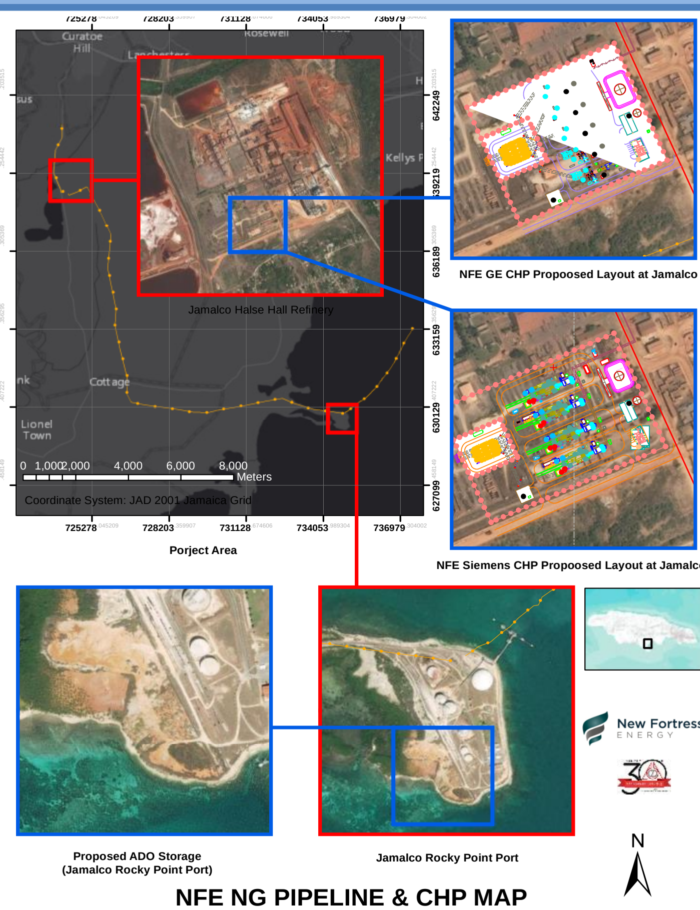
For submission to:

NFE South Power Holdings Limited
Pimento Way
Freeport
Montego Bay
St. James
Jamaica, W.I.

Environmental Impact Assessment
for the establishment of a
Natural Gas Fired Combined Heat and Power (CHP) Project
at
Portland Bight, Clarendon to Jamalco, Halse Hall, Clarendon

VOLUME I: Main Report

June 21, 2017



CONRAD DOUGLAS & ASSOCIATES LIMITED

14 Carvalho Drive, Kingston 10, Jamaica W.I.

(876)929-0023/0025/8824
info@cdaestech.com; cdaestech@hotmail.com; conraddouglasnassociatesltd@gmail.com
www.cdaestech.com

Environmental Impact Assessment

for the establishment of a

Natural Gas Fired Combined Heat and Power (CHP) Project

at

Portland Bight, Clarendon to Jamalco, Halse Hall, Clarendon

VOLUME I: Main Report

Prepared for:

NFE South Power Holdings Limited
Pimento Way
Freeport
Montego Bay
St. James
Jamaica, W.I.

Prepared by:

Conrad Douglas & Associates Limited
14 Carvalho Drive • Kingston 10 • Jamaica
Tel: (876) 929-0023 • (876) 929-0025 • (876) 929-8824
Fax: (876) 960-2014
Email: info@cdaestech.com
Website: www.cdaestech.com

June 21, 2017

PROPRIETARY RESTRICTION NOTICE

TABLE OF CONTENTS

Page Number

List of Figures

Page Number

List of Tables

Page Number

LIST OF APPENDICES

Page Number

List of Acronyms

ACI	**American Concrete Institute**
AGRRA	Atlantic and Gulf Rapid Reef Assessment
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALPART	Alumina Partners of Jamaica
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
ATV	All Terrain Vehicle
AWWA	American Water Works Association
AWS	American Welding Society
ADO	Automotive Diesel Oil
AF	Available Factor
BC	Building Code
BBL	Barrel of Crude Oil
BOD	Biochemical Oxygen Demand
BTU	British Thermal Unit
C	Celsius
CAD	Computer Aided Drawings
CAW	Clarendon Alumina Works
C-CAM	Caribbean Coastal Area Management
CD&A	Conrad Douglas & Associates
CDOM	Coloured Dissolved Organic Matter
CEMS	Continuous Emissions Monitoring System
CGA	Concrete Gas Association
CHP	Combined Heat & Power
CITES	Convention on International Trade in Endangered Species Wild Fauna and Flora
cm	Centimeter
CRSI	Concrete Reinforcing Steel Institute
CSO	Chief Security Officer
CTG	Combustion Turbine Generation
dBA	Decibels (A-weighted decibels)
DCS	Distribution Control System
DMS	Data Management System
ED	Enumeration Districts
ECD	Environmental Control Division
EDI	Electro-Deionization

EHS	Environmental Health and Safety
EHU	Environmental Health Unit
ELF	Extremely Low Frequency
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EMP	Environmental Management Plan
ENGO	Environmental Non-Government Organization
EPW	Enhanced Pressure Wave
ES	Environmental Specialist
ET	Environmental Team
ESA	Equipment Safety Analysis
F	Fahrenheit
FDOM	Fluorescent Dissolved Organic Matter
FOG	Fat, Oil and Grease
FAO	Food and Agriculture Organization
FRST	Floating Storage and Re-gasification Terminal
G	Gauss
GDP	Gross Domestic Product
GIS	Geographical Information System
GPD	Gallons per Day
gpm	Gallons per Minute
GoJ	Government of Jamaica
GPS	Global Positioning Software
h	Hour
HDD	Horizontal Directional Drill
HDPE	High Density Polyethylene
HEI	Heat Exchange Institute
HFO	Heavy Fuel Oil
HI	Hydraulic Institute
HRSG	Heat Recovery Steam Generator
HSE	Health, Safety and Environment
HSSE	Health, Safety, Security & Environment
HW2K	Highway 2000
IAS	Invasive Alien Species
IC&E	Instrumentation, Control and Electronics
ICEA	Insulated Cable Engineers Association
IES	Illuminating Engineering Society
IEEE	Institute of Electrical and Electronics Engineers
IPIECA	International Petroleum Industry Environmental Conservation Association
IMF	International Monetary Fund
INCD	Intended Nationally Determined Contribution
ISA	Instrument Society of America
IUCN	International Union for Conservation of Nature
JAAQS	Jamaica Ambient Air Quality Standards

JEP	Jamaica Energy Partner
JNHT	Jamaica National Heritage Trust
JNNS	Jamaica Noise National Standard
JPPC	Jamaica Private Power Company
JPS	Jamaica Public Service
JPSCo	Jamaica Public Service Company
JSA	Job Safety Analysis
Km	Kilometer
Kwh	Kilowatt-hour
kV	Kilovolt
LAT	Latitude
lb	Pound
LMO	Living Modified Organism
LNG	Liquefied Natural Gas
LONG	Longitude
m	Meter
mm	Millimeter
mL	Milliliter
MCM/yr	Million Cubic Metres per Year
MGD	Mines and Geology Division
MPN	Most Probable Number
MTPY	Metric Tons per Year
MW	Mega Watts
NEC	National Electric Code
NESC	National Electrical Safety Code
NEPA	National Environment and Planning Agency
NFE	New Fortress Energy
NFPA	National Fire Protection Association
NG	Natural Gas
NOAA	National Oceanic and Atmospheric Authority
NRCA	National Resources Conservation Authority
NSWMA	National Solid Waste Management Authority
NWC	National Water Commission
ODPEM	Office of Disaster Preparedness and Emergency Management
PBPA	Portland Bight Protected Area
PET	Polyethylene Terephthalate
PDM	Pressure Drop Measurement
ppb	Parts per Billion
ppm	Parts per Million
ppt	Parts per Thousand
PM	Pico meter
PRL	Pesticide Research Laboratory
PSIG	Pound per Square Inch
QA	Quality Assurance

QC	Quality Control
RSA	Residue Storage Area
RO	Reverse Osmosis
ROWS	Run-Off Water Storage
s	Seconds
SCOJ	Sugar Company of Jamaica
SLF	Super Low Frequency
SIA	Social Impact Assessment
SPAW	Special Protected Areas and Wildlife
SST	Sea Surface Temperature
STP	Standard Temperature and Pressure
STATIN	Statistical Institute of Jamaica
SUS	Secondary Unit Substation
µT	Micro Tesla
TBT	Tributyltin
TEMA	Tubular Exchanger Manufacturers Association
TOR	Terms of Reference
TPH	Total Petroleum Hydrocarbon
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
µg	Microgram
UNCED	United Nations Conference for Environmental and Development
UNCLOS	United Nations Convention on the Laws of the Sea
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
USEPA	United States Environmental Protection Agency
VBM	Volume Balance Measurement
WHO	World Health Organization
WMU	Water Management Unit
WRA	Water Resources Authority

1.0. Executive Summary

1.1. Introduction & Background

NFE South Power Holdings Limited (NFE), the project proponent, has retained the services of Conrad Douglas & Associates Limited (CD&A) to carry out an Environmental Impact Assessment (EIA) for the establishment of a 200 MW Natural Gas Fired Combined Heat and Power (CHP) co-generation power station proposed for location at Clarendon Alumina Works' brownfield alumina refinery in Halse Hall, Clarendon (Jamalco) (see figure 1 - Project Map). It is proposed to establish the CHP in two phases of 100 MW each.

The 1.4 million MTY Jamalco alumina refinery was commissioned in 1970, some forty-seven (47) years ago. It operates a Heavy Fuel Oil (HFO) fired co-generation power station (power station) to meet its internal demand for electricity and process steam. The electricity is used to power and energize its alumina plant and its support services while the steam is used to produce heat for extracting and refining alumina hydrate from bauxite. The alumina refining process is an extractive hydro-metallurgical process, which belongs to the alkaline series of processes. It is known as the Bayer Process.

50 Hz electricity is produced by the power station at the refinery. The alumina refinery is tied into the National Electricity Grid at the Parnassus sub-station. The plant has the capability to purchase or sell excess electricity to the national grid.

Jamalco's environmental socio-economic setting and baseline have evolved over the years of its establishment from secondary pastureland to one of gradually increasing human settlements and communities in proximity to the plant. The population density of the communities is variable and decreases along the alignment of the rail road from the alumina refinery to the port, as it moves towards the south.

The bio-physical and historical heritage resources have remained essentially unchanged over the last five decades, as one moves from the alumina plant along the railroad (the plant-to-port linkage) to the port. The port which is located at Rocky Point, Clarendon and the railroad is located in the Portland Bight Protected Area (PBPA).

The Portland Bight Protected Area falls within the International Union for the Conservation of Nature (IUCN) classification as a Multiple Use National Park. It is Jamaica's largest Protected Area and a biodiversity hotspot, which is the habitat of several species of plants and animals. It contains the largest continuous remaining stand of mangroves in Jamaica and is a RAMSAR site. Various rare and threatened species of plants and animals are located in the Portland Bight (Conrad Douglas & Associates Limited, "*A System of Natural Protected Areas for Jamaica*"). It also has several large seagrass beds, three fish sanctuaries and fourteen Cays.

1.2. Terms of Reference

The EIA was prepared in response to Terms of Reference which was approved by the National Environmental & Planning Agency (NEPA), to which an application has been made by New Fortress Energy for an environmental permit (Appendix 1).

1.3. Approach & Methodology

Using a range of standard internationally acceptable state of the art approaches and methodologies with state of the art equipment, the EIA addressed the CHP and all its physical infrastructure to be located in the bio-physical and socio-economic and historical heritage setting and baseline in the terrestrial and marine environment. It also addressed the applicable Regulatory Framework, Impact Identification, Impact mitigation, Environmental Management and Monitoring and Emergency Response. Voluntary Stakeholder consultations were also carried out among members of the primary impact communities within the sphere of influence of the project, in keeping with the principles of Agenda 21 to which Jamaica is a signatory.

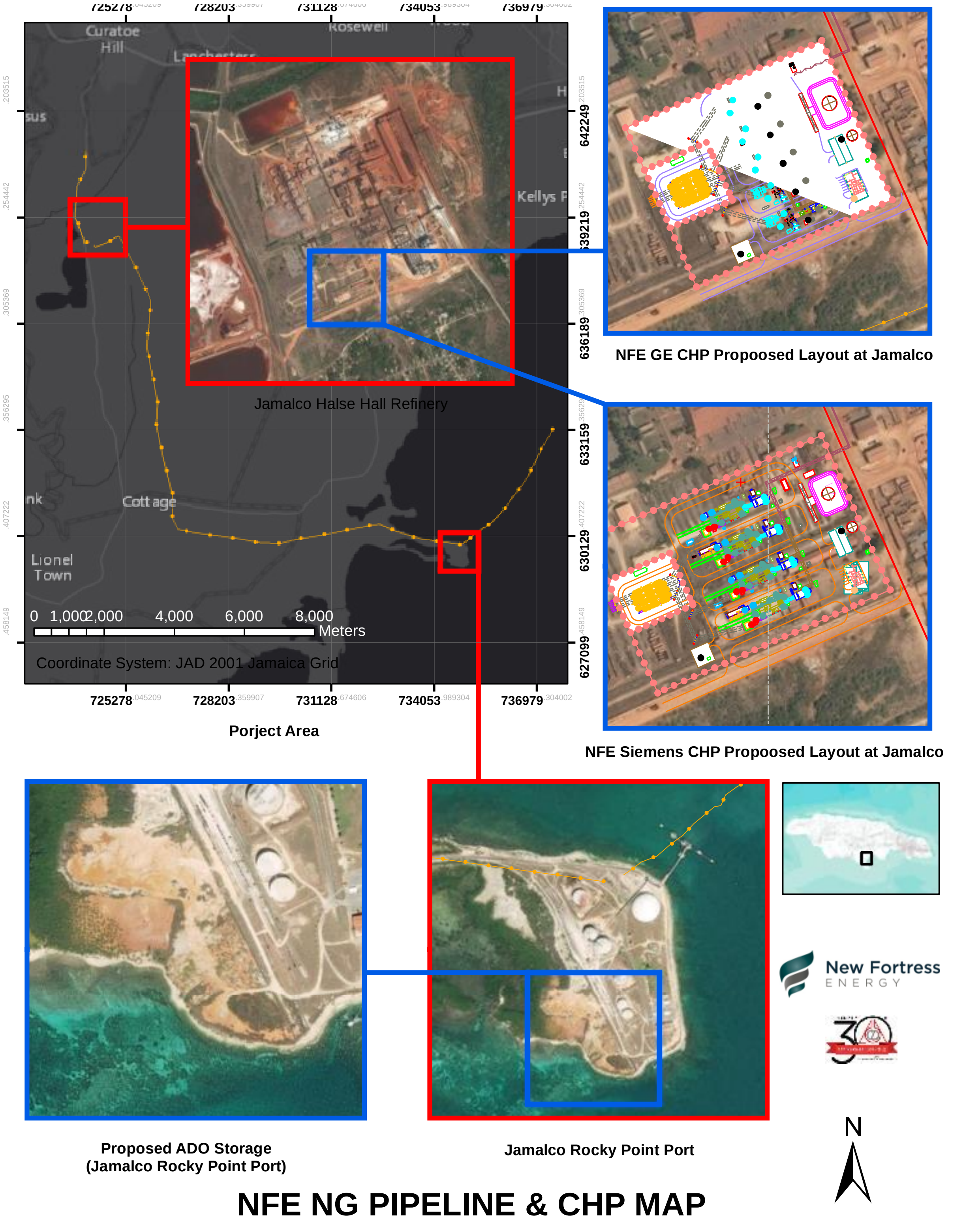


Figure 1: NFE NG Pipeline & CHP Map

1.4. Findings

Our findings are shown as follows:

- The planning and design of the NG fired CHP system was done in compliance with the requirements of the World Bank/NEPA guidelines for the NG/LNG Sector in Jamaica.
- The regulatory framework consisting of all relevant international policies, treaties, conventions and protocols as well as Jamaica's policies. legislations, regulations and standards have been taken into account for the pre-construction, construction, operations phases of the project. The project will be compliant with the regulatory framework.
- Both NFE and Jamalco have stringent EHS policies to which NFE will comply.
- The Floating Storage & Regassification Terminal (FSRT) located in the marine environment has already been permitted by NEPA.
- Except for the section of the pipeline, which will be buried beneath the sea from the FSRT to Rocky Point Port, and the first section of the pipeline on land, which traverses the mangroves, the <u>footprint of all other components of the project is practically confined to brownfield-sites which have existed since 1963, in the case of the Port and railroad corridor and 1970, in the case of the alumina refinery</u>.
- As shown in the summary table below, except for the already permitted FSRT, all other proposed facilities for the NG-Fired CHP will be located on existing or brownfield-site operations.

