have a storage capacity of 5 minutes minimum. Two full capacity pumps will be provided. Pumps will be of 316 SS construction.

The demineralizer regeneration will be with 66° Baume' sulfuric acid and 50% caustic. Bulk storage tanks will be provided for storage of acid and caustic. Tanks will be constructed of materials suitable for the service and will be housed in spill control areas.

The floor in the demineralizer area will have its cement done to a smooth finish. Once cured the floor will be sealed with an acid/caustic resistant resin or epoxy. An emergency eyewash station as well as a shower station will be placed as close to the demineralizer area as possible given the constraints of operating and maintaining the equipment.

Anion, cation and mixed bed units will be rubber lined carbon steel vessels designed in accordance with the ASME Boiler and Pressure Vessel Code- Section VIII, Division I for a pressure exceeding any that can be experienced under any condition.

Two full capacity demineralizer feed pumps, will be provided to supply raw water from the effluent/raw water storage tank. Pumps will have casings and impellers suitable for

the intended purpose.

A neutralization system will be provided. Tank will have the capacity to hold the regeneration waste from complete regeneration of one train. Mixing will be by recirculation and/or agitation. Materials for the system will be corrosion resistant. Tank discharge and pre-filter backwash will be used as cooling water make-up.

Boiler make-up water quality will meet the requirements of the HRSG manufacturer.

Two (2) x 50,000 demineralized water storage tanks will be supplied to provide 454,600 litres (100,000 gallons) of storage. The tank will be carbon steel epoxy coated.

4.3.5.2 Disposal Options

All drains in areas where there is potential for oil spills will be drained to a sump and pumped, if required through an oil/water separator. The water discharge of the oil water separator will be sent to the storm water run-off pond. The oil collected within the oil/water separator will alarm on high level and will be removed for storage and disposal. The oil/water separator will be sized according to the projection.

Oil separator effluent will be discharged to the water runoff pond before discharging into drainage ditch. A separate storage tank for skimmed oil and sludge removal will be provided with the separator. The following provisions have been proposed:

- ?? One double-wall oil separator
- ?? Packaged coalescing plate separator providing **10 mg/l of less** of oil effluent quality.
- ?? One double wall skimmed oil storage tank.
- ?? Waste oil transfer pump mounted on the skimmed oil tank to transfer oil to tank truck for disposal.

?? Means to discharge effluent to the runoff water pond.

All equipment having the potential to spill oil and not buried underground will be contained in a curbed area in order to prevent spillage to the land.

Underground gravity lines carrying oily wastewater will not require double containment piping.

Subsurface Investigation

Preliminary soil investigations was conducted by Owner, in order to determine the soil type and state in order to have preliminary information for the planning stages. The Contractor final foundation design and concrete quality will be based on the further soil investigations.

All major foundations will be supported on pre-cast concrete piles based on the preliminary soil investigation.

Boiler blowdown flash drains will be routed to the storm water run-off pond. The quality of the effluent leaving the facility will be within the requirements of the recommended trade effluent standards 1995.

Demineralizer rinses will be discharged to a neutralization tank, and the neutralized wastewater will be routed to the storm water run-off pond. This area will be sampled.

The effluent from these areas will have a sump where samples will be collected monthly to check the water quality going out in the ditch. The quality of the effluent is expected to be within the requirements of the recommended trade effluent standards for the specific parameters as shown in Appendix B.

The wastewater streams leaving the plant will be provided with sampling facilities for

manual extraction of representative samples.

4.3.5.6 Domestic Sanitary Waste

There are currently no sanitary sewer lines within the Bogue Industrial Complex. Most of the residential areas are connected to the Northern Coast Wastewater Treatment Facility that is an open pond system.

The existing system is a septic system, which is pumped every six months to a year or as required.

The sanitary waste from the new Administrative facility will be connected to the wastewater treatment facility - Bogue stabilization ponds, which is located 1 kilometers from the facility.

4.3.6 Chemical Feed Systems

Chemical feed system will be provided for boiler water, cooling water and auxiliary cooling water and condensate treatment. The chemical feed system will include the necessary tanks for storage, measurement and mixing of the chemicals, mixers, feed pumps and associated controls.

Chemical treatment for the condensate water system will include oxygen scavenger and pH control. The sodium phosphate feed system will provide to the HRSG drum to maintain desired boiler water pH and phosphate residual. Chemical treatment for the cooling water systems will consist of hypochloride, sulphuric acid for pH control and dispersant for corrosion inhibitor. This will be provided as dictated by the quality of the raw water. Condensate treatment will consists of copper corrosion inhibitor. The chemical treatment feed systems except acid for the cooling towers will be located in an

enclosure adjacent to the cooling towers. If a sulphuric acid system is provided for the cooling tower, equipment may be located outdoors.

The chemical storage facility will be equipped with the necessary spill control/prevention structures.

4.3.7 Insulation and lagging

Insulation and lagging will be provided for piping, gas ducts, tanks and equipment to reduce system heat losses, reduce noise, provide personnel protection and prevent condensation, as required for the specific application.

4.3.8 Phase 2 Description

4.3.8.1 Heat Recovery System and Steam Turbine

The steam turbine will be housed in a steam turbine enclosure along with an overhead crane.

Each of the combustion turbines will exhaust into a heat recovery steam generator, which will produce steam to drive the steam turbine.

The steam turbine will be coupled with a **totally enclosed** air-to-water cooled (TEWAC) generator. A surface condenser will condense the steam turbine exhaust steam using circulating cooling water from a mechanical draft-cooling tower. A deaerating surface condenser will condense the steam turbine exhaust steam using circulating cooling water from a mechanical draft cooling tower. The units will be controlled from a new DCS equipment, which will be housed in the new control room and administration building. In addition to a control room, offices, kitchen, laboratory will be built as part of

this expansion.

The distillate fuel will be piped to the site and stored in the existing or new fuel oil tanks. Fuel will be pumped, metered and filtered to the final condition required by the combustion turbine manufacturer.

4.3.8.5 Cooling Water System – PHASE 2

4.3.8.2.1 Supply

A raw water system complete with an inlet structures (pipelines) will be provided to supply “effluent water” from the “Bogue Sewage Water Treatment Facility” which is approximately 2.5 kilometers away from the plant. 3 x 100%, 1750 gpm (each) capacity “effluent water forwarding pumps” will pump the effluent via a 250 mm (10”) coated carbon steel pipe to the site. The preliminary effluent water outlet structure and the lift station arrangement is given in Appendix E. A SCADA controlled forwarding pump bank will be installed at the Sewage Treatment Facility operated by the National Water Commission. Pumps will be controlled with a SCADA system which could be based either on radio telemetry or telephone line. If required, an alum chemical feed system will be provided upstream of micro-filtration for chemical coagulation.

The effluent water will be microfiltered, treated (chlorinated if necessary) and stored in an effluent (raw) water tank at site. Effluent (raw) water storage tank will provide the necessary raw water for the water treatment (demineralizer) plant, the cooling tower make up and the service water. The water treatment plant, in turn, produce the condensate quality HRSG make-up water, the combustion turbine NO_x abatement injection water and the combustion turbine compressor off-line/on-line wash water.

4.3.8.2.2 Cooling Water System

The combined cycle plant will require cooling and a cooling water system. **A closed loop auxiliary cooling water system** will be provided for the plant to remove auxiliary head loads. A circulating cooling water system consisting of a multi-cell evaporative cooling tower and 2 X 100% circulating water pumps will be provided for the steam turbine condenser and balance of plant coolers. The cooling tower will be designed for the required number of cycles of concentration based on the water quality data.

The cooling tower will be designed to handle the heat load from the surface condenser and the auxiliary cooling water system at all conditions. The cooling tower and surface condenser will be optimized and guaranteed at steam turbine summer ambient conditions.

The cooling tower will be designed in accordance with CTI requirements of FRP or concrete material. The tower will not be of wood construction.

The cooling tower will have two speed motor operated fans. Fans, drives and stacks will be of corrosion resistant materials. Drives will be located outside of the fan stacks.

Fill and drift eliminators will be PVC or equivalent with a flame spread rating of less than 25 when tested by the ASTM E84 method. Other tower material will be suitable for the ambient conditions at the site.

If cooling tower is of FRP construction, then it will have a flame spread rating of less than 25 per ASTM E84. Fire-resistant partitions will be provided between each of the cells. The fire protection system will comply with NFPA 214.

Cooling tower basin will be of concrete. Screens will be provided between the tower basin and the pump structure for pump protection.

Stairs will be provided on one end of the tower for access to the fan deck. A ladder or stair will be provided for emergency egress from the other end. Stainless steel lines will be provided for draining, filling and monitoring lubricating oil outside of the fan housing.

Switches will be provided to shut down fans at high levels of vibration.

Circulating water pumps will be horizontal or vertical and have cast iron casings and bronze rotating elements.

Cooling water system will be analyzed for water hammer. Surge protection devices will be supplied if necessary.

Pumps will be manufactured of material suitable to handle the circulating water quality.

4.3.8.2.3 Auxiliary Cooling Water System

A closed loop auxiliary cooling water system will be provided for the plant to remove auxiliary heat loads. The closed cooling water system will contain two (2) 100% capacity heat exchangers, either plate and frame or shell and tube. The heat exchanger material will be compatible with the circulating water quality. Also included in the auxiliary cooling water system will be two (2) 100% capacity pumps, one expansion tank and chemical injection equipment.

The auxiliary cooling system will provide cooling water to the following, but not limited to:

- ?? Steam turbine lube oil coolers
- ?? Steam turbine generator coolers
- ?? HRSG feed pump lube oil seal coolers
- ?? HRSG circulating pump seal coolers
- ?? Air compressor coolers
- ?? Condenser air vacuum pumps coolers (if any)
- ?? Sample and analysis panel

4.3.8.6 Condensate System

Condensate pumps will be of vertical type with cast iron casing and bronze impellers. Two (2) 100% capacity condensate pumps will be used. The condensate pumps take suction from the condenser hotwell and eventually discharge to the LP economizers in the HRSGs after delivering the condensate through the gland steam condenser.

The condensate make-up system will automatically maintain the proper water level in the condenser hotwell; the condensate make-up to the condenser will be based on vacuum drag from the demineralized water storage tank through a make-up control valve at the condenser. One (1) condensate make-up pump will be provided to handle the surge conditions at start-up. This pump will be controlled from condenser hotwell low level signals.

The condensate will also be used for the following purposes:

- ?? Turbine exhaust hood spray
- ?? Steam system attemperator(s)
- ?? Condenser vacuum pump seals
- ?? Chemical injection solution tanks

?? Condensate receiver flash tank attemperator

?? Make-up water to the auxiliary cooling water surge tank

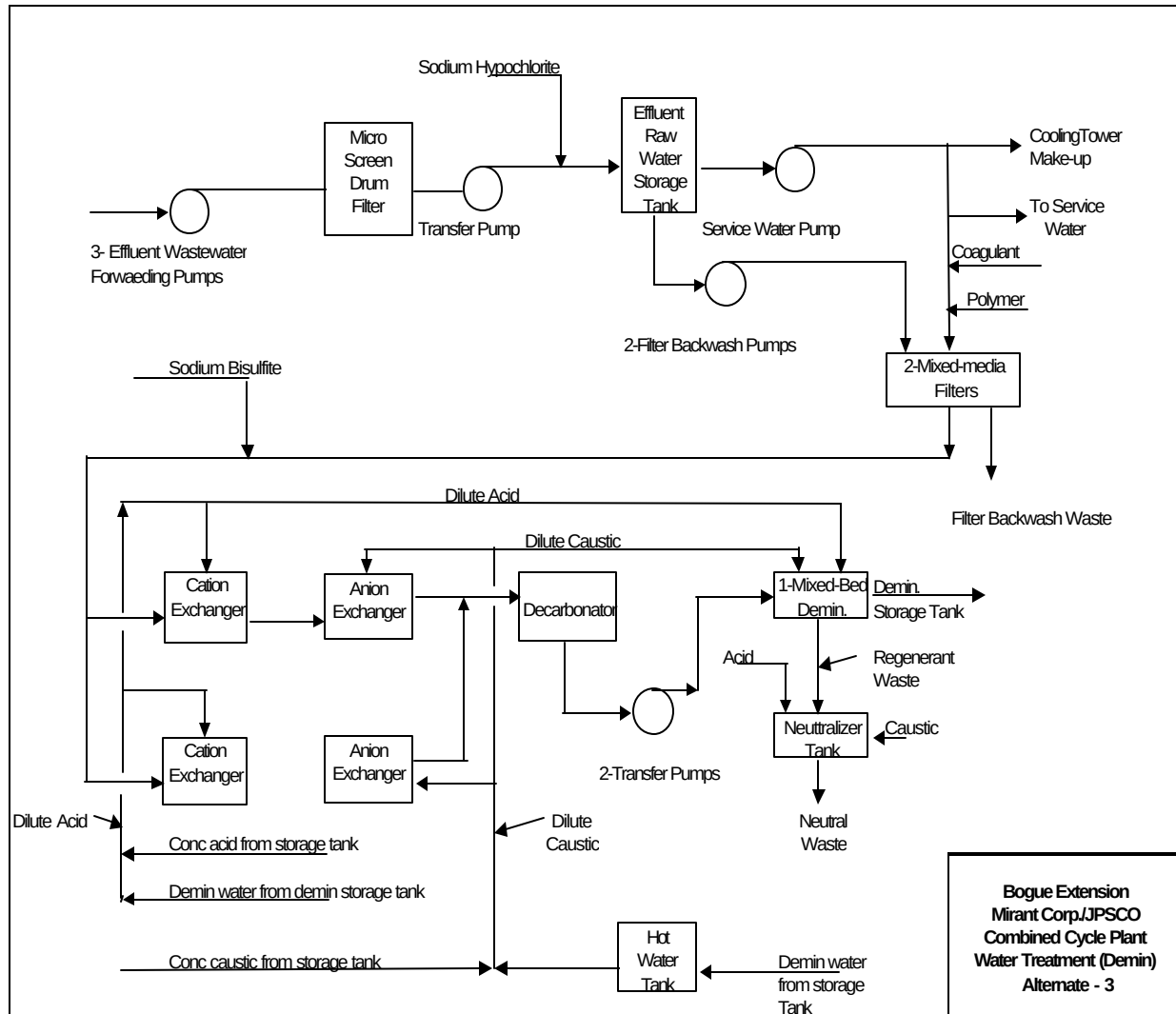
A condensate storage tank will be provided to supply 10 min. condensate storage at design condensate flow rates. The tank will be constructed of carbon steel.

4.3.8.4 Disposal of Cooling Water Phase 2

Effluent from the plant will be treated where necessary to be in compliance with the 1995 Trade Effluent Standards. The treated discharge from the plant will enter the either the existing storm water drains or new drainage systems will be constructed after being routed to a pond. The estimated discharge from the plant at the end of phase 2 is to be finalized by the engineers.

The cooling tower blowdown will be discharged to existing drains. The estimated blowdown quantity will be finalized by the engineers, during the final engineering of the plant. The blowdown quality will be comply with the recommended effluent standards (Appendix B).

The process of the cooling water from the intake at the Bogue Sewage Treatment facility is shown in the water treatment diagram shown on the next page in Figure 4.3.



CHAPTER 5 ENVIRONMENTAL IMPACTS ANTICIPATED FOR THE PROPOSED PROJECT

In the planning process for all elements of the projects due consideration has been given to the possible environmental impacts that can occur during projects of this nature and magnitude. The activities of both phases (construction and operation) were considered.

In doing so, the major activities of the each project were considered and the possible effects of the activities on the environment. In considering the effects of the projects, the major environmental resources and sub-resources that can be affected were examined.

The major environmental resources are divided into three major areas and are described below:

Physical environment

- ? ? Air quality
- ? ? Land resources (geology, topography, soils)
- ? ? Water resources

Biological environment

- ? ? Flora and fauna
- ? ? Conservation areas, parks, reserves

Socio-economic environment

- ? ? Population/demography/employment/community infrastructure

- ? ? Visual resources
- ? ? Land use
- ? ? Transportation
- ? ? Social and Economic
- ? ? Energy
- ? ? Public Health
- ? ? Cultural

The possible effects that can occur during the different phases of the project will be summarized below and where applicable detailed assessments will be discussed in the chapters dealing with each of the projects.

Social, Economic and Cultural

The increased activities of the project will attract people to the project site. It is not anticipated that any serious impacts relating to vendors will occur. However, the fact that they will be increased activities at the project site, positive impact associated with employment of skilled and unskilled labourers from the area is anticipated. Further with the use of construction materials and equipment, it is also anticipated that the Commercial and Industrial Community will benefit positively from this US\$127 million project.

The impact associated with transportation related to personnel and others accessing the proposed project site are expected to be temporary and limited. No major impact positive or negative is anticipated.

5.1 CONSTRUCTION

The major activities and the effects considered during construction are summarized below.

	CONSTRUCTION ACTIVITIES	EFFECTS CONSIDERED
1	Foundation laying	Nuisance dust,
2	Drainage construction	
3	Land Clearing & Grubbing	Topographical changes
4	Land Reclamation	Topographical changes
5	Site Grading	Erosion, Water pollution, Safety
6	Finish Grading	Erosion, Flooding, Safety
7	Sewage Treatment on the construction site	Pollution
8	Storage of equipment, chemicals, etc.	Land pollution, Public Safety
9	Movement of Heavy Equipment	Noise & Vibration, Safety
10	Access Road construction & improvement	Dust Nuisance, noise, Safety
11	Pipe Laying	Dust nuisance, Safety
12	Landscaping	Dust nuisance, Safety

5.1.1 General

The site will be left properly leveled with no construction debris or dirt piles. Consideration will be given to the drainage to ensure no low-lying areas are left where water could accumulate. All drainage will be away from buildings. Installation of site construction utilities will be planned and constructed. A facility sign will be installed at the start of the construction phase.

5.1.2 Clearing and Grubbing

As necessary, clearing will consist of cutting and disposal of sugar cane crop, all small trees, stumps, brush, bushes and debris from the areas to be graded. Root mats and stumps will be completely removed and holes refilled and compacted. The debris – dirt, cuttings from trees will be removed from the site in covered trucks to prevent dust or the debris fallen along the roadways.

The major impact to the biological community at the proposed site would relate to clearing activities prior to construction. The six hectares, will be cleared of all vegetation (sugarcane and small acacia trees) and graded. The vegetation loss can be considered not significant since it is 99% sugarcane, the other 1% comprise shrubs, grasses, vines and small trees. No endangered, protected or biologically significant species were identified during the site surveys. The wildlife utilization of the site was seen to be domesticated animals such as cows. No other significant biological species were seen.

In summary the removal of the sugarcane and shrubs from the site cannot be considered to be of major negative ecological consequence.

5.1.3 Earthwork

Erosion control during and after construction will be in accordance with local laws. The sediment and erosion plans will include where necessary the following

- ?? silt fences,
- ?? check dams,
- ?? drain swales,
- ?? erosion control pond and associated pipes where necessary.

All areas disturbed during construction will be graded and compacted to a smooth surface and covered with appropriate material approved by the Engineer.

During earth movement the likely impact would be noise and dust nuisance. The necessary mitigative measures as described above will be employed to reduce and/or eliminate the impact. The use of heavy equipment will be restricted to specific times for the day and monitoring will be done during the period.

5.1.4 Site Grading

Site grades will be established to accommodate permanent facilities, construction facilities and switchyard. Finish grading will be performed to conform to the finished design elevations for surface drainage with the natural drainage pattern of the land and to prepare the areas to receive the specified surface finishes where required.

5.1.5 Landscaping

Landscaping and grassing of the yard areas will be provided to provide the promotion of storm water infiltration and aesthetics. The switchyard, transformer yards and

surrounding areas will be surfaced with crushed stone on gravel with a minimum depth of 15 cm.

Areas of the site that have been disturbed and not built upon, stoned or paved, will be seeded with grass. Grass suitable for local site ambient conditions will be used.

5.1.6 Roadways/Paving

The site roads and service roads around the powerhouse will be asphalt pavement. Paving for all drives and parking areas will consist of not less than 6 inches of sand clay base and 3 inches of asphaltic concrete. Parking space will be provided as indicated in the site plan. Roadway and parking spaces will be designed to facilitate storm water run-off.

Paved roads will be a minimum of 6.1 metres (20') wide with 0.9 metres (3') shoulders each side. The driveways to vehicle access doors will be at least the width of the door plus a 3.05 metre (10 foot) width where there is an adjacent main door. The construction entrance will have a graveled section to minimize soil and sediment tracking onto local streets.

5.1.7 Crushed Stone Surfacing

The areas within the substation and around the equipment (as approved by Owner) will be finished with crushed stone surfacing and will be no less than 10.16 centimetres (4 inches) thick.

5.1.8 Fencing and Gates

The construction site will be cordoned off. Security fences, where applicable, are to be constructed as follows: 2.14 metre (seven-(7) foot) high standard galvanized chain link fence with 3 strands of barbed wire. Vehicular access gates will be installed for all roadway entrances to the project and as required by appropriate design/construction building codes. No personnel access gates are required.

5.1.9 Signs

Safety signs will be provided and installed throughout the Facility in accordance with general industrial practice and OSHA guidelines. Identification for all fire protection equipment will also be provided. Traffic markings and signs will be provided as necessary to assure proper traffic flow, control and safety. A facility sign will be provided and will be subject to approval by Owner. There is at the moment no requirement for the sign to be lighted.

5.1.10 Drainage

5.1.10.1 General

The working areas of the site will be well drained during and after construction. The site drainage plan and discharge from the site will conform to local requirements and laws. The drainage plan will take the natural drainage pattern for the land area into consideration. It is proposed that if necessary a storm water retention pond will be provided to settle suspended particles.

5.1.11 Erosion Control

Proper erosion control measures including the use of silt fences, hay bales and seeding will be employed during construction activities where necessary to control erosion of embankments, temporary material stockpile(s), and to limit sediment runoff.

5.1.12 Storm Water Drainage System

The site drainage will be designed for the maximum rainfall occurring with a frequency as specified by the local building codes, or regulations. The storm drainage system will be sized to discharge the 10 year, 24-hour run-off without flooding roads and the 50-year, 24-hour storm event without flooding the facility. Surface runoff will be collected and routed off the site by means of ditches and drainage pipes. Ditches and drainage pipes will be sized and graded to have a minimum velocity of 0.61 m/s (2.0 feet per second) and be self-cleaning. The maximum surface runoff will be calculated using the Rational Formula Method. Swales and ditches at +6% grade if necessary will be paved or lined with crushed stone to control concentrated flow velocities and minimize erosion and siltation concerns. The surface area of the switchyard and unpaved areas around and within the power plant will have a crushed stone surface to facilitate drainage, prevent ponding of water and provide a driving surface during wet conditions. Site drainage will be by surface drainage and swales with roadway culverts as required. A storm water detention pond will be provided if deemed necessary.

5.1.13 Manholes and Catch Basins

Manholes and catch basins will be provided as required by the final design stage.

5.1.14 Floor Drains and Sumps

A system of floor drains and sumps will be incorporated into the overall design of the power plant buildings. The system will consist of collection troughs, sumps, piping, fittings and valves necessary for gravity drainage of wastewater to various collection points. From these points, the wastewater will flow by gravity and/or be pumped to the oil/water separator sump and then on to the sewer or the facility effluent discharge.

5.1.15 Oil-Contaminated Wastewater Sewer System

An oil contaminated wastewater sewer system will be provided to collect discharges from areas that have potential for oil contamination, including the following:

- ?? Equipment drains
- ?? Pumps
- ?? Lube oil console

Areas where only minor oil leakage is likely will have equipment skid attached containment for local collection and subsequent cleanup, when required.

Oil contaminated runoff will be directed by gravity to an oil separator. Oil separator effluent will be discharged to the sanitary sewers system and pumped offsite. A separate storage tank for skimmed oil and sludge removal will be provided with the separator. The following will be provided:

- ?? One double-wall oil separator
- ?? Packaged coalescing plate separator providing less than 10 mg/l of oil effluent quality.
- ?? One double wall skimmed oil storage tank.
- ?? Waste oil transfer pump mounted on the skimmed oil tank to transfer oil to tank truck for disposal.

?? Sewer to discharge effluent to the sanitary sewer system.

All equipment having the potential to spill oil and hot buried underground will be contained in a curbed area in order to prevent spillage.

5.1.16 Foundations

The foundations for all the structures will be of reinforced concrete construction. Dynamic analysis will be performed for all equipment foundations susceptible to vibration, especially for gas turbine/generator and steam turbine/generator. Piling or other deep foundation will be considered as required based on the soil investigations. Equipment support will include considerations for vibration, stiffness, settlement etc. as required to ensure proper performance of the equipment.

All equipment on ground floor will be located atop a 150 mm (6") (minimum) concrete house-keeping pad. The top of foundations will be minimum 150 mm (6") above the high point of the grade.

5.1.17 Buildings and Equipment Foundations

Buildings and equipment foundations will be of reinforced concrete mat or footings to include all formwork, rebars, waterstops, etc. The soil investigation results will be appropriately incorporated in the design. Due consideration will be given to overall and differential settlement of structures, structural components and equipment foundations.

5.1.18 Tank Foundations

Foundations for storage tanks will be provided with either a ring wall design or individual footings as appropriate. Containment will be provided for the appropriate application.

a Embedments, Anchor Bolts, and Sole Plates

These devices will be furnished in accordance with the applicable codes. All devices will be of a material or provided with a coating that retards deterioration due to ambient or service conditions.

b Oil-Filled Transformer Foundations

These foundations will have an integral reinforced concrete spill containment area.

5.1.19 Occupational Health & Safety

Hazards constitute a major threat during construction activities. Clear guidelines will be given to all Contractors, employees and visitors authorized to visit the site as to the safety requirements for the site. There will be limited or restricted access areas on the site during working hours. No unauthorized person will be given access to these areas.

Head protection, steel toed shoes, eye protection and where necessary hearing protection will be part of the minimum requirements on the site.

5.2 OPERATION

During the operation phase of the projects, there are potential environmental issues/effects that are considered. The major activities are summarized below:

	OPERATION ACTIVITIES	EFFECTS CONSIDERED
1	Air Emission ?? Stack ?? Ambient	Air Pollution
2	Water Effluent ?? Industrial ?? Sewage ?? Storm water runoff	Water Pollution
3	Noise and Vibration	Safety Occupational Health
4	Storage ?? Oil	<u>Land Pollution</u> Soil Pollution Aesthetics
5	Waste Generation and Disposal	Pollution Aesthetics

The impact analysis for operation is detailed in Chapter 7

CHAPTER 6 IDENTIFICATION AND ANALYSIS OF ALTERNATIVES

Project Alternatives

Construction site alternatives

6.1 Project Alternatives

Over a period of years the Government through Jamaica Public Service Company has been exploring options for the siting of new power facilities to accommodate the increase in demand for electricity. As early as 1980s serious investigations were conducted for the siting new facilities including coal fired power plant. Siting studies for the selection of an appropriate site was done over a number of years. A total of 28 sites were studied for the location of the Power Plant and Port facility for fuel delivery (*Consultancy Services for Coal Plant and Harbour Siting Studies, October 1988: Electric Power Development Company Limited, Tokyo, Japan*).

The site selected for site reconnaissance included Cow Bay, Harbour View, Rockfort, Cockpit, Rocky Point, Old Harbour and Goat Island among others.

Site reconnaissance of the 28 sites resulted in short listing based on the economics and the environmental/physical conditions. Using the data collected, 11 suitable sites were selected to conduct more detailed studies. The sites included Cow Bay, Old Harbour, Rocky Point and Great Goat Island. Since then further detailed investigations were conducted in a number of these areas and at Salt River in Clarendon.