Table 1: Summary of Proposed Physical-Land Use Changes to the Marine and Terrestrial Environment

Locations	Existing Activity	Proposed Activity	Proposed Addition/Change
Rocky Point Port	Storage and shipment of alumina Storage and distribution of caustic soda by rail Storage and distribution of Heavy Fuel Oil	Increased ADO storage Natural Gas (NG) distribution by Pipeline (adjacent to railroad alignment) ADO distribution by	1 km of 16" diameter carbon steel corrosion protected underground pipeline to transport NG Two (2) 66,000 bbls ADO storage tanks

Locations	Existing Activity	Proposed Activity	Proposed Addition/Change
	Storage of Automotive Diesel Oil (ADO)	railroad and/or trucks	
Wetlands	Transport of Heavy Fuel Oil (HFO) by railroad Transport of alumina by railroad Transport of caustic soda by railroad	ADO transportation by railroad NG transmission by pipeline	4.5 km of 16" diameter carbon steel corrosion protected underground pipeline to transport NG Except for Salt River to Old Harbour corridor, transportation of ADO by truck under emergency conditions
Agricultural lands (mainly sugarcane farming)	Transport of (HFO) by railroad Transport of alumina by railroad Transport of caustic soda by railroad	ADO transportation by railroad and/or truck NG transmission by pipeline	15 km of 16" diameter carbon steel corrosion protected underground pipeline to transport NG Except for Salt River to Old Harbour corridor, transportation of ADO by truck under emergency conditions
Jamalco alumina refinery site	Processing of bauxite to alumina HFO storage Combustion of HFO for power generation Steam generation	Combustion of NG Combustion of ADO under emergency conditions ADO storage and use	Natural Gas Fired Combined Heat & Power Station 15,000 bbls ADO storage tank 138kv substation
Main road (Hayes to May Pen)	Low voltage transmission lines and poles High voltage transmission lines and pylons Heavy duty trucks and other motor vehicles (traffic)	High tension wires and pylons	3 km of high voltage transmission lines and infrastructure Transportation of ADO by truck under emergency conditions

- The project essentially involves the reduction in the use of Heavy Fuel Oil (HFO) by substituting HFO with Natural Gas (NG) for the generation of electricity and steam at the Jamalco alumina refinery plant site.
- Jamalco will continue to use HFO for its boilers at the Power Station and calciners.
- NG, being the lowest molecular weight compound of the hydrocarbons (CH_4) and of all the fossil fuels, is a cleaner more environmentally friendly fuel. On its combustion, this will result in reduced emission of atmospheric pollutants (NO_x, CO, TSP, PM_{10}, SO_2) and therefore represents a major improvement in air quality as shown in Figure 2. The graph was developed from atmospheric emission modelling for this project (See Volume II: Extended Appendix 10). This shows that:
  - ✓ Reduction in Nitrogen Oxides (NO_x)emissions by more than 75%
  - ✓ Reduction in Carbon Monoxide (CO) emissions by more than 25%
  - ✓ Reduction in Total Suspended Particulates (TSP) and Particulate Matter of size 10 microns (PM_{10}) emissions by more than 89%
  - ✓ Reduction in Sulphur Dioxide (SO_2) emissions by more than 98%

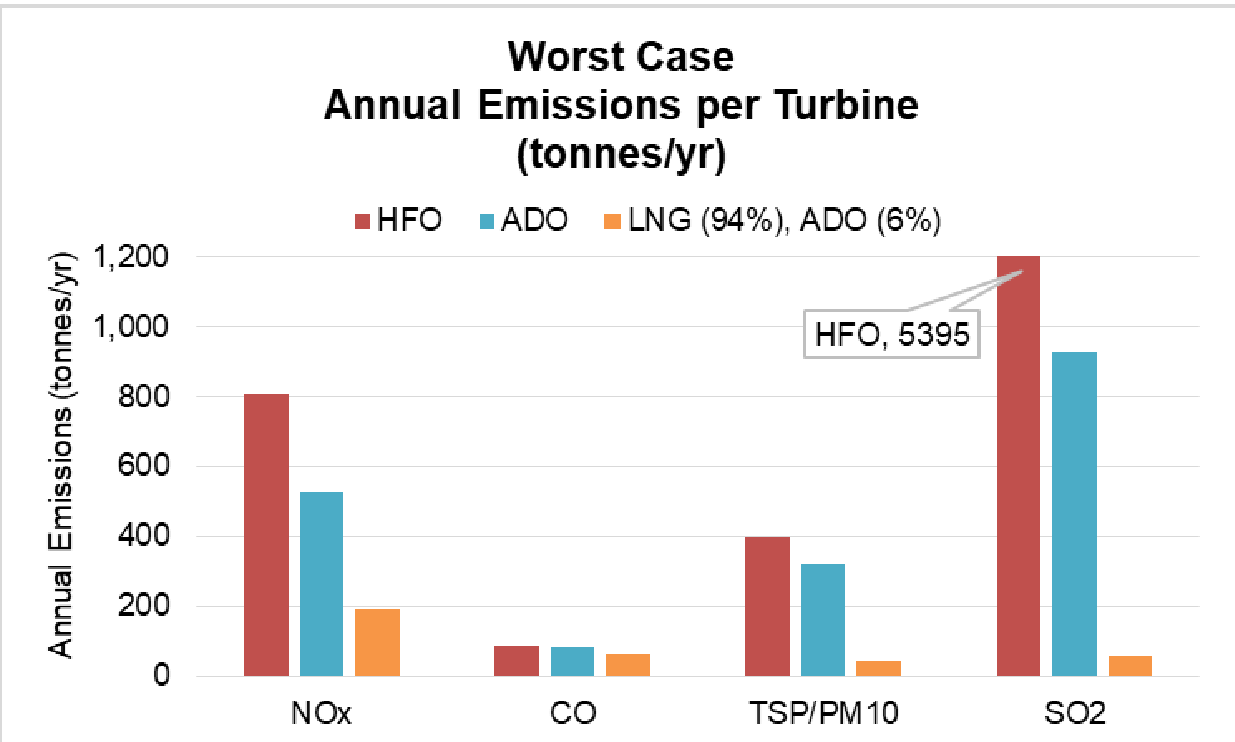


Figure 2: Worst Case Annual Emissions per Turbine (tonnes/yr)

- The project will result in reduction in the handling and transportation of HFO from the port to plant and consequently minimization of the risks associated with HFO handling and transportation.
- The potential for impacting on the marine environment from sediments generated through construction activity from laying of the pipeline is anticipated to be of low intensity and short duration. It would appear that the extent of this impact would be confined to Salt island. It would appear that the marine resources in the area are adapted to this condition because the ocean floor characteristically consists of fine sediments, which are readily disturbed by the frequent movement of ships in the area.
- The water quality in the marine environment and sediment on the seafloor showed that the level of water pollution in the Bight is high in respect of various parameters when compared with NEPA's water quality standards. This indicates that there is a high loading of pollutants to the Bight. The nutrient loading and coliform was particularly high. In the case of nutrient loading, it should be noted that the Bight is a receptor from farm land run-off, in which fertilizers are utilized in their farming practices. This cannot be significantly reduced unless land use is changed.
- It should also be noted that fish farming is practiced in the area. During spillage and maintenance, this is likely to increase the nutrient load.
- Where necessary, directional drilling will be the method of construction to bypass hard rocks, corals and seagrass beds. Pipelaying will be accomplished by tried and true methods with a long history of success from a safety and reliability standard. Therefore there will minimal impact on these resources.
- Impact to the fish sanctuary will be minor and of short duration.
- In the event that there is the need for mangrove modification the proponent will carry out mitigation activities through rehabilitation using appropriate methods.
- During the Environmental Baseline Studies (EBS) young seedlings were thriving in the wetlands. The conditions therefore exist for natural re-colonization.
- No historical heritage resources will be impacted by the project
- The major potential risk and hazard is the probability for fires to occur from leaking of NG.

- The potential environmental impacts from the pre-construction and construction phases are expected to be noise generation and fugitive dust dispersion. Dust suppression technologies will be applied during construction activities. Dust and noise will be monitored during pre-construction, construction and operations.
- Modeling has shown that there will be no noise impacts, which exceeds NEPA's day and night time standards for the boundary of an industrial property outside the boundaries of Jamalco.
- Appropriate health & safety protection will be employed using the GoJ's regulatory framework and the NFE's and Jamalco's EHS policies.
- The socio-economic survey showed that 87% of the households sampled were receptive to the project and looked forward to its implementation.
- The construction effort for the project will peak at a workforce of approximately 425 workers spread across the CHP, the gas pipeline, and the electrical substation and transmission infrastructures.
- Some 20 persons will be permanently employed during the operations phase of the project
- The following were among the major concerns raised during the socio-economic survey and voluntary stakeholder consultations:
    - The potential for dust pollution and noise pollution
    - The members of the communities should have first choice for jobs and any other benefits that may accrue from the project.
    - The need to know who will be the insurers of the project
    - They will receive compensation in the event of accidents.

1.5. Conclusions

Our conclusions are as follows:

✓ The project represents a major positive environmental and climate change impact in respect of air quality. In this regard, in its entirety may be considered as a major environmental mitigation and climate change mitigation project.

- ✓ The project has the potential to make a significant improvement in Jamaica's Intended Nationally Determined Contributions (INDC) to greenhouse gas emission long into the future. Consequent on the latter it is a major contribution to the reduction in the impact of global warming and climate change.

1.6. Recommendations

We strongly recommend that NFE, Jamalco and the Government of Jamaica (GOJ) make every effort to maximize the following potential benefits which would come to Jamaica as a result of this project:

- ✓ improved environmental quality,
- ✓ increased climate change mitigation,
- ✓ significantly improved macro and micro-economic benefits,
- ✓ increased job creation,
- ✓ economic growth through reduced fuel import,
- ✓ lower electricity prices,
- ✓ increased diversity of Jamaica's energy mix and development of infrastructure to support renewable energy expansion to the grid,
- ✓ increased competitiveness of Jamalco's operation,
- ✓ increased environmental, economic and social sustainability.

In this regard, we recommend that an environmental permit be granted to New Fortress Energy.

2.0. Description of the Proposed Project

2.1. Background & Context

New Fortress Energy (NFE), the project proponent, retained the services of Conrad Douglas & Associates Limited (CD&A) to carry out an Environmental Impact Assessment (EIA) for the establishment of a 200 MW Natural Gas Fired Combined Heat and Power (CHP) co-generation power station proposed for location at Jamalco's brownfield alumina refinery in Halse Hall, Clarendon (Jamalco). It is proposed to establish the CHP in two phases of 100 MW each.

Jamaica has an installed electricity generating capacity of 994 MW. The installed capacity is primarily fired by Heavy Fuel Oil (HFO). It is distributed among several plants. Going from east to west, the major power station on the coast are:

- Jamaica Private Power Company,
- Jamaica Energy Partner (JEP) barges,
- Hunts Bay,
- Old Harbour Bay, and
- Bogue (Montego Bay)

There are also several other private power generating plants mainly in the bauxite-alumina, cement and sugar industries and other production facilities. Some of the alumina plants are connected to the national grid. Two major exceptions are the 60 cycle Alumina Partners of Jamaica Power Plant, which is not connected to the 50 cycle national grid and Noranda Bauxite.

The table below shows the categories of electricity generation for JPS electricity production.

Table 2: Electricity Generation for JPS Electricity Production

Electricity Generation (MWh)					
	2010	**2011**	**2012**	**2013**	**2014**
Steam & Slow Speed Plants	1,673,386	1,583,387	1,500,498	1,499,306	1,460,625
Gas Turbines Plants	968,752	990,125	942,402	719,134	854,119
Hydro	151665	152157	150,695	124,345	135,955
JPS Net Generation	**2,793,803**	**2,725,669**	**2,593,595**	**2,342,785**	**2,450,699**
JPS Purchases	1,343,496	1,411,178	1,542,319	1,798,473	1,661,428
Total Net Generation	**4,137,299**	**4,136,847**	**4,135,914**	**4,141,258**	**4,112,127**
Losses	902,116	961,357	1,032,891	1,097,208	1,102,700
	21.8%	23.2%	25.0%	26.5%	26.8%

Source: *http://mstem.gov.jm/overview-jamaicas-electricity-sector*

In implementing the Government of Jamaica's (GoJ) energy mix policy the GOJ plans to increase the use of natural gas and renewable energy sources such as hydro-electricity, solar, wind, bio-fuels and bagasse as primary renewable energy sources. The non-renewable fossil fuel sources, which form a part of the energy policy mix consists of coal, heavy fuel oil (HFO). In addition, there is a thrust to increase the efficiency of low efficiency plants through the use of natural gas. The last-named project is exemplified by the recent commissioning of the Bogue Power Plant in which natural gas replaced Diesel Oil.

This project is another initiative with the continued introduction of natural gas in the energy mix policy for electricity generation through the establishment of a natural gas (NG) fired Combined Heat & Power (CHP) generation project. The project is proposed for location at Clarendon Alumina Works' alumina refinery at Halse Hall, Clarendon (Jamalco). It marks a further step in the introduction of natural gas by way of the use of steam as a co-product to supply the needs of the Jamalco alumina refinery for meeting its internal steam and electricity demand. The steam from the CHP will be used by the Jamalco alumina refinery. The electricity from the CHP will be supplied to the national grid. In essence, a low molecular clean and environmentally friendly hydrocarbon is being used to substitute HFO used in two processes. This has a myriad of significant positive benefits to the Jamaican economy and environment.

This project is a part of the larger 390MW NG substitution project with 190 MW already permitted and construction underway at Old Harbour to replace the HFO facilities. 100MW each will be introduced at Jamalco's brownfield alumina refinery operation at Halse Hall, Clarendon, which has been in operation since 1970. The Jamalco bauxite operation has been in operation since 1963.

The proponent of the project is New Fortress Energy (NFE) with registered office in Jamaica at NFE South Power Holdings, Pimento Way, Freeport, Montego Bay, St James, Jamaica.

2.2. Economic Profile

The Combined Heat and Power (CHP) project is vitally important for a number of climate change, environmental, macro and micro economic and social reasons in Jamaica's sustainable development thrust, energy policy mix, economic growth & job creation and Vision 2030.

The 200MW natural gas fired CHP at Jamalco Refinery project is planned for implementation in two phases of 100 MW each. There will be several common infrastructural features and facilities which will apply to both phases of the proposed development. These include land, pipeline and connections for expansion. These common features will tend towards an improvement in the economics of scale of the fully installed 200 MW capacity CHP. This should lead to further increased efficiency and cost effectiveness when the 200MW capacity is fully installed.

The capital cost of the project is approximately US$265 million. The cost of electricity to the national grid is now 13.97 US cents per Kwh (estimated)[1]. It is expected that the cost of electricity to the grid from the CHP plant will be similar to the new Old Harbour 190MW power plant[2]. The estimated rate of return on the investment is expected to be <8%[3] and the payback period is upwards of 20 years.

It is estimated that some 425 jobs will be created during the construction phase and an estimated 20 persons will be permanently employed during operations. There will also be an increased demand for local goods and services during construction and operation. Each new job created will have a multiplier effect of about five (5) for each household.

There will be a significant reduction in:

1. HFO consumption
2. Atmospheric pollution emission
3. Greenhouse gas emission and a concomitant reduction in Jamaica's Intended Nationally Determined Contribution (INDC)

The plant is expected to operate with a 94% average annual availability factor (AF) for its lifetime. The plant has been designed for an operating life of 25 years and its design was done to meet the requirements of the regulatory framework.

2.2.1. Macro-economic

The reduction in electricity cost and the reliability of supply has the potential to make a major positive impact on Jamaica's economic growth and development. It will result in a significant reduction in the country's import bill for fuel. The project will result in an increase in the competitiveness of Jamaica's industrial and agricultural products. It will promote an increase in import substitution and provide the potential for an increase in foreign exchange earnings through greater exports.

---

[1] *Estimated cost of marginal generation*
[2] *Assumptions related to inputs*
[3] *Takes into account all associated investments*

2.2.2. Micro-economic

The local economy will benefit from the planning, construction and operation of the CHP. Jobs will be created and local goods will be required by the workers on site. Living standards will improve with increased employment and earning and with reduced electricity costs.

2.2.3. Jamalco's Production and Competitiveness

Jamalco currently generates a nominal 700,000 to 750,000 lb/h of 900 psig/900° F process steam through multiple heavy fuel oil (HFO) fired boilers. A nominal 40 MW electrical power is generated through multiple back pressure steam turbine generators which reduce the steam to approximately 60 psig for process uses.

Among the objectives of the CHP plant is to reduce Jamalco's HFO-based steam production without increasing overall steam production quantities.

The CHP plant would base-load the process steam production while Jamalco's HFO-fired boilers would produce the balance of the required process steam production.

The modern design of the CHP plant will not only serve as a low-cost energy source for Jamaica and low-cost steam supply for Jamalco, but by burning natural gas, will also represent a significant environmental and climate change mitigation improvement over the existing Jamalco HFO fired boilers. The competitiveness of Jamalco's product alumina will also improve.

The efficiency upgrade of Jamalco's alumina refinery (from 1.4 to 2.8 MTPY) which was permitted, was aborted because HFO could not be used for the upgrade without adversely impacting on air quality. The constraints imposed by the use of HFO are no longer existent and it is now possible to upgrade the efficiency of the alumina refinery, if required. This presents an opportunity for capital investment, major increase in revenue (foreign exchange earnings) and significant increase in job creation, while at the same time improving environmental quality and climate change mitigation.

Jamalco will see the following benefits:

- Cost of steam generation will be reduced
- Transportation of fuel will be reduced
- Risk of fuel accidents will be reduced
- Reduction in atmospheric pollution
- Reduction in overall operating cost
- Unit cost of alumina will be reduced

The competitiveness of Jamalco in the global alumina market will be increased.

2.3. Methane

Methane (CH_4) is a naturally occurring gaseous substance that is referred to as marsh gas, swamp gas, natural gas, bog gas or biogas that is associated with the decomposition of organic matter in mainly oxygen limited environments.

Methane (NG) is, however, a colourless and odourless gas and liquefied methane (LNG) is a colourless odourless cryogenic liquid. Methane is non-toxic, however, it is a simple asphyxiant as it displaces oxygen making it difficult for humans to breathe. This condition is totally reversible once exposure is discontinued.

The discovery of methane was due mainly to its ability to ignite in air. Fires in swamps and marshes got the attention of scientists in the 18th century and it was soon discovered that the compound responsible for the fires was methane. It has a lower explosion limit of approximately 5% and upper explosion limit of 15- 17% at standard pressure. This property has as well as the high energy density of methane has led to the gas being integral in the energy sector of many countries for the last 2 centuries. Methane burns to produce predominantly carbon dioxide and water and energy that can be harnessed to do work. The high amount of energy emitted compared to its low molecular mass makes methane the highest energy density hydrocarbon with relatively little pollutants being emitted. These advantages make methane a very attractive source of energy in this era of climate change.

Methane is also an important greenhouse gas which aids in maintaining global temperatures at a level that is habitable for mankind. The natural global background concentration of methane has been increasing and it is therefore impacting the progress of climate change. Methane is a significantly more efficient greenhouse gas than CO_2 therefore its release into the atmosphere is to be controlled. Worldwide background concentration has been increasing with industrialization and increased agricultural activities. The background concentration approximately 1.9 ppm[4] up from approximately 900 ppb a century and a half ago[5].

The distribution of contributors to the emission of methane in Jamaica is presented below. The waste sector contribution includes the management of solid and liquid waste with emissions from the decomposition of waste. The energy sector emissions are typically from unburnt fuel during combustion and volatilization during storage.

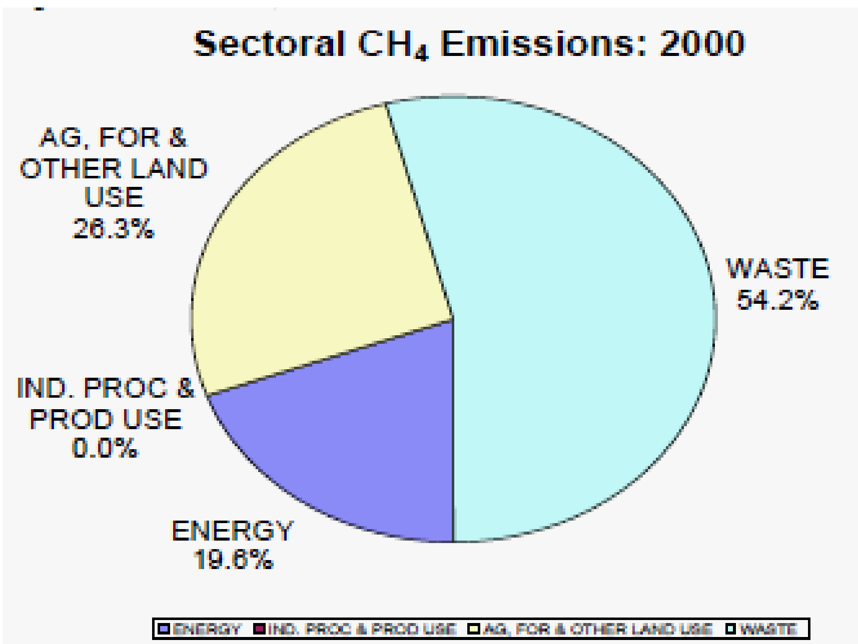


Figure 3. Contributors to methane emissions in Jamaica. Source: (Ministry of Local Government and the Environment and Disaster Unit, Jamaica, 2011)

[4] https://www.esrl.noaa.gov/gmd/obop/mlo/programs/esrl/methane/methane.html
[5] E. J. Dlugokencky L. P. Steele The growth rate and distribution of atmospheric methane P.M. Lang, K. A. Masade JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 99, NO. D8, PAGES 17,021-17,043, AUGUST 20, 1994

The CHP will reduce emissions of methane from both combustion and storage of the fuel. This should therefore result in an overall improvement in the methane emissions. The state of the art safety features and the heavy regulation of the industry make methane use as a fuel for power generation very attractive to utilities. The price of natural gas and its available accessible reserves also makes it attractive for investment in the long term.