The project was not executed during that period and since then interim capacity was provided based on the installation of Gas Turbines and Independent Power Producers (IPPs).

6.2 Options Considered

In reviewing the expansion programme, two important considerations were brought into fore:

The environmental impact/effects of the fuel was an important consideration. Studies have indicated that while natural gas tops the rest as being lowest in effects on the environment, the cost is however the debilitating factor when it is not produced in the country.

6.3 Selected Capacity Expansion Programme

Based on the above-mentioned analyses and issues, the company has established the need for a 360 MW of Base load power generating capacity over the 10 years period 2001-2010 to meet the forecast growth in demand for electricity.

The plan calls for the following:

- 2001 Improved Reliability 90%
- 20 MW Interim/Short term capacity (optional based on reliability)
- 2002 80 MW Combustion Turbine
- 2003 40 MW Steam Turbine

6.4 Siting Considerations

The issue of siting for the new power plant was one that benefited from extensive exploration work and serious consideration. Because of the continuous expansion of the power system over the years, JPSCo has had to examine on an ongoing basis a number of candidate locations for the development of new power generating projects.

These considerations include leveraging the available space and infrastructure on existing plant sites as well as the development of new Greenfield sites. For ongoing projects consideration, several sites were evaluated and screened for this development, including:

1. Hunts Bay in Kingston
2. Old Harbour in St Catherine
3. Salt River in Clarendon
4. Goat Island
5. Bogue

These alternatives were evaluated on the basis of the following factors:

- ii. Available land area and
- iii. Economics of preparing the site for the project construction and cost of operation. The economic factors were influenced by:
 - a. Proximity of the site to the load center and the relative cost to move electricity to the points of demand.
 - b. Appropriateness of the site topography and geology and its requirements for site and foundation preparation.
 - c. Access to water for cooling
 - d. Extent of transmission infrastructure required for connecting the plant to the grid. This is a function of proximity of site to existing transmission network.
 - e. Ability of the project to comply with environmental standards
 - f. Availability of basic domestic infrastructure – water, telephone, electricity, roads etc. and requirements to make these available.
 - g. Ease of fuel supply and cost to establish arrangement for fuel supply.

This site evaluation drew heavily on previous detailed site exploration works and studies carried out by a local consultant, Wallace Evans and an overseas consultant, Electric Power Development Company from Japan. Information was also gathered from a study funded by CIDA for the development of the Salt River project site.

The use of new green field sites will more likely cause increased environmental impact where existing infrastructure is not in place. The effects to construct new infrastructure and support structures for a new power plant will inevitable cause more environmental effects than using extension of existing site where a number of the important infrastructures are in place.

Based on these factors, Bogue is the preferred site for the development of this project at this time.

6.5 No Project Alternative

The alternative of “no action” is one that will have a negative social and economic impact. The need for additional capacity is very critical. The rippling effect (both social and economical) of not having adequate generation capacity for the country cannot be quantified in this evaluation but the effects are known generally to be negative.

Chapter 7 **IMPACT ANALYSIS and MITIGATION ACTION/MITIGATION PLAN**

ENVIRONMENTAL CONSIDERATIONS FOR CONSTRUCTION & OPERATION ACTIVITIES/PHASES

Environmental Assessment

Air Quality Impact

Water Quality Impact (Phase 2)

Noise

Land –Physical, Biological

Social & Cultural

7.0 Air Quality Impact

The Air Quality of the Bogue Industrial Park will be determined by the following methods:

1. Climatic condition for the area and surrounding sites.
2. Interpretation of the data on climatic conditions and different features relating to the existing site and proposed project
3. Modeling of the Bogue area – 3 – 5 kilometres radius

The concentrations of the following parameters will be determined:

? ? Carbon Oxides

? ? Particulates

? ? Sulphur Dioxide (SO₂)

? ? Nitrogen Oxides (NO₂, NO)



Ambient Air Dispersion Modeling Report

7.1 Executive Summary

Parker & Associates, Inc. was retained by the Jamaica Public Service Company (JPSCo) to conduct ambient air dispersion modeling to comply with the requirements of the Jamaican National Environment & Planning Agency (NEPA) Ambient Air Quality Regulations for the proposed installation of a new 120 Megawatt Turbine Electric Generation Unit at the Bogue Facility, located in Montego Bay, Jamaica. The unit will be composed of three separate components, two 40 MW simple cycle gas turbines and a 40 MW steam turbine in combined cycle. The two gas turbines will be operational first and the steam turbine will be operational in the future. Air dispersion modeling was conducted for Nitrogen Oxides (NO_x), Sulfur Dioxide (SO_2), Carbon Monoxide (CO), and Particulate Matter with nominal aerodynamic diameter less than or equal to 10 microns (PM_{10}) for both the simple and combined cycles.

The impact to ambient air quality predicted as a result of the installation of new 120 MW plant was assessed utilizing detailed modeling by the USEPA AERMOD software. The NEPA Ambient Air Quality Guideline Document (September 1999) was consulted to establish model parameters, report format, and impact significance levels. The facility emissions were modeled for pollutants that would reasonably be emitted and have an ambient air quality standard. The averaging periods are those corresponding to an NEPA ambient air quality standard.

With the addition of more efficient units, 20 MW in July 2001 and now the 120 MW, the capacities of the existing, older units will further be reduced. As a result, there will be a reduction in the total emissions of the facility. The modeling of the entire facility



emissions with the new capacity factors, including the new 120 MW plant, has been compared with the modeling performed in July 2001 for the existing units.

Modeling was performed for each pollutant and averaging period for the addition of the 120 MW (simple and combined cycles), including the new capacity factors, utilizing 1995-1998 meteorological data. These results were compared to the existing emissions determined by the modeling in July 2001, with the 20 MW addition and the existing capacity factors. The maximum concentrations for each pollutant and averaging period were evaluated for a significant level increase from July 2001 to September 2001. The comparison is summarized below.

Significant Increase Level Determination					
Pollutant	Averaging Period	July 2001 Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	September 2001 Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	NEPA Guideline Significant Increase Level ($\mu\text{g}/\text{m}^3$)	Significant Increase Level Exceeded
NO _x	Annual	61	21	20	No
CO	1-Hour	2,699	1,178	Not Applicable	No
CO	8-Hour	477	235	Not Applicable	No
SO ₂	1-Hour	1,663	750	Not Applicable	No
SO ₂	24-Hour	97	132	80	No
SO ₂	Annual	30	31	20	No
PM ₁₀	24-Hour	85	70	Not Applicable	No
PM ₁₀	Annual	21	17	20	No



As demonstrated by the table above, there were no Ambient Air quality increases classified as significant increases as defined in the NEPA Air Quality Guidance Document. Also note that the predicted increases are the maximum increase levels for the maximum individual receptor. The following table summarizes the maximum predicted ambient air concentration impact and the NEPA Ambient Air Standard for each compound.

Pollutant	Averaging Period	Simple Cycle Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	NEPA Ambient Air Standard ($\mu\text{g}/\text{m}^3$)	NEPA Ambient Air Standard Exceeded (Maximum Predicted)
NO _x	Annual	6	21	100	No
CO	1-Hour	1,178	1,060	40,000	No
CO	8-Hour	235	217	10,000	No
SO ₂	1-Hour (1995)	556	591	700	No
SO ₂	1-Hour (1996)	609	655	700	No
SO ₂	1-Hour (1997)	684	656	700	No
SO ₂	1-Hour (1998)	750	680	700	Yes
SO ₂	24-Hour	65	132	365 primary 280 secondary	No No
SO ₂	Annual	9	31	80 primary 60 secondary	No No
PM ₁₀ (Includes Montego Bay urban baseline)	24-Hour	70	70	150	No
PM ₁₀ (Includes Montego Bay urban baseline)	Annual	16	17	50	No



As outlined in the table above, only the simple cycle 1998 1-Hour SO₂ ambient air standard was predicted to be exceeded. However, this standard was predicted to be exceeded by the current existing equipment without addition of the new unit and is significantly lower than the existing equipment. For the four years modeled, the standard was exceeded for only one off site receptor during one hour. The hour of exceedance produced a model error due to out of range friction velocity. For these reasons, the predicted exceedance is not expected to be reflective of actual site conditions and should not be used for determining compliance with the ambient air quality standard.

The simple and combined cycle modes of the 120 MW plant will have significantly lower emissions per unit of rated capacity than the current existing equipment and is more fuel-efficient. Additionally, due to the reduction of capacity factors for the older units, the average emissions will be significantly lower for all pollutants.

Based on the modeling results presented, JPSCO believes that the installation of the two components will provide significant economic and production benefit, with a reduction of all pollutants emitted to the environment.



7.2 BACKGROUND

The Jamaica Public Service Company (JPSCO) is planning to install a 120 Megawatt Turbine Electric Generation Unit in Bogue, Jamaica. This modeling report has been prepared to satisfy the requirements of the Jamaica National Environmental Planning Agency (NEPA) ambient air monitoring and assessment regulations.

JPSCO has requested that Parker & Associates conduct air dispersion modeling to evaluate the potential impact to existing air quality in the area surrounding the Bogue plant. This modeling report will assist NEPA in their evaluation of the permit application submitted for construction of these units.

7.2.1 Modeling Methodology

Parker & Associates conducted the modeling using the USEPA AERMOD modeling software. The regulatory default options were employed for the model.

The unit will be composed of three separate components, two 40 MW simple cycle gas turbines and a 40 MW steam turbine in combined cycle. The two gas turbines will be online first and the steam turbine will be added sometime in the future. The model was run for both simple and combined cycles.

The capacity factors for each unit were determined by JPSCO and based upon predicted load demand. The capacity factors for the older, less efficient units were increased beyond the demand to represent a worst-case scenario during peak hours of demand. The capacity factors are attached as Appendix A. Modeling of the addition of the 120 MW and the new capacity factors was compared to the modeling performed in July 2001 for the addition of the 20 MW unit using the old capacity factors.



Emissions for the existing units were estimated using manufacturer's estimates and performance specifications. Emissions for the older units (excluding the new 20 MW

unit) will be evaluated at a later date for conformance with the stack emissions standards for existing sources as outlined in the stack emission standards regulations. Supporting data and emissions calculations, including a table of stack parameters, are included as Appendix A.

No major industrial sources emitting similar pollutants are present in the immediate vicinity of the Bogue plant. Therefore, the models include only emissions from the existing units and the components of the new 120 MW combined cycle to be installed at the Bogue plant. Figure 1 is a site location map showing the plant boundaries. Since the Bogue plant is within 3 kilometers of the Montego Bay Metropolitan Area, urban dispersion was selected for the model. As outlined in the ambient air monitoring and assessment regulations, background concentrations have been added for particulate matter associated with the Montego Bay metropolitan area. This is discussed in more detail in Section 4.4.

The modeling was performed using preprocessed hourly meteorological data based on surface air measurements made at the weather station in Montego Bay, Jamaica and upper air measurements made in Kingston, Jamaica. The number of missing hours for the year 1999 exceeds the regulatory limit of ten percent of the total. This limit is set by Section 5.3.2 of "On-site Meteorological Program Guidance for Regulatory Modeling Applications" (EPA-450/4-87-013). NEPA acknowledges this exceedance and has approved modeling using meteorological data for the years 1995-1998, which are all below the ten percent limit.



The ground level concentrations were calculated using three receptor grids. These receptor grids were chosen to identify the maximum off-property ground-level concentrations. The first grid, a fence line grid, consisted of discrete receptors placed at 100-meter intervals around the Bogue plant site boundary. The second was a fine grid with receptors placed at 150-meter intervals and covered all areas at least 1-kilometer beyond the Bogue plant boundary. The third grid was a coarse grid with receptors placed at 1000-meter intervals to provide a large enough receptor grid to provide at least one fully bounded average concentration plume for each compound modeled. A fourth receptor grid with 100-meter spacing was utilized for the SO₂ modeling to fully delineate the estimated impact area.

Building Downwash Effects and GEP Stack Height

The effects of buildings on site were assessed for potential influence on the proposed emission source. The major structure dimensions are included as Appendix B. The nearest building to the proposed unit is the Generation Building with a height of 8.1 meters and width of 15 meters. The Good Engineering Practice (GEP) stack height for the unit was determined according to the formula $H_g = \text{Height of nearby building plus } 1\frac{1}{2} \text{ times the lesser of the height or projected width of the building}$. The Generation Building is approximately 8.1 meters in height and a width of 15 meters. Therefore the GEP stack height would be 20.25 meters. The proposed stack height for the new unit is approximately 25 meters, well above the GEP stack height.



Terrain Effects

The effects of terrain were also considered. A 1:12,500 topographic map was consulted to obtain terrain elevations. Because the terrain east and south of the facility was at a higher elevation than the proposed stack height, complex terrain algorithms with enabled terrain elevations were chosen for the model results. Terrain within the modeled receptor grid ranged from sea level elevation to the west of the facility, to greater than 45.7 meters (1500 feet) to the southwest of the facility.

7.2.2 Data Presentation

The model runs were conducted with capacity factors determined by JPSCO and based upon load demand. The capacity factors for the older, less efficient units were increased beyond the demand to represent a worst-case scenario during peak hours of demand. The model runs were completed for 1995-1998. The results of all model runs are summarized in Section 4.

Electronic copies of the model run files are included with this report on compact disk. Appendix C contains an index that references the model files to each modeled scenario.

7.2.3 RESULTS

7.2.3.1 NO_x AMBIENT AIR MODEL

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit.



The maximum annual average NO_x concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted Annual Average Existing (µg/m ³)	Simple Cycle Maximum Predicted Annual Average (µg/m ³)	Combined Cycle Maximum Predicted Annual Average (µg/m ³)
NO _x	61	6	21

As indicated above, the maximum predicted value for the existing sources is significantly higher than that of the proposed 120 MW unit. This decrease is shown to comply with Table 5-4 of the NEPA Ambient Air Quality Guideline Document, which defines a significant increase in annual ambient air concentrations of NO_x to be 20 µg/m³.

The maximum predicted annual average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

NO _x	Simple Cycle Maximum Predicted Annual Average (µg/m ³)	Combined Cycle Maximum Predicted Annual Average (µg/m ³)	Ambient Standard Annual Average (µg/m ³)
1995	6	21	100
1996	4	14	100
1997	5	16	100
1998	4	14	100



As indicated above, the maximum predicted value for both modes in all four years was $21 \mu\text{g}/\text{m}^3$ (21% of the annual average ambient air standard of $100 \mu\text{g}/\text{m}^3$). This value was obtained from the 1995 meteorological data. Figure 2 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.2 CO AMBIENT AIR MODEL

7.2.3.2.1 1-Hour CO Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 1-Hour average CO concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 1-Hour Average Existing ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted 1-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 1-Hour Average ($\mu\text{g}/\text{m}^3$)
CO	2,699	1,178	1,060

As indicated above, the maximum predicted 1-Hour value for the existing sources was $2,699 \mu\text{g}/\text{m}^3$. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.



The maximum predicted annual average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

CO	Simple Cycle Maximum Predicted 1-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 1-Hour Average ($\mu\text{g}/\text{m}^3$)	Ambient Air Standard 1-Hour Average ($\mu\text{g}/\text{m}^3$)
1995	808	740	40,000
1996	920	869	40,000
1997	781	702	40,000
1998	1,178	1,060	40,000

As indicated above, the maximum predicted 1-Hour value was $1,178 \mu\text{g}/\text{m}^3$ (3% of the ambient air standard of $40,000 \mu\text{g}/\text{m}^3$). This value was obtained from the 1998 meteorological data. Figure 3 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.2.2 8-Hour CO Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 8-Hour average CO concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 8-Hour Average Existing ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted 8-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 8-Hour Average ($\mu\text{g}/\text{m}^3$)
CO	477	235	217



As indicated above, the maximum predicted 8-Hour value for the existing sources was $477 \mu\text{g}/\text{m}^3$. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.

The maximum predicted 8-Hour average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

CO	Simple Cycle Maximum Predicted 8-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 8-Hour Average ($\mu\text{g}/\text{m}^3$)	Ambient Air Standard 8-Hour Average ($\mu\text{g}/\text{m}^3$)
1995	135	123	10,000
1996	218	196	10,000
1997	235	217	10,000
1998	231	188	10,000

As indicated above, the maximum predicted 8-Hour value was $235 \mu\text{g}/\text{m}^3$ (2% of the ambient air standard of $10,000 \mu\text{g}/\text{m}^3$). This value was obtained from 1997 meteorological data. Figure 4 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.



7.2.3.3 SO₂ AMBIENT AIR MODEL

7.2.3.3.1 1-Hour SO₂ Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 1-Hour average SO₂ concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 1-Hour Average Existing (µg/m ³)	Simple Cycle Maximum Predicted 1-Hour Average (µg/m ³)	Combined Cycle Maximum Predicted 1-Hour Average (µg/m ³)
SO ₂	1,663	750	680

As indicated above, the maximum predicted 1-Hour value for the existing sources was 1,663 µg/m³. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.



The maximum predicted 1-Hour average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

SO ₂	Simple Cycle Maximum Predicted 1-Hour Average (µg/m ³)	Combined Cycle Maximum Predicted 1-Hour Average (µg/m ³)	Ambient Air Standard 1-Hour Average (µg/m ³)
1995	556	591	700
1996	609	655	700
1997	684	657	700
1998	750	680	700

As indicated above, the maximum predicted 1-Hour value was exceeded for once for the 1998 meteorological data. The exceedance was recorded for 3/13/98 at 21:00. The hour of exceedance produced a meteorological data error message due to out of range friction velocity. As an average, the SO₂ 1-Hour results compared to the results generated from the July 2001 modeling were significantly lower due to the changes in capacity factors of the older, less efficient units. Figure 5 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.



7.2.3.3.2 24-Hour SO₂ Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 24-Hour average SO₂ concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 24-Hour Average Existing (µg/m ³)	Simple Cycle Maximum Predicted 24-Hour Average (µg/m ³)	Combined Cycle Maximum Predicted 24-Hour Average (µg/m ³)
SO ₂	97	65	132

As indicated above, the maximum predicted value for the new combined cycle is 132 µg/m³. The maximum predicted value for the existing sources was 97 µg/m³, an increase of 35 µg/m³. Therefore, the increase is 44% of the 80 µg/m³ NEPA Guideline Significant Increase Level.

The maximum predicted 24-Hour average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

SO ₂	Simple Cycle Maximum Predicted 24-Hour Average (µg/m ³)	Combined Cycle Maximum Predicted 24-Hour Average (µg/m ³)	Ambient Air Standard 24-Hour Average (µg/m ³)
1995	34	65	280
1996	54	132	280
1997	65	87	280
1998	48	101	280



As indicated above, the maximum predicted 24-Hour value was $132 \mu\text{g}/\text{m}^3$ (47% of the ambient air standard of $280 \mu\text{g}/\text{m}^3$). This value was obtained from 1996 meteorological data. Figure 6 shows the predicted ambient air average concentration plume for this

model run. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.3.3 Annual SO_2 Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum annual average SO_2 concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted Annual Average Existing ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted Annual Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Annual Average ($\mu\text{g}/\text{m}^3$)
SO_2	30	9	31

As indicated above, the maximum predicted value for the new combined cycle is $31 \mu\text{g}/\text{m}^3$. The maximum predicted value for the existing sources was $30 \mu\text{g}/\text{m}^3$, an increase of $1 \mu\text{g}/\text{m}^3$. Therefore, the increase is 5% of the $20 \mu\text{g}/\text{m}^3$ NEPA Guideline Significant Increase Level.



The maximum predicted annual average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

SO ₂	Simple Cycle Maximum Predicted Annual Average (µg/m ³)	Combined Cycle Maximum Predicted Annual Average (µg/m ³)	Ambient Air Standard Annual Average (µg/m ³)
1995	9	31	60
1996	6	21	60
1997	7	24	60
1998	6	21	60

As indicated above, the maximum predicted annual value was 31 µg/m³ (52% of the ambient air standard of 60 µg/m³). This value was obtained from 1995 meteorological data. Figure 7 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.4 PM₁₀ Ambient Air Model

To reduce the number of model runs, it has been conservatively assumed that all particulate matter emissions are PM₁₀ emissions. USEPA AP-42 emission factors for diesel-fired equipment indicate that an estimated 85% of the total particulate emissions are classified as PM₁₀ emissions.



7.2.3.4.1 24-Hour PM₁₀ Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 24-Hour average PM₁₀ concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 24-Hour Average Existing with Background ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted 24-Hour Average with Background ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted with Background 24-Hour Average ($\mu\text{g}/\text{m}^3$)
PM ₁₀	85	70	69

As indicated above, the maximum predicted Annual value for the existing sources was 85 $\mu\text{g}/\text{m}^3$. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.

The maximum predicted 24-Hour average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

PM ₁₀	Simple Cycle Maximum Predicted 24-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 24-Hour Average ($\mu\text{g}/\text{m}^3$)	Ambient Air Standard 24-Hour Average ($\mu\text{g}/\text{m}^3$)
1995	67	66	150
1996	70	69	150
1997	70	69	150
1998	69	67	150



As indicated above, the maximum predicted value plus background concentration for the Montego Bay urban area was $70 \mu\text{g}/\text{m}^3$ (47% of the ambient air standard of $150 \mu\text{g}/\text{m}^3$). This value was obtained from 1996 and 1997 meteorological data. Figures 8

and 9 show the predicted ambient air average concentration (without background of $60 \mu\text{g}/\text{m}^3$) plume for these model runs. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.4.2 Annual Average PM_{10} Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum annual average PM_{10} concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted Annual Average Existing with Background ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted Annual Average with Background ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Annual Average with Background ($\mu\text{g}/\text{m}^3$)
PM_{10}	21	16	17

As indicated above, the maximum predicted Annual value for the existing sources was $17 \mu\text{g}/\text{m}^3$. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.



The maximum predicted annual average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

PM ₁₀	Simple Cycle Maximum Predicted Annual Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Annual Average ($\mu\text{g}/\text{m}^3$)	Ambient Air Standard Annual Average ($\mu\text{g}/\text{m}^3$)
1995	16	17	50
1996	16	16	50
1997	16	16	50
1998	16	16	50

As indicated above, the maximum predicted value plus background concentration for the Montego Bay urban area was $17 \mu\text{g}/\text{m}^3$ (34% of the ambient air standard of $50 \mu\text{g}/\text{m}^3$). This value was obtained from 1995 meteorological data. Figure 10 shows the predicted ambient air average concentration plume for the model run. The highest predicted ambient air concentration point value is also designated on this figure.



7.3 Conclusions

The impact to ambient air quality predicted as a result of the installation of the new 120 MW plant was assessed utilizing detailed modeling by the USEPA AERMOD software. The maximum predicted increase levels from Section 4 of this report are summarized below.

Significant Increase Level Determination					
Pollutant	Averaging Period	July 2001 Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	September 2001 Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	NEPA Guideline Significant Increase Level ($\mu\text{g}/\text{m}^3$)	Significant Increase Level Exceeded
NO _x	Annual	61	21	20	No
CO	1-Hour	2,699	1,178	Not Applicable	No
CO	8-Hour	477	235	Not Applicable	No
SO ₂	1-Hour	1,663	750	Not Applicable	No
SO ₂	24-Hour	97	132	80	No
SO ₂	Annual	30	31	20	No
PM ₁₀	24-Hour	85	70	Not Applicable	No
PM ₁₀	Annual	21	17	20	No

As demonstrated by the table above, there are no Ambient Air quality increases classified as significant increases as defined in the NEPA Air Quality Guidance Document. Also note that these predicted increases are the maximum increase levels



for the maximum individual receptor. The average increase across all receptors will be much lower than those projected in the table above.

The following table summarizes the maximum predicted ambient air concentration impact for each compound.

Pollutant	Averaging Period	Simple Cycle Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	NEPA Ambient Air Standard ($\mu\text{g}/\text{m}^3$)	NEPA Ambient Air Standard Exceeded (Maximum Predicted)
NO _x	Annual	6	21	100	No
CO	1-Hour	1,178	1,060	40,000	No
CO	8-Hour	235	217	10,000	No
SO ₂	1-Hour (1995)	556	591	700	No
SO ₂	1-Hour (1996)	609	655	700	No
SO ₂	1-Hour (1997)	684	656	700	No
SO ₂	1-Hour (1998)	750	680	700	Yes
SO ₂	24-Hour	65	132	365 primary 280 secondary	No No
SO ₂	Annual	9	31	80 primary 60 secondary	No No
PM ₁₀ (Includes Montego Bay urban baseline)	24-Hour	70	70	150	No
PM ₁₀ (Includes MoBayurban baseline)	Annual	16	17	50	No



As outlined in the table above, only the 1998 1-Hour SO₂ ambient air standard was predicted to be exceeded. However, this standard was predicted to be exceeded by the current existing equipment without addition of the new unit and is significantly lower than the existing equipment. For the four years modeled, the standard was exceeded for only one off site receptor during one hour. The hour of exceedance produced a model error due out of range friction velocity. For these reasons, the predicted exceedance is not expected to be reflective of actual site conditions and should not be used for determining compliance with the ambient air quality standard.

The simple and combined cycle modes of the 120 MW plant will have significantly lower emissions per unit of rated capacity than the current existing equipment and is more fuel-efficient. Additionally, due to the reduction of capacity factors for the older units, the average emissions will be significantly lower for all pollutants.

Based on the modeling results presented, JPSCO believes that the installation of the two components will provide significant economic and production benefit, with a reduction of all pollutants emitted to the environment.

7.2 WASTEWATER QUALITY & IMPACT

During construction activities – clearing and grading of the site, the potential for impact to service water is possible. The mitigation that will be employed during construction activities is to install a settling pond where storm water run off can settle before it is discharged in the storm water drains.

In addition care will be taken for all construction areas, roads, buildings, area where chemicals are being used to ensure that there is no spills and preventative and mitigative measures are in place.

During operation the impact of each area on water quality leaving the site will be carefully managed. Roadways will have the necessary drainage for storm water runoff that would lead to oil/water separator. Other areas will be grassed or have crushed stone surfacing that would reduce or eliminate the impact of erosion and heavy sedimentation in the drains. All surface runoff will be collected (storm water detention pond) and routed off the site by means of ditches and drainage pipes.

Floor drains and sumps will have collection troughs, sumps, piping and valves necessary for gravity drainage of wastewater to various collection points. From these points, the water will flow to an oil/water separator sump and then on to the sewer or facility effluent discharge point.

An oil contaminated wastewater sewer system will mitigate against any potential discharges from areas likely to have oil contamination – equipment drains, pumps, valves and lube oil consoles. Areas where minor oil leak is possible will have equipment skid attached containment for local collection, cleanup and disposal when necessary.

A tank with the required systems will be provided to collect and store prior to the disposal of the oil separator effluent.

7.3 NOISE ASSESSMENT

7.3.1 INTRODUCTION

PURPOSE

The objective of the Noise Evaluation exercise is to determine the noise impact resulting from the addition of the new turbines on the surrounding communities.

The following terms of reference submitted by ESL based on the scope of work in the RFP, were approved by the Client.

- 1) To assess the noise level at the perimeter fence of the Bogue compound.
- 2) To evaluate five (5) data collection sites (to be jointly selected by JPSCo and ESL personnel):
 - one station upwind of the site
 - one station downwind of the site
 - one station in the nearest residential area
 - one station in the immediate area where the turbines are located on the compound.
 - two stations in the bogue industrial complex.

To prepare a defined map of each location with distance clearly outlined.