2.4. Major Components of Project

The proposed project consists of the following major components:

1. Installation (build out) of a pipeline under the seabed to deliver Natural Gas (NG) from a permitted Floating Storage and Re-gasification Terminal (FSRT) in the Portland Bight Protected Area (Old Harbour Bay) to the Jamalco owned and operated Rocky Point Port.
2. Installation of a pipeline from the Rocky Point Port to Jamalco Refinery at Halse Hall for delivery of Natural Gas to the proposed new CHP.
3. Construction of a new 200 MW natural gas fired power station at Jamalco's brownfield alumina refinery located at Halse Hall, Clarendon. It is proposed to install the plant in two phases of 100 MW each.
4. Installation of a pipeline to deliver steam from the new power station to Jamalco boiler steam headers.
5. Tie-in of the Jamalco potable fire and domestic water and condensate feedwater to the CHP
6. Tie-in of the CHP run-off water (storm water) to the Jamalco storm water drain system
7. Tie-in of the CHP blowdown and process water drains to the Jamalco process water system
8. Tie-in of the CHP sanitary drains to Jamalco sanitary drains system
9. Construction of a 138 kV substation
10. Construction of an electricity distribution network to deliver power to the National Grid

As stated in 1 above, natural gas supply to the pipeline and the power station will be from an already permitted Floating Storage and Re-gasification Terminal (FSRT) located in the Portland Bight Protected Area.

For Phase 1, a nominal 100 MW combustion turbine CHP project would send approximately 300,000 to 440,000 lb/h of 900 psig/900°F process steam to Jamalco and have a separate power sales agreement with Jamaica Public Service (JPS) for the entire net CHP plant electricity output capability.

The Phase 2 expansion would bring the total steam production to 600,000 to 740,000 lb/h with an additional 100 MW of electricity being produced. As stated above, both phases would amount to the total of 200 MW, nominal electricity generation capacity.

Typically, a large portion (approximately 2/3) of the energy inputted for the generation of electricity is wasted in the form of heat energy which is normally discharged or lost to the atmosphere for most power station. CHP is an electricity generation facility that uses the heat that would have been lost, to provide useful thermal energy in the form of steam or hot water.

Jamalco currently generates a nominal 700,000 to 750,000 lb/h of 900 psig/900°F process steam through multiple heavy fuel oil-fired boilers. A nominal 40 MW electrical power is generated through multiple back pressure steam turbine generators which reduce the steam to approximately 60 psig for process uses.

The intent of the CHP project is to reduce heavy fuel oil based steam production without increasing overall steam production quantities. The gas-fired CHP project would operate as a baseload generator of the steam production while Jamalco's liquid fuel oil-fired boilers would produce the balance of the steam production.

Fuel for the generation of electricity will be conveyed to the CHP plant from a FSRT in the Portland Bight – Old Harbour Bay Area via a pipeline to be installed during Phase 1 of this project. The pipeline will be installed below the seafloor from the FSRT to Jamalco's Rocky

Point Port. The installation of the pipeline conveyance system will continue overland (buried beneath the surface north and east as influenced by the orientation of the alignment of the rail line) from the port to the southwest corner of the Jamalco alumina refinery property.

The combustion of the natural gas (NG) will result in the generation of steam as outlined above as well as generation of electricity. The electricity will be transmitted to the national distribution grid via a substation and transmission network to be established during Phase 1 of this project. The layout for the delivery and the distribution network of the project is illustrated in Figure 4 below.

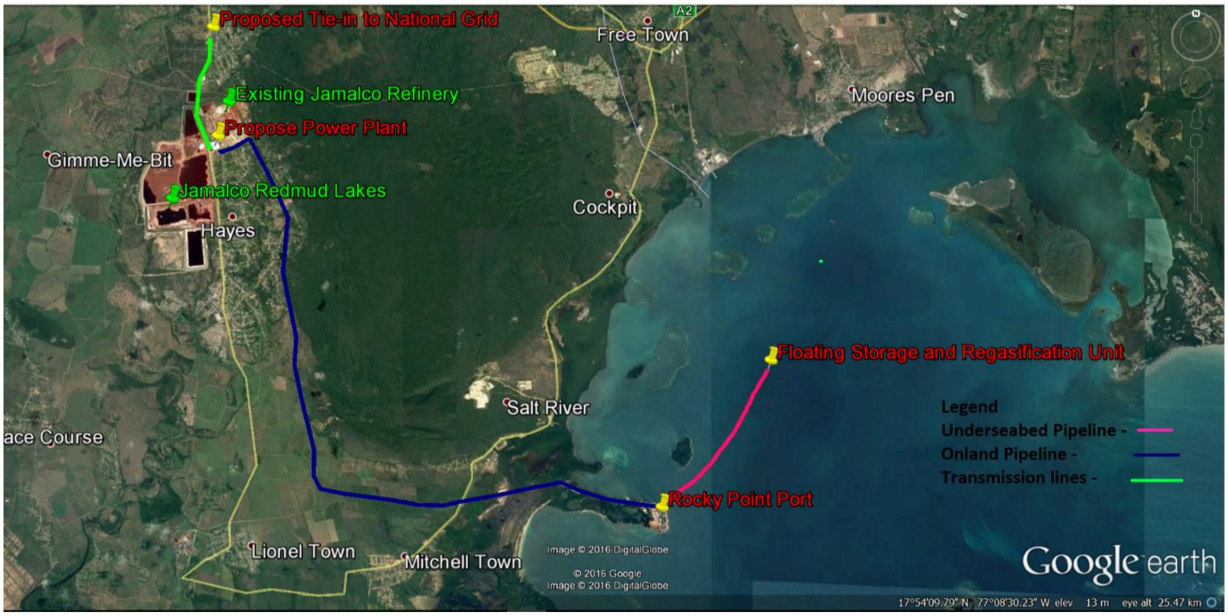


Figure 4: Proposed project location plan and layout

2.4.1. Natural Gas Pipeline

The project proposes to install a pipeline for the conveyance of natural gas from the Floating Storage and Regasification Terminal (FSRT) to the electricity generation facility.

The pipeline will be onshore (buried) and offshore (under the seafloor) and will be made of carbon steel of up to 16 inches in outside diameter (40.64 cm). The construction/installation of the pipeline will extend from the offshore regasification platform to the on land Jamalco Refinery.

The total length of this pipeline is approximately 22,400 meters with approximately 5,600 meters of this length being offshore (below the seabed). The natural gas pipeline system will have a receiver, filter, meter/regulator skid, and control building. Flow rate and pressure in the subsea pipeline will be continuously monitored and recorded at the onshore pipeline facility. A metering facility will be constructed at the on-shore end of the pipeline to measure the gas before it enters the Jamalco facility. This facility will be constructed to allow additional connections for gas distribution to future customers as demand requires.

It is proposed that the pipeline be trenched to at least a depth of 1 meter (measured from the existing ground/seabed to the top of the pipe). In addition, parts of the pipeline will be directionally drilled using a horizontal directional drill (HDD) where needed along the planned route spanning the tie in the metering facility at Jamalco to the terminal offshore. The length of the HDD, where needed, will allow the proposed pipeline to go under corals, seagrass beds, road crossing and safety zones as necessary. The onshore portion of the pipeline will shadow the existing Jamalco rail system (reservation) from Rocky point all the way to the Jamalco alumina refinery.

It is proposed to transport the natural gas to shore via an ~22.4 km pipeline (See Figure 5 below) with an operating pressure of 41.4 barg, and design pressure of 95 barg. The pipeline is expected to have a diameter of up to 16 inches comprising material similar to API 5L Grade X65 PSL2 and a preliminary thickness of 21.4 mm. The final wall thickness will be determined based on pressure requirement, buoyancy, and seismic analysis, type of cathodic protection system, and other factors. The proposed leak detection system is a HIMA LDS that uses Enhanced Pressure Wave (EPW), Compensated Volume Balance (VBM), and Pressure Drop (PDM) and leak detection.

The origin of the pipeline from the FSRT platform is:

- LAT: 17°50'40.15"N
- LONG: 77°06'58.09"W

At on-shore tie-in:

- LAT: 17°49'8.21"N
- LONG: 77° 8'38.84"W

At Jamalco Gas Metering:

- LAT: 17°54'1.93"N
- LONG: 77°14'14.40"W

The design of the pipeline will be in accordance with ASME B31.8. A seismic analysis of the pipeline will be performed during detailed design. The pipe will be coated with a corrosion coating and where applicable either an abrasive resistant overlay coating or a concrete weight coating. The concrete weight coating is to ensure on-bottom pipeline stability under environmental loading (wave, current, and buoyancy). The concrete coating will also provide impact protection. Bracelet type aluminum alloy anodes will be installed on the pipe to provide corrosion protection in addition to the corrosion coating. These anodes will be installed at pre-determined locations along the pipeline length.

Venting of natural gas will only be done in the event of an emergency. Continuous venting is not considered under normal operations. This is not good industry practice and will be avoided.

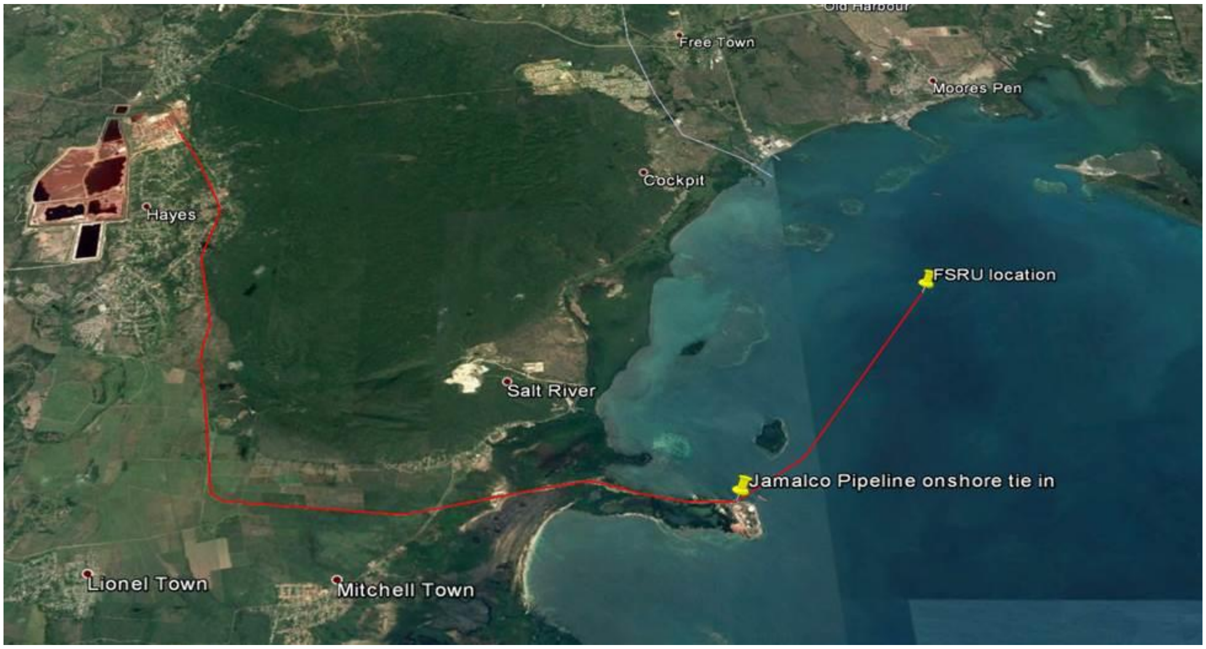


Figure 5: Pipeline Route

The inlet pressure at the FSRT into the pipeline is (bar) 70 barg, while the gases will enter the outlet facility at a pressure (bar) 27.5 barg. The pipeline layout showing property boundaries over its length is shown in Figure 6.

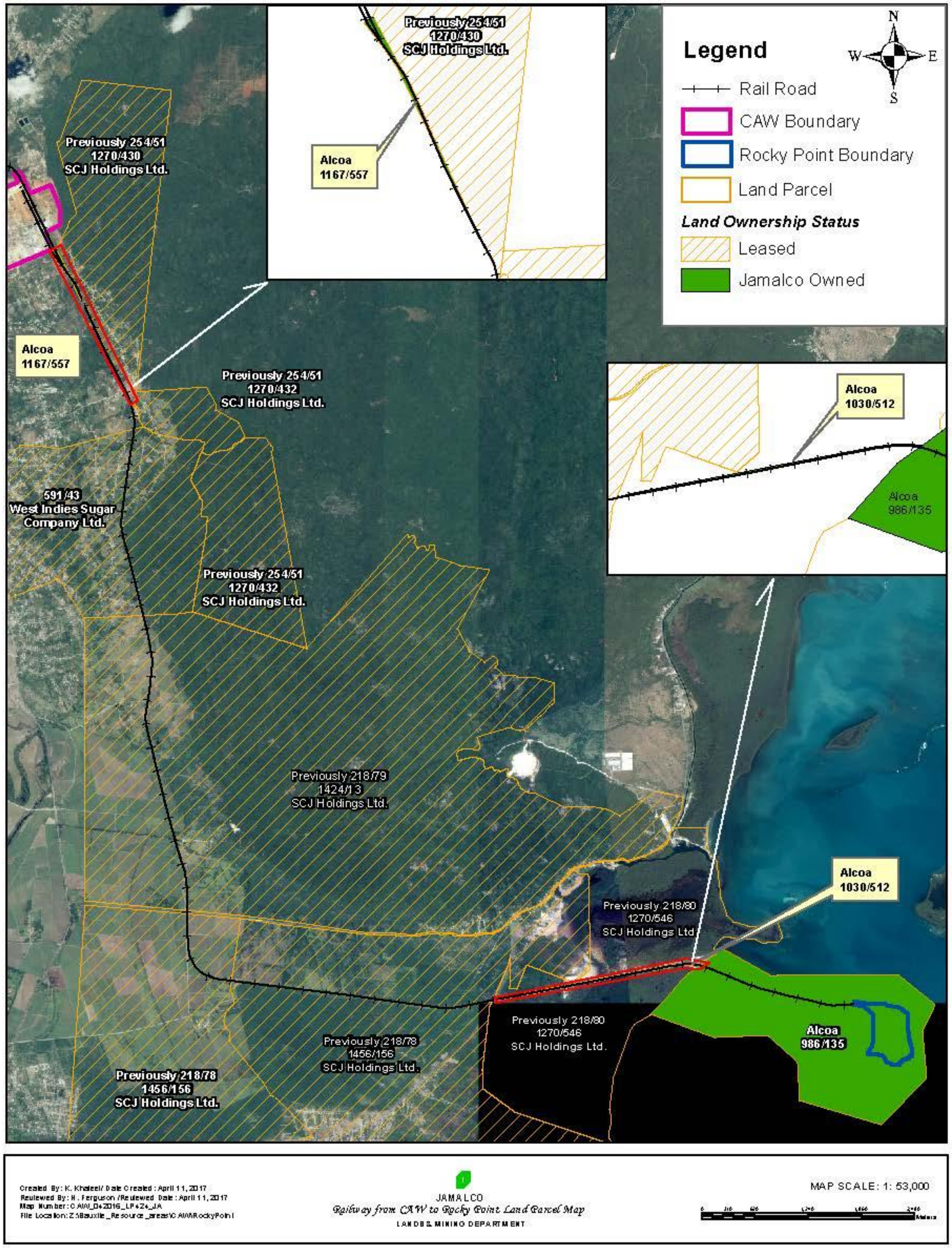


Figure 6: Pipeline Route with Property Ownership Information

2.4.2. Proposed Power Station Technical Specifications

The proposed Phase 1 CHP plant will consist of a nominal 100 MW combustion turbine cogeneration plant. The plant's configuration consists of combustion turbine generators (CTGs) with heat recovery steam generators (HRSGs) installed on each CTG. The combustion turbines will be dual fuel, utilizing natural gas (LNG) as the primary fuel and automotive diesel oil (ADO) as the emergency back-up fuel.

The CTGs will utilize dry-low NO_x (DLN) combustors with 25 ppm NO_x and 15 ppm CO emissions limits while firing natural gas and 74 ppm NO_x and 20 ppm CO emissions limits while firing ADO. SO_2 emission when using ADO is projected at 95 ppm.

Natural gas will be supplied by NFE at a pressure that does not require additional compression to the southwest corner of the project boundary. Estimated phase 1 natural gas usage is 25,000 to 35,000 cm^3/h, based on 38,000 Btu/cm^3 conversion factor. The exhaust gas from each combustion turbine is ducted to the associated HRSG for generating the steam which will be piped to the Jamalco facility's existing boiler steam header for tie-in.

The HRSGs will be single pressure, non-reheat type. HRSG bypass dampers and stacks will be included to allow each CTG to operate in simple cycle mode should steam not be required by the Jamalco facility.

De-aerated and chemically treated condensate will be piped to the new plant from the existing Jamalco Boiler Feed Pump (BFP) suction piping via new boiler feed pumps and deaerator located near the Jamalco facility's powerhouse. Steam from each HRSG will be combined into a common header and piped to the existing Jamalco facility's powerhouse area and tied into the nearest boiler steam header. A new above grade pipe rack or T-stands will be required between the existing powerhouse and the CHP plant area for routing the interconnecting utilities.

Auxiliary equipment cooling will utilize a closed cycle cooling water system and air-cooled heat exchanger for each CTG. Expected cooling loads are CTG generator and lube oil, air compressors and sample panel.

ADO will be utilized as an emergency back-up fuel. The back-up ADO fuel system will consist of a storage tank sized for at least one day's fuel consumption. New ADO delivery truck and rail car unloading facilities will be provided, as required, for re-filling the plant's ADO tank. Demineralized water will be required for water injection. The demineralized water system will consist of a storage tank sized for at least one day's water consumption, a truck unloading system, reverse osmosis and electro-deionization (EDI) system.

Other mechanical/chemical systems anticipated include instrument/service air with new air compressors and dryers, fuel gas supply and conditioning, steam cycle sampling and analysis, site fire protection (new underground headers, hydrants, and distribution only from water supply by Jamalco), sanitary drains, process water collection drains (including oil-water separator effluent), service water distribution, and potable water distribution with new safety showers where required.

In addition to the CTG electrical equipment, Phase 1 major balance-of-plant electrical equipment will include generator step-up transformers, station service transformers, CTG start transformers, 13.8 kV switchgear enclosures, Secondary Unit Substation (SUS) transformers, pre-fabricated power distribution center(s), and an emergency backup black start diesel generator. Balance-of-plant equipment enclosures are expected to include power distribution centers, continuous emissions monitoring system (CEMS) enclosures, 13.8 kV switchgear enclosures, and steam cycle sampling and analysis enclosure. These enclosures are anticipated to be each shop-fabricated and shipped as a packaged unit to the site.

A new standalone DCS control system will be included for the new CHP plant and located in a new administration/control/warehouse building. The CHP plant DCS control system will have communication ability with the existing Jamalco facility's control system.

Galvanic anode cathodic protection systems will be required for underground metallic piping such as fuel gas and closed cycle cooling water. Underground HDPE piping will be utilized to the maximum extent possible where not limited by system design conditions.

Lightning protection system is only anticipated for the administration/control/warehouse building as the steel structures and stacks will provide adequate protection for the CTGs, HRSGs, and exhaust stacks.

Figure 7: Proposed location of CHP Station within Jamalco's existing Plant

2.4.3. Thermal and Water Process Description

The proposed natural gas fired Combined Heat and Power (CHP) station at Jamalco alumina refinery will utilize dual fuel (natural gas and ADO) capable combustion turbine generators (CTGs) to produce electricity for supply to Jamaica Public Service Company. A heat recovery steam generator (HRSG) will also be installed with each CTG to utilize hot combustion exhaust gas in the conversion of boiler feed water to nominal 900 psig/900 F steam. The steam will be used by Jamalco for electrical power production through their existing steam turbines and existing process use.

Condensate will be piped to the new CHP plant from the existing Jamalco facility via new boiler feed pumps located near the existing Jamalco powerhouse. Steam from each HRSG will be combined into a common header, piped to the existing powerhouse area, and tied into the existing boiler steam header for use by Jamalco.