- 3) To conduct the test during a twenty four (24) hour period. Measurements will be done with and without background noise.

- 4) The noise levels shall be measured in low, mid and high frequency bands so that the noise attributable to the Plant can be more clearly defined.
- 5) To prepare a report detailing the findings of the Evaluation. The report will contain the following:
 - a) Dates, times and places of test.
 - b) Test Method used.
 - c) Copies of instrumentation calibration certificates.
 - d) Noise level measurements.
 - e) Any other relevant operating information (such as unusual local noise source, JPSCO loading, etc)
- 6) Evaluation of data, discussions and statement giving a professional opinion of the noise impact due to each of the three additional phases.

7.3.2 LEGISLATION AND REGULATION

Local

Jamaica does not have currently any regulations governing noise, the National Environmental and Planning Agency has however a draft national Noise Standard for Jamaica. The permissible limits for the noise standard are dependent on the zone in which the noise source occurs. The table 7.1 below details the noise limits.

Table 7.1 NEPA draft Noise Standards

ZONE	7 a.m. to 10 p.m.	10 p.m. to 7 a.m.
Industrial	75 dBA	70 dBA
Commercial	65 dBA	60 dBA

Residential	55 dBA	50 dBA
Silence	45 dBA	40 dBA

Measurements are to be made at the property line from which the sound is emitted.

7.3.3 World Health Organisation (WHO) Noise Standards

It is now widely recognized that noise pollution is a serious health hazard. The WHO recommends that for most persons, life-time continuous exposure to an average community noise level of 70 dBA will not cause hearing impairment. The USEPA recommends however a community noise equivalence limit of 65 dBA.

In occupational situations exposure to noise in excess of 85 dBA for more than eight hours per day is hazardous. Exposure to industrial noise around 90 dB will cause hearing damage. The Occupational Safety and Health Administration (OSHA) has a permissible exposure limit of 90 dBA for an eight hour day.

7.3.4 METHODOLOGY

Thirteen (13) monitoring sites were identified by ESL personnel (see Table 7.2 and Appendix G). Noise level readings were taken at each site by four teams of specially trained technicians, at hourly intervals. Noise level readings, wind direction and any unusual local noise sources were recorded. Frequency spectrum of the noise at the turbines and 10 m from the turbines were also measured, in order to more clearly define the noise.

Measurements were taken using Quest Electronics sound level meters, which conform with ANSI S1.4 - 1983, TYPE 2 and IEC 651 - 1979, TYPE 2 standards. A Quest Model 2700 sound level meter fitted with an octave band filter was used to measure the frequency spectrum of the noise. All meters were calibrated before and after each set of readings. In addition, before and after the survey, each instrument was checked with

a calibrator, which was pre-calibrated at the factory (see calibration certificate Appendix G).

Table 7.2 Noise Evaluation Station numbers and locations.

STATION #	LOCATION
1	NW corner of Property
2	West Perimeter Fence
3	GT3
4	Southern Perimeter Fence
5	South Eastern corner of Property
6	Eastern Perimeter Fence
7	GT8 & GT9
8	GT6 & GT7
9	NE corner of Property
10	Bogue Main Road by Palm Bay Guest House, NW of Plant
11	Across from Primary School in Bogue Hills, South of plant
12	Bogue Hills, 70m from the Kingdom Hall turnoff, SW of plant.
13	Intersection of Fairview Close and Granville Main Road. NE of Plant

7.3.5 FINDINGS

Noise levels

The average noise level readings were calculated using the following formula below because of the logarithmic nature of the decibel.

$$L_{avg} = 20 \log 1/N \sum 10^{(L/20)}$$

where:

L_{avg} = average sound pressure level

N = number of measurements

L = the measured sound pressure levels

7.3.6 OBSERVATIONS & CONCLUSIONS

7.3.6.1 OBSERVATIONS

The noise levels measured within the JPSCo Bogue Facility Stations 1 - 9 are higher than those outside the compound. Noise levels at the perimeter of the facility vary depending on its proximity to the turbines. The western and eastern boundaries are most affected.

Noise level in the communities (Stations 10 -13) during daytime hours range between 53 and 65 dBA when the plant is fully online. During the quiet hours of the early morning, noise levels range between 49 and 54 dBA.

Noise readings suggest that the plant is generally contributing to higher noise levels in the communities sampled.

Evaluation of the data shows that when two turbines (GT8 and GT9) went offline noise

levels at Station 6 fell by approximately 6 decibels.

A well established rule of thumb is that in a free field (i.e. one without obstructions) with a single noise source, noise levels will fall approximately 6 decibels for every doubling of the distance from the source. Disregarding other community noise (vehicular noise, etc) and the fact that there are buildings and trees in between the plant and the community, the results show that there is some correlation with the noise output from the plant. Using Stations 7, 6 and 13 show that noise level decrease with distance from the plant. Calculations based on the rule of thumb show that Station 13 should be 48.3 dBA. However including the fact that there are two other noise source (adding 6 decibels) and also that Station 13 is up wind of the noise sources, 60 dBA seems fairly consistent.

It should however be stated that increases in decibel levels are not in one to one correlation with human perception of noise. A 3 dB increase in noise level represents a 1.2 times increase in perceived loudness, but represents a doubling of noise energy output. A 1 dB increase would be very hard to perceive. Annoying sounds are however apparent to the listener at very low levels.

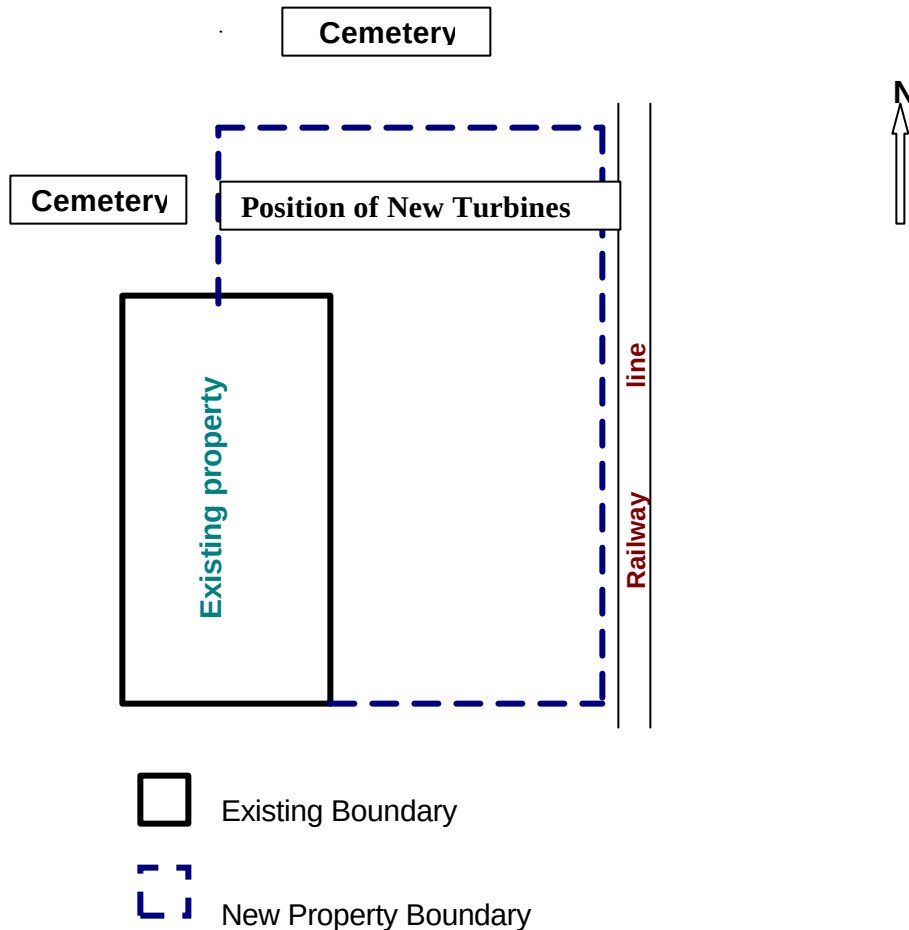
This suggests that addition of one or more turbines will likely increase noise levels by roughly 6 decibels (less if the silencers are absorbing efficiently). Although measured noise may well still be within the CNEL noise perceived by residents will be greater.

7.3.6.2 NOISE IMPACT OF ADDITIONAL TURBINES

Based on the information in the foregoing sections, it is the Consultants professional opinion that the addition of each new turbine to the Bogue facility will likely increase noise levels at the perimeter by up to 6 decibels. The actual value between 1 and 6 dBA will depend on whether the silencers are attenuating efficiently (to factory specification).

Measured noise at the perimeter of the existing Bogue property with all the turbines in operation is exceeding the local draft standards of 70 to 75 dB at three locations of the six boundary locations. The range is from 76 dBA to 81 dBA. This infers that the addition or more turbines will likely increase the sound levels at these stations. JPS has acquired more property along the existing northern and eastern perimeter of the Bogue compound.

Figure 7.1 Position of new turbines



The extension of the property along with the reduction of the use of the existing turbines and the implementation of measures to mitigate noise pollution will however significantly reduce the noise impact. Noise mitigation measures such as use of noise buffers, and regular maintenance to ensure the sound attenuation of the turbines is working according to the manufacturers specification.

7.3.6.3 CONCLUSIONS

Criteria for noise levels which cause community noise nuisance vary greatly from country to country. A major consideration in determining noise nuisance is often based on percent of community complaints at various noise levels. This can be a very subjective measurement and depends on the nature of the community and whether or not residents are used to certain noise levels. A simple rule of thumb which, is often used to determine the possibility of the existence of nuisance noise, is an increase of 10 dBA or more above the pre- existing noise level.

The noise level in the communities measured are presently within the community noise equivalence level (CNEL) of 65 dBA.

Noise levels in the communities at Stations 10 through 13 are influenced by the low frequency noise from the existing plant, particularly Stations 11 and 12.

Noise levels within the JPSCo compound are influenced by noise emission from all turbines. The farther the station is from the turbine the lower the noise level.

The frequency spectrum of the noise emitted by the plant indicated a high proportion of low frequency noise.

Introduction of additional turbines should cause some residents to perceive an increase in noise. The measured noise however should still be within the CNEL if JPSCO ensures that the silencers attenuate noise to meet 85 dBa at one meter or other mitigative measures are implemented.

Stations 2 and 6 directly west and east of the turbines are most affected. Noise levels

at these stations will likely increase. Noise levels in the Granville area and its immediate environs are presently at 60 dBA close to the CNEL. Significant increase in the noise level at Station 6 will cause increases in the noise level of this area and the residences in between the plant and Granville. This is however not anticipated as no additional turbines are proposed for this location and property boundary will be extended.

Noise mitigation measures should be introduced for these two perimeter stations in particular.

7.3.7 RECOMMENDATIONS

Experience has shown that noise nuisance is very subjective. As long as any noise is discernible, some residents will complain. Their reaction however will very often not correlate with actual noise levels. As indicated here the noise levels are within the CNEL.

1. We recommend that JPSCO investigate the reason for the increase in noise levels at GT6 and GT7 and ensure that the silencers are indeed performing as stated.
2. The doors of the main turbine, GT3 should be closed as best as possible to lower noise from that turbine.
3. Plant trees around the perimeter of the property. These will act as a buffer, reducing the noise experienced outside the property.
4. Monitor noise levels after installation of each additional turbine. Additionally, periodic monitoring of noise levels at the plant and in the communities should be performed to ensure the turbines are working as efficiently as possible.

7.3.8 Noise Impact and Mitigation Measures

Noise impacts were evaluated based on the expected contribution of the additions of the turbines to the noise level at the existing facility. It is expected that the noise level will increase by approximately 6 dBA. This increase will not however cause significant increase in the communities and the levels will be below the proposed standards. Further it is anticipated that the noise levels will be less because the existing turbines will also be operating less, the contribution of the noise levels by GT 3 will be reduced in the near future, as the stack will be replaced. A temporary stack is on the turbine due an explosion.

Mitigation measures recommended are to:

- ?? Plant trees around the perimeter of the site and
- ?? To check and maintain the attenuation of the existing turbines.

Further the noise level will be less because the older units will be operated less once the new units are commissioned.

7.4 SOCIAL AND CULTURAL ENVIRONMENT

7.4.3 Land use Impacts

The proposed construction of the 120 MW Combined Cycle Plant will modify the existing land use to accommodate the two combustion turbines, steam recovery system,

a steam turbine and other attendant facilities.

The existing land use – sugar cane in ruinate does not support any formal employment or does not yield an annual revenue to the prior owner. The land is now in the ownership of JPSCo. The proposed construction of the plants will add to the economy in the form of employment during the construction and operation phases and will improve on the needed generation capacity for the country. This will move the economic base from zero.

Because the land is in ruinate cane, there are no resettlement issues to be considered for this site.

7.4.4 Economic Impacts

The proposed construction activities for the project will cause positive impacts as the expenditure of the project for construction materials, for labour (unskilled and skilled) transportation (local and shipping) and other increase activities will add benefit to the local communities. Further during the operation of the plant, the additional employment and salaries and maintenance activities will also boost the economic base of the area.

The increased activities of the project will attract people to the project site. It is not anticipated that any serious impacts relating to vendors will occur. However, the fact that they will be increased activities at the project site, positive impact associated with employment of skilled and unskilled labourers from the area is anticipated.

In general it is anticipated there will be positive impact for the Montego Bay community. With the use of construction materials and equipment, it is also anticipated that the Commercial and Industrial Community will benefit positively from this approximately US\$100 million project.

The impact associated with transportation related to personnel and others accessing the proposed project site are expected to be temporary and limited. No major impact positive or negative is anticipated.

The proposed projects are not anticipated to have any positive or negative cultural, archaeological impacts. Historically the site was a sugar cane plantation and the proposed project will impact on that, as the site will be converted to an Industrial area, typically of much of the surrounding area.

7.4.5 Cultural Resources

It is not anticipated that the proposed construction of the 120 MW power plants will have any impact on historical or archaeological resources. This is so because the proposed lands have been in sugar cane cultivation for decades.

During earth movement, if any such resources are discovered, the Archaeological Division should be contacted regarding the find.

7.5 LAND – PHYSICAL & ECOLOGICAL

7.5.1 Construction

The proposed project is the extension of the existing Bogue facility with the addition of two 40 MW combustion turbines in 2002 with construction to begin in 2001. The proposed site is just north and east of the existing site, which is currently in sugar cane. The proposed site is in the industrial zone. The major impact to the biological community at the proposed site would relate specifically to clearing activities prior to construction. The site will be cleared and graded according to the natural contours and the existing natural drainage system.

The existing sugar cane lands are in ruinate. The existing sugarcane is not in production for sugar and the plants that are present have no value and can be considered as 'wild growth'. Further the soil is also not suitable for any other cultivation and it is envisage that approximately 1.8 metres will have to be replaced during construction. It has been stated that sugar cane land that have cultivated over a period of time is not suitable for any other use and generally the soil cannot support anything.

The clearing activities will result in the removal of all the sugar cane (if present) presently on the site. This vegetation loss cannot be considered significant, as it is plantation that is in sugar cane. Sugarcane lands normally support invertebrate species – insects, lizards, dragonflies. No endangered, protected, rare or otherwise significant species are supported by this type of land use activity. Wildlife utilization of the site was seen as minimal, as the only observable animal species seen were domesticated animals – cows.

The removal of the sugar cane and the wildlife from the proposed site is not considered to be of major ecological consequence.

7.5.2 Operation

During operation the potential for oil spills is likely. Since large volumes of fuel will be stored on site on a continuous basis, without mitigative measures there is the potential of contamination to the land resources. The mitigative measures that will be employed are as follows:

The fuel oil management system will be equipped with the following:

- ?? Fuel shut-off valve
- ?? Sump tank and sump pump
- ?? Spill containment structures (bundwall) – including secondary structures
- ?? Oil-water separator(s) where necessary

The implementation of the above strategies if implemented will eliminate and/or reduce any likely impact that may occur during the transfer and storage of the fuel oil.

The potential impacts associated with this method of delivery will be mitigated based on the risk. The following mitigative measures should be implemented and should form part of the mitigation plan:

3. All flanges, valves and pipeline will be managed to reduce the potential of spills during unloading to the tank.
4. A spill control plan for the site should be documented and available to all parties.

7.6 AQUATIC IMPACTS

7.7.1 Construction Activities

As described in chapter 3, there are no major surface water features within the boundaries of the proposed site. A natural drain is located west of the proposed boundary of the land. The primary impacts associated with construction activities would be turbidity and siltation caused by run off from land clearing and digging activities. However the construction activities will take into consideration the likely impact as described in Chapter 4 detailed description of the project. Mitigative measures will be employed and a siltation pond would be constructed. The mitigative measures were taken into consideration during the planning stages of the project.

7.7.2 Operation Activities

During operation the likely impact anticipated during operation is the run off of surface water and the discharge of wastewater to the receiving water.

The description of the project in Chapter 4 described the construction of oil -water separators, containment structures and sumps which will be collected at specific points where the effluent can be sampled before it is discharged into the storm water drain – the existing drain along the western boundary of the existing and proposed facilities. The engineers have indicated that existing earthen natural drain will be upgraded along the boundary of the property and will be maintained by JPSCo. This will mitigate against any effects that are likely during the operation of the plant. It is further recommended that the receiving area be sampled every quarter after the commissioning of the new combustion turbines.

7.7 OTHER PLANS

JPSCo is currently assessing information regarding the remediation projects for four major facilities. The project entails the following:

Engineering of the Remediation Programme

- Cleaning up of contaminated soil
- Removal of Solid waste and transformers
- Pollution prevention strategies and systems and containment upgrades
- Ground water remediation
- Pollution prevention training
- Designing of containment systems for impacted soils
- Permitting requirements for remedial projects

These activities will enhance the activities associated with the new construction at the Bogue facility and certainly throughout the major facilities at JPSCo sites.

CHAPTER 8 ENVIRONMENTAL MANAGEMENT & TRAINING

8.2 Management Activities

The construction activities of the project will be supervised by personnel from the JPSCo's Environmental Affairs Department along with the Resident Engineer/Project Manager. The activities during the clearing and earth movement activities as described in Chapter 5 will be carefully supervised.

The Resident Engineer and the Contractor will be fully aware of the requirements under the Mitigation Plan. The Project Manager and Resident Engineer will also have the responsibility to supervise and suspend any activity that is considered to be environmentally hazardous or may cause serious damage to the surrounding environment.

The Project reports on the project implementation activities will highlight the monitoring activities of the Environmental Officer in charge of the project. This will ensure that the activities will not cause any adverse effects on the surrounding environment.

8.2 Training

Training programmes should include practical applications and specific technical operating procedures relating to fuel management, operation and monitoring of air pollution control equipment, and in the second phase (2003) any discharge from the cooling tower or other waste water streams from the operations.

The training should include all operational aspects for the turbines to ensure that all the equipment are operated according to the guidelines of the manufacturers. This will ensure that all requirements are met and there will be reduction of any incident, which may occur as a result of equipment not operating according to the manufacturer

specification.

The Environmental Affairs Department (Mirant Corporate and JPSCo) is developing a training matrix for the staff of the Company whose activities/job function can impact on the environment. This matrix will be further developed to organize the training programmes according to the different groups of employees who will require different levels of training. This will form the basis to develop the training component of the Environmental Management System to be developed later this year. The programme is expected to provide awareness training for all employees. The programme that is planned is expected to use web based training for environmental awareness and other structured classroom training for more in depth training for personnel on the plant site or in other critical areas of the operation. It is also expected that a train the trainer course will be planned.

It is expected that JPSCo will report on the development and execution of the training programme as it relates to the new 120 MW Combined Cycle Plant as well as other training programmes that will be developed in the near future.

8.2.1 Operator Training

Commencing at least 2 months prior to the Initial Operation Date of each Block, Contractor will provide on-the-job training for Owner's personnel in the operation and maintenance of the Facility. Such training will include, without limitation, instruction related to the facility's control system, emission monitors and other balance of plant equipment. Training for the gas turbines and steam turbine will be conducted by Owner. The HRSG manufacturer will as a minimum provide one week of on-site classroom training. Similarly, the DCS manufacturer and the cooling tower manufacturer will hold training sessions to adequately train plant personnel. Training for the DCS should be an applied course.

8.3 Site Clean-up and Waste Disposal

As described in of the Terms and Conditions, Contractor will keep the Facility Site free from waste materials, including, without limitation, paints, chemicals and solutions, rubbish and other debris, resulting from performance of the Works. Where possible Contractor will recycle and put to good use such waste materials as packaging, office paper, metals and earth. All cleanup and disposal will be conducted in accordance with all Applicable Laws. The burning of waste materials on site will not be allowed.

8.4 Clearing and Handover

As set forth in the Terms and Conditions and as a condition to Final Completion, Contractor will remove from site all construction debris and plant and ensure that all surfaces are clean. The disposal plan must be documented and approved.

8.5 Safety & Supervision

Contractor will be required to comply with (1) the provisions of the Occupational Safety and Health Act of 1974 and regulations issued there under, (2) the Federal, state and local regulations pertaining to the work or service of the contractor based on Contractor requirement.

Contractor will implement a Project wide pro-active safety program covering all his and any subcontractors' employees on the Project. Submit the Safety Program to Owner for review and approval within (30) days of Notice to Proceed (NTP).

The requirements of the Safety Program will be adhered to at all times during construction and initial operation to ensure the facility is not injurious to the health and welfare of all personnel involved on or in the vicinity of the facility.

Contractor will initiate, maintain and supervise all safety precautions and programs in connection with the performance of the Contract. Contractor will provide all protection

to prevent damage, injury or loss to: a) all Persons employed by Contractor, subcontractors or any other contractors in connection with the Project and all other Persons who may be affected thereby.

b) all materials and equipment to be incorporated into the Project in storage on the Facility Site.

c) other property at the Facility Site or adjacent thereto.

Contractor will supply fire-extinguishing equipment and a first-aid room suitably equipped to deal with the potential chemical and other hazards associated with the Project.

If any operation, work or labor condition involves a risk to persons or property, such operation will be immediately suspended and Contractor will adopt all the necessary safety measures to enable the work to proceed in safety.

Contractor will immediately advise Owner of any accident during construction affecting personnel, equipment or Project, its own or Owner's staff or persons, or properties or goods of third parties. Contractor will submit a written report to Owner within 5 days from the date of accident detailing, as a minimum, the results of his investigation into the cause of the accident and what actions have been taken to prevent recurrence.

8.5.1 Construction Supervision

Contractor will supervise, coordinate and schedule all construction, fabrication, erection and testing at the Facility Site. Contractor will manage the site to avoid hazards during construction at all times. This will be achieved by good planned working practices on site, a system of safety monitoring and corrective actions, and reporting and follow-up of any incidents and/or near misses. All designs of equipment, erection procedures, access provisions; methods of working and temporary works will be such as to minimize

hazards to personnel.

8.5.2 Control Of Substances Hazardous to Health

Contractor will prepare, maintain and hand over to Owner, in a readily accessible and agreed format all information relating to all Hazardous Substances encountered or released by Contractor in connection with the Work.

CHAPTER 9 *MONITORING PLANS*

9.1 Emission

9.1.1 Air Emission and Quality

The facility emissions were modeled for pollutants that would reasonably be emitted and have an ambient air quality standard. The averaging periods are those corresponding to an NEPA ambient air quality standard.

With the addition of more efficient units, 20 MW in July 2001 and now the two phases of the 120 MW, the capacities of the existing, older units will further be reduced. As a result, there will be a reduction in the total emissions of the facility.

Modeling was performed for each pollutant and averaging period for the addition of the 120 MW (simple and combined cycles), including the new capacity factors, utilizing 1995-1998 meteorological data. These results were compared to the existing emissions determined by the modeling in July 2001, with the 20 MW addition and the existing capacity factors. The maximum concentrations for each pollutant and averaging period were evaluated for a significant level increase from July 2001 to September 2001. The comparison is shown in Chapter 7.

Generally there were no Ambient Air quality increases classified as significant increases as defined in the NEPA Air Quality Guidance Document. Also note that the predicted increases are the maximum increase levels for the maximum individual receptor. The average increase across all receptors will be much lower than those projected in the table above.

Only the simple cycle 1998 1-Hour SO₂ ambient air standard was predicted to be exceeded. However, this standard was predicted to be exceeded by the current

existing equipment without addition of the new unit and is significantly lower than the existing equipment. For the four years modeled, the standard was exceeded for only one off site receptor during one hour. The hour of exceedance produced a model error due to out of range friction velocity. For these reasons, the predicted exceedance is not expected to be reflective of actual site conditions and should not be used for determining compliance with the ambient air quality standard.

The simple and combined cycle modes of the 120 MW plant will have significantly lower emissions per unit of rated capacity than the current existing equipment and is more fuel-efficient. Additionally, due to the reduction of capacity factors for the older units, the average emissions will be significantly lower for all pollutants.

One of the permit conditions for the 20 MW plant is to install an ambient and meteorological monitoring station in the area of Bogue where the ground level concentration appears to be above the standard. The parameter to be investigated is SO_2 . The station is expected to be in operation for one year. It is envisaged that information will be gathered from the stations after the installation of the first phase of the 120 MW plant (i.e. 2 X 40 MW Combustion Turbines). This will allow information on the operations at the facility during the last quarter of 2002 when it is expected that the two 40 MW turbines will be in operation.

9.1.2 Stack Emission

The NO_x emissions for the two turbines should be measured to guarantee the performance of the NO_x emission controls to guarantee the manufactures rate of emission for NO_x .

The standard for SO_2 is based on the sulphur content in the fuel. The sulphur content in the fuel based on the manufacturers requirements is 0.5%. Currently the fuel delivered to the site has 0.5% sulphur. The SO_2 emission should be calculated using the actual

fuel sulphur content based on the fuel delivered to the site. Records of the analysed fuel should be kept as part of the monitoring and reporting for emission data. This information can be used if necessary to determine more accurate air dispersion modelling analysis to predict the maximum ground level concentration.

9.2 Noise Emission

1. The stack on GT 3 will be changed and the stack height will be increased. Further the noise attenuation will be 85 dBA and will be checked to ensure that this is so.
2. Further noise evaluation will be conducted after the commissioning of the two additional turbines. This is to ensure that the noise levels and the perimeter (new perimeter) will be according to the recommendation of NEPA.
3. Noise evaluation at 1 meter from the turbines will be checked on a quarterly basis by our Safety and Occupational Health Department.
4. The hearing protection programme will be further enforced and there will be sanctions for not adhering to the Safety and Occupational Health Policies.

9.3 Water Quality – Phase 2 (2003)

The quality of water disposed of will be monitored. During the start up of operations, waste water from phase 2 operations the combined cycle will be monitored on a monthly basis for the first quarter and quarterly thereafter.

Sampling points will be established during the first weeks of operations so that:

- ?? Points established will be representative of the operations
- ?? All wastewater points will be mapped.
- ?? All requirements will be met

The company will ensure in that qualified personnel will be used of perform specific tasks.

A wastewater management plan will be established for the site outlining the following

- ?? Map of waste points
- ?? The parameters to be measured and reported
- ?? Frequency of monitoring
- ?? Personnel involved
- ?? Reporting requirements

The existing wastewater management plans for the other plants will be used to complete the Bogue Management Plan and will be submitted to NEPA. The remediation programme that is slated for the Bogue facility will also enhance this monitoring plan.