General plant water needs will be satisfied through an interface with existing Jamalco water supply system that will satisfy service water, potable water, and fire water demands of the new facility. In addition to general plant service water and potable water demands, the new facility will include fire water distribution headers and hydrants in accordance with local regulations. New fire water and or service water storage tanks are not anticipated other than demineralized water storage noted below.

A new oil-water separator for collecting potentially oily plant drains will be utilized and non-oily effluent directed to a new process water collection sump. Collected oil will be transported via truck to an appropriate off-site disposal facility. The non-oily water collected in the sump will be directed to the existing Jamalco process water system. New sanitary drains will also be directed to the existing Jamalco sanitary drains system. New storm water drains, as required, will be directed to the existing underground storm water drains system.

The CTGs will utilize dry-low NO_x (DLN) combustors that do not require water injection for NO_x emissions control while burning natural gas fuel. However, water injection may be necessary for liquid ADO fuel combustion NO_x emissions control. The ratio of ADO to water injection will be no more than one to one. To meet this requirement, demineralized water storage will be utilized. The demineralized water will also be used for occasional water washing of the CTG blades. Wash water will be disposed off-site (trucked).

The demineralized water treatment system will utilize Jamalco service water as the raw water source. The treatment system will consist of a reverse osmosis (RO) system followed by an electro-deionization (EDI) system. Drains and reject water from the treatment system will be directed to the process water collection sump noted above. The demineralized water storage and forwarding system will consist of storage tank, a truck unloading station (for optional off-site water supply), and water forwarding pumps to the CTGs.

Auxiliary equipment cooling will utilize a closed cycle cooling water system and air-cooled heat exchanger for each CTG.

The details of inputs and outputs of the power station are present in the block diagram in Figure 8. The details of the interconnection to the Jamalco system will be provided with the site design. Water mass balances are for the CHP are provided in Figure 9 and Figure 10 below. The proposed CHP tie-in with Jamalco's systems for condensate, steam, water supply, sanitary drains, storm water drains, and process water drains for both proposed GE and Siemens Plants are shown in Figure 11 and Figure 12 below, respectively.

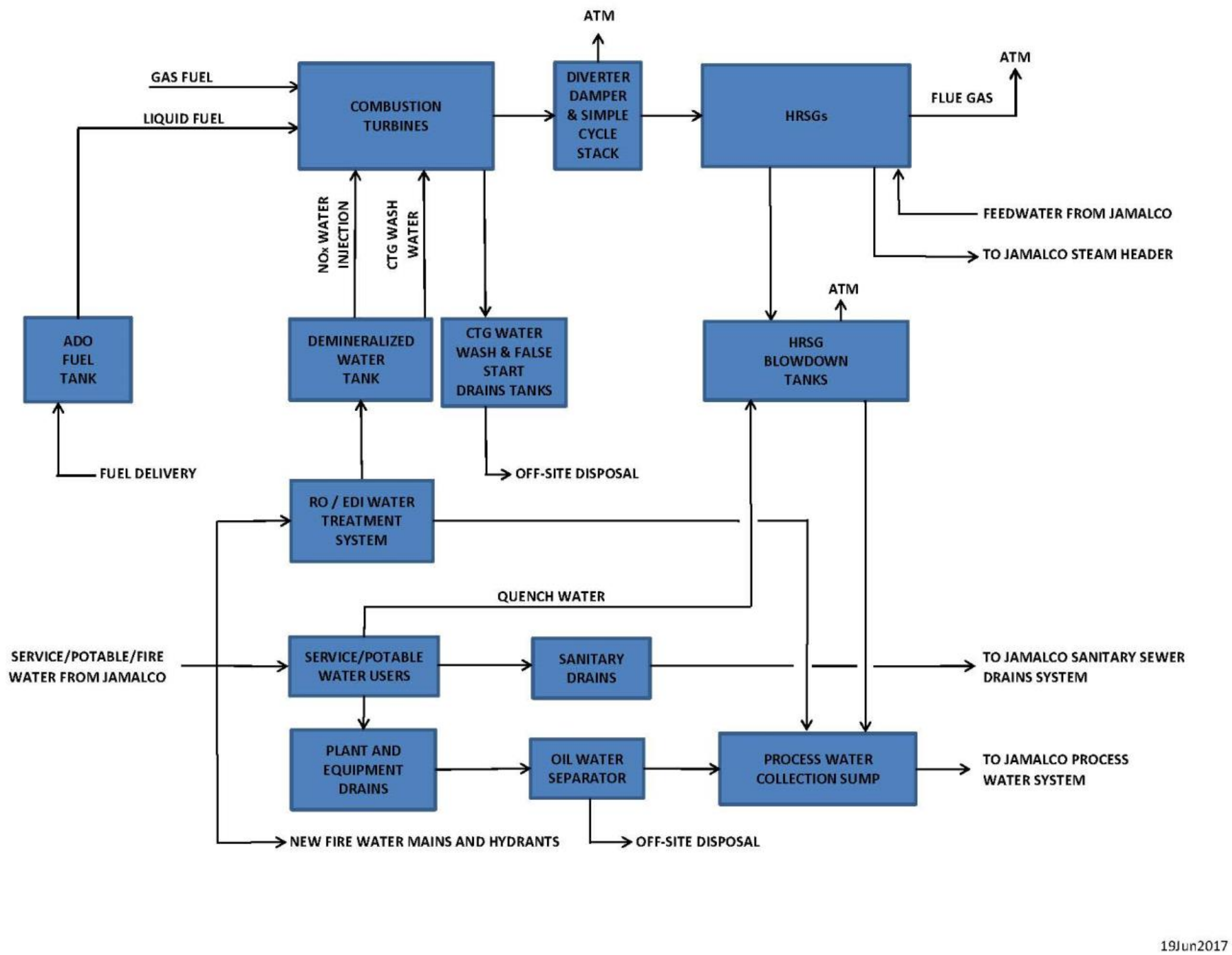


Figure 8: Flow chart for resources and outputs of the proposed CHP plant at Jamalco

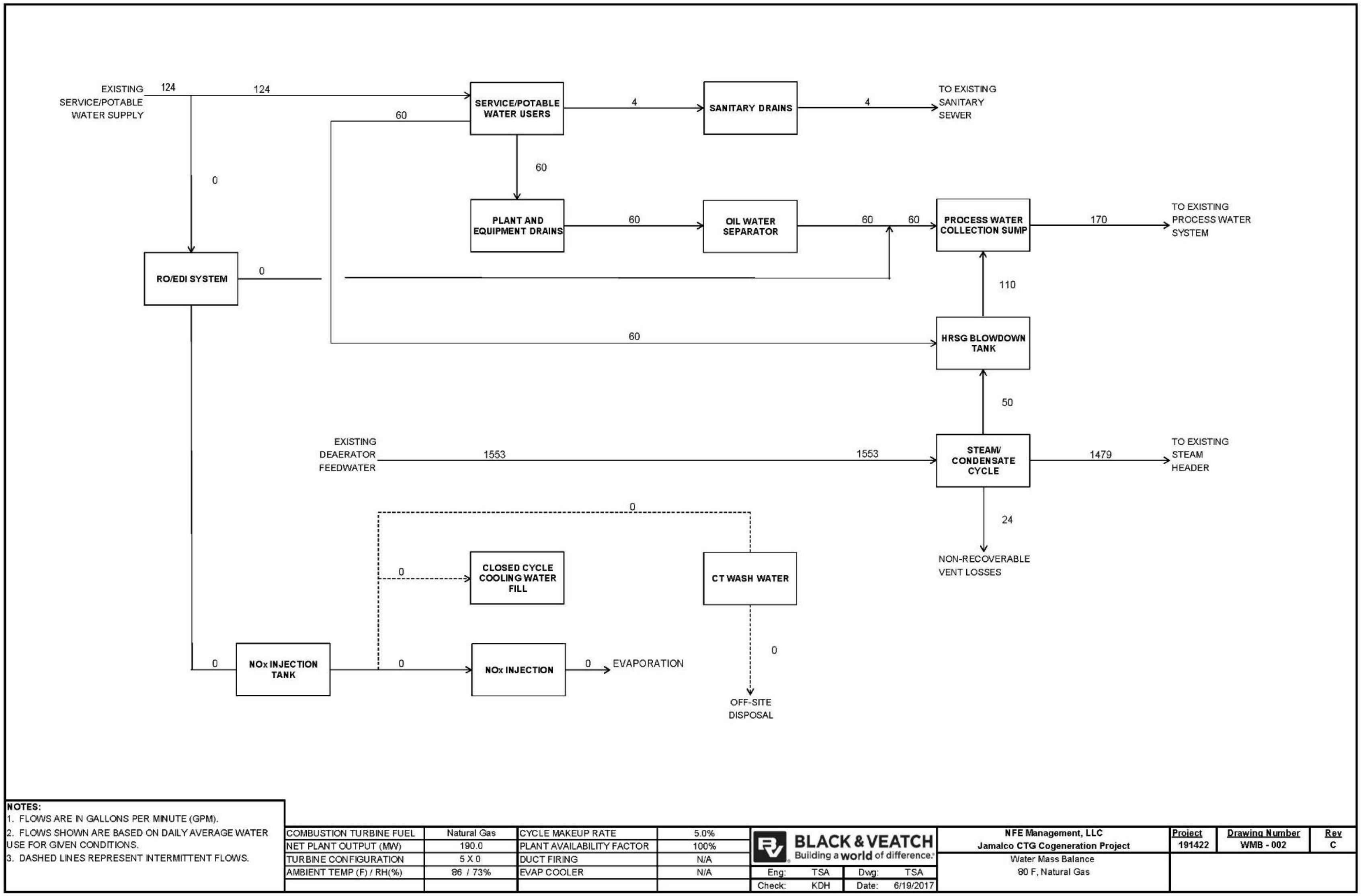


Figure 9: Water Balance – Natural Gas

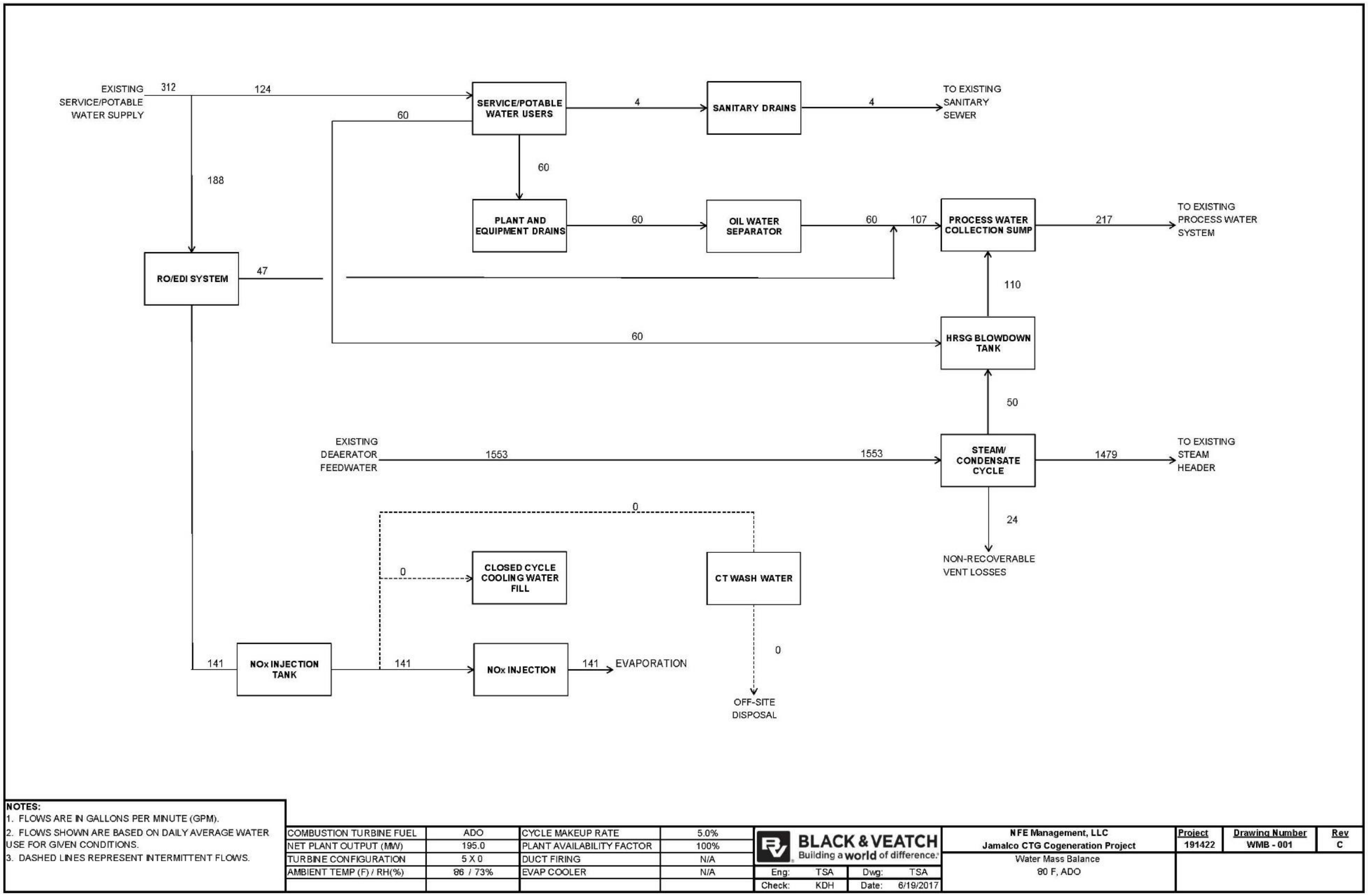


Figure 10: Water Balance – Automotive Diesel Oil (ADO)

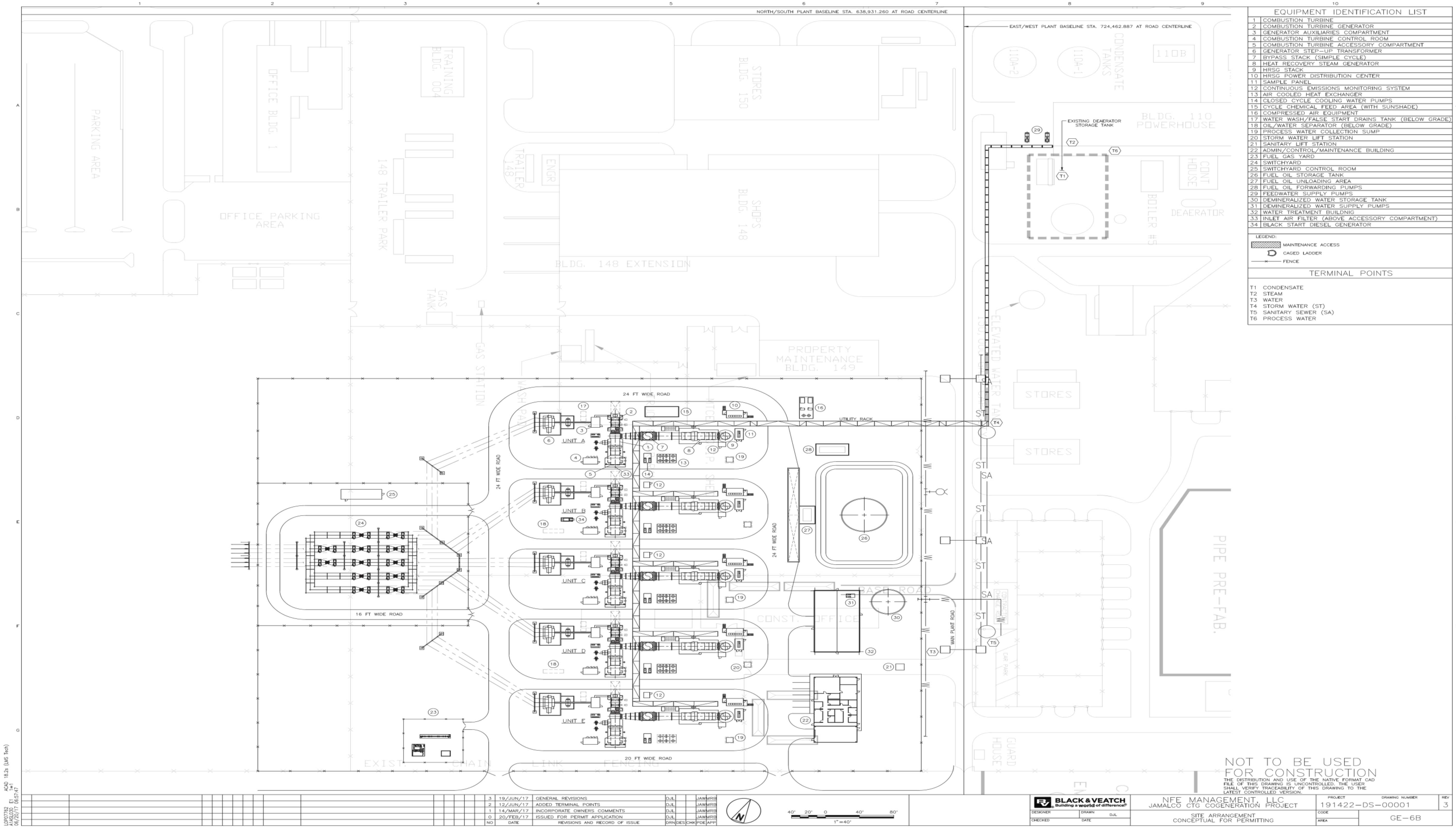


Figure 11: Proposed CHP Tie-in with Jamalco's systems for Condensate, Steam, Water Supply, Sanitary Sewer Drains, Storm-water Drains and Process Water (GE Plant)

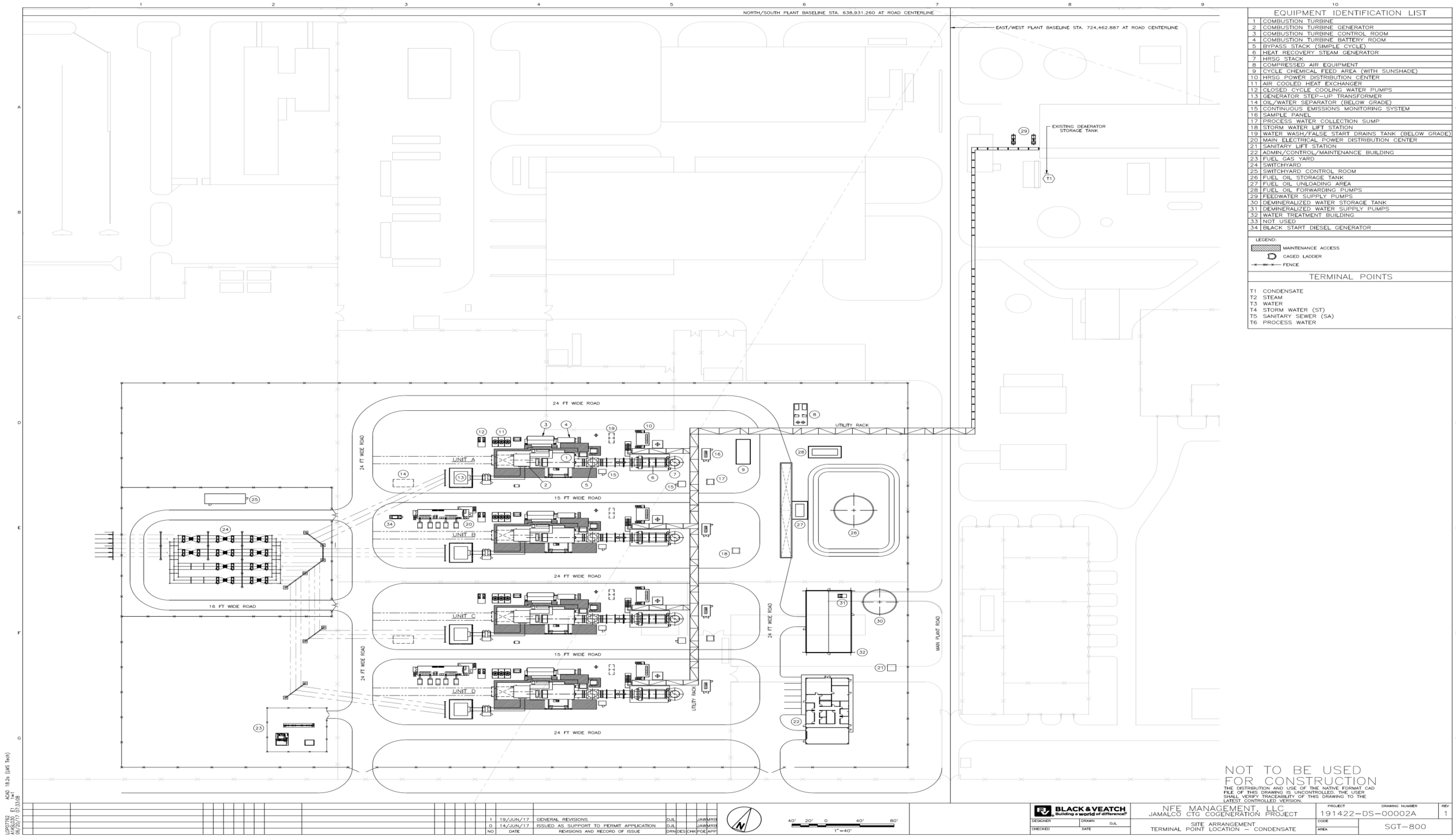


Figure 12: Proposed CHP Tie-in with Jamalco's systems for Condensate, Steam, Water Supply, Sanitary Sewer Drains, Storm-water Drains and Process Water (Siemens Plant)

2.4.4. Proposed Substation and Transmission Line Specification

The Phase 1 project will also include a new 138 kV substation located adjacent to the CHP plant and an approximately 3 mile single-structure, double-circuit transmission system to the north for tie-in to an existing 138 kV distribution system that passes from east to west through Halse Hall.