9.4 Implementation of Best Management Practices (BMPs)

1. Formation of a Pollution Prevention Team
2. Good Housekeeping
3. Preventive Maintenance
4. Spill Prevention and Emergency Cleanup Plan
5. Employee Training
6. Inspection and Record keeping

Pollution Prevention Team

Establishing a pollution prevention team (PPT) is necessary to delegate the implementation of the BMPs. The identification and selection of the team members should be the responsibility of the Bogue Power Plant Manager. Basic responsibilities of the PPT include:

1. Development of the SWPPP
2. Hold regular meetings to review the overall operation of the BMPs and the results of the inspections.
3. Establish responsibilities for inspections, operation and maintenance of BMPs, availability in emergency situations and recordkeeping.

Good Housekeeping

The following are required housekeeping measures at the Bogue Power Plant:

1. Prompt cleanup of any pollutant fluid and fuel leaks and spills on soil or paved areas. Contaminated soil should be removed and properly disposed in accordance with guidelines provided in the SWPPP.

2. In impervious areas such as paved ground surface, cleanup of pollutant fluid and fuel leaks and spills should be conducted at the end of each working day using solid absorbents, e.g. clay and peat absorbents and rags as applicable.
3. Clean stormwater drainage system periodically. Keep stormwater canals free of any deposits.
4. Remove and properly dispose of all waste stored at the site including oil sludge. Oil sludge disposal options are provided under a separate report.
5. Regularly remove accumulated oil from ducts and canals.
6. Promptly repair or replace all substantially cracked or otherwise damaged pavement and other impervious containment areas that are subject to contamination due to fluid leaks and/or spills.

Spill Prevention and Cleanup

1. The following spill kit is recommended:
 - ?? Salvage high density polyethylene drum,
 - ?? Polyethylene disposal bags,
 - ?? Emergency response guidebook,
 - ?? Safety gloves, clothes and equipment,
 - ?? Shovel and other soil removal equipment, and
 - ?? Adsorbent pads and oil containment booms.
2. Keep emergency spill containment and cleanup kit in each area where there is a potential for liquid spill.

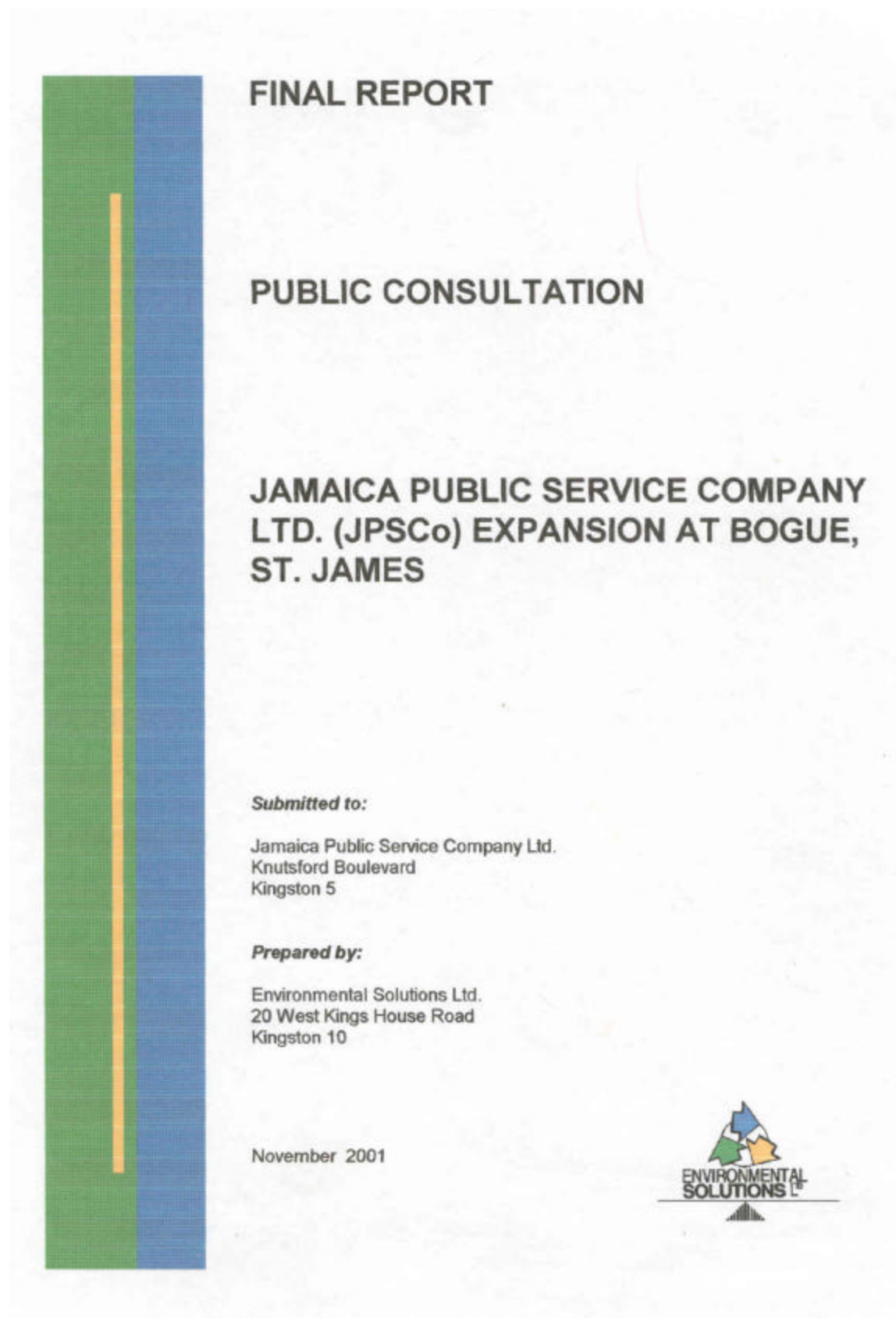
3. Make sure employees can reach and use the spill containment kits quickly and easily.
4. Notify the SWPPP coordinator immediately if a spill has occurred.
5. Do not flush or dispose absorbent materials into the stormwater canals.
6. Collect the contaminated absorbent material and place it in appropriate disposal container.

Finalize an Oil Spill Prevention Control and Countermeasure Plan for the site. It may include specific procedures for each oil storage tank.

FUEL SPECIFICATION BOGUE FACILITY

SPECIFICATION – NO.2 DIESEL OIL

PROPERTY/ COMPONENT	AERODERIVATIVES	ASTM TEST METHOD	GENERAL ELECTRIC
Ash content WT%	0.005 Max	D 482	0.005 Max
Carbon Residue %	0.25 Max	D 524	0.25 Max
Cloud Point, DEG F	To be reported	D 2500	-
Flash Point, DEG F	To be reported	D 93	To be reported
Sediment	24 mg/gal Max	D 2276	0.1% Max (D1796)
Sodium, PPM	0.6 Max	D 2288	1.0 Max (Sodium & Potassium)
Sulphur, %wt	0.5 Max	D 192	0.5 Max
Vanadium, PPM	0.2 Max	D 192	2.0 Max
Calcium, PPM	0.1 Max	D 2788	1.0 Max
Lead, PPM	0.1 Max	D 2787	-
Copper, PPM	0.02 Max	D 130	-
Viscosity CS @ 100F	3.5 Max	D 445	0.5 – 5.8 Max
Water, % Vol.	0.05 Max	D 1744	0.05 Max
Higher Calorific Value BTU/LB	19,000 Min	D 240	19,000 Min
Specific Gravity API	To be reported	D 1298	To be reported



JAMAICA PUBLIC SERVICE CO. LTD.
PUBLIC CONSULTATION
held at
MONTEGO BAY COMMUNITY COLLEGE, MONTEGO BAY
on
THURSDAY, OCTOBER 4, 2001
for
120 MW COMBINED CYCLE PLANT BOGUE, MONTEGO BAY

1.0 Introduction

Jamaica Public Service Company (JPSCo) is the sole electrical utility for Jamaica. JPSCo operates four electrical generating plants and the electrical transmission and distribution system for the island.

The mandate to ensure continuous adequacy of electricity to the Jamaican economy is that of the JPSCo. The company is embarking on a programme to meet this requirement with the development of a 120 Combined Cycle Plant over the next 2-3 years. This development will be carried out in two phases. The site of choice is adjacent to the existing Bogue Power Plant facility - Montego Bay, St. James. The Bogue site currently has five (5) operating gas turbines and one under installation.

A Public Consultation for the proposed expansion of the JPSCo facilities at Bogue was held on Thursday, October 4, 2001 beginning at 6:30 p.m., at the Montego Bay Community College. Invitations to the meeting were facilitated through flyers (Appendix I), posted letters of invitation (Appendix II) and advertisements. The meeting was well attended. A list of persons invited is given in Appendix III and a list of attendees who signed in is given in Appendix IV.

- A. Sampling was conducted over a 24 hr period. Noise was 76 dBH which was above the standard. If noise abatement is implemented, noise levels should be lowered.
- Q. Levels are now close to the threshold for the area, what happens when other industries move in?
- A. Each industry/factory will be responsible for putting mitigating measures in place to ensure noise levels at their perimeter are within recommended standards.
- Q. What is the contribution from background noise.
- A. Unable to say definitively as the turbines would have had to be turned off to measure background noise, which was not possible at the time of sampling due to the demand on the system. However, during the evening of the measurement period, there was a power outage and background noise was still measurable. Noise in the community was about 40 dBA during the power outage.
- Q. Noise is ferocious in the evening in the area of Granville. 252 acres of land will be going into housing next year. What can be done about the noise.
- A. Most of the problems are due to the noise of the old GT3 unit. These problems will be addressed when the new units are installed. The noise will also decrease after the installation of the new stack. The manufacturers indicated that the new stack will have attenuation of 55dBA.

Emissions

- Q. Emissions with metallic particles appear to be coming from JPSCo. which has caused damage to vehicles.
- A. There should be no metallic particles in the emissions. There will be particulate matter like ash. Recommend collection of these particulates and submission to JPSCo for analysis.
- Q. The exhaust for Unit #3 is low and must be higher.
- A. Agreed. A shorter stack was taken from another unit (as a result of damage to the stack) until the manufacture of the new stack is completed.

Old Units

- Q. Will old units (turbines) be restored?
- A. No. But older units will be used less, relegated to low capacity factor (6%). They will return to their original function as reserve units.

APPENDICES

Final Report - Public Consultation

Environmental Solutions Ltd.

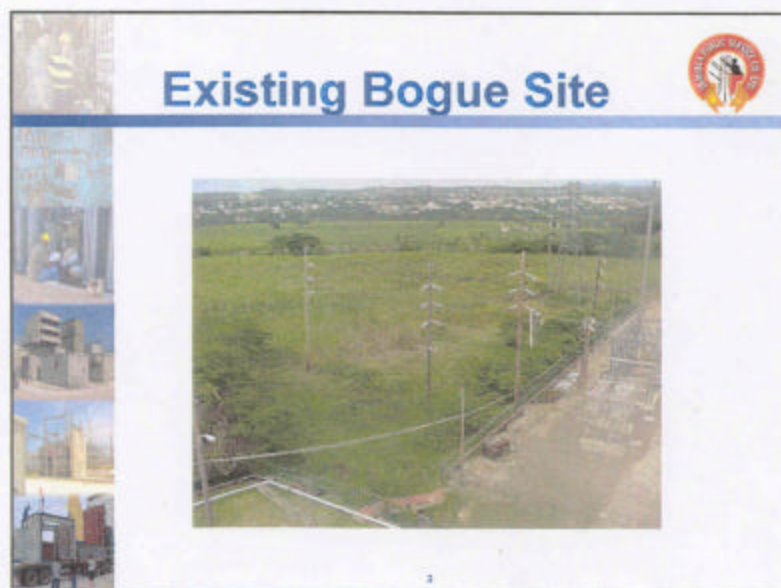
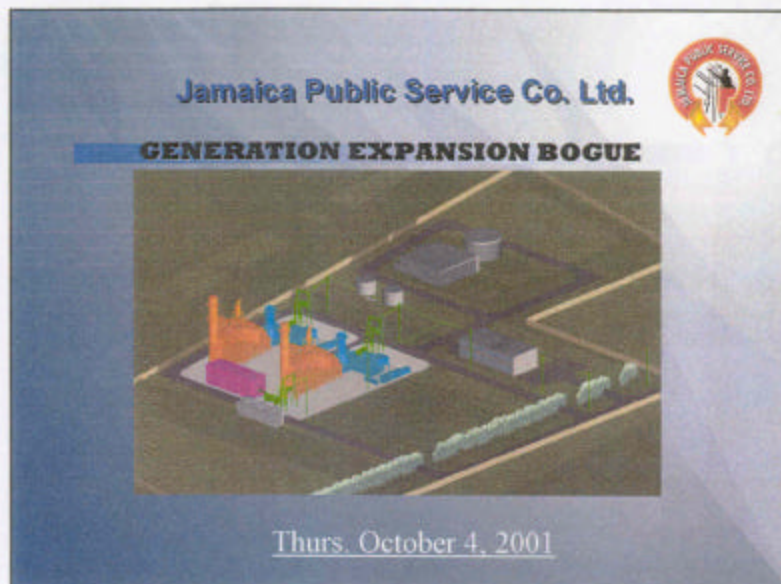
APPENDIX V

POWER POINT PRESENTATIONS

JPSCo Expansion at Bogue, St. James

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Jamaica Public Service Co. Ltd.



Final Report - Public Consultation

APPENDIX I

Environmental Solutions Ltd.

The logo is a circular emblem. The outer ring contains the text 'JAMAICA PUBLIC SERVICE CO. LTD.' in a sans-serif font. The inner circle features a stylized map of Jamaica, with a central element that resembles a power transmission tower or a stylized 'J'.

JPSco is Expanding at Bogue & you need to know about it

**Come hear about JPSCo's
generation expansion plans and
give your feedback
on Thursday October 4, 2001
6:00 p.m.**

Channina Lives with Our Energy

APPENDIX II

EXAMPLE LETTER OF INVITATION

2001 September 18

Mr John Beckford
Principal
Herbert Morrison Technical High School
Alice Eldermire Drive
Catherine Hall, Montego Bay
St. James

Dear Mr Beckford

The Jamaica Public Service Company invites you to a public meeting at the Montego Bay Community College on Thursday, October 4, at 6:00 p.m.

The meeting is being held to discuss with residents and business representatives in Montego Bay the JPSCo's generation capacity expansion programme for the Bogue Power Plant. This power plant is at the centre of the company's plans to increase generating capacity to meet the needs of our customers in the near future.

We would like to use the opportunity to provide you with details of these plans, and to have your input as we seek to better serve you, our valued customers.

We look forward to your participation in this meeting, which will be held in the Assembly Hall of the Community College.

Sincerely

Winsome Callum
Manager, Corporate Communication

APPENDIX III

LIST OF INVITEES

PUBLIC CONSULTATION – 120 MW COMBINED CYCLE PLANT BOGUE, MONTEGO BAY

Title	First Name	Last Name	Job Title	Company	Address1	Address2	City
Mr	John	Beckford	Principal	Herbert Morrison Technical High School	Alice Eldermire Drive	Catherine Hall, Montego Bay	St. James
Dr.	Angela	Samuels	Principal	Montego Bay Community College	Alice Eldermire Drive	Montego Bay	St. James
Mrs	Deloris	Moore	Principal	Catherine Hall Primary School	Westgreen	Montego Bay	St. James
Mr	Lincoln	James	Principal	Howard Cooke Primary School	Catherine Hall	Montego Bay	St. James
Mrs	Valrie	Wade	Principal	DRB Grant Basic School & Resource Centre	Catherine Hall	Montego Bay	St. James
Mrs	Serva	Fletcher	Principal	Granville All Age School	Granville	Montego Bay	St. James
Miss	Lorna	Stephenson	Acting Principal	Sam Sharpe Teachers'	Granville	Montego Bay	St. James

JPSCo Expansion at Bogue, St. James

Jamaica Public Service Co. Ltd.

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Title	First Name	Last Name	Job Title	Company	Address1	Address2	City
Ms.	Ann	Chang	Manager	College Fontana Pharmacy	Montego Bay Shopping Centre	Montego Bay	St. James
Mrs	Antoinette	Chen	Director	Super Plus Food Stores	24 Barnett Street	Montego Bay	St. James
Mr	Minor	Taylor	Managing Director	Grains Jamaica Limited	14 Pimento Way	Montego Bay	St. James
Mr	Tony	Hart	Director	Hart Samuel & Sons Limited	Shop 14 Montego Bay Freeport	Freeport Montego Bay	St. James
Ms.	Jill	Williams	Director	Montego Bay Marine Park	Pier One	Montego Bay	St. James
Mr	Godfrey	Dyer	President	JHTA - Montego Bay Chapter	c/o Wexford Court Hotel	Gloucester Avenue, Montego Bay	St. James
Mr	Mark	Kerr-Jarrett	President	Montego Bay Chamber of Commerce & Industry	Shop 5 Overton Plaza	Montego Bay	St. James
Mr	Phillip	Gore	Chairman	Gore Developments Limited	2C Braemar Avenue	Kingston 10	
Ms.	Faith	Thomas	Manager	Montego Bay Freeport Limited	Shop 34 Montego Bay Freeport	Montego Bay	St. James
Ms.	Florence	Logan	Manager	National	42B Union	Montego	St. James

Title	First Name	Last Name	Job Title	Company	Address1 Street	Address2 Bay	City
Ms.	Krishna	Desai	Director - Costal Zone Management Unit	Water Commission National Environment & Planning Agency	10 Caledonia Avenue	Kingston 10	Kingston
Mr	Errol	Mortley	Environmental Specialist	Urban Development Corporation	12 Ocean Boulevard	Kingston	Kingston
Mr	Gladstone	Wilson	Director - Public Relations	Highway 2000 Project	National Development Bank of Jamaica	11A Oxford Road	Kingston 5
Ms.	Evelyn	Dayes	Manager	Palm Bay Guest House & Restaurant	Lot 14 Bogue Heights	Montego Bay	St. James
Mr	Ian	Kerr	General Manager	Sunset Beach Resort & Spa	Montego Bay Freeport	Montego Bay	St. James
Ms.	Doris	Gross	Architect	Portico	P.O. Box 2100	Kingston 8	Kingston
Mr	Desmond	Flowers	Managing Director	Westech Limited	9 Duke Street	Montego Bay	St. James
Ms.	Arlene	Gaynor	President	Kiwanis Club of Montego Bay	c/o National Commercial Bank	Baywest Shopping Centre, Montego Bay	St. James
Mrs	Lilieth	Allen	Secretary	St. James Parish Council	19A Union Street	Montego Bay	St. James
Mr	Denton	Campbell	Operations	Airports	c/o Sangster	Montego	St. James

Title	First Name	Last Name	Job Title	Company	Address1	Address2	City
Mr	Horace	Underhill	Parish Manager	Authority of Jamaica Ministry of Agriculture	International Airport c/o Rural Agriculture Development Authority	Bay Catherine Hall, Montego Bay	St. James
Mr	Anthony	Bowen	General Manager	Port Handler's Limited	Montego Bay Freeport	Montego Bay	St. James
Mr	Owen	Higgins	General Manager	Montego Bay Free Zone Company Ltd	Montego Bay Freeport	Montego Bay	St. James
Dr	Mearle	Barrett	Deputy Executive Director	Natural Resources Conservation Authority	10 Caledonia Avenue	Kingston 5	
Mr	Steve	Houghton	Senior Director - Pollution Control	Natural Resources Conservation Authority	10 Caledonia Avenue	Kingston 5	
Mr	James	Samuels	President	Jamaica Hotel & Tourist Association	2 Ardenne Road	Kingston 10	
Ms	Ann Marie	Frazer	Manager - Accounting	NCP International (Jamaica) Limited	1 Mangrove Way, Montego Bay Freeport	Montego Bay	St. James
Mr	Joe	Hylton	Financial Controller	Wyndham Rose Hall Golf & Beach Resort	Rose Hall	St. James	

Title	First Name	Last Name	Job Title	Company	Address1	Address2	City
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Ms	Ann Marie	Frazer	Manager - Accounting	NCP International (Jamaica) Limited	1 Mangrove Way, Montego Bay Freeport	Montego Bay	St. James
Mr	Joe	Hylton	Financial Controller	Wyndham Rose Hall Golf & Beach Resort	Rose Hall	St. James	

Title	First Name	Last Name	Job Title	Company	Address1	Address2	City
Mr	Franklin	McDonald	National Environment & Planning Agency	Chief Executive Officer	10 Caledonia Avenue	Kingston 5	
Mr	Joseph	McCarthy		National Environment & Planning Agency	10 Caledonia Avenue	Kingston 5	
Mr	John	Tulloch	Group Treasurer	Sandals Resorts International Limited	Kent Avenue	Montego Bay	St. James
Mr	Noel	Stoley, Jr.	Operations Manager	Jamaica Tours Limited	1207 Providence Drive	Rose Hall	St. James
Mr	Lloyd B.	Smith	General Manager	Western Mirror	82 Barnett Street	Montego Bay	St. James
Mr	Gordon	Brown	Attorney-at-law	Chancellor & Company	Suite 1500 St. James Place	Montego Bay	St. James
Mr	Lee	Bailey			66 Claude Clarke Avenue	Montego Bay	St. James
Mr	Edmond	Bartlett	JLP Caretaker - North West St. James	Blue Diamond Shopping Centre	Montego Bay	St. James	
Mr	Errol	Gayle	Regional Manager	Atlas Protection Limited	20 Kerr Crescent	Montego Bay	St. James

Title	First Name	Last Name	Job Title	Company	Address1	Address2	City
Mrs	Janet	Madden	Senator	c/o Madden's Funeral Supplies & Crematorium Limited	37 Union Street	Montego Bay	St. James
Mr	Junior	Virgo	General Manager	Caribbean Brake Products Limited	Lot 25 Bogue Industrial Estate	Montego Bay	St. James
			Manager	Combined Auto Repairs & Sales Limited	Bogue Industrial Estates	Montego Bay	St. James

APPENDIX IV **LIST OF ATTENDEES SIGNED IN**

NAME	AFFILIATION
Ouida Petakin	Herbert Morrison Technical High
Deloris C. Moore	Catherine Hall Primary
Patricia Young	JPSCo
David Whitman	Mirant Corporation
Robert Patrick	JPSCo
David Cook	JPSCo
Cecile Walden	Sam Sharpe Teachers College
Charles McKenzie	N.E.P.A Mo-Bay
Earl Jackson	JPSCo Montego Bay
Ferris Stewart	JPSCo Bogue
Leon Watson	JPSCo Bogue
Steve Windross	JPSCo Bogue
Desmond Flowers	Westech Ltd
Dirk Scholl	ACS/NPC Free Zone (Data Entry)
Mark Kerr Jarrett	Montego Bay Chamber of Commerce
Andrew Hunter	JPSCo Bogue
Margaret Jones Williams	Environmental Solutions Ltd
Sharonmae Shirley	Environmental Solutions Ltd
Robert Moo Young	Chen's Rent-A-Car Ltd; Bogue Ind. Estate
Glaister Dehaney	Cams Garage Ltd; Bogue Ind. Estate
Marcel A. Anderson	JPSCo
Mearle Barrett, Phd.	NEPA
Joseph McCarthy	National Environment & Planning Agency
Cade Bourgue	Parker & Associates
Owen Lawrence	JPSCo
Nigel Grant	JPSCo
Dave Stamp	JPSCo
Fabian Lyew	JPSCo
Dean Eccleston	JPSCo
Kathi Cooke	JPSCo
Veneice Hamil	Sam Sharpe Teachers College
M. Lawrence	JPSCo
Randy Maxwell	N.W.C.
Daron Burgher	JPSCo
Eglan Richards	JPSCo
Gerald Hall	Hall's Garage
Michelle Dunn	JPSCo Environmental Affairs



Expansion Needs



JPS Grid

•Total Capacity	688 MW
•Peak Demand 2001	568 MW
•Growth Rate	5%
•Future Demand (yr 2004)	644 MW

3



Site Selection



Engineering Considerations

- ◆ Water Availability
- ◆ Geotechnical
- ◆ Transmission Line Access
- ◆ Environmental
- ◆ Economic
- ◆ Access to competent skills



4



Plant Selection



Combined Cycle

- ◆ Efficiency
- ◆ Environmental performance
- ◆ Development cost
- ◆ Timing

5

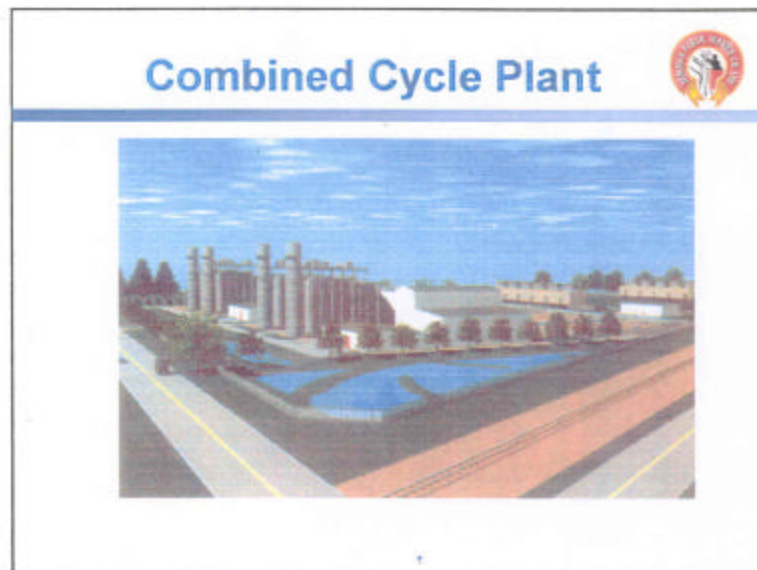


Project Implementation



- Gas turbine 2x40 MW Year 1
- Combined Cycle 40 MW Year 2
- Expansion of site by 16 acres
- Budgeted Cost US\$100M

4



Important Features



- Reuse sewage water - Environmental Plus
- Second largest plant on Island. Expanding generation in the west
- Focus on improving the performance of the entire site.

Environmental Protection



Permits



- Environmental
- NWC - sewage system
- Parish council
- Consultation with stake holders



Implementation Strategy



- General Electric - Supply of equipment and training
- EPC contractor - fixed price contract
- JPS - Interconnections & Support
- Mirant - Engineering & Management support
- Local support



JPS BOGUE NOISE EVALUATION

Presented By

HARON WISE

Senior Consultant

Environmental Solutions Limited



DEFINITIONS:

NOISE:

Sound that bears no information and whose intensity varies in time. There is no instrument that can distinguish noise from *wanted* sound – only human reaction can.

ENVIRONMENTAL SOLUTIONS
LIMITED

DEFINITIONS:

- **COMMUNITY NOISE:** - Also described as environmental or residential noise. Noise levels associated with non industrial noise. The main sources are a/c, home appliances, and neighborhood noises.

ENVIRONMENTAL SOLUTIONS
LIMITED

DEFINITIONS:

- **OCCUPATIONAL NOISE:** - The many and varied sources of noise from industrial applications – machinery and processes

ENVIRONMENTAL SOLUTIONS
LIMITED

STANDARDS:

NEPA: Industrial-75 dBA during daytime and 70 dBA during quiet hours at property boundary .

Residential – 55 and 50 dBA respectively

WHO: Industrial, commercial and traffic areas – 70 dBA ; 24 hrs

Outdoor living areas 50 –55 dBA

ENVIRONMENTAL SOLUTIONS
LIMITED

FINDINGS OF THE EVALUATION

METHODOLOGY

Noise level readings were taken at each site at hourly intervals. Measurements were taken using Quest Model 2700 sound level meter fitted with an octave band filter to measure the frequency spectrum of the noise. All meters were calibrated before and after each set of readings.

ENVIRONMENTAL SOLUTIONS
LIMITED

STATION LOCATION

STATION	LOCATION
1	NW corner of JPSCO Bogue Facility
2	West Perimeter Fence
3	GT3
4	Southern Perimeter Fence
5	South Eastern Perimeter Fence
6	Eastern Perimeter Fence
7	GT8 & GT9
8	GT6 & GT7
9	NE corner of JPSCO Bogue Facility
10	Bogue main Road by Palm Bay Guest House
11	Primary School at Ramble Hill
12	Bogue Hills
13	Intersection of Fairview and Granville main Road

ENVIRONMENTAL SOLUTIONS
LIMITED

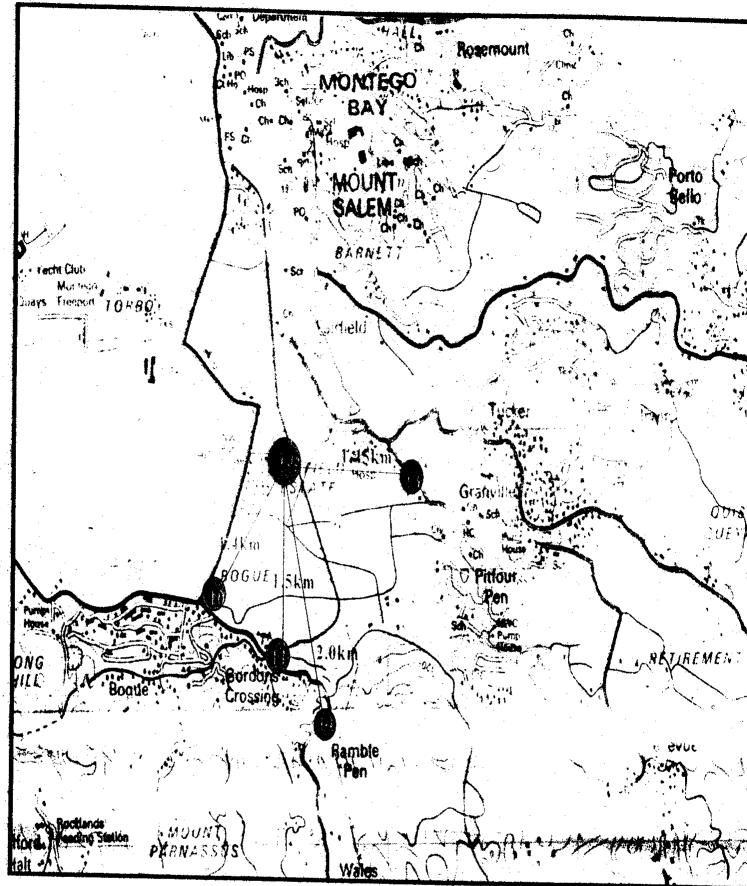
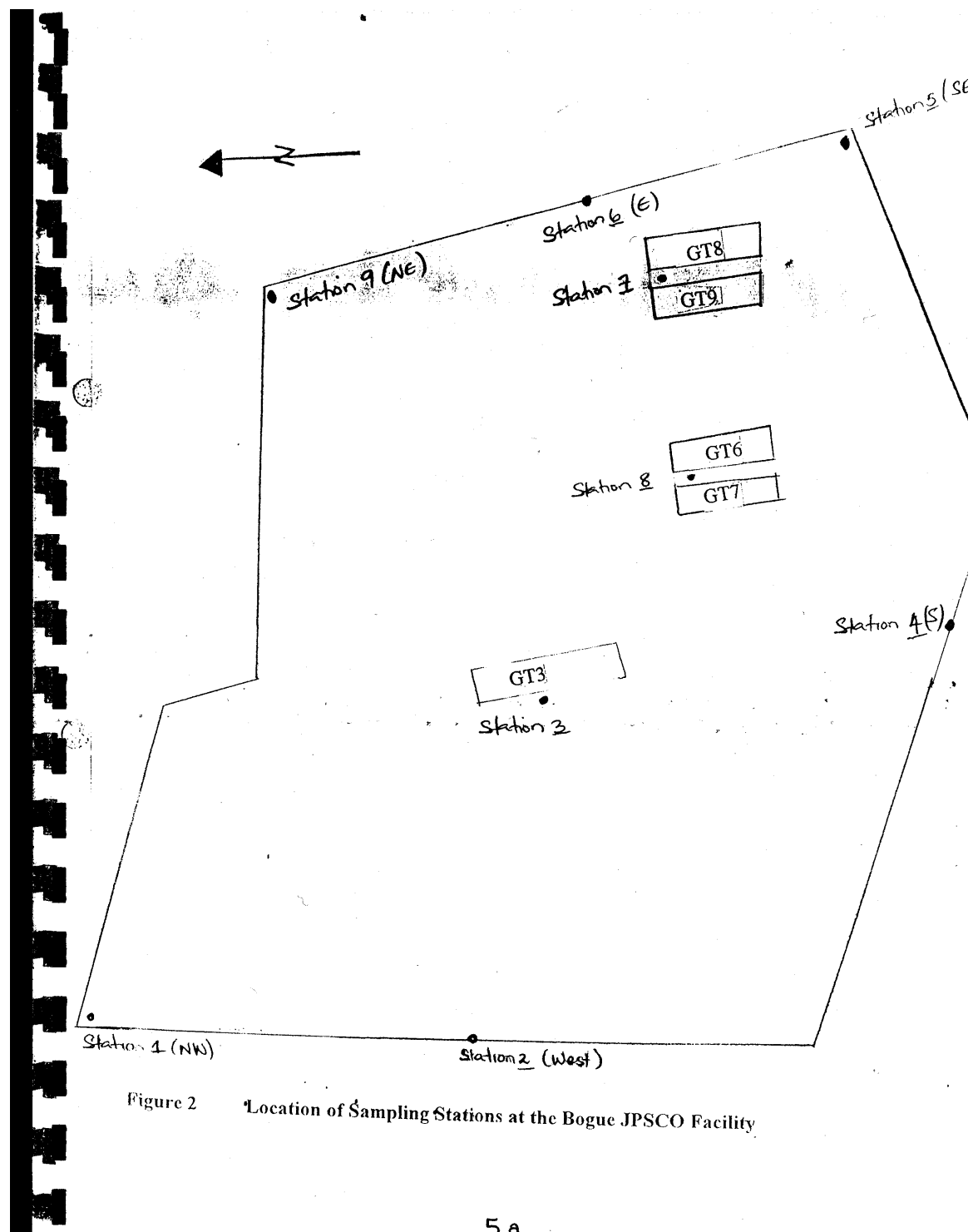


Figure 1.0: Location of Noise Sampling Stations in the Bogue Community



5 a

STATION	LOCATION	AVERAGE NOISE LEVEL dBA
1	NW corner	66.8
2	West Perimeter	77.3
3	GT3	95.7
4	S Perimeter	76.1
5	SE Perimeter	67.5
6	E Perimeter	81.0
7	GT8 & GT9	90.5
8	GT6 & GT7	96.3
9	NE corner	70.3
10	Palm Bay Guest Hse	65.9
11	Primary School at Ramble Hill	55.2
12	Bogue Hills	53.8
13	Fairview and Granville Rd	60.2

ENVIRONMENTAL SOLUTIONS
LIMITED

FINDINGS

The consultant did not have an opportunity to evaluate the true background noise levels when all the turbines were offline. Noise measurements in the communities neighboring the plant ranged between 43 and 56 dBA at 9:00 pm, Wednesday night when there was a power outage. Similarly at 2:00 and 3:00 am when the JPSCO plant was the only apparent noise source, the levels ranged between 49 and 55 dBA.

ENVIRONMENTAL SOLUTIONS
LIMITED

FINDINGS

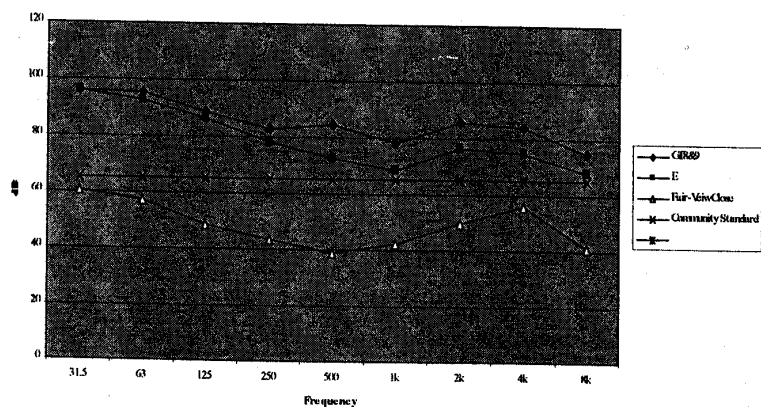
Noise spectrum analysis

The octave band frequency measurements taken at Stations 2, 3, 6, 7, 8, 11 and 13 indicate that the sound-pressure levels were highest in the very low frequency range (<125 Hertz). Noise levels were also high in the 2-4 kHz frequency band. For the noise spectrum analysis Station 3 (GT3) was compared with Station 2 (Western property boundary) and Station 13 (Granville- upwind of the plant). Similarly Stations 7 and 8 were compared with Station 6 (Eastern perimeter) and Station 11 (Bogue Primary - downwind of the plant).

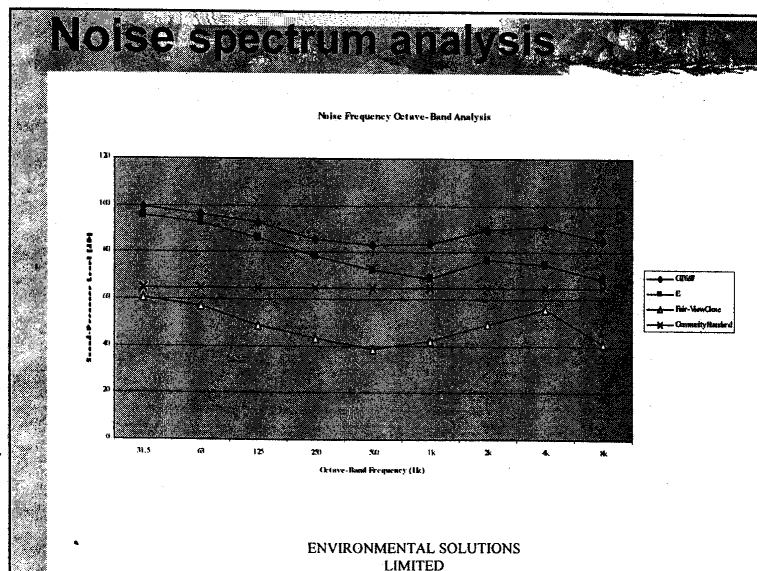
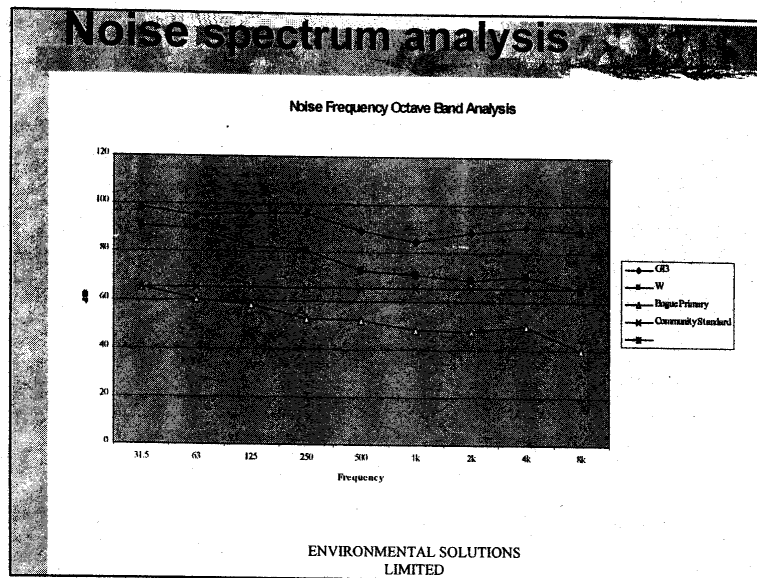
ENVIRONMENTAL SOLUTIONS
LIMITED

Noise spectrum analysis

Noise Frequency Octave Band Analysis



ENVIRONMENTAL SOLUTIONS
LIMITED



CONCLUSIONS

Criteria for noise levels which cause community noise nuisance vary greatly from country to country. A major consideration in determining noise nuisance is often based on percent of community complaints at various noise levels. This can be a very subjective measurement and depends on the nature of the community and whether or not residents are used to certain noise levels. A simple rule of thumb which is often used to determine the possibility of the existence of nuisance noise is, an increase of 10 dBA. or more above the pre-existing noise level.

ENVIRONMENTAL SOLUTIONS
LIMITED

CONCLUSIONS

Noise level at the eastern, western and southern perimeter are presently exceeding the NEPA standard.

Noise frequency octave band analysis suggest that relative sound absorptivity in the range 2 - 4 khz for the Pratt and Whitney turbines is not very good. Relative sound absorptivity was best in the mid level frequency band for all turbines.

ENVIRONMENTAL SOLUTIONS
LIMITED

Turbines GT6 and GT7 had the greatest measured noise output. The fact that both turbines are Pratt and Whitney turbines similar to GT8 and GT9 suggest that some malfunction must be causing the lower noise attenuation of these turbines.

At present, measurements at one (1) meter from all three turbines was greater than 85 dBA. JPSCO should investigate the cause of this to improve the performance of the silencers.

The noise level in the communities measured are presently within the community noise equivalence level (CNEL) of 65 dBA.

ENVIRONMENTAL SOLUTIONS
LIMITED

Noise levels within the JPSCo compound are influenced by noise emission from all turbines. The farther the station is from the turbine the lower the noise level.

The frequency spectrum of the noise emitted by the plant indicated a high proportion of low frequency noise.

Introduction of additional turbines should cause some residents to perceive an increase in noise. The measured noise however should still be within the CNEL if JPSCO ensures that the silencers attenuate noise to meet 85 dBA at one meter and implement noise buffers along the affected perimeter. Additionally if the peaking units are not operated beyond 10 pm.

ENVIRONMENTAL SOLUTIONS
LIMITED

RECOMMENDATIONS

1. We recommend that JPSCO investigate the reason for the increase in noise levels at GT6 and GT7 and ensure that the silencers are indeed performing to meet factory settings (85 dBA at 1m).
2. The doors of the main turbine, GT3 should all be closed to lower noise from that turbine. The stack should be replaced as soon as possible.

ENVIRONMENTAL SOLUTIONS
LIMITED

RECOMMENDATIONS

3. Plant trees or use other noise barriers around the perimeter of the property. These will act as a buffer, reducing the noise experienced outside the property. Particularly at the eastern, western and southern boundaries.
4. It was observed during the survey that many JPSCO staff were not wearing appropriate hearing protection. This should be corrected as a matter of urgency particularly those working directly at the turbines.

ENVIRONMENTAL SOLUTIONS
LIMITED

RECOMMENDATIONS

5. Monitor noise levels after installation of each additional turbine. Additionally, periodic monitoring of noise levels at the plant and in the communities should be performed to ensure the turbines are working as efficiently as possible.

ENVIRONMENTAL SOLUTIONS
LIMITED

JPSCO Bogue Facility

Air Dispersion Modeling 120 MW Combined Cycle Plant Addition

October 2001

Air Dispersion Modeling

- ♦ Calculate Predicted Emission Concentrations
- ♦ Performed for Regulated Pollutants (NO_x, SO₂, CO, PM₁₀)
- ♦ Performed for 1995-1998
- ♦ Site Specific Parameters

Sources

- ◆ “Old Sources”: Units 3,6,7,8,9
- ◆ “New Sources”:
 - 20 MW Unit – July 2001 Modeling
 - 120 MW Unit – 3 Components
 - Two 40 MW Simple Cycle Gas Turbines
 - One 40 MW Steam Turbine in Combined Cycle

Source Parameters

◆ Sources

- Location
- Height
- Temperature
- Flow Rate
- Emission Rate
- Capacity Factor

Site Specific Parameters

- ◆ Meteorological Data
 - Based upon Met. Stations (Kingston/Montego Bay)
 - Hourly Recorded Data
 - Wind Speed, Mixing Height, etc.

Dispersion Model Results

◆ Highest Predicted Concentrations

- SO₂ (1-hr, 24-hr, Annual)
- NO_x (Annual)
- CO (1-hr, 8-hr)
- PM₁₀ (24-hr, Annual)
- 1995-1998
- Regulatory Limits & July 2001 Modeling (20 MW)

Dispersion Model Results

◆ Results vs Regulatory Limits

- NO_x (Annual)– Highest Predicted Conc. for all years = 21 µg/m³
NEPA Ambient Air Standard = 100 µg/m³
- CO (1-hr)– Highest Predicted Conc. for all years = 1178 µg/m³
NEPA Ambient Air Standard = 40,000 µg/m³
- CO (8-hr)– Highest Predicted Conc. for all years = 235 µg/m³
NEPA Ambient Air Standard = 10,000 µg/m³
- PM10 (24-hr)– Highest Predicted Conc. for all years = 70 µg/m³
NEPA Ambient Air Standard = 150 µg/m³

APPENDIX A

Dispersion Model Results

◆ Results vs July 2001 Results

- NOx (Annual)– Highest Predicted Conc. for all years = 21 $\mu\text{g}/\text{m}^3$
July 2001 Results = 61 $\mu\text{g}/\text{m}^3$
- CO (1-hr)- Highest Predicted Conc. for all years = 1178 $\mu\text{g}/\text{m}^3$
July 2001 Results = 2699 $\mu\text{g}/\text{m}^3$
- CO (8-hr)- Highest Predicted Conc. for all years = 235 $\mu\text{g}/\text{m}^3$
July 2001 Results = 477 $\mu\text{g}/\text{m}^3$
- PM10 (24-hr)- Highest Predicted Conc. for all years = 70 $\mu\text{g}/\text{m}^3$
July 2001 Results = 85 $\mu\text{g}/\text{m}^3$

Conclusions

- ◆ Newer/Higher Output/More Efficient Units
- ◆ Change Capacity Factors
 - “Older” Units Low Capacity Most of Day
- ◆ Significantly Lower Emissions

FUEL SPECIFICATION BOGUE FACILITY

SPECIFICATION – NO.2 DIESEL OIL

PROPERTY/ COMPONENT	AERODERIVATIVES	ASTM TEST METHOD	GENERAL ELECTRIC
Ash content WT%	0.005 Max	D 482	0.005 Max
Carbon Residue %	0.25 Max	D 524	0.25 Max
Cloud Point, DEG F	To be reported	D 2500	-
Flash Point, DEG F	To be reported	D 93	To be reported
Sediment	24 mg/gal Max	D 2276	0.1% Max (D1796)
Sodium, PPM	0.6 Max	D 2288	1.0 Max (Sodium & Potassium)
Sulphur, %wt	0.5 Max	D 192	0.5 Max
Vanadium, PPM	0.2 Max	D 192	2.0 Max
Calcium, PPM	0.1 Max	D 2788	1.0 Max
Lead, PPM	0.1 Max	D 2787	-
Copper, PPM	0.02 Max	D 130	-
Viscosity CS @ 100F	3.5 Max	D 445	0.5 – 5.8 Max
Water, % Vol.	0.05 Max	D 1744	0.05 Max
Higher Calorific Value BTU/LB	19,000 Min	D 240	19,000 Min
Specific Gravity API	To be reported	D 1298	To be reported

TRADE EFFLUENT STANDARDS SEPTEMBER 1995

PARAMETER	STANDARD LIMIT
Ammonia/Ammonium	1.0 mg/L
Barium	5.0 mg/L
Beryllium	0.5 mg/L
Boron	5.0 mg/L
Calcium	No Standard
Chloride	300 mg/L
Colour	100 TCU
Fluoride	3.0 mg/L
Iron	3.0 mg/L
Magnesium	No Standard
Manganese	1.0 mg/L
Nitrate (as Nitrate+Nitrite)	10 mg/L
Oil and Grease	10 mg/L or <0.01kg/1000kg product
pH	6.5 - 8.5, pH units
Phenols	0.1 mg/l
Phosphate	5.0 mg/L
Sodium	100 mg/L

1

Sulphate	250 mg/L
Sulphide	0.2 mg/L
TDS	1000 mg/L
Temperature	2°C < or > Avg Ambient Temperature
TOC	100 mg/L
TSS	Max. Day < 150 mg/L Monthly Avg. 50 mg/L
<u>Heavy Metals</u>	
Arsenic	0.5 mg/L
Cadmium	0.1 mg/L
Chromium	1.0 mg/L
Copper	0.1 mg/L
Cyanide (Free HCN)	0.1 mg/L
(Total CN)	0.2 mg/L
Lead	0.1 mg/L
Mercury	0.02 mg/L
Nickel	1 mg/L
Selenium	0.5 mg/l
Silver	0.1 mg/L
Tin	No Standard
Zinc	1.5 mg/L
Total Heavy Metals	2.0 mg/L

APPENDIX C



THE

JAMAICA GAZETTE

SUPPLEMENT

PROCLAMATIONS, RULES AND REGULATIONS

3361

Vol. CXIX

WEDNESDAY, AUGUST 7, 1996

No. 66E

No. 89H

THE NATURAL RESOURCES CONSERVATION AUTHORITY ACT

THE NATURAL RESOURCES CONSERVATION (AMBIENT AIR QUALITY STANDARDS) REGULATIONS, 1996

In exercise of the power conferred upon the Minister by section 38 of the Natural Resources Conservation Authority Act, the following Regulations are hereby made:—

1. These Regulations may be cited as the Natural Resources Conservation (Ambient Air Quality Standards) Regulations, 1996.
2. The standards specified in the Schedule are hereby declared to be the Ambient Air Quality Standards.

336M

PROCLAMATIONS, RULES AND REGULATIONS

[Aug. 7, 1996]

SCHEDULE		
AMBIENT AIR QUALITY STANDARDS		
Air Pollutant	Averaging period	Standard
Particulates		
Total suspended particulates (a)	Maximum annual average	Limit of 60 $\mu\text{g}/\text{m}^3$
	Maximum twenty-four hour average	Limit of 150 $\mu\text{g}/\text{m}^3$
PM ₁₀ (b)	Maximum annual average	Limit of 50 $\mu\text{g}/\text{m}^3$
	Maximum twenty-four hour average	Limit of 150 $\mu\text{g}/\text{m}^3$
Lead	Per calendar quarter	Limit of 2 $\mu\text{g}/\text{m}^3$
Sulphur Dioxide	Maximum annual average	Limit of 80; 60 $\mu\text{g}/\text{m}^3$ (c)
	Maximum twenty-four hour average	Limit of 365; 280 $\mu\text{g}/\text{m}^3$ (c)
	Maximum one hour average	Limit of 700 $\mu\text{g}/\text{m}^3$
Photochemical Oxidants (Ozone)	Maximum one hour average	Limit of 235 $\mu\text{g}/\text{m}^3$ (0.12 ppm)
Carbon Monoxide	Maximum one hour average	Limit of 40 mg/m^3 (35 ppm)
	Maximum eight hour average	Limit of 10 mg/m^3
Nitrogen dioxide	Maximum annual average	Limit of 100 $\mu\text{g}/\text{m}^3$

- NOTE: (a) Total Suspended Particulates means all particles and aerosols that have an aerodynamic diameter of 100 micrometers or less and can be measured by the high volume sampling method.
- (b) PM₁₀ refers to particulates with an aerodynamic diameter of 10 micrometers or less as measured by a PM₁₀ sampler.
- (c) The secondary standards for Sulphur Dioxide (maximum annual average 60 $\mu\text{g}/\text{m}^3$ and maximum twenty-four hour average 280 $\mu\text{g}/\text{m}^3$) are designed to protect public health and welfare. They represent the long term goal for air quality and provide the basis for an Anti-degradation Policy for unpolluted parts of the country and for continuing development of pollution control technology.

Dated this 1st day of August, 1996.

EASTON DOUGLAS,
Minister of Environment and Housing.

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APPENDIX D

NATURAL RESOURCES CONSERVATION AUTHORITY

PETROLEUM STORAGE FACILITIES

DRAFT GUIDELINES FOR PROJECT PROPONENTS

1. INTRODUCTION

This document should be used in conjunction with the “Guideline for Project Proponents for the Permit and Licence System”. Under Section 9 of the Natural Resources Conservation Authority (NRCA) Act, 1991, and the Natural Resources Conservation (Permits and Licences) Regulations, 1996, industrial projects involving petroleum production, refinery, storage and production require a Permit.

For the purposes of this Regulation the NRCA has defined a petroleum product as follows:

Petroleum product – a single product or mixture of at least 70% hydrocarbons, refined from crude oil, with or without additives, that is used, or could be used, as a fuel, lubricant, or power transmitter. Without restricting the foregoing, such products include gasoline, diesel fuel, aviation fuel, kerosine, naphtha, lubricating oil, fuel oil, engine oil (including used oil), **propane and butane gases (LPG)**.

2. REQUIREMENTS

The following summarises the requirements of the NRCA for the installation and operation of Petroleum Storage Facilities:

- i) All petroleum storage tanks shall be equipped with some form of **secondary containment** to ensure that all leaks are effectively contained.
- ii) All Underground Storage Tanks (USTs) shall have a **leak detection system** to ensure that no leak goes undetected.
- iii) All USTs shall be equipped with a **line leak detection system** to ensure that no line leak goes undetected.
- iv) All storage tanks shall have properly functioning **overfill protection devices**.

- v) **Spill protection** shall be in place at all facilities to ensure that there is no spillage to the environment during the transfer of product.
- vi) All USTs shall have **corrosion protection**.
- vii) All Aboveground Storage Tanks (ASTs) shall have a bund constructed to contain at least 120 % of the maximum volume of product being stored in the tank.
- viii) Structural integrity (**pressure**) tests shall be conducted on all storage tanks and pipelines as follows:
 - a) at installation,
 - b) six (6) months after commencement of operation, and
 - c) annually thereafter.

A **Precision Test** shall be conducted on all tanks and pipelines once every five (5) years.

- ix) Monitoring activities involving **leak detection** and **structural integrity tests** shall be undertaken and reports submitted to the NRCA, with copies to the Water Resources Authority (WRA) and the Environmental Health Unit of the Ministry of Health as follows:
 - a) Half yearly during the first year of operation, and
- b) Annually after the first year of operation
- x) All petroleum storage installations shall have appropriate fire defence systems which have been inspected and approved by the Fire Department, before any product is received in any tank.
- xi. A proposal for the removal and disposal of all tanks shall be approved by the NRCA prior to any tank being taken out of service.
- xii. A Closure Plan shall be prepared for all petroleum storage facilities to include, but not limited to, site clean up and post-closure monitoring.

3. GENERAL RECOMMENDATION

Corrective measures shall be undertaken immediately once a leak or spill is detected and the NRCA informed within twenty-four (24) hours of the incident.