This transmission system will provide power into the Jamaica Public Service Company's electrical distribution system. Refer to Figure 4 for proposed distribution route. The 138kV substation is a breaker and a half configuration with three (3) incoming slack spans from generation step-up transformers and two (2) outgoing line positions. The substation will be treated as a separate entity from the CHP Plant and not share common infrastructure (station power, communication, etc.) aside from points of interconnection. All control and protection relays and panels will be contained in a control building. A metering system is used in order to measure net energy output from the plant, and to monitor and co-ordinate operation of the facility.

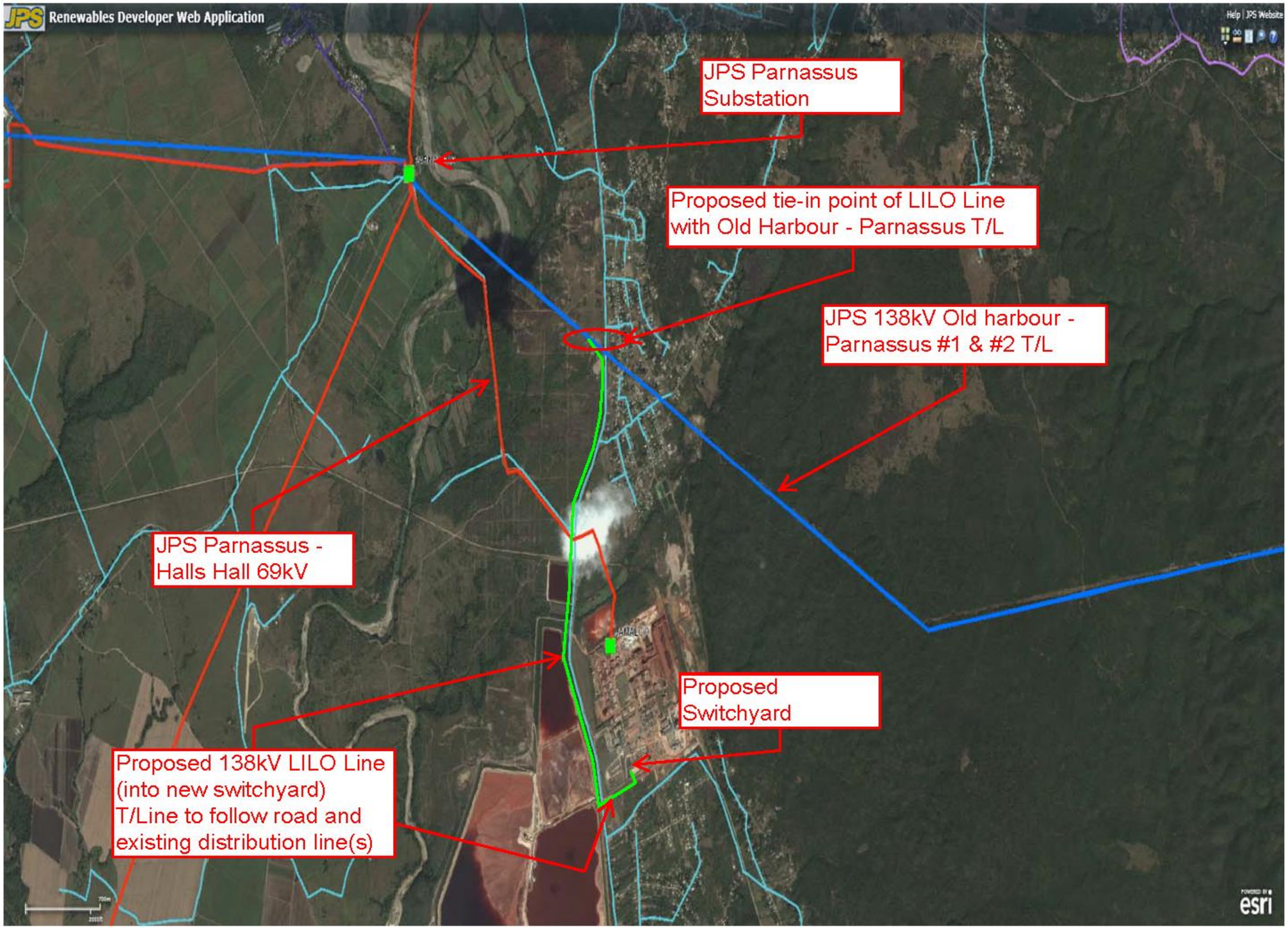


Figure 13: Preliminary layout of electricity Transmission Lines

2.4.5. Automotive Diesel Oil (ADO)

Automotive Diesel Oil (ADO) will be used as back up fuel in the CHP Combustion Turbines installed at the Jamalco brownfield alumina refinery, the location of the CHP.

A 15,000 bbls ADO storage tank will be installed within the Jamalco alumina refinery or CHP facilities. The tank will be able to accommodate the 1½ day storage for the 100MW build out to be located within the NFE CHP facility will be constructed. The proposed new ADO storage tank is shown in the yellow highlighted area on the preliminary plant arrangement in Figure 14.

The CHP Combustion Turbines will be used to supply electricity during scheduled NG systems maintenance operations as well as during emergency shutdowns, which could occur, for example, after a hurricane. For this reason, the storage capacity of ADO would be sufficient to cover up to three weeks supply to the power station. The volume of ADO in storage will be up to 232,000 barrels (7.308 million gallons) distributed across two (2) locations to guarantee the stability of supply and operation during emergency conditions. The volume of ADO to be transported during emergency is ~5,500 barrels/day. This is estimated to take place over a period of three weeks maximum (assuming the elapsed time for returning to normal operations, after an emergency, is up to 3 weeks).

The two (2) locations for ADO storage for emergency conditions are located off the alumina refinery site. These are outlined below:

2.4.5.1. Rocky Point Port New Tank

Storage tanks will be constructed at the Rocky Point Port onshore facility with a capacity of up to 132,000 barrels. The storage tanks will be constructed within a containment bund in close proximity to the existing Jamalco Rocky Point HFO storage tanks. These ADO tanks will provide a back-up fuel source to the NFE CHP plant, in case of interruptions in NG delivery due to hurricanes or other factors. The ADO will be supplied by ship as necessary and off loaded using new lines to transport the ADO from the dock to the storage tanks. The ADO storage tanks will each be located inside containment bunds sufficient to hold 120%

of the volume of one tank (See Figure 15 and Figure 16) in compliance with the *Natural Resources Conservation Authority Guidelines for Secondary Containment of hazardous Liquids stored above-ground*. Each tank will be fitted with instrumentation to automatically shut down refilling operations to prevent spillage. Under regular conditions, the ADO from storage will be transported to the plant via the rail system.

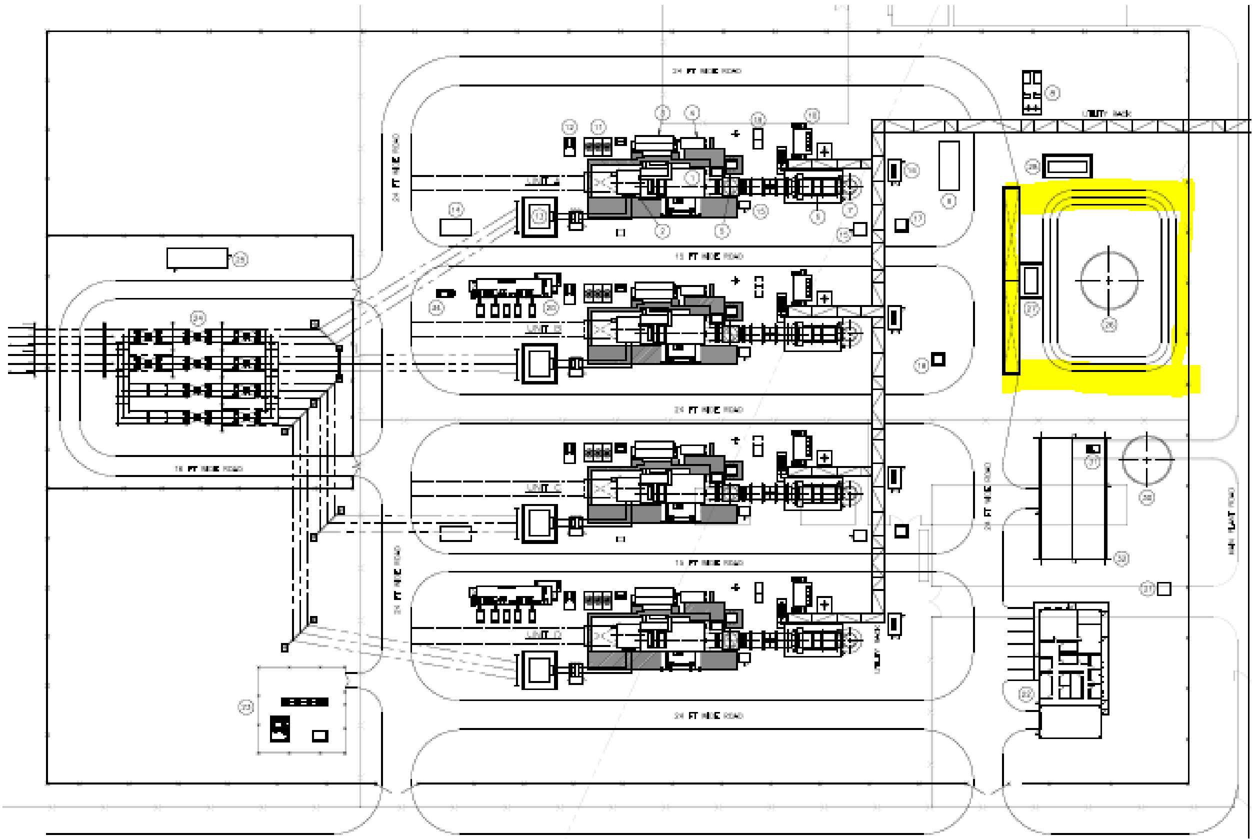


Figure 14: Proposed location of newly constructed ADO storage tanks on Jamalco's alumina refinery

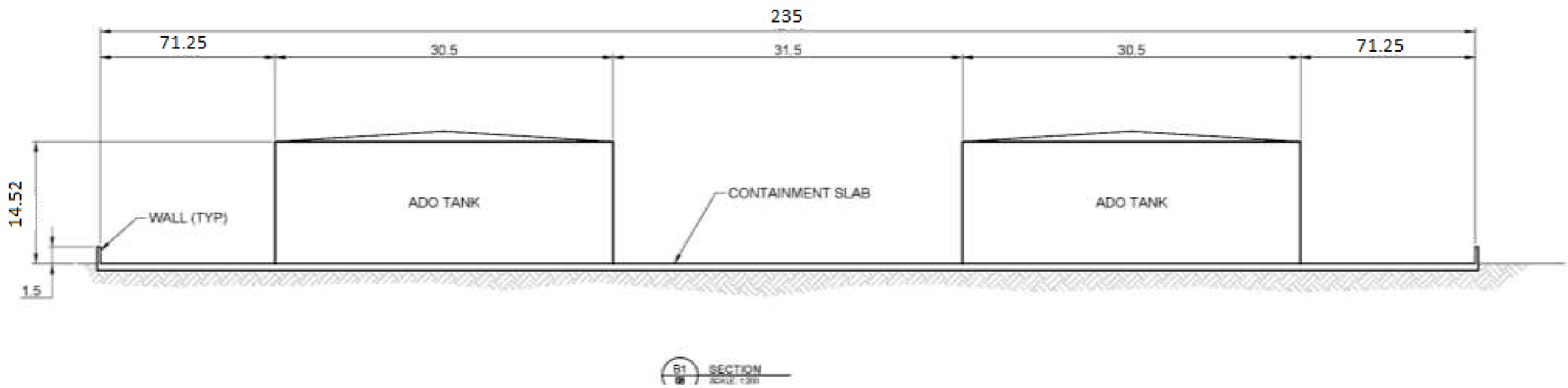


Figure 15: Design for ADO Storage Tank at Rocky Point Port

Figure 16: Proposed ADO Storage Tanks at Jamalco Rocky Point Port

2.4.5.1. Proposed ADO Storage at JPSCo Old Harbour

The use of the already permitted ADO storage facilities at the Old Harbour Power Plant consists of two (2) 50,000 barrel tanks in close proximity to the 190MW gas fired power station, which is now under construction. ADO will be delivered to the Jamalco CHP plant using road fuel tankers along Highway 2000 east-west.

In summary, two (2) sources and routes of supply of ADO to the CHP system during emergency conditions are being proposed. These are as follows:

a. Supply from newly constructed facility on NFE leased property at the Rocky Point Port to store of up to 132,000 barrels of ADO in two (2) tanks (See Figure 16 above). Delivery will be by:
    i. rail from Port to Plant
    ii. road from Port to Plant under emergency conditions
b. Supply from the already permitted facility at Old Harbour Bay under emergency conditions. Delivery will be by:
    i. road to the Jamalco ADO storage tanks via Old Harbour Bay Main Road to Highway 2000 at Mineral Heights and to Halse Hall Main Road followed by delivery to Jamalco

2.5. Codes and Standards

The design and specification of work will be in accordance with applicable Jamaican laws and regulations, and local codes and ordinances. The World Bank/NEPA Guidelines and Planning Standards for the LNG Sector in Jamaica will be adhered to. United States codes and industry standards used for design, fabrication, and construction will generally be as listed below and could be used where applicable. Similar international standards could be used for equipment and components sourced outside of the United States.

- American Concrete Institute (ACI)
- American Institute of Steel Construction (AISC)
- American Iron and Steel Institute (AISI)
- American National Standards Institute (ANSI)
- American Petroleum Institute (API)
- American Society of Civil Engineers (ASCE)
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- American Society of Mechanical Engineers (ASME)
- American Society for Nondestructive Testing (ASNT)
- American Society for Testing and Materials (ASTM)
- American Water Works Association (AWWA)
- American Welding Society (AWS)
- Compressed Gas Association (CGA)
- Concrete Reinforcing Steel Institute (CRSI)
- Heat Exchange Institute (HEI)
- Hydraulic Institute (HI)
- Illuminating Engineering Society (IES)
- Institute of Electrical and Electronics Engineers (IEEE)
- Instrument Society of America (ISA)
- Insulated Cable Engineers Association (ICEA)

- International Building Code (when no local codes prevail)
- National Electrical Safety Code (NESC)
- National Electric Code (NEC)
- National Fire Protection Association (NFPA)
- Steel Structures Painting Council (SSPC)
- Tubular Exchanger Manufacturers Association (TEMA)

2.6. Civil Works

The civil works to be carried out will be subjected to engineering designs based on the geotechnical investigation and topographical surveys. The design and philosophy of the suitable foundation type will be based on the soil investigation.

Jamalco made available for Black & Veatch's review two geotechnical studies previously completed at the facility; Copper State Engineering, Inc. April 2002 and Golder Associates December 2004. These were reviewed by Black & Veatch and incorporated into their conceptual design. <u>The review did not indicate any special measures that must be taken with regard to civil works or foundation design</u>.

2.7. Structural and Foundation Design Approach

A geotechnical investigation at the specific locations of the new CHP equipment and structures is planned for completion during third quarter 2017. The results will be used during the detailed design phase of the project.

In addition to the new buildings and equipment enclosures shown on the plant arrangement drawing, the only additional significant structures include the HRSGs and utility racks for piping and electrical cable tray. The HRSGs and utility rack will be support by standard structural steel beams and columns bolted to a concrete foundation.

Plant design building code, wind, and seismic requirements are as follows:

General Design Data	
Building Code	Jamaican Standard JS 306 / International Building Code 2012
Risk Category	III
Nominal Site Elevation (Mean Sea Level), m (ft)	49 (160)
Wind Design Data	
Ultimate Design Wind Speed, V_{ult}, Nominal 3 second gust wind speed at 33 ft (10 m) above ground for Exposure C category, m/s (mph)	80 (180)
Exposure Category	C
Topographic Factor, K_{zt}	1.0
Seismic Design Data	
Short Period Mapped Spectral Acceleration, S_s	0.38 (Site specific S_s to be determined)
One Second Period Mapped Spectral Acceleration, S_1	0.17 (Site specific S_1 to be determined)
Site Class	D
Importance Factor (Seismic Loads), I	1.25

2.8. Equipment and Machinery Delivery

In order to insure the safe and successful supply and installation of the plant, and along with help from experienced and knowledgeable service providers, we will put together a transport concept plan which includes:

- Detailed route surveys to determine maximum shipping parameters and facilitate safe and efficient handling of equipment and material from the port facility (Port Esquivel/Rocky Point) to the designated Jamalco CHP area.
- Identify obstructions and assess relevant risk factors along the proposed delivery route
- Staff and service providers will be onsite as required for successful delivery and installation of the co-gen facilities.

The CHP construction equipment will include the use of backhoe/excavators, roller, forklifts, rough terrain hydraulic cranes, articulating boom lift cranes, crawler crane, air compressors, electric welders, threading machines, ATV carts, water truck, service and pick-up trucks. Heavy machinery and equipment for installation will be delivered to Jamalco Rocky Point Port by barge and transport by road or rail to the plant site. The other option for transporting of heavy machinery and equipment is from Port of Kingston via Highway 2000 east-west to Jamalco alumina refinery.