PCWM BRANCH
August 30, 2000

APPENDIX E

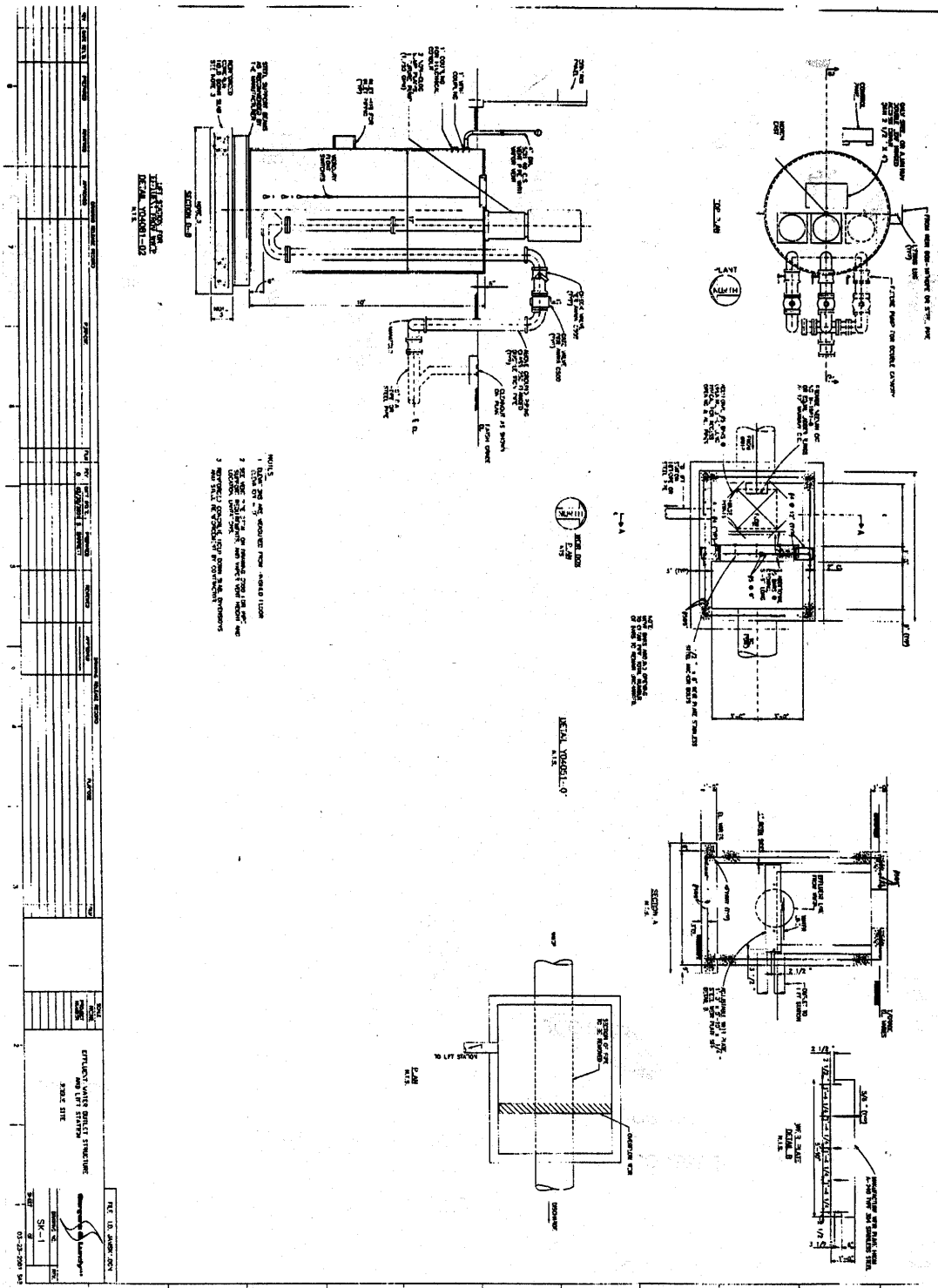




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Ambient Air Dispersion Modeling Report

7.1 Executive Summary

Parker & Associates, Inc. was retained by the Jamaica Public Service Company (JPSCo) to conduct ambient air dispersion modeling to comply with the requirements of the Jamaican National Environment & Planning Agency (NEPA) Ambient Air Quality Regulations for the proposed installation of a new 120 Megawatt Turbine Electric Generation Unit at the Bogue Facility, located in Montego Bay, Jamaica. The unit will be composed of three separate components, two 40 MW simple cycle gas turbines and a 40 MW steam turbine in combined cycle. The two gas turbines will be operational first and the steam turbine will be operational in the future. Air dispersion modeling was conducted for Nitrogen Oxides (NO_x), Sulfur Dioxide (SO₂), Carbon Monoxide (CO), and Particulate Matter with nominal aerodynamic diameter less than or equal to 10 microns (PM₁₀) for both the simple and combined cycles.

The impact to ambient air quality predicted as a result of the installation of new 120 MW plant was assessed utilizing detailed modeling by the USEPA AERMOD software. The NEPA Ambient Air Quality Guideline Document (September 1999) was consulted to establish model parameters, report format, and impact significance levels. The facility emissions were modeled for pollutants that would reasonably be emitted and have an ambient air quality standard. The averaging periods are those corresponding to an NEPA ambient air quality standard.

With the addition of more efficient units, 20 MW in July 2001 and now the 120 MW, the capacities of the existing, older units will further be reduced. As a result, there will be a reduction in the total emissions of the facility. The modeling of the entire facility



emissions with the new capacity factors, including the new 120 MW plant, has been compared with the modeling performed in July 2001 for the existing units.

Modeling was performed for each pollutant and averaging period for the addition of the 120 MW (simple and combined cycles), including the new capacity factors, utilizing 1995-1998 meteorological data. These results were compared to the existing emissions determined by the modeling in July 2001, with the 20 MW addition and the existing capacity factors. The maximum concentrations for each pollutant and averaging period were evaluated for a significant level increase from July 2001 to September 2001. The comparison is summarized below.

Significant Increase Level Determination					
Pollutant	Averaging Period	July 2001 Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	September 2001 Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	NEPA Guideline Significant Increase Level ($\mu\text{g}/\text{m}^3$)	Significant Increase Level Exceeded
NO _x	Annual	61	21	20	No
CO	1-Hour	2,699	1,178	Not Applicable	No
CO	8-Hour	477	235	Not Applicable	No
SO ₂	1-Hour	1,663	750	Not Applicable	No
SO ₂	24-Hour	97	132	80	No
SO ₂	Annual	30	31	20	No
PM ₁₀	24-Hour	85	70	Not Applicable	No
PM ₁₀	Annual	21	17	20	No



As demonstrated by the table above, there were no Ambient Air quality increases classified as significant increases as defined in the NEPA Air Quality Guidance Document. Also note that the predicted increases are the maximum increase levels for the maximum individual receptor. The following table summarizes the maximum predicted ambient air concentration impact and the NEPA Ambient Air Standard for each compound.

Pollutant	Averaging Period	Simple Cycle Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	NEPA Ambient Air Standard ($\mu\text{g}/\text{m}^3$)	NEPA Ambient Air Standard Exceeded (Maximum Predicted)
NO _x	Annual	6	21	100	No
CO	1-Hour	1,178	1,060	40,000	No
CO	8-Hour	235	217	10,000	No
SO ₂	1-Hour (1995)	556	591	700	No
SO ₂	1-Hour (1996)	609	655	700	No
SO ₂	1-Hour (1997)	684	656	700	No
SO ₂	1-Hour (1998)	750	680	700	Yes
SO ₂	24-Hour	65	132	365 primary 280 secondary	No No
SO ₂	Annual	9	31	80 primary 60 secondary	No No
PM ₁₀ (Includes Montego Bay urban baseline)	24-Hour	70	70	150	No
PM ₁₀ (Includes Montego Bay urban baseline)	Annual	16	17	50	No



As outlined in the table above, only the simple cycle 1998 1-Hour SO₂ ambient air standard was predicted to be exceeded. However, this standard was predicted to be exceeded by the current existing equipment without addition of the new unit and is significantly lower than the existing equipment. For the four years modeled, the standard was exceeded for only one off site receptor during one hour. The hour of exceedance produced a model error due to out of range friction velocity. For these reasons, the predicted exceedance is not expected to be reflective of actual site conditions and should not be used for determining compliance with the ambient air quality standard.

The simple and combined cycle modes of the 120 MW plant will have significantly lower emissions per unit of rated capacity than the current existing equipment and is more fuel-efficient. Additionally, due to the reduction of capacity factors for the older units, the average emissions will be significantly lower for all pollutants.

Based on the modeling results presented, JPSCO believes that the installation of the two components will provide significant economic and production benefit, with a reduction of all pollutants emitted to the environment.



7.2 BACKGROUND

The Jamaica Public Service Company (JPSCO) is planning to install a 120 Megawatt Turbine Electric Generation Unit in Bogue, Jamaica. This modeling report has been prepared to satisfy the requirements of the Jamaica National Environmental Planning Agency (NEPA) ambient air monitoring and assessment regulations.

JPSCO has requested that Parker & Associates conduct air dispersion modeling to evaluate the potential impact to existing air quality in the area surrounding the Bogue plant. This modeling report will assist NEPA in their evaluation of the permit application submitted for construction of these units.

7.2.1 Modeling Methodology

Parker & Associates conducted the modeling using the USEPA AERMOD modeling software. The regulatory default options were employed for the model.

The unit will be composed of three separate components, two 40 MW simple cycle gas turbines and a 40 MW steam turbine in combined cycle. The two gas turbines will be online first and the steam turbine will be added sometime in the future. The model was run for both simple and combined cycles.

The capacity factors for each unit were determined by JPSCO and based upon predicted load demand. The capacity factors for the older, less efficient units were increased beyond the demand to represent a worst-case scenario during peak hours of demand. The capacity factors are attached as Appendix A. Modeling of the addition of the 120 MW and the new capacity factors was compared to the modeling performed in July 2001 for the addition of the 20 MW unit using the old capacity factors.



Emissions for the existing units were estimated using manufacturer's estimates and performance specifications. Emissions for the older units (excluding the new 20 MW

unit) will be evaluated at a later date for conformance with the stack emissions standards for existing sources as outlined in the stack emission standards regulations. Supporting data and emissions calculations, including a table of stack parameters, are included as Appendix A.

No major industrial sources emitting similar pollutants are present in the immediate vicinity of the Bogue plant. Therefore, the models include only emissions from the existing units and the components of the new 120 MW combined cycle to be installed at the Bogue plant. Figure 1 is a site location map showing the plant boundaries. Since the Bogue plant is within 3 kilometers of the Montego Bay Metropolitan Area, urban dispersion was selected for the model. As outlined in the ambient air monitoring and assessment regulations, background concentrations have been added for particulate matter associated with the Montego Bay metropolitan area. This is discussed in more detail in Section 4.4.

The modeling was performed using preprocessed hourly meteorological data based on surface air measurements made at the weather station in Montego Bay, Jamaica and upper air measurements made in Kingston, Jamaica. The number of missing hours for the year 1999 exceeds the regulatory limit of ten percent of the total. This limit is set by Section 5.3.2 of "On-site Meteorological Program Guidance for Regulatory Modeling Applications" (EPA-450/4-87-013). NEPA acknowledges this exceedance and has approved modeling using meteorological data for the years 1995-1998, which are all below the ten percent limit.



The ground level concentrations were calculated using three receptor grids. These receptor grids were chosen to identify the maximum off-property ground-level concentrations. The first grid, a fence line grid, consisted of discrete receptors placed at 100-meter intervals around the Bogue plant site boundary. The second was a fine grid with receptors placed at 150-meter intervals and covered all areas at least 1-kilometer beyond the Bogue plant boundary. The third grid was a coarse grid with receptors placed at 1000-meter intervals to provide a large enough receptor grid to provide at least one fully bounded average concentration plume for each compound modeled. A fourth receptor grid with 100-meter spacing was utilized for the SO₂ modeling to fully delineate the estimated impact area.

Building Downwash Effects and GEP Stack Height

The effects of buildings on site were assessed for potential influence on the proposed emission source. The major structure dimensions are included as Appendix B. The nearest building to the proposed unit is the Generation Building with a height of 8.1 meters and width of 15 meters. The Good Engineering Practice (GEP) stack height for the unit was determined according to the formula $H_g = \text{Height of nearby building plus } 1\frac{1}{2} \text{ times the lesser of the height or projected width of the building}$. The Generation Building is approximately 8.1 meters in height and a width of 15 meters. Therefore the GEP stack height would be 20.25 meters. The proposed stack height for the new unit is approximately 25 meters, well above the GEP stack height.



Terrain Effects

The effects of terrain were also considered. A 1:12,500 topographic map was consulted to obtain terrain elevations. Because the terrain east and south of the facility was at a higher elevation than the proposed stack height, complex terrain algorithms with enabled terrain elevations were chosen for the model results. Terrain within the modeled receptor grid ranged from sea level elevation to the west of the facility, to greater than 45.7 meters (1500 feet) to the southwest of the facility.

7.2.2 Data Presentation

The model runs were conducted with capacity factors determined by JPSCO and based upon load demand. The capacity factors for the older, less efficient units were increased beyond the demand to represent a worst-case scenario during peak hours of demand. The model runs were completed for 1995-1998. The results of all model runs are summarized in Section 4.

Electronic copies of the model run files are included with this report on compact disk. Appendix C contains an index that references the model files to each modeled scenario.

7.2.3 RESULTS

7.2.3.1 NO_x AMBIENT AIR MODEL

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit.



The maximum annual average NO_x concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted Annual Average Existing (µg/m ³)	Simple Cycle Maximum Predicted Annual Average (µg/m ³)	Combined Cycle Maximum Predicted Annual Average (µg/m ³)
NO _x	61	6	21

As indicated above, the maximum predicted value for the existing sources is significantly higher than that of the proposed 120 MW unit. This decrease is shown to comply with Table 5-4 of the NEPA Ambient Air Quality Guideline Document, which defines a significant increase in annual ambient air concentrations of NO_x to be 20 µg/m³.

The maximum predicted annual average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

NO _x	Simple Cycle Maximum Predicted Annual Average (µg/m ³)	Combined Cycle Maximum Predicted Annual Average (µg/m ³)	Ambient Standard Annual Average (µg/m ³)
1995	6	21	100
1996	4	14	100
1997	5	16	100
1998	4	14	100



As indicated above, the maximum predicted value for both modes in all four years was $21 \mu\text{g}/\text{m}^3$ (21% of the annual average ambient air standard of $100 \mu\text{g}/\text{m}^3$). This value was obtained from the 1995 meteorological data. Figure 2 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.2 CO AMBIENT AIR MODEL

7.2.3.2.1 1-Hour CO Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 1-Hour average CO concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 1-Hour Average Existing ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted 1-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 1-Hour Average ($\mu\text{g}/\text{m}^3$)
CO	2,699	1,178	1,060

As indicated above, the maximum predicted 1-Hour value for the existing sources was $2,699 \mu\text{g}/\text{m}^3$. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.



The maximum predicted annual average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

CO	Simple Cycle Maximum Predicted 1-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 1-Hour Average ($\mu\text{g}/\text{m}^3$)	Ambient Air Standard 1-Hour Average ($\mu\text{g}/\text{m}^3$)
1995	808	740	40,000
1996	920	869	40,000
1997	781	702	40,000
1998	1,178	1,060	40,000

As indicated above, the maximum predicted 1-Hour value was $1,178 \mu\text{g}/\text{m}^3$ (3% of the ambient air standard of $40,000 \mu\text{g}/\text{m}^3$). This value was obtained from the 1998 meteorological data. Figure 3 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.2.2 8-Hour CO Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 8-Hour average CO concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 8-Hour Average Existing ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted 8-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 8-Hour Average ($\mu\text{g}/\text{m}^3$)
CO	477	235	217



As indicated above, the maximum predicted 8-Hour value for the existing sources was $477 \mu\text{g}/\text{m}^3$. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.

The maximum predicted 8-Hour average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

CO	Simple Cycle Maximum Predicted 8-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 8-Hour Average ($\mu\text{g}/\text{m}^3$)	Ambient Air Standard 8-Hour Average ($\mu\text{g}/\text{m}^3$)
1995	135	123	10,000
1996	218	196	10,000
1997	235	217	10,000
1998	231	188	10,000

As indicated above, the maximum predicted 8-Hour value was $235 \mu\text{g}/\text{m}^3$ (2% of the ambient air standard of $10,000 \mu\text{g}/\text{m}^3$). This value was obtained from 1997 meteorological data. Figure 4 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.



7.2.3.3 SO₂ AMBIENT AIR MODEL

7.2.3.3.1 1-Hour SO₂ Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 1-Hour average SO₂ concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 1-Hour Average Existing (µg/m ³)	Simple Cycle Maximum Predicted 1-Hour Average (µg/m ³)	Combined Cycle Maximum Predicted 1-Hour Average (µg/m ³)
SO ₂	1,663	750	680

As indicated above, the maximum predicted 1-Hour value for the existing sources was 1,663 µg/m³. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.



The maximum predicted 1-Hour average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

SO ₂	Simple Cycle Maximum Predicted 1-Hour Average (µg/m ³)	Combined Cycle Maximum Predicted 1-Hour Average (µg/m ³)	Ambient Air Standard 1-Hour Average (µg/m ³)
1995	556	591	700
1996	609	655	700
1997	684	657	700
1998	750	680	700

As indicated above, the maximum predicted 1-Hour value was exceeded for once for the 1998 meteorological data. The exceedance was recorded for 3/13/98 at 21:00. The hour of exceedance produced a meteorological data error message due to out of range friction velocity. As an average, the SO₂ 1-Hour results compared to the results generated from the July 2001 modeling were significantly lower due to the changes in capacity factors of the older, less efficient units. Figure 5 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.



7.2.3.3.2 24-Hour SO₂ Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 24-Hour average SO₂ concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 24-Hour Average Existing (µg/m ³)	Simple Cycle Maximum Predicted 24-Hour Average (µg/m ³)	Combined Cycle Maximum Predicted 24-Hour Average (µg/m ³)
SO ₂	97	65	132

As indicated above, the maximum predicted value for the new combined cycle is 132 µg/m³. The maximum predicted value for the existing sources was 97 µg/m³, an increase of 35 µg/m³. Therefore, the increase is 44% of the 80 µg/m³ NEPA Guideline Significant Increase Level.

The maximum predicted 24-Hour average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

SO ₂	Simple Cycle Maximum Predicted 24-Hour Average (µg/m ³)	Combined Cycle Maximum Predicted 24-Hour Average (µg/m ³)	Ambient Air Standard 24-Hour Average (µg/m ³)
1995	34	65	280
1996	54	132	280
1997	65	87	280
1998	48	101	280



As indicated above, the maximum predicted 24-Hour value was $132 \mu\text{g}/\text{m}^3$ (47% of the ambient air standard of $280 \mu\text{g}/\text{m}^3$). This value was obtained from 1996 meteorological data. Figure 6 shows the predicted ambient air average concentration plume for this

model run. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.3.3 Annual SO_2 Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum annual average SO_2 concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted Annual Average Existing ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted Annual Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Annual Average ($\mu\text{g}/\text{m}^3$)
SO_2	30	9	31

As indicated above, the maximum predicted value for the new combined cycle is $31 \mu\text{g}/\text{m}^3$. The maximum predicted value for the existing sources was $30 \mu\text{g}/\text{m}^3$, an increase of $1 \mu\text{g}/\text{m}^3$. Therefore, the increase is 5% of the $20 \mu\text{g}/\text{m}^3$ NEPA Guideline Significant Increase Level.



The maximum predicted annual average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

SO ₂	Simple Cycle Maximum Predicted Annual Average (µg/m ³)	Combined Cycle Maximum Predicted Annual Average (µg/m ³)	Ambient Air Standard Annual Average (µg/m ³)
1995	9	31	60
1996	6	21	60
1997	7	24	60
1998	6	21	60

As indicated above, the maximum predicted annual value was 31 µg/m³ (52% of the ambient air standard of 60 µg/m³). This value was obtained from 1995 meteorological data. Figure 7 shows the predicted ambient air average concentration plume for this model run. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.4 PM₁₀ Ambient Air Model

To reduce the number of model runs, it has been conservatively assumed that all particulate matter emissions are PM₁₀ emissions. USEPA AP-42 emission factors for diesel-fired equipment indicate that an estimated 85% of the total particulate emissions are classified as PM₁₀ emissions.



7.2.3.4.1 24-Hour PM₁₀ Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum 24-Hour average PM₁₀ concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted 24-Hour Average Existing with Background ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted 24-Hour Average with Background ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted with Background 24-Hour Average ($\mu\text{g}/\text{m}^3$)
PM ₁₀	85	70	69

As indicated above, the maximum predicted Annual value for the existing sources was 85 $\mu\text{g}/\text{m}^3$. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.

The maximum predicted 24-Hour average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

PM ₁₀	Simple Cycle Maximum Predicted 24-Hour Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted 24-Hour Average ($\mu\text{g}/\text{m}^3$)	Ambient Air Standard 24-Hour Average ($\mu\text{g}/\text{m}^3$)
1995	67	66	150
1996	70	69	150
1997	70	69	150
1998	69	67	150



As indicated above, the maximum predicted value plus background concentration for the Montego Bay urban area was $70 \mu\text{g}/\text{m}^3$ (47% of the ambient air standard of $150 \mu\text{g}/\text{m}^3$). This value was obtained from 1996 and 1997 meteorological data. Figures 8

and 9 show the predicted ambient air average concentration (without background of $60 \mu\text{g}/\text{m}^3$) plume for these model runs. The highest predicted ambient air concentration point value is also designated on this figure.

7.2.3.4.2 Annual Average PM_{10} Ambient Air Model

The model runs for the new 120 MW unit in simple and combined cycle modes were compared with the July 2001 modeling for the addition of a 20 MW unit. The maximum annual average PM_{10} concentrations of the four years are shown in the table below.

Pollutant	Maximum Predicted Annual Average Existing with Background ($\mu\text{g}/\text{m}^3$)	Simple Cycle Maximum Predicted Annual Average with Background ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Annual Average with Background ($\mu\text{g}/\text{m}^3$)
PM_{10}	21	16	17

As indicated above, the maximum predicted Annual value for the existing sources was $17 \mu\text{g}/\text{m}^3$. The new unit and capacity factors result in a decrease for the maximum predicted concentrations.



The maximum predicted annual average for both simple and combined cycle modes were compared to the ambient standard for all four years. The results are summarized in the table below.

PM ₁₀	Simple Cycle Maximum Predicted Annual Average ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Annual Average ($\mu\text{g}/\text{m}^3$)	Ambient Air Standard Annual Average ($\mu\text{g}/\text{m}^3$)
1995	16	17	50
1996	16	16	50
1997	16	16	50
1998	16	16	50

As indicated above, the maximum predicted value plus background concentration for the Montego Bay urban area was $17 \mu\text{g}/\text{m}^3$ (34% of the ambient air standard of $50 \mu\text{g}/\text{m}^3$). This value was obtained from 1995 meteorological data. Figure 10 shows the predicted ambient air average concentration plume for the model run. The highest predicted ambient air concentration point value is also designated on this figure.



7.3 Conclusions

The impact to ambient air quality predicted as a result of the installation of the new 120 MW plant was assessed utilizing detailed modeling by the USEPA AERMOD software. The maximum predicted increase levels from Section 4 of this report are summarized below.

Significant Increase Level Determination					
Pollutant	Averaging Period	July 2001 Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	September 2001 Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	NEPA Guideline Significant Increase Level ($\mu\text{g}/\text{m}^3$)	Significant Increase Level Exceeded
NO _x	Annual	61	21	20	No
CO	1-Hour	2,699	1,178	Not Applicable	No
CO	8-Hour	477	235	Not Applicable	No
SO ₂	1-Hour	1,663	750	Not Applicable	No
SO ₂	24-Hour	97	132	80	No
SO ₂	Annual	30	31	20	No
PM ₁₀	24-Hour	85	70	Not Applicable	No
PM ₁₀	Annual	21	17	20	No

As demonstrated by the table above, there are no Ambient Air quality increases classified as significant increases as defined in the NEPA Air Quality Guidance Document. Also note that these predicted increases are the maximum increase levels

for the maximum individual receptor. The average increase across all receptors will be much lower than those projected in the table above.

The following table summarizes the maximum predicted ambient air concentration impact for each compound.

Pollutant	Averaging Period	Simple Cycle Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	Combined Cycle Maximum Predicted Ambient Concentration ($\mu\text{g}/\text{m}^3$)	NEPA Ambient Air Standard ($\mu\text{g}/\text{m}^3$)	NEPA Ambient Air Standard Exceeded (Maximum Predicted)
NO _x	Annual	6	21	100	No
CO	1-Hour	1,178	1,060	40,000	No
CO	8-Hour	235	217	10,000	No
SO ₂	1-Hour (1995)	556	591	700	No
SO ₂	1-Hour (1996)	609	655	700	No
SO ₂	1-Hour (1997)	684	656	700	No
SO ₂	1-Hour (1998)	750	680	700	Yes
SO ₂	24-Hour	65	132	365 primary 280 secondary	No No
SO ₂	Annual	9	31	80 primary 60 secondary	No No
PM ₁₀ (Includes Montego Bay urban baseline)	24-Hour	70	70	150	No
PM ₁₀ (Includes MoBayurban baseline)	Annual	16	17	50	No

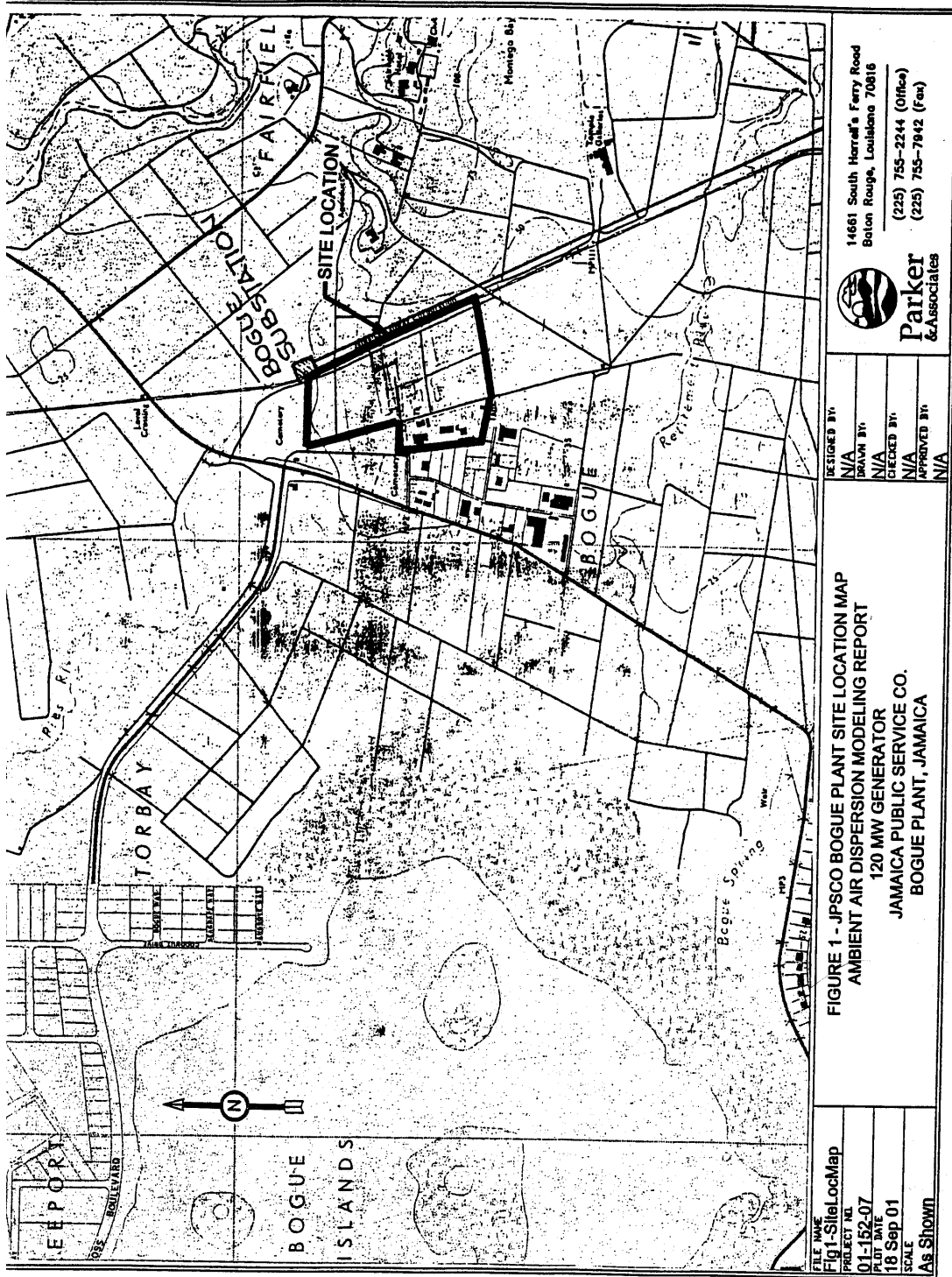
As outlined in the table above, only the 1998 1-Hour SO₂ ambient air standard was predicted to be exceeded. However, this standard was predicted to be exceeded by the current existing equipment without addition of the new unit and is significantly lower than the existing equipment. For the four years modeled, the standard was exceeded for only one off site receptor during one hour. The hour of exceedance produced a model error due out of range friction velocity. For these reasons, the predicted exceedance is not expected to be reflective of actual site conditions and should not be used for determining compliance with the ambient air quality standard.