2.9. Personnel Requirements

2.9.1. Construction Phase

The construction effort for the project will peak at a workforce of approximately 425 workers spread across the CHP, the gas pipeline, and the electrical substation and transmission infrastructures. The construction workers will primarily be on-island, locally contracted individuals. Off-island workers during the construction phase of the project will primarily consist of construction management professionals which specialize in the construction of combustion turbine generator facilities and the equipment manufacturer's technical associates, which supervise the installation and commissioning of their supplied equipment.

2.9.2. Temporary Structures for Construction Phase

The CHP anticipates temporarily utilizing one four-wide construction trailer and two double-wide construction trailers. It is also anticipated that two large tent shelters (one for craft breaks and craft assemblies and one for dry laydown storage) be installed during while the construction and commissioning tasks are being performed. There will also be tool trailers/connexs located on site as the various equipment is delivered to the project.

2.9.3. Operations & Maintenance (O&M) Phase

The total manpower requirements for operations and maintenance will be approximately 20 persons. Below is the currently anticipated organization chart for the CHP plant.

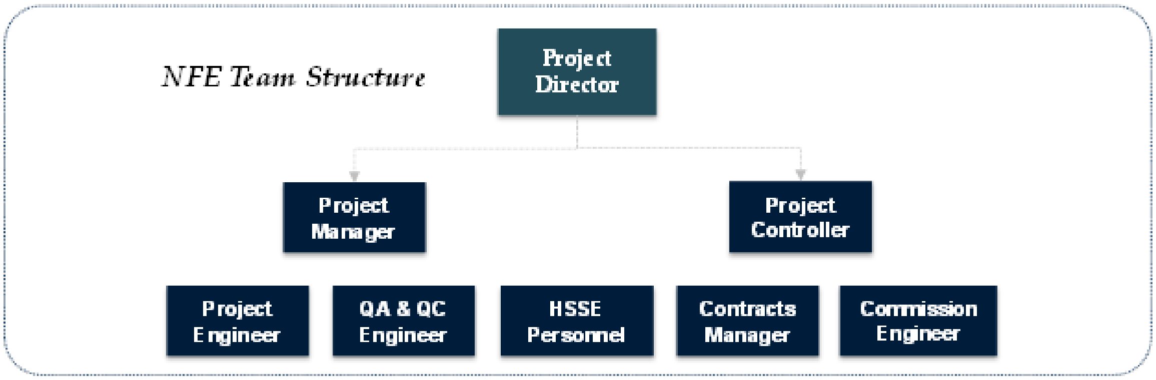


Figure 17: NFE Team Structure

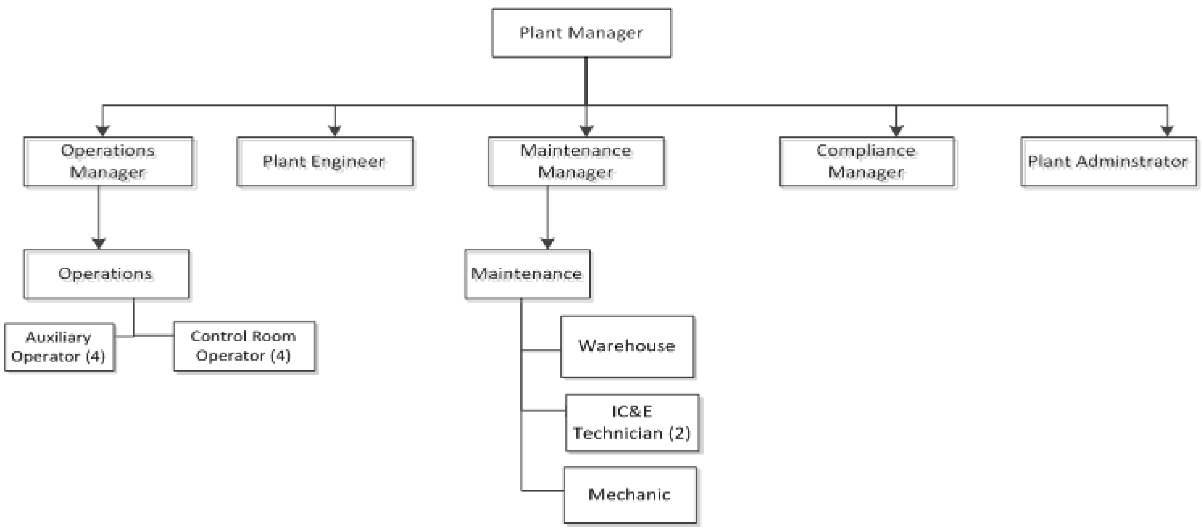


Figure 18: Organizational Chart for CHP Operations

2.1. Potable Water System

Water is supplied to Jamalco for use through five (5) existing abstraction wells located in an around the Jamalco facility. Each well in licensed by the Water Resources Authority (WRA), with subsequent conditions. Water is taken primarily from the deep wells (Production well #1 and Hanbury 2R). However, three (3) other abstraction wells located in the residue storage area (RSA) are able to supply water to the location. Production well 1, Dry River 5 and Hanbury 2R after abstraction flows through a chlorination system managed by the Instrument and Electrical department. The potable water is then supplied for industrial and domestic uses within the facility. A high tank is in place to stabilize water pressure in the water ring that surrounds the facility. The other two (2) abstraction wells do not go through direct chlorination. Water safety backflow valves are installed and the potable water tie-in procedure governs connections to the potable water lines. Potable water lines are separated from process water lines and connections. In 2016, an average of 9,493 cubic meters of water was abstracted, which is below the capacity of the existing permit limits. The system will have to be evaluated to determine if the additional 124gpm during normal operations and 317gpm for ADO use at the full build-out can be supported. The existing drawings for the potable water lines are shown below.

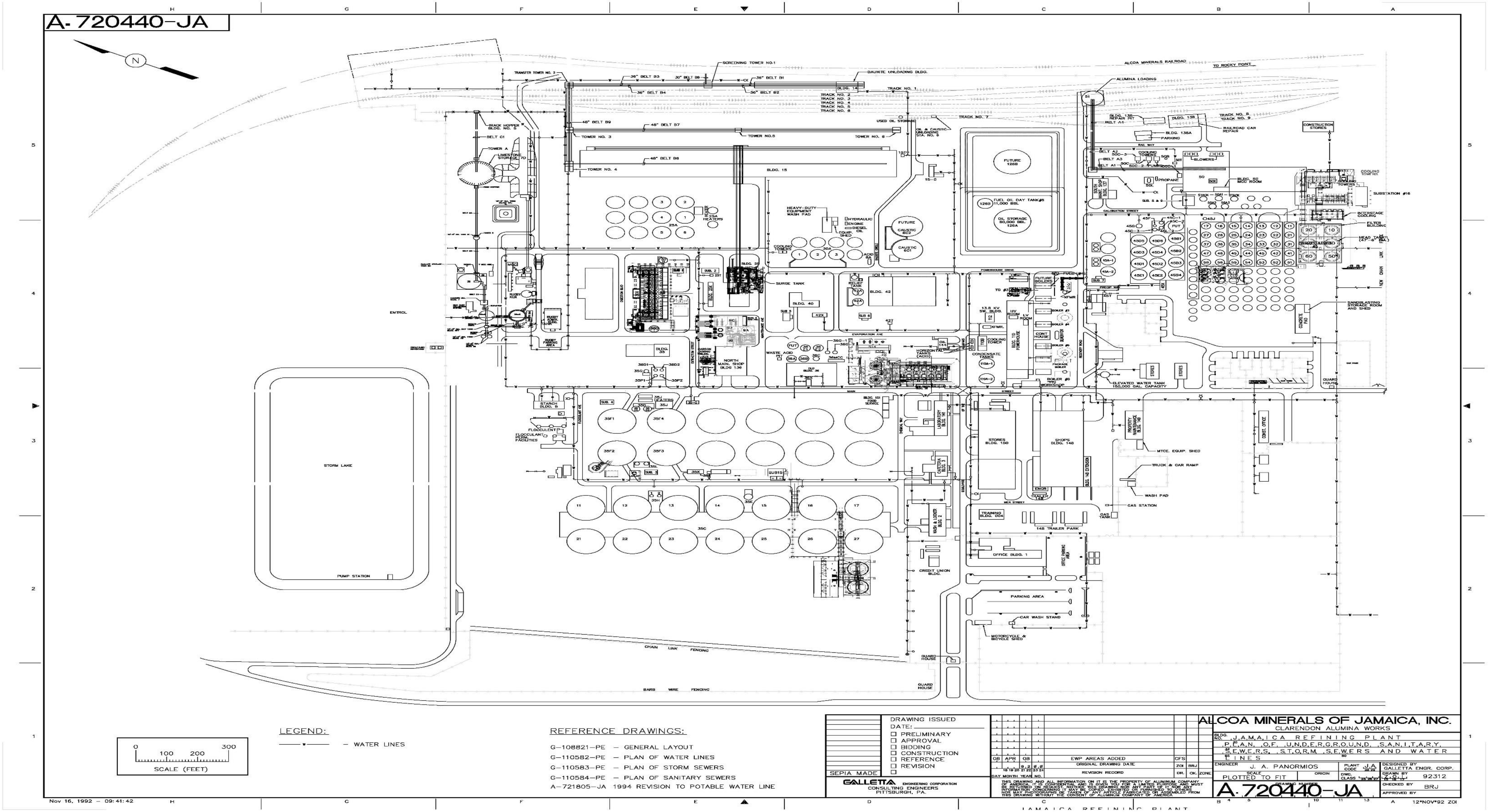


Figure 19: Installed Water System at Jamalco

2.2. Solid Waste Management

Jamalco categorizes waste into non-hazardous and hazardous streams and currently has procedures to handle each waste stream. Final handling and disposal of each waste stream is determined by the characteristics of the waste. Currently, there are five (5) methods of waste disposal that is practiced at Jamalco. These are:

- Landfill
- Recycle/reuse (internal and external)
- Storage – Impoundments (permanent) and
- Shipment overseas (hazardous waste)
- Sanitary Sewage Treatment Plant

Hazardous wastes are stored and approved domestic non-hazardous substances are sent to the landfill. Small quantities of solid waste are recycled/reused.

The main recycle streams from Jamalco to which the minor waste stream from the CHP will be added are as follows:

- Scrap metals
- Used oil
- PET & HDPE Bottles
- Wastewater (plant, laboratory, sewage treatment plant, storm water)
- Freon gas
- Boiler & Heater tubes

Waste management is governed under the Jamalco's Waste Management Program

Waste materials should be segregated into non-hazardous and hazardous wastes and considered for treatment, re-use /recycling prior to disposal. A waste management plan shall be developed that contains a waste tracking mechanism from the originating location to the final waste reception location. Storage, handling and disposal of hazardous and non-hazardous waste should be conducted in a way consistent with good EHS practice for waste management.

2.3. Wastewater Management

Jamalco operates a secondary wastewater treatment plant at the Clarendon Alumina Works alumina refinery. It has been in operation since 1970 and is a packaged wastewater treatment plant, which can be operated in either extended aeration mode or contact stabilization mode. Both of these modes are modifications of the basic activated sludge process. In contact stabilization mode the plant is designed to accommodate a flow of 45,000 GPD (31.25 gpm). The plant was designed for a maximum of 1,150 persons. The effluent enters a zero-discharge system that does not discharge to the environment. The wastewater treatment plant has several components: two aerobic digesters, a re-aeration tank, an aeration tank, a circular clarifier and a chlorine contact tank. The capacity of each tank is given below:

- Aerobic Digester: 5,625 gallons each
- Reaeration Tank: 12, 500 gallons
- Aeration Tank: 6.250 gallons
- Clarifier: 6,990 gallons
- Chlorine Contact chamber: 6,250 gallons
- Sludge drying bed

There are plans to re-route the effluent for plant care in order to reduce Jamalco's water volume in the alumina refining process. The average effluent flow recorded for the plant is 31.2 gpm, with a range of 27-45 gpm. The STP currently caters for employees and contractors spanning the refinery, port and the RSA.

2.3.1. Sampling and Analysis

Regulatory sampling is done twice per month by the Environmental Technologist on the influent and effluent. These samples are analyzed at an external laboratory for Total

Nitrogen, Phosphates, Biochemical Oxygen Demand, Chemical Oxygen Demand, Total Suspended Solids, Faecal Coliform and Total Coliform. Residual Chlorine and pH is determined on site using a Pocket Colorimeter.

2.3.2. Inspection and Maintenance Process

Inspections of the wastewater treatment plant takes place daily. The inspection process captures:

- housekeeping
- mal odours
- floatables and
- equipment functionality.

Deviations identified are then addressed.

Inspections are completed by the Environment, Health and Safety Department to ensure that documents are maintained for the inspection process and the treatment plant is in good order.

2.3.3. Training

A total of eight (8) persons at the Refinery have received the Water & Wastewater Operators training offered at the University of Technology and have sat the California State University certification examinations for Water & Wastewater Operators Level 1. Competent Operators therefore manage the plant.

2.4. Wastewater/Storm water

Jamalco has constructed sewer and drainage systems that encircles the operations on the refinery and extends towards the proposed CHP plant. The expected water run-off from rainfall and flood events from the proposed location is expected to be the same volume, hence there is no expected increase in run-off. The Jamalco facility is a zero discharge, which allows the water to be sent and returned from the residue storage area for use in the refinery process. Excess volumes of water are stored in the run-off water storage (ROWS) pond.

Water balance remains a critical process for Jamalco. Accumulation of water in the refinery process can affect the productivity and viability of Jamalco. The present water balance is already a challenge for the refinery which generates excess condensate of approximately 500 gpm, which is further stressed during the "wet" seasons. Jamalco is currently working on a number of initiatives to put it in a favorable position by controlling the amount of water that is stored during a wet year. The installation of eight (8) turbo-misters to evaporate excess water/condensate from the ROWS pond is one of the initiatives being pursued and this project is expected to come on stream this year. The construction of a condensate pond to cool condensate with the help of Turbo-misters so that it can replace some of the potable water consumers is another initiative that will reduce Jamalco's water input. This project is slated for next year but the necessary preliminary work has started. It is estimated that for each 65 gpm of waste water output from the CHP to Jamalco then one additional turbo-mister would have to be added to accommodate the additional input. For current 3 boiler operation at Jamalco the condensate blow down averages 72 gpm. For the initial first phase implementation of the CHP project capacity of 100 MW then this blowdown would decrease by 16 gpm. In addition, there is recycling of water to Jamalco's existing powerhouse from oily water separator. Heat recovery steam generator (HRSG) and blowdown (non-contaminated water) is sent back to Jamalco's existing systems. The size of the drainage line running near the proposed energy plant is 12". The line then slopes into a 48" main drainage line. The drainage system is shown in the attached diagram.

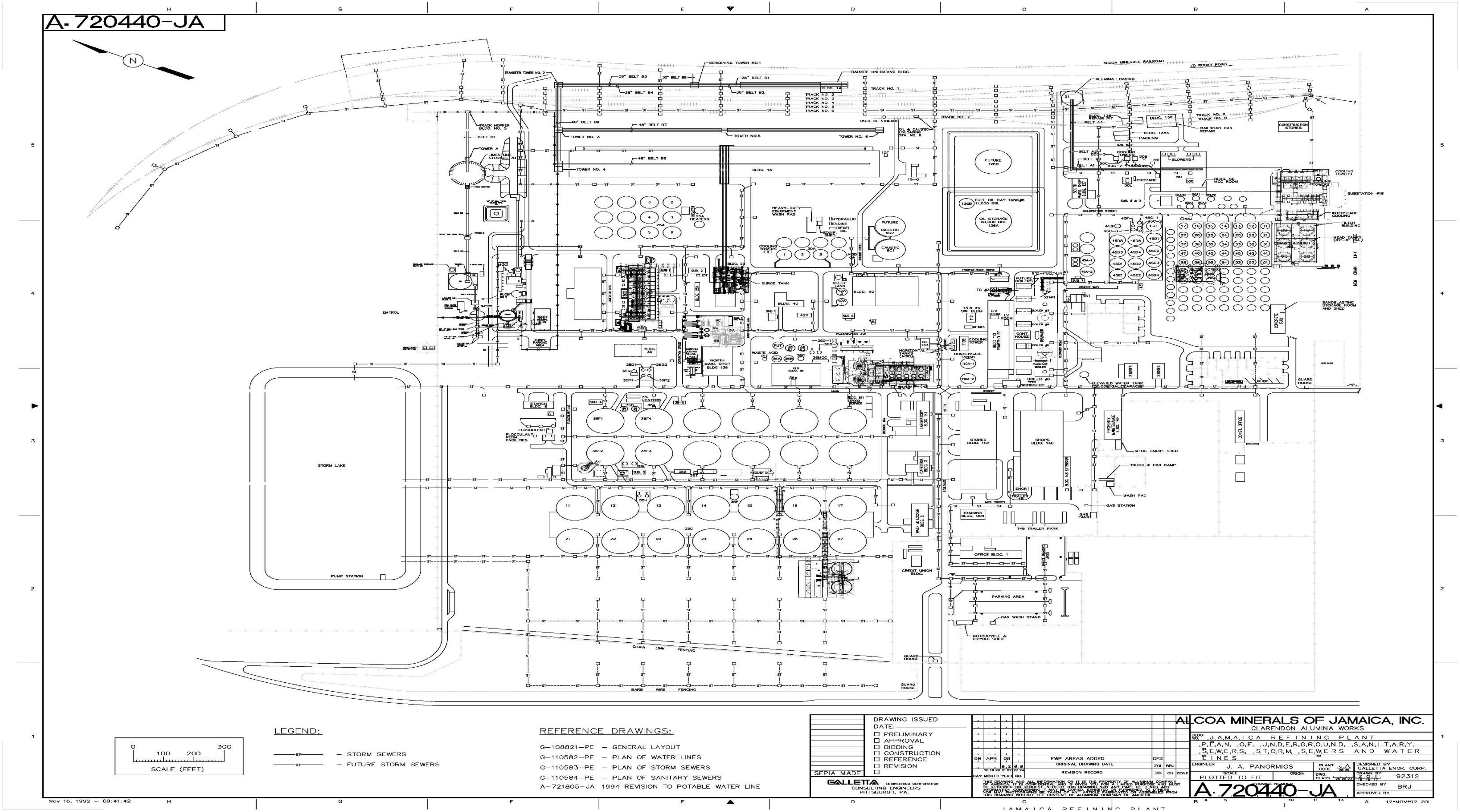


Figure 20: Installed Storm Water Drainage System at Jamalco

Jamalco does not operate an industrial wastewater treatment facility.

2.5. Scrap Metal

During maintenance activities at the mines, refinery and port small quantities of scrap metal is generated. Scrap metal is stored onsite at the refinery in a designated area, which is located adjacent to the Civil Maintenance department and on the western side of the property. A new location will be identified for scrap metal storage.

2.5.1. Storage

The current scrap metal storage yard (145ft x 100ft) is a secured within a fenced area with an access gate that is managed by the Stores department.

Figure 21: Scrap Yard Sign at Jamalco's Scrap Yard

The scrap metal programme covers a number of metal components including:

- pipes
- gratings
- metal rollers
- angle iron
- round bar
- zinc sheeting
- pump impellors
- metal shavings

- guards
- sheet metal

Figure 22: Shows types of scrap metal found in scrap yard

2.5.2. Management and Disposal

Jamalco recycles scrap metal through an external recycling contractor. The recycler's collection rate is a minimum of twice per month to a maximum of four times per month. The amount of scrap metal per collection event vary from a minimum of 3.04 tonnes to a maximum of 25 tonnes. The contractor will take the scrap metal offsite for recycling or shipping to the export market. Scrap metal is weighed before leaving Jamalco site.