The simple and combined cycle modes of the 120 MW plant will have significantly lower emissions per unit of rated capacity than the current existing equipment and is more fuel-efficient. Additionally, due to the reduction of capacity factors for the older units, the average emissions will be significantly lower for all pollutants.

Based on the modeling results presented, JPSCO believes that the installation of the two components will provide significant economic and production benefit, with a reduction of all pollutants emitted to the environment.

REFERENCES

- Natural Resources Conservation Authority. Guidelines For Conducting Environmental Impact Assessments – 1998
- Natural Resources Conservation Authority. Permit and Licence System – Guidelines for Project Proponents December 1996
- Natural Resources Conservation Authority. Permits and Licences Regulations, 1996
- Statistical Institute of Jamaica. Population Census 1991 Volume XI Part 8, Parish of St. James.
- Statistical Institute of Jamaica. Population Census 1991 Volume 1 Part 8, Parish of St. James.
- Natural Resources Conservation Authority. Ambient Air Quality Guideline Document – September 1999
- Natural Resources Conservation Authority. Draft Stack emission Monitoring Regulations 1999
- Natural Resources Conservation Authority. Air Pollutant Discharge Licence Regulations
- Natural Resources Conservation Authority. Recommendations for National Noise Standards for Jamaica
- Natural Resources Conservation Authority Act 1991.
- Natural Resources Conservation Authority Act (Ambient Air Quality Standards Regulations, 1996)
- National Building Code of Jamaica
- Office of Utilities Regulation Act, 1995



APPENDIX A

Simple Cycle Mode

Source No.	Description	NOx		SO ₂		CO	
		kg/hr	g/sec	kg/hr	g/sec	kg/hr	g/sec
GT 3	Gas Turbine No. 3	173	21.60	687.410	141	17.77	580.256
GT 6	Gas Turbine No. 6	200	25.20	794.683	131	16.51	520.524
GT 7	Gas Turbine No. 7	200	25.20	794.683	131	16.51	520.524
GT 8	Gas Turbine No. 8	200	25.20	794.683	131	16.51	520.524
GT 9	Gas Turbine No. 9	320	40.32	1271.509	187	21.04	653.569
GT11	New 20 MW Turbine	41	5.21	164.223	97	12.20	384.810
GT12	New 40 MW Gas Turbine	150	19.07	682.549	236	29.78	1033.366
GT13	New 40 MW Gas Turbine	158	19.67	682.549	236	29.78	1033.366

Source No.	Description	Particulates		UTM Coordinates		Stack Height (meters)	Stack Diameter (meters)	Stack Gas Exit Velocity (m/s)	Stack Gas Exit Temp. (°C)
		kg/hr	g/sec	North	East				
GT 3	Gas Turbine No. 3	5	0.630	19.657	553254	231100	10.7	4.6	15.4
GT 6	Gas Turbine No. 6	10	1.260	38.735	553080	231232	8	3.1	27
GT 7	Gas Turbine No. 7	10	1.260	38.735	553104	231284	8	3.1	27
GT 8	Gas Turbine No. 8	10	1.260	38.735	553128	231413	8	3.1	27
GT 9	Gas Turbine No. 9	10	1.260	38.735	553137	231456	7.6	4.1	24.6
GT11	New 20 MW Turbine	19	2.417	78.211	553399	231565	9	4.5	18.1
GT12	New 40 MW Gas Turbine	11	1.389	48.188	553598	231181	25.000	3.7	11.8
GT13	New 40 MW Gas Turbine	11	1.389	48.188	553743	231283	25.000	3.7	11.8

Capacity Factors

Source No.		1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00
GT-3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-6	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-7	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-9	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-11	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%	47%
GT-12	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-13	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Source No.		13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
GT-3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-6	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-7	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-9	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT-11	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
GT-12	78%	85%	82%	81%	73%	55%	55%	80%	91%	84%	71%	70%	30%
GT-13	78%	85%	82%	81%	73%	55%	55%	80%	91%	84%	71%	70%	30%

Emission Parameters Summary

Appendix A

Combined Cycle Mode

Source No.	Description	NO _x		SO ₂		CO	
		lb/hr	g/sec	lb/hr	g/sec	lb/hr	g/sec
GT 3	Gas Turbine No. 3	173	21.798	141	17.766	560.259	702.687
GT 6	Gas Turbine No. 6	200	25.200	131	16.506	520.524	647.794
GT 7	Gas Turbine No. 7	200	25.200	131	16.506	520.524	647.794
GT 8	Gas Turbine No. 8	200	25.200	131	16.506	520.524	647.794
GT 9	Gas Turbine No. 9	320	40.319	187	23.642	833.569	1041.937
GT11	New 20 MW Turbine	41	5.207	184.223	23.26	1033.366	1291.708
HRSG 1	New Combined Cycle Steam Generator	156	19.670	692.549	87.58	3048	3810.8
HRSG 2	New Combined Cycle Steam Generator	156	19.670	692.549	87.58	3048	3810.8

Source No.	Description	Particulates		UTM Coordinates		Stack Height (meters)	Stack Diameter (meters)	Stack Gas Exit Velocity (m/s)	Stack Gas Exit Temp. (°C)
		lb/hr	g/sec	North	East				
GT 3	Gas Turbine No. 3	5	0.630	563254	231100	10.7	4.9	19.4	427
GT 6	Gas Turbine No. 6	10	1.260	563254	231232	8	3.1	27	427
GT 7	Gas Turbine No. 7	10	1.260	563254	231294	8	3.1	27	427
GT 8	Gas Turbine No. 8	10	1.260	563254	231413	8	3.1	24.5	427
GT 9	Gas Turbine No. 9	10	1.260	563254	231456	7.6	4.1	18.1	482
GT11	New 20 MW Turbine	19	2.417	563254	231565	9	4.5	11.6	480
HRSG 1	New Combined Cycle Steam Generator	11	1.389	563254	231160	25.000	3.048	22.570	112.400
HRSG 2	New Combined Cycle Steam Generator	11	1.389	563254	231275	25.000	3.048	22.570	112.400

Capacity Factors

Source No.	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00
GT - 3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 6	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 7	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 9	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 11	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
HRSG 1/2	71%	78%	85%	83%	63%	68%	47%	65%	85%	100%	100%	100%

Source No.	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	24:00
GT - 3	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 6	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 7	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 8	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 9	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
GT - 11	51%	88%	70%	65%	45%	45%	98%	70%	64%	45%	45%	0%
HRSG 1/2	100%	100%	100%	100%	100%	81%	90%	100%	100%	100%	90%	65%

Emission Parameters Summary

Appendix B Description of Buildings at Bogue Facility

Generation Building is 15 m wide x 26 m long x 8.1 m high

Transport building 24 m long x 12.6 m wide x 6.1 m high

Canteen structure 14.6 m x 7.2 m x 3.6 m high

New Linesmen facility 6.7 m x 18.3 m X 2.7m (located behind the Transport building and in front of the warehouse building)

Appendix C Index of Model Files for CD

Simple Cycle Mode

NO_x Folder

1995noxnew.inp	1995 Meteorological Data NOx simple cycle input file
1995noxnew.lst	1995 Meteorological Data NOx simple cycle output file
1996noxnew.inp	1996 Meteorological Data NOx simple cycle input file
1996noxnew.lst	1996 Meteorological Data NOx simple cycle output file
1997noxnew.inp	1997 Meteorological Data NOx simple cycle input file
1997noxnew.lst	1997 Meteorological Data NOx simple cycle output file
1998noxnew.inp	1998 Meteorological Data NOx simple cycle input file
1998noxnew.lst	1998 Meteorological Data NOx simple cycle output file

CO Folder

1995conew.inp	1995 Meteorological Data CO simple cycle input file
1995conew.lst	1995 Meteorological Data CO simple cycle output file
1996conew.inp	1996 Meteorological Data CO simple cycle input file
1996conew.lst	1996 Meteorological Data CO simple cycle output file
1997conew.inp	1997 Meteorological Data CO simple cycle input file
1997conew.lst	1997 Meteorological Data CO simple cycle output file
1998conew.inp	1998 Meteorological Data CO simple cycle input file
1998conew.lst	1998 Meteorological Data CO simple cycle output file

PM₁₀

1995pmnew.inp	1995 Meteorological Data PM10 simple cycle input file
1995pmnew.lst	1995 Meteorological Data PM10 simple cycle output file
1996pmnew.inp	1996 Meteorological Data PM10 simple cycle input file
1996pmnew.lst	1996 Meteorological Data PM10 simple cycle output file
1997pmnew.inp	1997 Meteorological Data PM10 simple cycle input file
1997pmnew.lst	1997 Meteorological Data PM10 simple cycle output file
1998pmnew.inp	1998 Meteorological Data PM10 simple cycle input file
1998pmnew.lst	1998 Meteorological Data PM10 simple cycle output file

SO₂

1995so2new.inp	1995 Meteorological Data SO2 simple cycle input file
1995so2new.lst	1995 Meteorological Data SO2 simple cycle output file
1996so2new.inp	1996 Meteorological Data SO2 simple cycle input file
1996so2new.lst	1996 Meteorological Data SO2 simple cycle output file
1997so2new.inp	1997 Meteorological Data SO2 simple cycle input file
1997so2new.lst	1997 Meteorological Data SO2 simple cycle output file
1998so2new.inp	1998 Meteorological Data SO2 simple cycle input file
1998so2new.lst	1998 Meteorological Data SO2 simple cycle output file

Combined Cycle Mode

NO_x Folder

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1995noxnew.lst	1995 Meteorological Data NOx combined cycle output file
1996noxnew.inp	1996 Meteorological Data NOx combined cycle input file
1996noxnew.lst	1996 Meteorological Data NOx combined cycle output file
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1997noxnew.lst	1997 Meteorological Data NOx combined cycle output file
1998noxnew.inp	1998 Meteorological Data NOx combined cycle input file
1998noxnew.lst	1998 Meteorological Data NOx combined cycle output file

CO Folder

1995conew.inp	1995 Meteorological Data CO combined cycle input file
1995conew.lst	1995 Meteorological Data CO combined cycle output file
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1996conew.lst	1996 Meteorological Data CO combined cycle output file
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PM₁₀

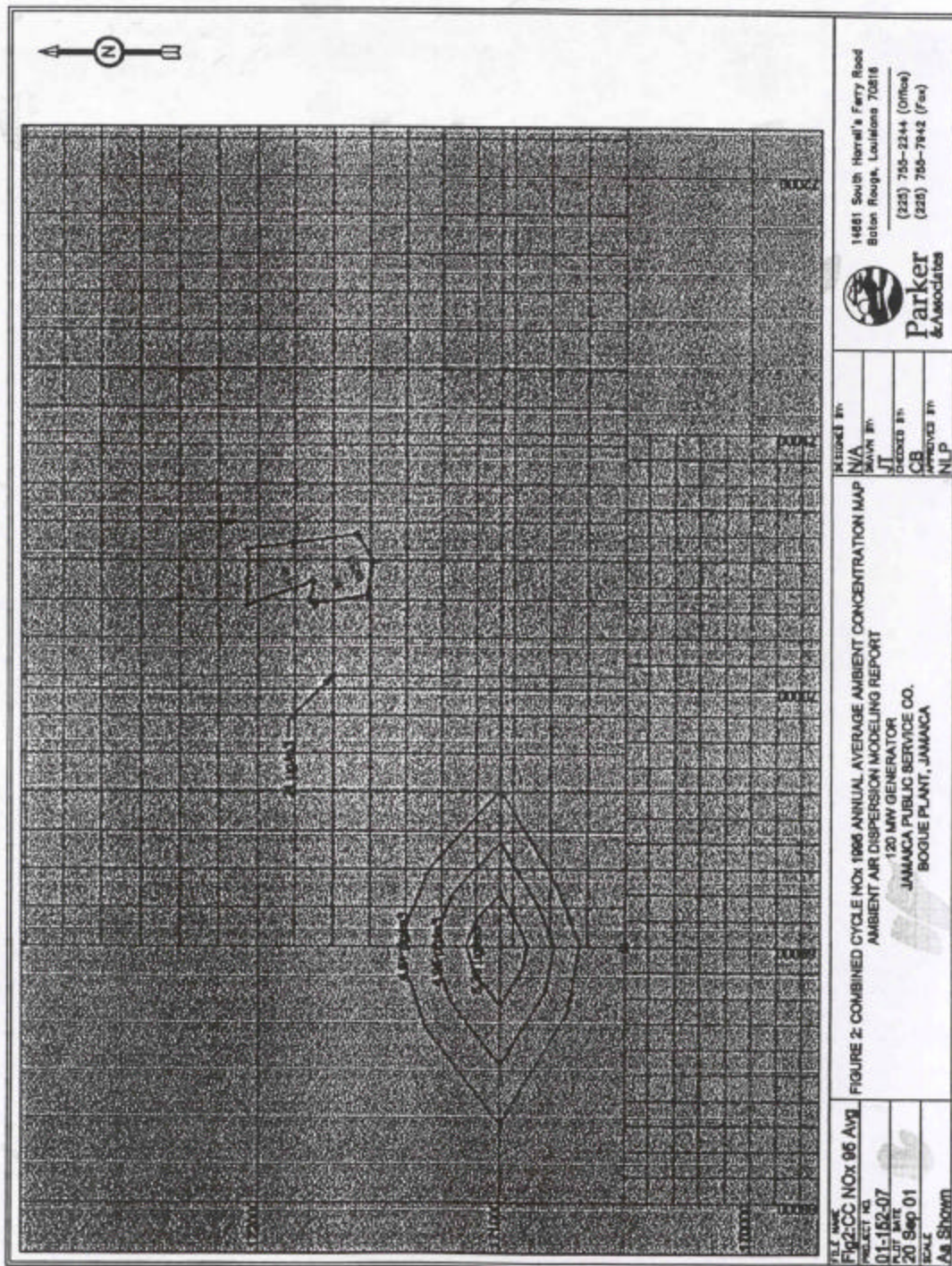
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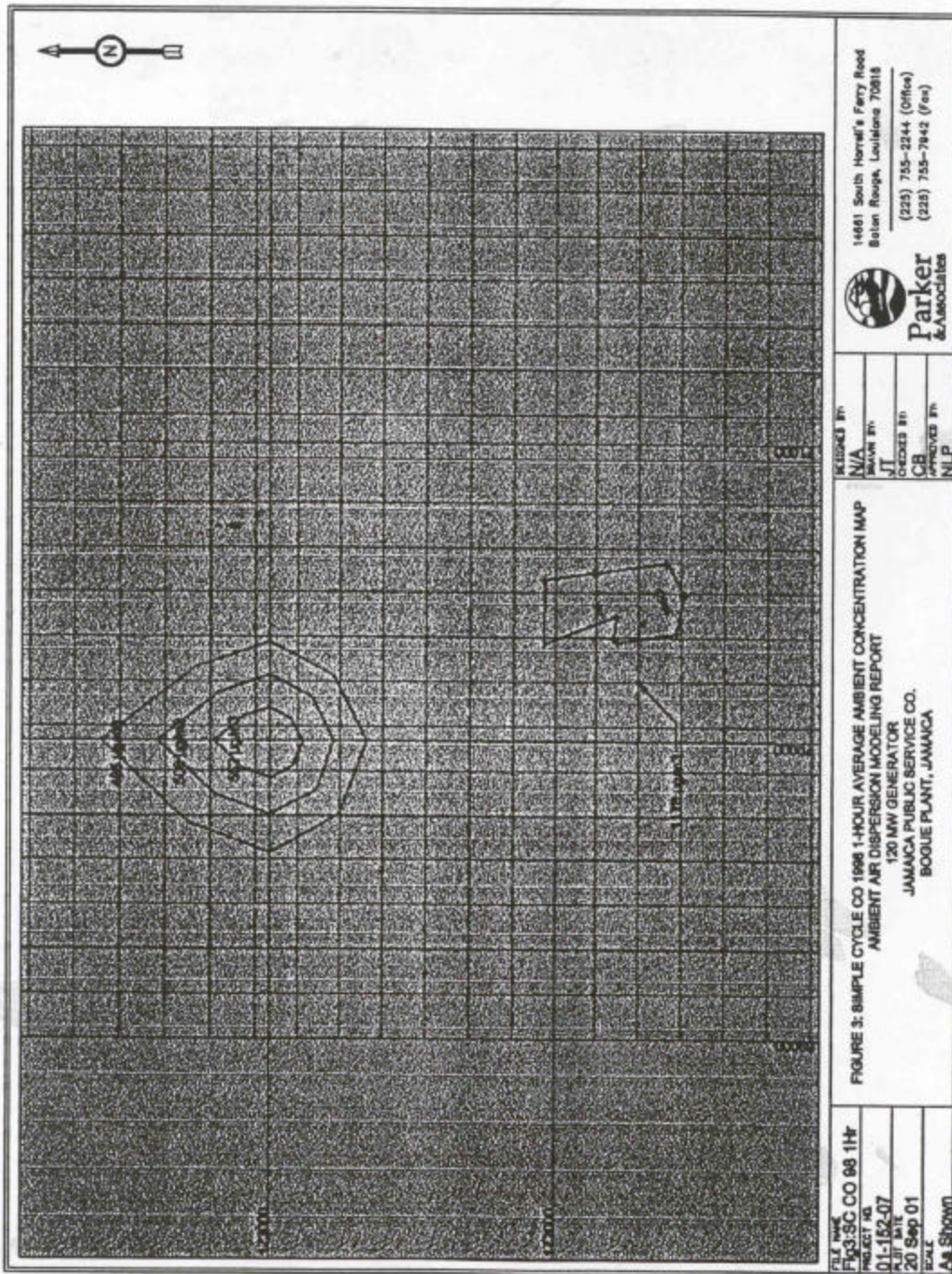
SO₂

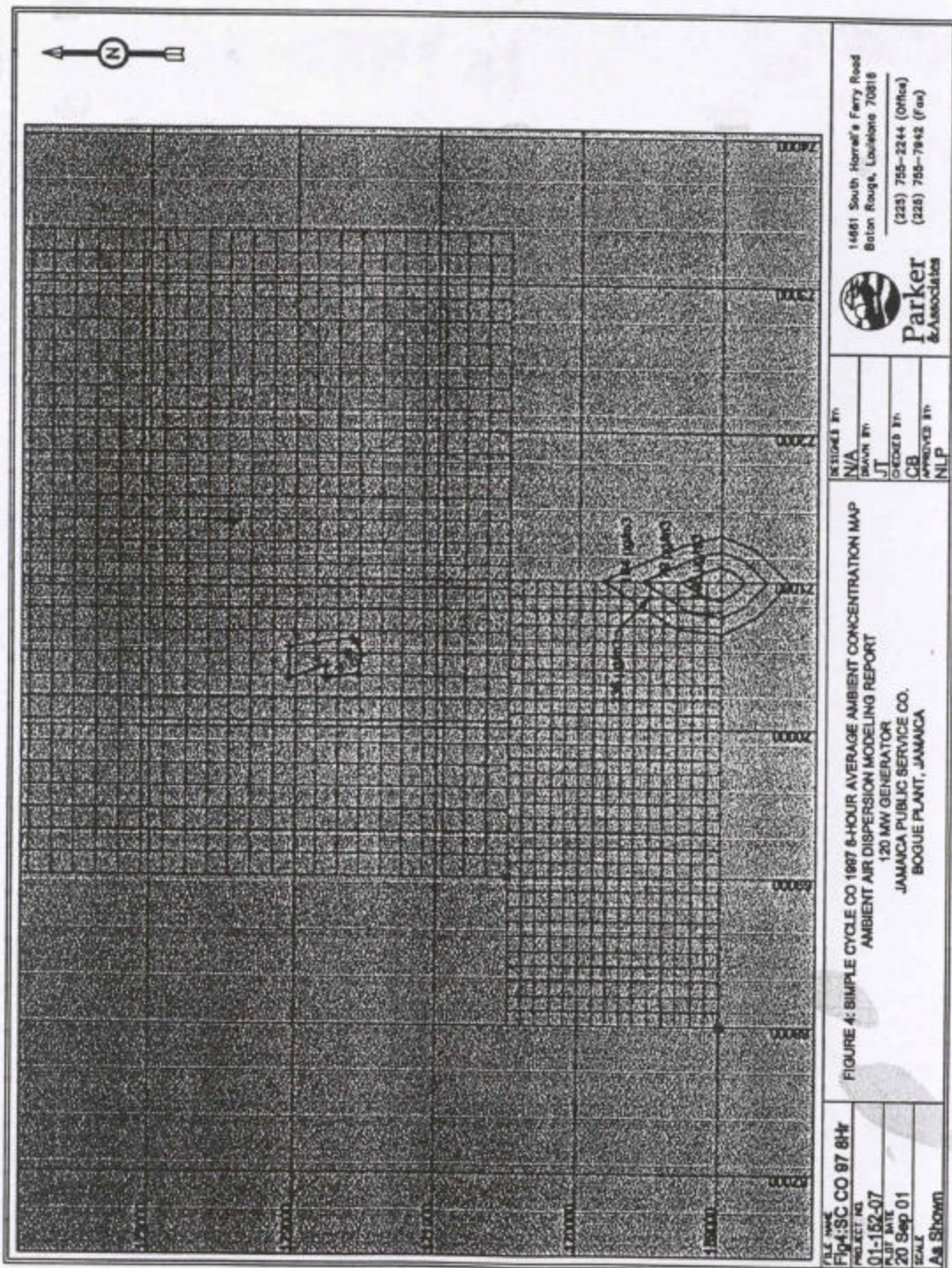
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1998so2new.lst	1998 Meteorological Data SO2 combined cycle output file

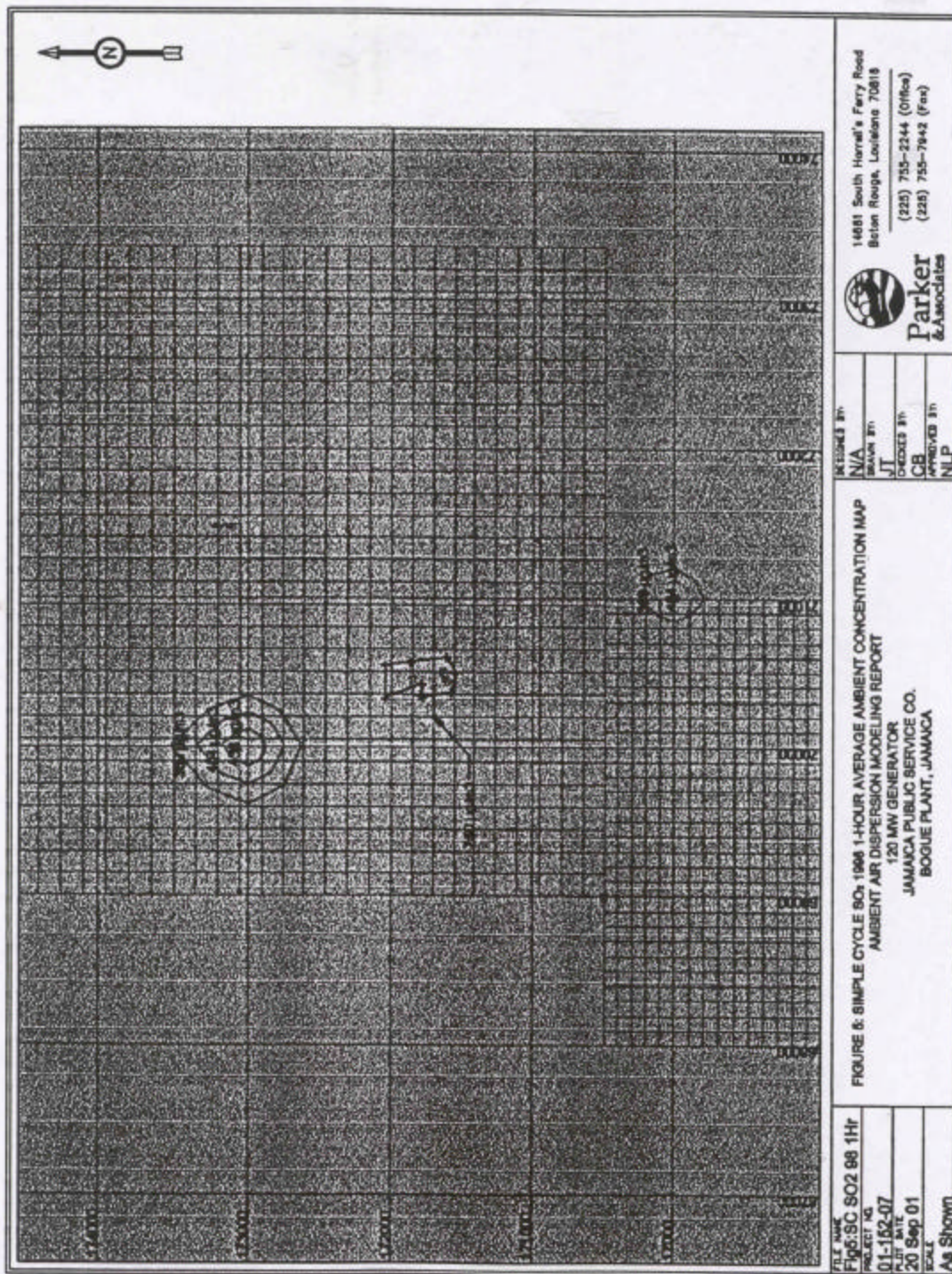
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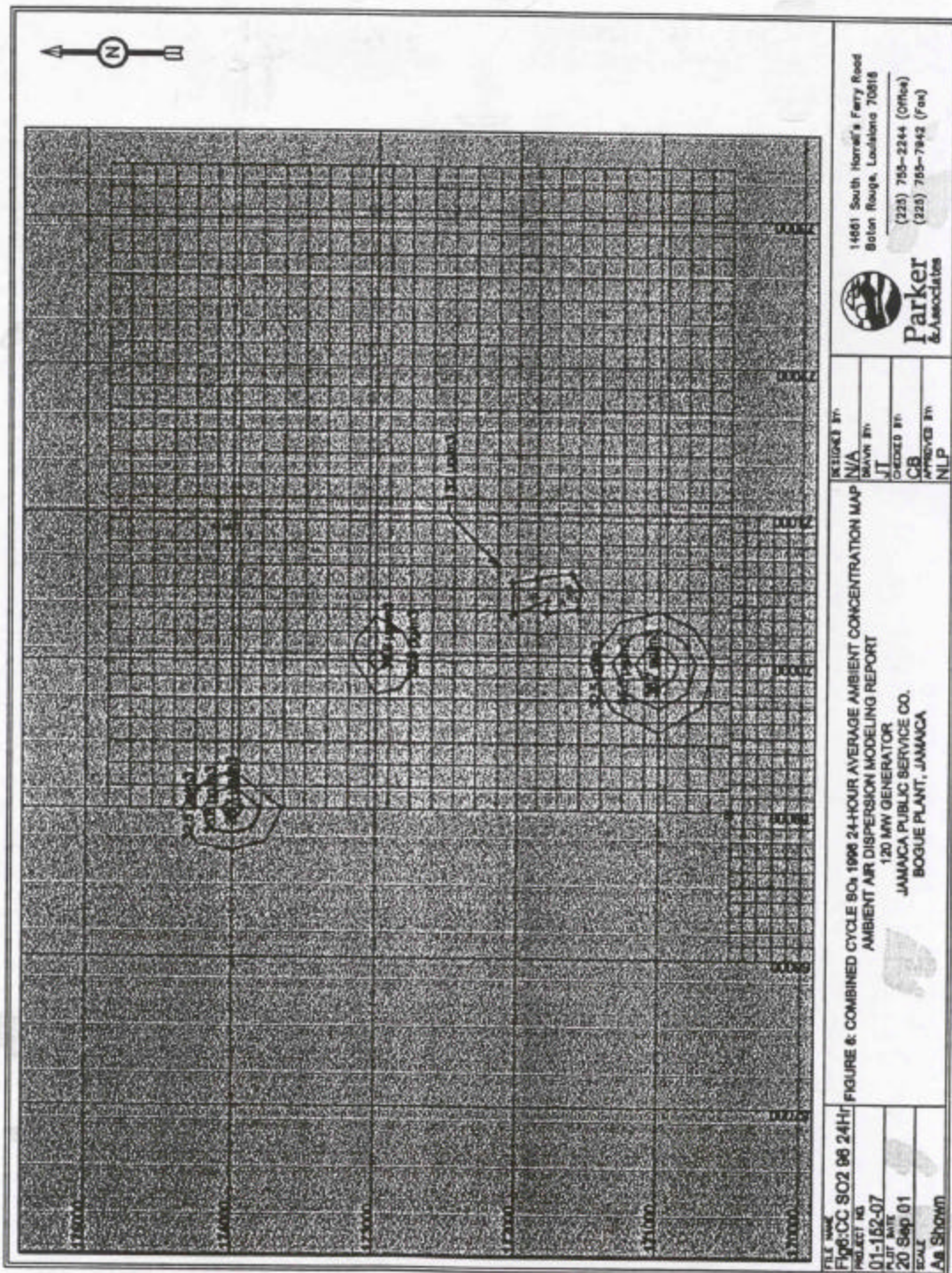
MKJ95-2.SFC	Montego Bay Surface Meteorological Data File 1995
MKJ95-2.PFL	Kingston Upper Air Meteorological Data File 1995
MKJKGN96.SFC	Montego Bay Surface Meteorological Data File 1996
MKJKGN96.PFL	Kingston Upper Air Meteorological Data File 1996
MKJKGN97.SFC	Montego Bay Surface Meteorological Data File 1997
MKJKGN97.PFL	Kingston Upper Air Meteorological Data File 1997
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MKJKGN98.PFL	Kingston Upper Air Meteorological Data File 1998