2.5.3. Hazardous Waste Management

Small quantities of hazardous waste such as mercury, chromate, toner cartridges, computers, printers, medical, oxalate filter cloth and lead acid batteries are temporary stored on site prior to final disposal or recycling overseas. Waste is collected and stored on site in designated areas and managed in accordance with best practices. National regulatory guidelines are followed to develop the process. Petroleum products such as waste oils are re-used by sending the liquid portions to the waste oil storage tank in the Raw Materials department for burning by the powerhouse boilers.

Medical waste is temporary stored onsite and later to an approved offsite facility for incineration.

2.5.4. Landfill

The Jamalco Refinery landfill is privately owned and was started in 1972 simultaneously with the opening of the Refinery operations. It receives uncontaminated industrial solid and domestic waste. The acreage of the active area is about seventy (70) acres. The area is fenced and material received is covered daily. It is operated by Jamalco with security guards located at its entrance twenty-four hours per day.

The landfill is located to the North East of the refinery and abuts against a hilly limestone outcrop of the Brazilleto Mountains. Topographically, it slopes slightly towards the south and is flat - a characteristic of the Vere Plains. Geologically, the limestone under Jamalco's Halse Hall operations (refinery, Residue Storage Areas [RSAs]) is made up primarily of the Newport Limestone Formation. This formation extends throughout the Rio Minho Basin, which is the major aquifer that provides water to the wells that support irrigation, domestic and industrial uses in the basin. The alluvium atop the limestone consists mostly of sands, gravels and clays. Specific borehole samples taken at the landfill confirm that there is a thick clay layer overlying the limestone. This low permeability clay layer offers a natural existing barrier to the potential for water to percolate from the surface of the landfill to the groundwater.

The annual amount of industrial and domestic solid waste received by the landfill in 2016 was approximated at 2,100 tonnes. Jamalco is currently in an extensive drive to reduce landfill waste through recycling and reuse where possible. Burning and scavenging at the landfill is prohibited and enforced through round the clock security.

2.5.5. Management

The landfill is managed under the Jamalco Landfill Management Program. In managing the landfill Jamalco performs the following functions as described below:

- Access Control
- Site Access roads
- Unloading of waste
- Control of air pollutants
- Compaction
- Landfill cover
- Storm water management
- Fire protection

The following domestic and non-hazardous wastes are allowed at the landfill.

- Small dry cell Batteries *
- Oil Filters * (drained free of liquid)
- Packaging material (boxes, cardboard, paper, etc)
- Yard waste
- Paper and other waste office stationary
- Waste safety gears
- Empty drums *
- Waste hand rags * (liquid free)
- Wooden pallets and scrap wood
- Contaminated adsorbent – free of dripping liquid (oil & lubricants) *
- Empty freon gas cylinder
- Scrap food from canteen
- Other non-hazardous insulation material
- Empty chemical containers from Laboratory and Powerhouse *
- General garbage waste from RSAs, Great House, Sports Club, Rocky Point Port and the Mining areas
- Maintenance waste (waste parts, supplies, etc)

Solid waste disposal to the landfill is characterized, quantified and tracked to ensure proper management of the landfill.

2.6. Security

2.6.1. Control System

A control & Instrumentation system will be provided for control, monitoring and operation of the CHP in all regimes of operation in a safe and efficient manner. The system is complete with measuring instruments, associated process connection and piping, local instrument enclosures and racks, junction boxes, control system cabinets, associated human machine interface system (comprising of servers, workstations, printers etc.), engineering work stations, master and slave clock system, plant wide networking, instrumentation cables, networking cables, etc.

A new stand-alone distributed control system (DCS) will be provided for monitoring and controlling the facility during all operating conditions from the central console station located in the main control room. Local workstations will be furnished where local control capability is necessary for balance-of-plant facilities. The DCS will have communication ability with the existing Jamalco facility's powerhouse control system for integration of process control parameters.

The Unit Protection System hardware and logic will be designed in accordance with the following codes and standards:

- NFPA 85–Boiler and Combustion Systems Hazards Code.
- ASME Boiler and Pressure Vessel Code.

The CTGs will be supplied with an automatic control system suitable for unattended local operation throughout the entire load range. Each system will be a complete, self-contained system designed for operation of the combustion turbines and generators locally and remotely from the station control room. The control system will provide logic and protective functions for firing natural gas and ADO. Automatic tripping devices will be provided to shut down a unit in an orderly and safe manner to prevent damage to equipment or harm to personnel. The CTG control's protective system will provide the control logic necessary for protection of the turbine generator against potential damaging conditions and for execution of automatic tripping actions on the occurrence of abnormal operating conditions.

The CHP plant will utilize a stand-alone Digital Control System (DCS) with state-of-the-art software designed to prevent a cyber-attack of the facility. The DCS control system will have built-in firewalls for the two external interfaces to the Plant. One external interface will exchange information with the JPS system for electric grid dispatching. The second interface will provide operating information to the Jamalco facility (no process control). The Plant's control system will incorporate all governmental required provisions with respect to cyber security.

2.6.2. Site Security

The site will be secured by a permanent fence, and this will be initiated as early as the stage of construction. Security guards will be employed to patrol the site and control access 24 hours a day. All vehicles entering and leaving the site will be searched. All personnel will be required to display personal identification and all visitors will be required to sign in.

2.6.3. Pipeline Security & Security Fencing of Pipeline

In the interest of public and operations safety, care of pipeline rights-of-way is critical. We will follow a variety of procedures, including frequent inspection, patrols and a regular brush clearing program to minimize the risk of hazardous action by others. Pipeline right of way will be routinely patrolled and inspected, - with frequent leak surveys, and - pipeline and right-of-way maintenance. Warning markers or signs may be located within any right-of-way near the pipeline. Since pipelines are buried and out of sight, we will post important warning signs above ground. The route of an underground pipeline will be identified with above-ground pipeline markers; Pipeline markers are located at road, railroad and waterway crossings and at regular intervals across the pipeline path. The procedures are reviewed every three years. .

2.6.4. Precautions for Fire and Fire Fighting:

2.6.4.1. Fire Protection System

The CHP fire protection system will provide fire suppression and detection systems throughout the plant to support personnel safety and minimize equipment damage and outage duration for repairs. The systems will be a combination of automatic and manual systems that provide alarm, detection, and suppression that are in accordance with local building code requirements.

The CHP will rely on fire water storage and pressurized water supply from the existing Jamalco facility by connecting the CHP's underground fire water distribution piping with Jamalco existing underground fire water distribution system.

Underground fire water mains will be provided to supply fire protection water throughout the new CHP plant. The distribution piping system will include loop(s) around the power generation equipment as well as piping to any remote areas requiring protection. The system will support fire hydrants, hose stations, buildings and fixed water suppression systems (as determined required for the plant) in the event of fire.

Sectional valves will be furnished on the piping network for isolation purposes. The valves will be located to minimize loss of protection to the protected areas in the event of a break or maintenance activity. The location of isolation valves also addresses the potential for a loss of both the automatic and manual suppression systems serving a given area. Sectional isolation valves are furnished with post indicators to provide visible conformation the valves remain open. Hydrants will include an isolation valve at each location for ease of repairs and maintenance.

The piping will be sized to supply the required fire water demands to any point within the plant with the most direct path of piping isolated or taken out of service by turning off the appropriate valve.

Each combustion turbine generator will include a fire detection and protection system to protect the combustion turbine, generator enclosure, and other enclosed accessory compartments that required active fire protection. The system will be designed in accordance with equipment manufacturer and NFPA requirements for power generation equipment. The type of suppression system will be selected by the combustion turbine supplier but is typically CO_2, FM-200, or water mist type system specifically designed for combustion turbine fire.

Fire extinguishers will be distributed as required by the local building codes and the requirements of the Local Fire Brigade. Training of staff will be routinely done to ensure continuous and effective management of the fire suppression and management facilities.

2.6.4.2. Leak Detection System

Flow rate and pressure in the pipeline will be continuously monitored and recorded at the onshore pipeline facility and at the offshore platform. The natural gas pipeline will have a leak detection system which will detect a break or leak in the subsea pipeline. The system will send a signal to the automated block valves to close and a signal will be sent to the platform to stop delivering natural gas into the pipeline. Coordination with CHP plant will take place immediately as well. An automated block valve will be located at the launcher and receiver and will be used for isolation and emergency shutdown purposes. The launcher block valve will be located on the platform and the receiver valve will be onshore.

Automated block valves will be located at the inlet of the meter skid and at the inlet to each regulator skid. In the event of a pipeline leak, the automated block valves will close to stop transportation of natural gas to the power station and isolate the pipeline. The location of the leak will be determined by utilizing an active acoustic wave analysis monitoring system. In the event of a fire at the power station, the automated block valves will close and a signal will be sent to the platform to stop delivering natural gas into the pipeline. The need for an automated subsea block valve will be evaluated during the detailed design process. If needed, the automated subsea block valve will be located on the subsea pipeline approximately 60 to 150 meters (200 to 500 feet) away from the offshore platform and will be used for isolation and emergency shutdown purposes. The subsea valve will prevent a fire on the offshore platform from being fed by the natural gas in the subsea pipeline.

2.7. Railroad System

Jamalco owns and operates a railway system that includes industrial contractors, Individual Contractors and Jamalco staff employees, locomotives, a rail car and locomotive maintenance shop, and approximately 22 miles of track that connects Clarendon Alumina Works with the railhead at St. Jago, Harmon's Valley mines and the port facility at Rocky Point.

Fuel oil and caustic (from Rocky Point) are moved into the facility at a rate of 6 - 9 trainloads per day; each trainload consists of a maximum of nine (9) rail cars, five (5) containing oil and 4 containing caustic soda.

Alumina products from the facility are transported to Rocky Point for shipment to overseas customers at a rate of three (3) trainloads per day with 8 rail cars per train. The line between Clarendon Alumina Works and Rocky Point passes through three communities.

In addition to the transportation of raw materials and finished products, the Jamalco Railway System conducts its maintenance activities at the Railroad Equipment Repair Shop, Building 138. These activities include the limited use of solvents and paints, storage of assorted lubricants in drums, and storage of waste oil in an above ground tank.

NFE will comply with Jamalco's railroad management systems. The NG pipelines will run close to the railway. There will be no modification to the existing railroad.

3.0. Analysis of Alternatives

3.1. Introduction

The objective of the proposed project is to provide 200 MW (in two phases of 100MW each) of electric power to the national grid and replace the steam requirement of Jamalco alumina refinery steam demand for power generation and process steam in a manner that is safe, efficient and cost effective with as small a footprint as possible. The CHP is baseload for the power grid and must supply steam continually to the Jamalco alumina refinery for its 24-hour operation. The CHP concept has one of the highest energy efficiency in the energy industry only surpassed by hydro-electricity. The following alternatives have been analyzed for the project:

- No Action Alternative
- The Proposed Development
- Location
- Technology

3.2. No Action Alternative

The 'No Action' alternative means that nothing will be done. This implies that Heavy Fuel Oil (HFO) will continue to be the only fuel source to generate steam and electricity at Jamalco's alumina refinery located at Halse Hall Clarendon.

The volume of HFO to be handled at the Rocky Point Port that is transferred from ship to storage tanks would remain unchanged. The volume of HFO to be transferred to the rail cars and transported to the Jamalco alumina refinery by rail and stored for use at the powerhouse will remain unchanged.

The emission characteristics from the stack gases will remain unchanged. Hence air quality and the contributions to the environment, in general and greenhouse gas, in particular will remain unchanged.

The cost of generating steam and electricity at Jamalco's power station will remain unchanged. The energy cost for the production of Jamalco's alumina will also remain unchanged. Jamalco will not meet its target to be a low-cost producer (1st quartile) of alumina producers worldwide. Jamalco will have to invest millions of dollars to replace its aging boilers.

The sustained production of alumina and the sustainability of the macro and micro benefits to the Jamaican economy and society could be tenuous and vulnerable to external shocks such as further escalation in the price of HFO.

The cost of electricity to the national grid from Jamalco as an existing source, will essentially remain unchanged.

3.3. The Proposed Development

Installation of the CHP at Jamalco will bring the following benefits:

- Use of HFO will be dramatically reduced as a primary fuel to generate steam and electricity at Jamalco. It is likely that the use of HFO for this purpose will also be ultimately substituted with Natural Gas (NG).
- The volume of HFO to be handled at the Rocky Point Port, that is transferred from ship to storage tanks would be reduced. The volume of oil to be transferred to the rail cars and transported to the Jamalco alumina refinery by rail and stored for use at the powerhouse will also be reduced.
- The emission characteristics from the stack gases will be changed. The criteria pollutants being emitted to the atmosphere will be significantly reduced. Atmospheric emission modeling has shown that the CHP as a stand-alone facility on the Jamalco's property will be below 75% of the Jamaica Ambient Air Quality Standards (JAAQS). Hence air quality and the contributions to the environment, in general and greenhouse gas emission, in particular, will be reduced.
- Jamaica's Intended Nationally Determined Contribution (INDC) to air quality will be reduced and contributions to environmental health will be improved.

- The cost of generating steam and electricity at Jamalco's power station will be reduced. The cost of energy for the production of Jamalco's alumina will also be improved. Jamalco is expected to improve its ranking in competitiveness among the producers of alumina worldwide.
- The risk to the sustained production of alumina and the sustainability of the macro and micro benefits to the Jamaican economy and society as a result of the vulnerability to external shocks such as further escalation in the price of HFO will be reduced.
- Jamalco now has the option to expand its operations and generate further macro and micro benefits to Jamaica's Economic Growth & Job Creation policies, while at the same time make a significant contribution to environmental quality through the reduction of greenhouse gas emission and improved air quality.
- The proposed development will provide about (estimated) 445 jobs to be distributed as follows:
    - Construction Phase
        - 325 for the CHP
        - 50 for switchyard and substation,
        - 50 for the pipeline installation
    - Operations Phase
        - 20 permanent jobs
- The cost of electricity to the national grid from Jamalco as an existing source, will be reduced.

3.4. Location

The project is essentially a substitution project in which its location is governed by the location of the critical brownfield facilities in Jamalco's alumina system, which has been operation in the case of the Port for more than 50 years (1963) and in the case of the Alumina Refinery 50 years (1970) and in the case of the railway.

3.4.1. Power Station

The relocation of the power station to the Port (the only other brownfield site with capacity) will result in the distribution of steam over a much longer distance.

The cost of steam delivery and condensate return would be greatly increased. This would reduce the benefits of the project in this aspect and result in energy loss in the form of heat loss during steam transmission and energy required to return condensate for reheating.

This is not technically nor economically feasible.

3.4.2. Automotive Diesel Oil (ADO) Storage and Distribution

The alternatives are:

a. Supply from newly constructed facility at Rocky Point Port to store up to 132,000 barrels of ADO in two (2) tanks (See Figure 16 above). Delivery may be by:
    i. rail from Port to Plant
    ii. road from Port to Plant under emergency conditions
b. Supply from the already permitted facility at Old Harbour Bay under emergency conditions. Delivery may be by:
    i. road to the Jamalco ADO storage tanks via Old Harbour Bay Main Road to Highway 2000 at Mineral Heights and to Halse Hall Main Road followed by delivery to Jamalco
    ii. road to ADO storage tanks at Jamalco via Salt River main road

<u>With the exception of the Salt River Route</u>, the proposed options for the transportation of ADO under emergency conditions above are technically feasible and practicable. In the event of a spill, the Salt River route bears the potential for major negative impacts on the water quality, drainage system, wetlands and the marine environment.

3.5. Technology

Electricity can be generated using a number of alternative technologies. The combined heat and power concept on this large scale cannot be replaced by many other technologies while providing the same benefits and advantages. The proposed project serves the dual purpose of supplying steam to Jamalco and electricity to the national grid (co-generation). This places a major constraint on most other potential methods of electricity generation. A statement on each alternate technology is provided below.

3.5.1. Coal

The FSRT for the supply of NG for the project has already been permitted. Hence it is not practical as an alternative fuel for this project.

3.5.2. Hydroelectric Energy

The use of hydroelectric technology is not feasible as a very large dam would be needed resulting in significant dislocations of residential, commercial and industrial activity. The generation of steam would be subsequent to the generation of the electrical power from the damn. Power from the damn would be consumed for the steam generation reducing the availability of power to the national grid. This would therefore require an increased output from the hydropower plant to effectively meet the project objective.

Hydroelectric facilities are typically small (maximum output 15 MW) in Jamaica due to the size of the rivers. A plant of capacity 200 MW would not be feasible in Clarendon.

3.5.3. Solar Energy

The use of photovoltaics (PV) to generate 200 MW of electricity would require a massive land area. Steam would not be generated as a co-product to meet Jamalco's requirements.

3.5.4. Wind Energy

Wind is not baseload energy production and requires backup supply. It is therefore not a viable alternative to the objectives of the proposed project.

3.5.5. Bio-fuel – (bio-diesel, biomass including bagasse and woodchip)

The use of solid bio-fuels in the combustion process is not feasible as the technology is developed for liquid or gaseous fuels.

The use of biodiesel is not recommended, as the NG option is the cleanest burning fuel available for the process. The benefits of cleaner air quality would be lost if bio-diesel is used.

The major benefits for the co-generation process is its high efficiency, clean burn and lower cost of NG. These benefits would be lost by replacing with bio-fuel technology.

3.6. Conclusion

The CHP is the most technically and economically project for location at Jamalco's alumina refinery at this time.

4.0. Legislative and Regulatory Framework

4.1. Introduction

This section provides a background on the following that are applicable to the Proposed Combined Heat & Power Station:

- NFE's Environment, Health & Safety and Security Policies & Practices
- Jamalco's Environmental Policy,
- International & National Policies, Legislation and Regulations

It is important to note that NFE and Jamalco has agreed that NFE will conform to Jamalco's Environmental Health & Safety, Security Planning, Construction Management, and Emergency Response Policies and Procedures in construction and operating the Project (see Appendix 4).

4.2. NFE Environment, Health & Safety and Security Policies & Practices

4.2.1. Operations & Maintenance Philosophy

NFE undertakes and shall be responsible for the operation and maintenance of the CHP in accordance with the standards and with qualified and experienced operators. The maintenance will be performed in accordance and subject to the Law and Safety Regulations of Jamaica or the US.

An operability and maintainability study shall be part of the contractor scope of work and a report of the Study shall be prepared. As part of this study, all the CHP and infrastructure shall be designed and reviewed from an operations and maintenance point of view to ensure that each terminal equipment can be isolated and/or removed quickly and easily with no (or minimum) loss of production during maintenance.

The following parameters should be considered and included in the operability and maintainability report:

- HSE compliance with safe operation and maintenance
- All equipment, materials, parts and tools are as per standard and readily available.
- Identification of Non-standard tools, equipment and spares with potential failure rates
- Accessibility for operation, work on and remove
- Accessibility for purging, draining, venting, cleaning/ decontamination facilities.
- Availability of laydown area or routing to a crane access area for transporting equipment
- Training of personnel
- Vendor data availability
- List of systems required for calibration and maintenance.

4.2.2. HSE Philosophy:

NFE is committed to conducting its business lawfully, ethically and in a socially and environmentally responsible manner. NFE believe exemplary performance in the areas of environmental management, health and safety is essential to fulfil NEF's business goals and meet the expectations of NFE's many stakeholders.

NFE management is committed to this philosophy. NFE expect to achieve excellence in environmental, health and safety performance through the active participation and support of all management, employees and contractors. NFE's commitment is to integrate the following "Guiding Principles" into all decisions affecting NFE's operations:

4.2.2.1. Health and Safety

The health and safety of each worker is essential for NFE's success. Occupational health and safety practices and principles will not be compromised. Each member of the workforce is afforded the same level of protection

NFE will provide its employees with the training and tools that ensure that they have the knowledge and skills needed to implement this philosophy and perform their jobs safely and competently.