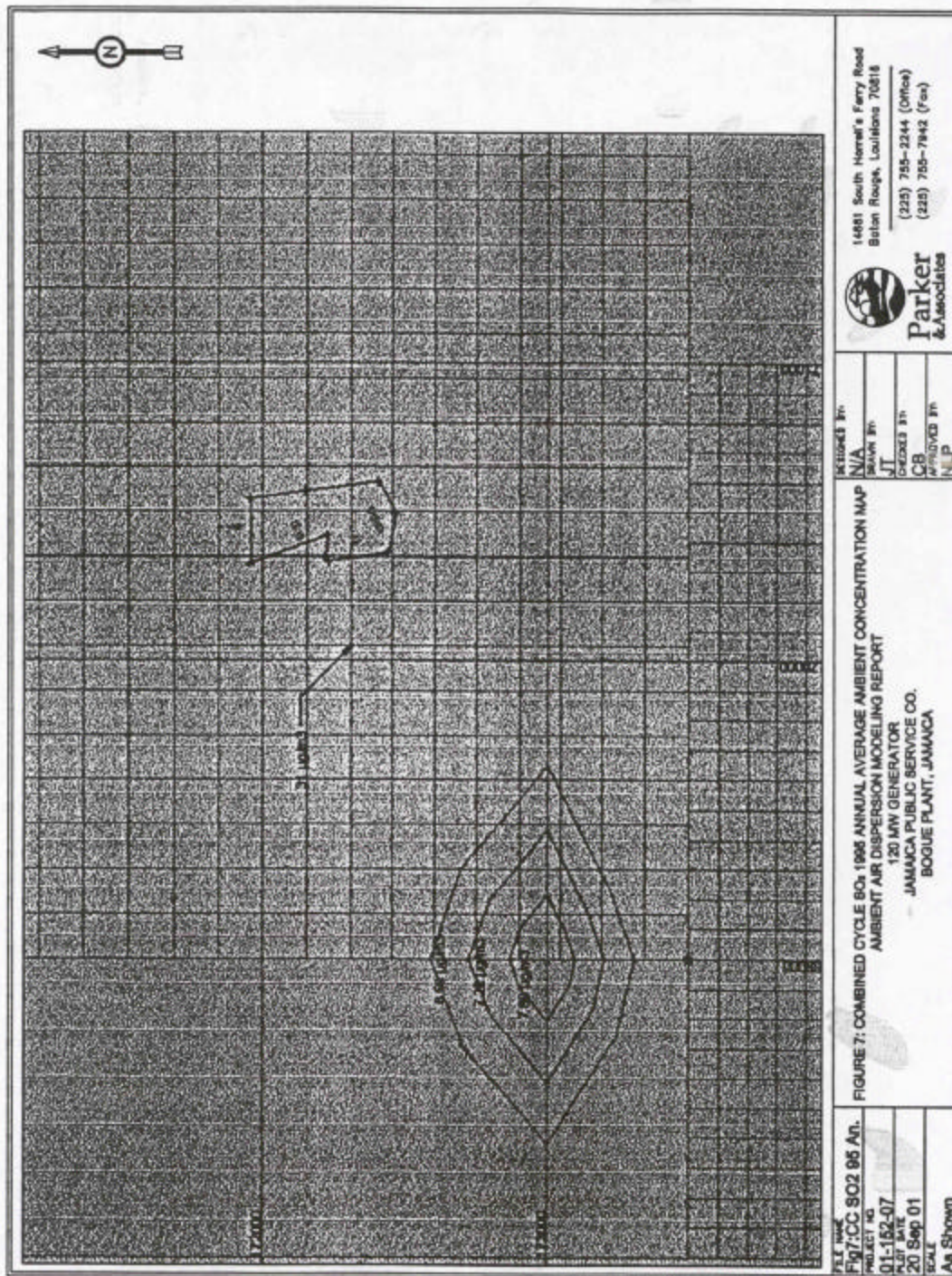


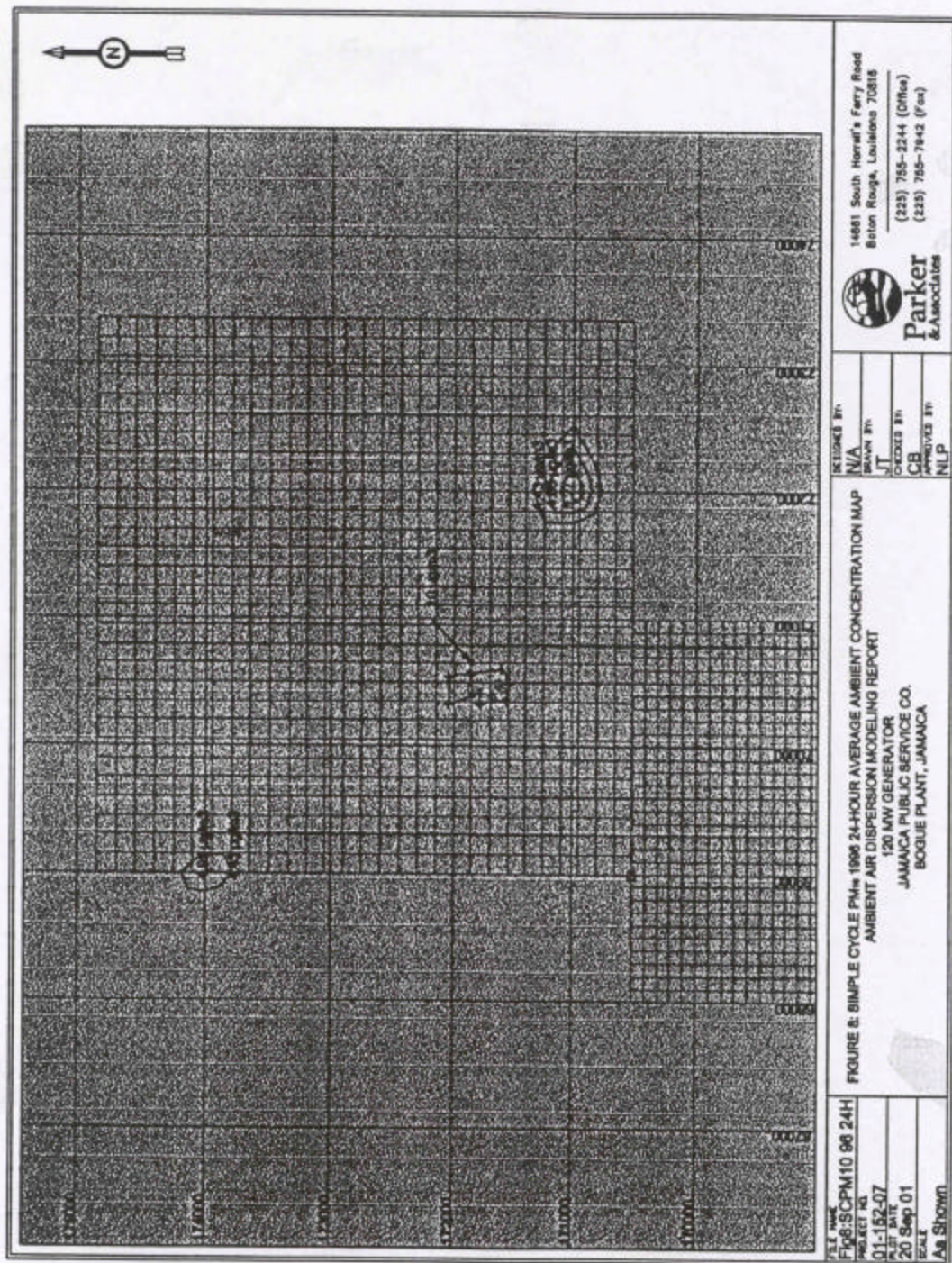


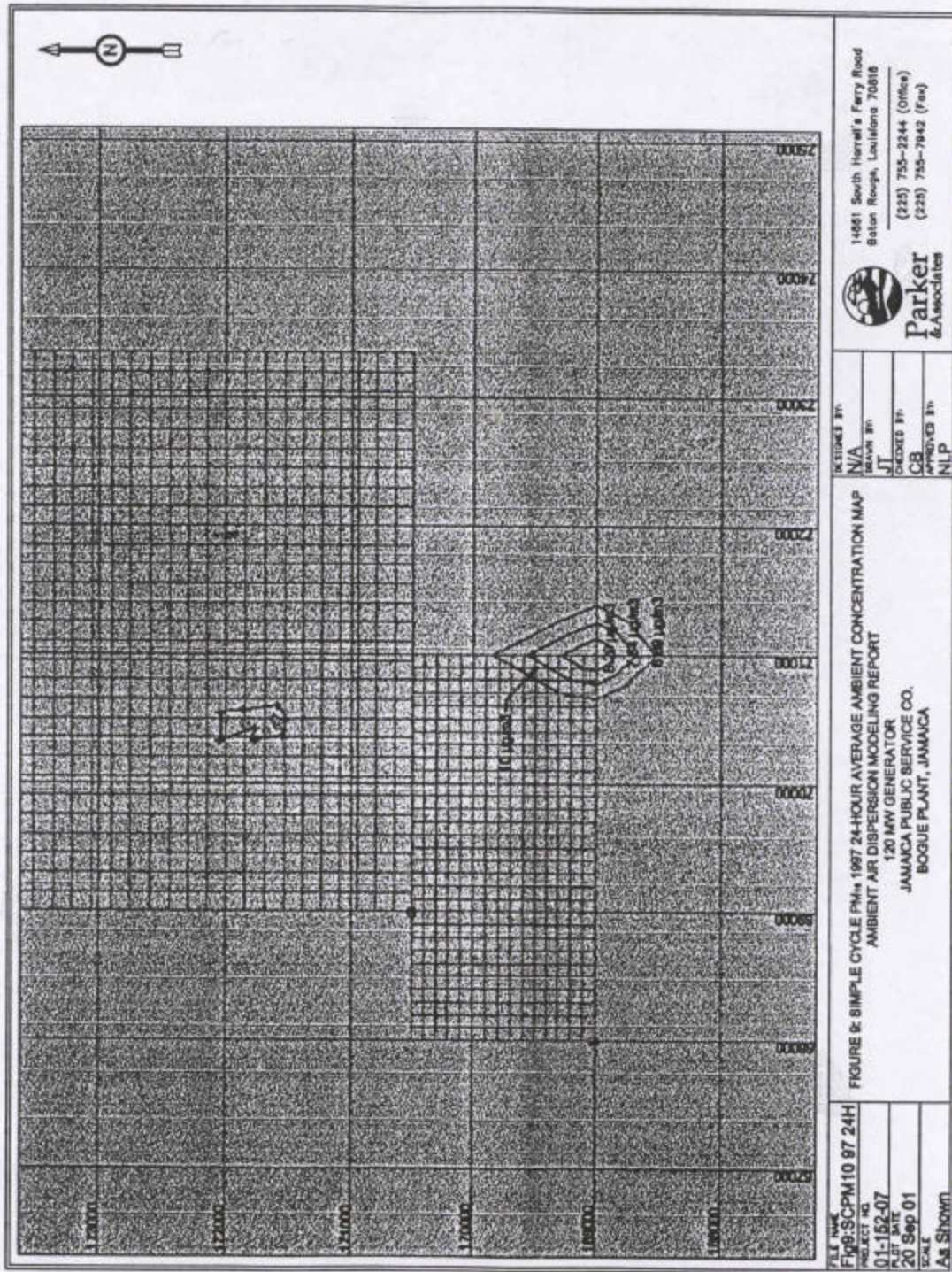


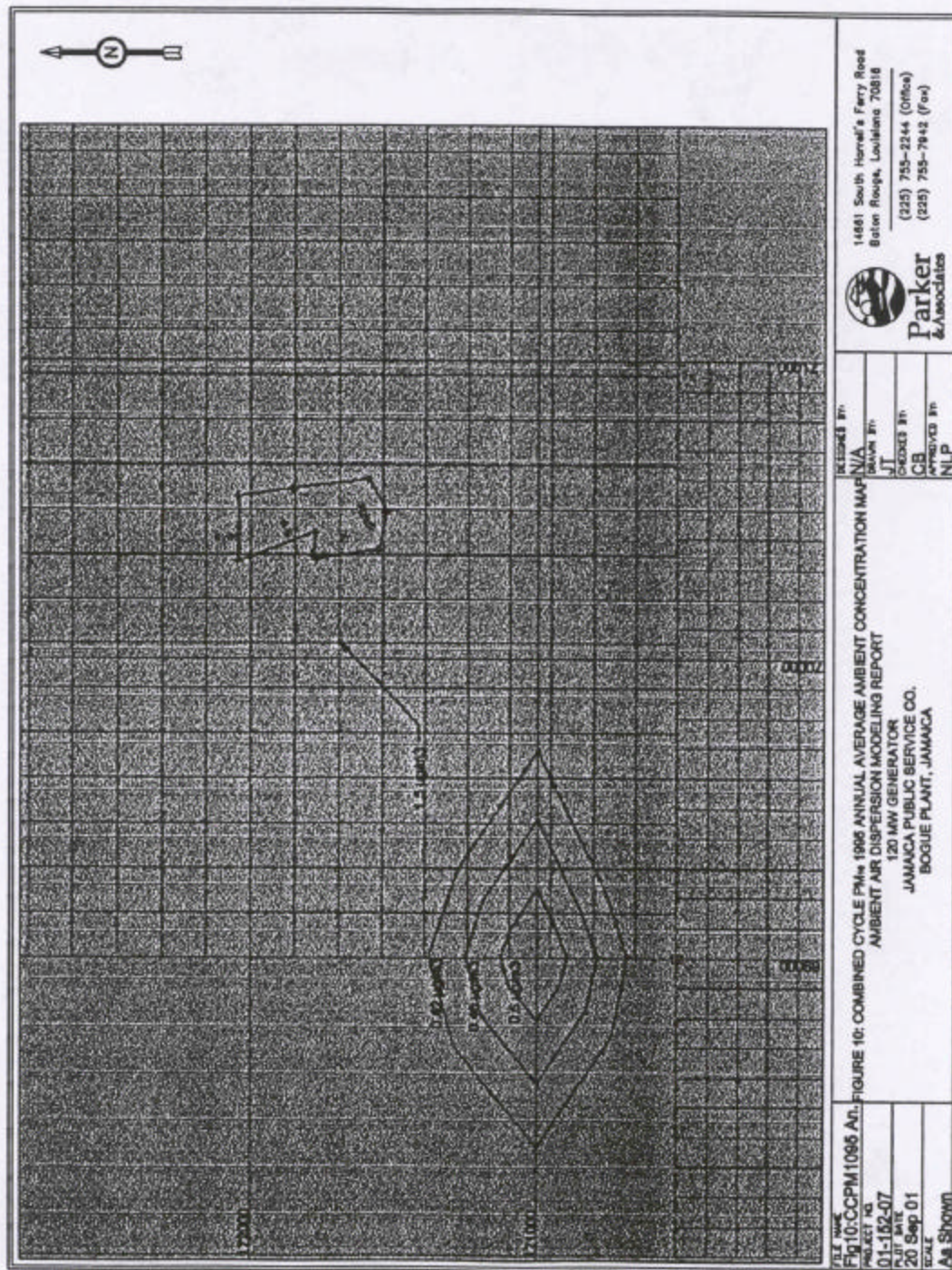












Project: Soil Investigation		Job Number: 200105	Sheet 1 of 2
Manager: _____	Client: Jamaica Public Service Co. Ltd.	Project Notes: _____	
Location: <u>Bouge, Montego Bay</u>	<u>6 Knutsford Boulevard</u>	_____	
	<u>Kingston 5,</u>	_____	
Elevation Datum: _____			

Borehole Depth Elev.	Specimen Description				Bulk Density	Dry Density	Water Content	Layer Code	Sample Data				
	LL	PL	PI	Fines					Top	Bottom	Type	Rec	'N'
IA 1.5				44.6					1.5	2.0	SS	25,45	17,34,18
IA 2.3	71.0	32.5	38.0			37.1			2.3	2.7	SS	38,45	2,3,6
IA 3.1	58.9	24.2	35.0			28.8			3.1	3.7	TW	61,61	
IA 4.6	47.8	27.4	21.0			27.2			4.6	5.0	SS	43,45	10,9,12
IA 6.1						18.7			6.0	6.5	SS	43,45	6,10,16
IA 7.6				36.4					7.6	8.1	SS	38,45	11,12,12
IA 10.7	46.8	25.9	21.0			49.4			10.7	11.1	TW	36,61	
IA 12.2				8.2					12.2	12.6	SS	10,45	10,10,11
IA 13.7				22.7					13.7	14.2	SS	45,45	8,16,17
IA 15.2				25.5					15.2	15.7	SS	45,45	9,9,40
IA 16.8				20.1					16.8	17.2	SS	41,45	14,24,15
IA 19.8				14.5					19.8	20.3	SS	45,45	16,35,33
2D 0.8	102.0	25.0	77.0			48.4			0.8	1.2	SS	36,45	2,2,5
2D 1.5	68.5	25.5	43.0			30.3			1.5	2.0	SS	31,45	2,1,4
2D 2.3	85.6	30.3	56.0			30.4			2.3	2.9	TW	53,61	
2D 3.8	55.7	29.6	26.0			26.1			3.8	4.3	SS	43,45	3,6,9
2D 6.1				31.8					6.1	6.6	SS	31,45	4,6,8
2D 9.1				35.2					9.1	9.6	SS	45,45	2,5,5
2D 10.7	74.2	38.9	35.0			37.0			10.7	11.1	SS	45,45	7,5,3

**Jamaica Engineering
& Technical Services
Ltd.**

Summary of Soil Properties

TABLE

1000 0 1000 01

JAMAICA ENGINEERING & TECHNICAL SERVICES LTD.

CLIENT: Jamaica Public Service Co.Ltd. SAMPLE I.D. 1A #10 @ 35' (10.7m)

PROJECT: Bogue, Montego Bay

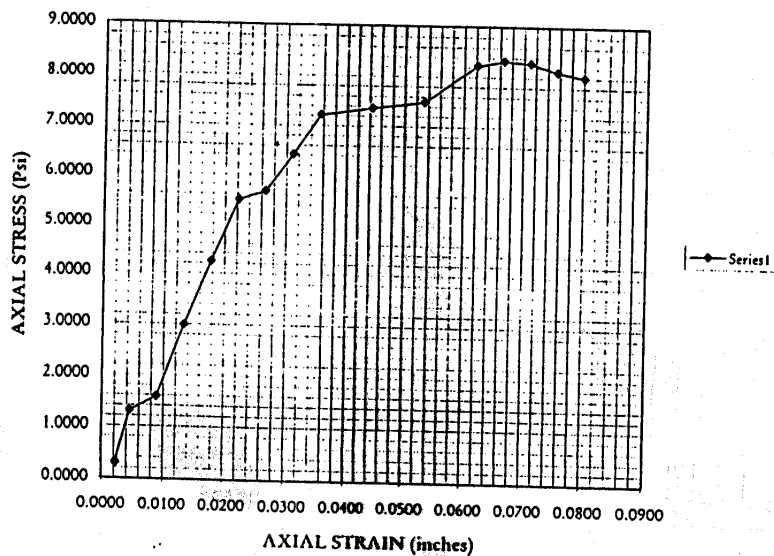
ASTM D2166

Deformation ΔL (inches)	Axial Strain ΔL / L ₀	Actual Area A ₀ /1-E (in ²)	Dial Reading	Load in P (lbs)	Axial Stress P/2A (Psi)
0.005	0.0022	1.6550	4	0.95	0.2871
0.010	0.0044	1.6587	18	4.28	1.2889
0.020	0.0089	1.6661	22	5.23	1.5682
0.030	0.0133	1.6736	42	9.98	2.9805
0.040	0.0178	1.6812	60	14.25	4.2386
0.050	0.0222	1.6888	78	18.53	5.4853
0.060	0.0267	1.6965	81	19.24	5.6704
0.070	0.0311	1.7043	92	21.85	6.4110
0.080	0.0356	1.7122	104	24.70	7.2140
0.100	0.0444	1.7281	107	25.42	7.3537
0.120	0.0533	1.7443	110	26.13	7.4895
0.140	0.0622	1.7609	122	28.98	8.2286
0.150	0.0667	1.7692	124	29.45	8.3238
0.160	0.0711	1.7777	124	29.45	8.2842
0.170	0.0756	1.7863	122	28.98	8.1116
0.180	0.0800	1.7949	121	28.74	8.0064
0.190	0.0844	1.8036	120	28.50	7.9019

Wet Density = 114.2 Pcf

Unconfined Shear Strength = 8.32 (Psi)

Dry Density = 84.12 Pcf

**UNCONFINED COMPRESSION TEST
AXIAL STRAIN vs AXIAL STRESS**

j:\office\jets\unconfine comp.xls

CLIENT: <u>Jamaica Public Service Co. Ltd.</u> PROJECT: <u>oil Investigation</u> ADDRESS: <u>Quayside, Montego Bay</u>		Location Reference Northing _____ Easting _____ Datum _____ Elevation _____		Type/Size 15.2cm O.D. Hollow Stem Auger with 8cm Shelby Samples and SPT's taken using 63.5kg Cathead Hammer	
Sample Type: ☒ Wash ☐ Grab ☒ Split S. ☐ T.W. Tube ☐ R. Core					
Depth (m) 0 1 2 3 4 5	Soil Description Comp: White Silty Coarse-Medium SAND with Some Gravel Dense White Silty Coarse-Fine SAND Stiff Brown CLAY with a Trace of Silt (Moist) Shelby Sample Brown CLAY Stiff Brown CLAY with Some Silt and Medium Fine Sand (Moist) Very Stiff Brown CLAY with Some Silt	Strata Plot Water Level SPT Blow Cnt	Samples Type 20 Mark Recovery	Plasticity P.L. M.C. L.L. 20 40 60 80 Wet Unit Weight ☐ (kNm ⁻³) 14.0 18.0 22.0 26.0	Standard Penetration Test (Blows/0.3m) 20 40 60 80 Undrained Unconfined Shear (kPa) Comp. Test + Vane Shear 50 100 150 200

EXPLORATION SERVICES LIMITED
 14a Hope Road
 Kingston 10 Jamaica W.I.

Dates		Job No. 200105	
Start	24/02/01	B.H. No.	Sheet 1 of 3
Completion	24/02/01		
Final W.L.	8.8		
OFFICE BOREHOLE RECORD		1A	FIG No. 5.

Soil Descriptions are subjective

CLIENT: JAMAICA PUBLIC SERVICE CO. LTD.		PROJECT: Oil Investigation		Type/Size	
ADDRESS: Boone Montego Bay		Northings	Datum	15.2cm O.D. Hollow Stem Auger with 8cm Shelby Samples and SPT's taken using 63.5kg Cathead Hammer	
Sample Type: ☒ Wash ☐ Grab ☒ Split S. ☐ T.W. Tube ☐ R. Core		Elevation			
Depth (m)	Soil Description	Strata Plot	Meter Level	SPT Blow Cnt.	Plasticity
					Wet Unit Weight (kNm ⁻³)
					Standard Penetration Test (Blows/0.3m)
					Undrained Unconfined Shear (kPa)
					Comp. Test
					Vane Shear
6	Very Soft Light-Brown Silty CLAY with some Medium-Fine Sand			6 10 16	43 45
7					
8	Comp. Light-Brown Silty Coarse-Fine SAND with Traces of Clay and Fines Gravel			11 12 12	38 45
	Very Loose Brown Coarse-Fine SAND with some Clay and Traces of Silt and Gravel (Ver)			2 2 1	20 45
EXPLORATION SERVICES LIMITED		Dates		Job No. 200105	
Hope Island, Jamaica W.I.		Start	24/02/01	B.I. No.	Sheet 2 of 3
OFFICE BOREHOLE RECORD		Completion	24/02/01	1A	FIG No. 5.
		Final W.L.	8.8		

Soil Descriptions are subjective