4.2.2.2. Environmental Stewardship

NFE will continually seek to understand its relationship to the environment and adopt technically sound and economically feasible controls that will avoid or mitigate negative impact. This includes efforts to control emissions, minimize waste and protect aquatic resources.

4.2.2.3. Contingency Planning

NFE will identify and control environmental, health and safety risks and ensure that appropriate contingency plans are in place to address unforeseen events.

4.2.2.4. Compliance

NFE will comply with all applicable policies, environmental, health and safety laws, regulations and standards and adopt best sound professional judgment where laws and regulations are not formal or poorly enforced.

4.2.2.5. Contractors

NFE will carefully select high quality, environmentally sound and safe work from its contractors. NFE expects its contractors to supply and retain quality personnel who are adequately trained and equipped to perform their jobs safely.

NFE will review and score its contractors to assure that it maintains the expected level of EHS Performance.

4.2.2.6. Performance Review

NFE will set goals for its EHS performance based on its history and industry statistics. We will track progress against these goals. We will review company operations to ensure compliance with these principles.

Management, supervisors, and employees will foster a work environment that holds employees and contractors accountable for fully implementing this EHS Philosophy and encourage all stakeholders to express their views about EHS concerns.

4.2.3. Quality Assurance/Quality Control (QA/QC)

4.2.3.1. Health and Safety

The safety and health of each worker is essential for our success. Occupational health and safety practices and principles will not be compromised. Each member of the workforce is afforded the same level of protection

Our EHS performance is critical to our operational success. Our operations and maintenance procedures are aligned with our EHS principles and procedures. A qualified expert will be engaged to oversee the EHS implementation and management

4.2.3.2. Preventative Maintenance

Our preventative maintenance program is designed to keep equipment operating safely at its design capacity. Equipment is tested and maintained as prescribed in the vendor documents and industry standards and benchmarks.

4.2.3.3. System Integrity

The integrity of each system is maintained by having maintenance performed by trained craftsmen and using parts, tools and equipment that are appropriate for the task. The specifications for each part are matched to the procedures before it is installed.

4.2.3.4. Procedures

Standard Operating Procedures for operating and maintenance procedures are documented, reviewed, and followed. Changes to the procedures must go through a rigorous management of change process and be reviewed and approved before they are implemented:

4.2.3.5. Waste Management

Waste management procedures will be developed for the CHP and a waste management manual produced. This will include details of segregation and storage of specific waste materials; handling procedures for wastes; inventory and on-site management of hazardous waste; and personal protective equipment requirements. The waste management procedures will include initiatives for waste reduction, reuse and recycling and treatment of hazardous wastes, and separation of hazardous waste from non-hazardous waste.

4.3. Jamalco's Environment Health & Safety Policy

4.3.1. EHS Policy

It is Jamalco's policy to operate in a safe responsible manner, which respects the environment and the health of our workforce, our customers, and the communities where we operate. Jamalco will continually improve our Environmental Health and Safety Management System and support pollution prevention strategies. We will not compromise environmental, health or safety values for profit or production.

All Jamalcoans are expected to understand, promote and assist in the implementation of this policy and the accompanying principles.

4.3.2. EHS VALUE

We work safely, promote personal well-being and environmental sustainability.

4.3.3. EHS Principles

In support of Jamalco's EHS Policy, the following principles have been developed to provide additional direction on specific issues. The implementation plan, which follows, provides details on how the Policy and Principles will be carried out:

- We are accountable for conforming to the EHS policy.
- We will work diligently to prevent all incidents.
- We will practice sound environmental, health and safety management.
- We will comply with all applicable laws, regulations and permits, and will develop and employ more restrictive internal standards where necessary to conform to Jamalco's EHS policy.
- We will audit our operations and report findings.
- We will sponsor activities to improve the science of environmental, health and safety protection.
- We will report our activities.
- We will support sustainable development, the responsible use of natural resources and energy conservation.
- We will supply safe and reliable products and services.

4.3.4. Jamalco's Industrial Hygiene Policy

Jamalco's Management will at all times strive to maintain a work environment in which all workers are protected from recognized health hazards.

Management's goal and responsibility is to ensure that employees will at no time suffer any adverse health effects related to the work environment. In meeting this obligation, JAMALCO will comply with all health and safety Standards as well as related Government Regulations. These objectives will be achieved through the following activities:

- Conduct periodic monitoring of the work environment.
- Institute appropriate control measures.

- Train employees on all hazardous chemical/physical agents.
- Provide appropriate personal protective equipment and training.

Both management and employees accept responsibility for compliance with Standard Industrial Hygiene Practices and the elimination of any condition in the work environment that is detrimental to health.

4.3.5. Injury, Illness and Incident Reporting Policy

Jamalco's policy is that all accidents and incidents be reported immediately. This includes property damage incidents; mobile equipment incidents; Injury free-events and any other significant incident or occurrence.

If an individual suspects or has an actual injury/illness, he/she should first seek prompt medical evaluation by reporting to the supervisors of the area where the incident occurred and then to the medical department.

Once medical treatment is received, it is then mandatory that the injury, illness and incident (Triple-I) form be completed by line supervision to report the incident.

It is the responsibility of line supervision to immediately advise the safety department after an incident occurs. Line supervision should initiate a Triple-I Report for all non-injury incidents.

Further investigation should be organized; the completed final Triple-I form should be reviewed by the department manager and returned to EHS department within seventy-two (72) hours of the incident.

In case of an injury, a Medical treatment form should be completed by supervision and submitted to the Medical Department. Under no condition should medical treatment be delayed due to the non-submission of this form.

4.4. Applicable National Legislations, Standards and Policies

The following represents descriptions of applicable legislative requirements with which activities of this proposed development must comply:

- The NRCA Act, 1991
- Petroleum Act
- Electric Lighting Act
- Electricity (Frequency Conversion) Act
- Electricity (Survey) Act
- Electricity Development Act
- Petroleum Act
- Petroleum Act (Prescribed Articles) Regulations
- Petroleum Act (Extension of Functions) Order for Renewable Energy
- Petroleum and Oil Fuel (Landing and Storage) Act
- Petroleum and Oil Fuel (Landing and Storage) Act Rules and Regulations
- Petroleum (Quality Control) Act
- Petroleum (Quality Control) Regulation
- The Watershed Protection Act, 1963
- The Wildlife Protection Act, 1945
- The Forestry Act, 1937
- Jamaica Railway Corporation Act and associated legislations and regulations
- Water Resources Act, 1995
- Underground Water Control Act, 1959
- Irrigation Act
- The Clean Air Act, 1964
- The Town and Country Planning Act, 1987
- The Jamaica National Heritage Trust Act, 1985
- The Public Health Act, 1975
- Disaster Preparedness and Emergency Management Act, 2001

- Occupational Safety & Health Act, 2003 (Draft)
- The Road Traffic Act, 2016
- The Parochial Roads Act
- Clarendon Parish Provisional Development Order,1982
- Town and Country Planning (St. Catherine Coast) Parish Development Order, 1964
- The Portland Bight Protected Area
- Fishing Industry Act of 1975, Special Order for Special Fishery Conservation Areas
- Harbours Act, 1874
- The Maritime Areas Act, 1996
- The Docks (Safety, Health and Welfare) Regulations, 1968
- The Port Authority (Port Management and Security) By- Laws 2009

4.4.1. The NRCA Act, 1991

The Act is the overriding legislation governing environmental management in the country. It also designates National Parks, Marine Parks, Protected Areas and regulates the control of pollution as well as the way land is used in protected areas.

This Act requires among other things, that all new projects or expansion of existing projects which fall within a prescribed description or category must be subjected to an Environmental Impact Assessment (EIA).

The regulations require that fourteen (14) copies of the EIA Study Report must be submitted to the Authority for review. There is a preliminary review period of ten days to determine whether additional information is needed. After the initial review the process can take up to ninety days for approval. If on review and evaluation of the EIA the required criteria are met, a permit is granted.

Specifically, the relevant section(s) under the Act which addresses the proposed project activities are:

s.10:(1) Subject to the provisions of this section, the Authority may by notice in writing require an applicant for a permit of the person responsible for undertaking in a prescribed area, any enterprise, construction or development of a prescribed description or category-

(a) to furnish the Authority such documents or information as the Authority thinks fit; or

(b) where it is of the opinion that activities of such enterprise, construction or development are having or are likely to have an adverse effect on the environment, to submit to the Authority in respect of the enterprise, construction or development, an EIA containing such information as may be prescribed, and the applicant or, as the case may be, the person responsible shall comply with the requirement.

s.12: Licenses for the discharge of effluents etc.

s.17: Information on pollution control facility

s.18: Enforcement of Controls – threat to public health or natural resources

s.32-33: Ministerial Orders to protect the environment

s.38: Regulations

All the necessary applications have been submitted and found acceptable to the Agency. This EIA document satisfies the penultimate review process, mandatory public meeting next, before the required licences and permits can be issued. An application for a Permit and License was completed and submitted to NEPA as well as a Project Information Form (PIF) and Terms of Reference (ToR). The approved ToR for this EIA is included in the appendix of this document (Appendix 1)

4.4.1.1. The Natural Resources Conservation Authority (Air Quality) Regulations, 2006

These regulations were gazetted on July 12, 2006. This regulation speaks to the quality of the air shed within which an industrial entity is discharging emissions (gases or particulate matter). Discharge license requirements are outlined in Part I of this Act, and Part II speaks to the stack emission targets, standards and guidelines.

The environmental impact from any air emissions (gasses or particulate matter) will be influenced by the ambient meteorological conditions within the area, such as wind (speed and direction), and rain.

Table 3below outlines the ambient air quality standards as issued by NEPA.

Table 3: Air Quality Standards for Jamaica (NEPA)

Pollutant	Averaging Time	Standard (maximum concentration in µg/m³)
Total Suspended Particulates Matter (TSP)	Annual	60
	24 hour	150
PM10	Annual	50
	24 hour	150
Lead	Calendar Quarter	2
Sulphur Dioxide	Annual	80 primary, 60 secondary
	24 hour	365 primary, 280 secondary
	1 hour	700
Photochemical oxidants (ozone)	1 hour	235
Carbon monoxide	8 hour	10,000
	1 hour	40,000
Nitrogen Dioxide	Annual	100

4.4.1.2. Trade Effluent Standards

The Trade Effluent Standards have existed in draft format since 1996. These standards regulate the quality of effluent discharged from any entity into public drains/sewers and all surface and water bodies such as ponds, sea or lake. Similar to the Air Quality regulations, a discharge license is required to release any trade effluent and guidelines set forth for acceptable water quality standards including sewage effluent.

A new tertiary effluent treatment plant is proposed for this project.

4.4.1.3. Noise Standards

Noise Standards for Jamaica have been proposed by NEPA based on the World Bank standards. The guideline for daytime perimeter noise is 75 decibels and 70 decibels for night-time noise.

4.4.2. Petroleum Act

This act involves the vesting of all petroleum in the Crown. No exploration or the development or the acquisition of any right, title, interest or estate in any petroleum which is vested in the Crown may take place. The act also provides that any exploration or development of petroleum resources or the acquisition of any right, title, interest or estate in any petroleum in the exclusive economic zone shall be subject to the provisions of the Exclusive Economic Zone Act or any order made under Section 11 of that Act.

4.4.3. Electric Lighting Act

This act involves the power of the Minister to grant licences to supply electricity to any Local Authority as defined by the Act or any company or person for public and private purposes within any given area. The licence will stipulate the conditions under which the supply of electricity is to be provided.

4.4.4. Electricity (Frequency Conversion) Act

This act involves a private supplier who consumes electricity supplied by an undertaker is a consumer within the meaning of the act only as far as it relates to the electrical apparatus required for the consumption of electricity. The cost of altering or replacing the electrical apparatus of the undertaker and the consumers affected by a scheme and any other expenditure reasonably and necessarily caused by, or incurred in connection with altering or replacing of the electrical apparatus or the financing of the conversion which is to be determined by the Minister to be an item of expenditure which may be included in the cost of conversion.

4.4.5. Electricity (Survey) Act

This act involves the establishment of and constitution of a commission whose duty is to obtain, collect, compile and analyse particulars and information in relation to the generation, distribution and use of electricity, and the quantities and types of electrical apparatus in use. The act also provides that the commission in proper discharge of their duty under the act undertake tests with the object of determining the effect of standardization of electrical frequencies and other conditions of supply of electricity on the operations of persons who may be affected.

4.4.6. Electricity Development Act

This act involves the establishment of and incorporation of an Electricity Authority whose duty is to prepare and submit to the Minister proposals for the establishment of an efficient, co-ordinated and economical system of electricity generation and supply capable of meeting the needs for electricity throughout the island. It is also responsible for preparation and submission to the Minister detailed schemes for the development and supply of electricity in particular areas and carry out such schemes as they are approved. The Authority is responsible for the promotion and encouragement the development and use of the resources of the Island in connection with the generation of electricity.

4.4.7. Petroleum Act (Prescribed Articles) Regulations

These regulations involve the prescribed articles which may be taken imported into Jamaica, or taken out of bond in Jamaica, free of duty pursuant to section 15 of the act. The corporation or every contractor who imports any prescribed article free of duty under the provisions of the act if so directed by the Commissioner cause a distinctive mark prescribed by the Commissioner to be placed on such article.

4.4.8. Petroleum Act (Extension of Functions) Order for Renewable Energy

This order extends the functions of the Petroleum Corporation of Jamaica to include the exclusive right to explore and develop in addition to petroleum, all renewable and other energy resources existing in Jamaica including the bed and subsoil of its territorial sea, its continental shelf and the exclusive economic zone.

4.4.9. Petroleum and Oil Fuel (Landing and Storage) Act

This act involves the method of testing petroleum imported into the island which gives off an inflammable vapour if so required by the Collector of Customs at the port of entry, be for the purposes of the act ascertained by such test apparatus and according to such directions as the Minister may from time to time by order prescribe. The act also provides for the standard of petroleum to be imported into the island which should not be below seventy-three degrees Fahrenheit in vessels containing more than eight fluid ounces each except in steel or tin vessels so constructed as to prevent leakage or escape of vapour. The act also provides for the granting of licenses for the sale of petroleum not exceeding twelve months and conditions of renewal are set out in the act.

4.4.10. Petroleum and Oil Fuel (Landing and Storage) Act Rules and Regulations

These regulations involve the importation of oil fuel in barrels, steel or tin vessels may be landed as ordinary cargo but the proper officer of Customs at the port of landing may by notice in writing addressed to the importer may prevent the removal of such oil fuel from the place where it is landed. The regulations also prescribe that any person desirous of landing oil fuel in bulk supply must apply to Customs for a permit to do so. These regulations also provide that no oil fuel in bulk must not be discharged from or taken aboard any ship except through a suitable hose or pipe prepared for that purpose in order to prevent any oil from falling or reaching the surface of the sea. Persons desirous of providing a store for oil fuel must make an application to the Minister in writing.

4.4.11. Petroleum (Quality Control) Act

This act involves the restrictions on retailing and transportation of petroleum as the act provides that no person shall sell petroleum by retail unless he is a licensed retailer, has insured his premises against fire with an insurance company approved by the Minister and has public liability insurance. The act also provides no person must engage in transporting petroleum in bulk unless he is a licensed haulage contractor and is registered under the act.

4.4.12. Petroleum (Quality Control) Regulation

These regulations involve the licensing of haulage contractors, the registration of retailers, haulage contractors and drivers. The regulations also involve the refusal of applications, suspension or cancellation of registration. The regulations provide for the presumptions as to contamination where the result of a test of any sample of a category of petroleum a deficiency in the normal constituents of a particular category is discovered, that deficiency shall raise a presumption that the petroleum from which the sample was taken is contaminated. The licensing of producers is set out in the regulations.

4.4.13. The Watershed Protection Act, 1963

This act involves the declaration of any area defined in the order to be a watershed area for the purposes of the Act by the Minister upon recommendation of the Authority. The act also involves the prohibition of fires in watershed areas. The act also provides for the inspection of watershed areas.

4.4.14. The Wildlife Protection Act, 1945

This act involves the declaration of game sanctuaries and reserves, game wardens, control of fishing in rivers, protection of specified rare or endemic species. The Act also provides for the protection of animals and makes it an offence to harm or kill a species which is protected. It stipulates that, having in one's possession ―whole or any part of a protected animal living or dead is illegal.

This Act has to be considered for the proposed project, ecological assessments will determine if rare or endangered species will be impacted. Six species of sea turtle, one land mammal, one butterfly, three reptiles and several species of birds including rare and endangered species and game birds are protected under this Act.

Though threatened and/or rare wildlife species were discovered during the ecological survey, the proposed project is not expected to have any significant impact on these reserves in the area.

4.4.15. The Forestry Act, 1937

This Act provides for the management and the declaration of Forest Reserves on Crown Lands and regulates activities in Forest Reserves. This Act will be reviewed to determine if the upgrade activities (particularly mining) will impact on Forest Reserves and to what extent.

4.4.16. Jamaica Railway Corporation Act and associated legislations and regulations

This act provides for the management of Jamaica's railway network. The act provides for the establishment of the Jamaica Railway Corporation which has the power to purchase, take, hold and dispose of land and other property of whatever kind under the act. The Corporation must manage and operate in accordance with the act the railway thereby transferred to the Corporation and any expansion or extension and any new railway and to provide all reasonable facilities for carriage by the Corporation of passengers and goods.

The pipeline will not encroach on the railway owned and operated by Jamalco

4.4.17. Water Resources Act, 1995; Underground Water Control Act, 1959

The Underground Water Control Act of 1959 is the legal instrument and is enforced by the Water Resources Authority (WRA). The Water Resources Act is expected to provide for the management, protection, controlled allocation and use of water resources of Jamaica. Thus, the water quality control for both surface and ground water are regulated by this Act.

If the proposed facility intends to utilize any existing ground water, permission would be needed, in the form of an issued license for this activity. Under this Act exploratory activities such as the boring/drilling of wells for the purpose of searching for underground water without the written consent would be a violation.

In addition, any activity which negatively influences the quality of existing water, whether ground or surface, would be relevant to this Act.

4.4.18. Irrigation Act

The Irrigation Act speaks to the regulation of irrigation systems in Jamaica. There is a company to be the Irrigation Authority for the purposes of the act which must do all acts or things as may be necessary to give effect to irrigation schemes and to manage, control and operate, subject to directions given by the Minister, any irrigation works established in an irrigation area.

4.4.19. The Clean Air Act, 1964

The Clean Air Act speaks to entities such as the Stockpiles, conveyors and ship loading, which are industrial operations. This facility has the potential to discharge particulate matter to the atmosphere. This Act makes reference to the use of inspectors to inspect any premises, carry out tests, and take samples of any substance that he/she considers necessary or proper for the performance of duties.

This project will be regulated by this Act in accordance with the NRCA (Air Quality) Regulations. NFE intends to abide by all regulations regarding air quality and intends to put in place best management practices used in other operations globally at this site

4.4.20. The Town and Country Planning Act, 1987

This Act governs the development and use of land. Under this law the Town Planning Department is the agency responsible for the review of any plans involving industrial development. The law allows for specific conditions to be stipulated and imposed on any approved plans. This planning decision is based upon several factors, these include;

- the location of the development

- the nature of the industrial process to be carried out
- the land use and zoning
- the effect of the proposal on amenities, traffic, etc.

This Act is applicable to the proposed activities. All necessary permits and licences will be applied for.

4.4.21. Parish Councils Act 1901 (Amended 2007)

This act provides that each Parish Council has the authority to cancel or alter the regulations with regard to the construction and restrictions as to the elevation, size and design of buildings built with the approval of the relevant Minister.

4.4.22. Clarendon Parish Provisional Development Order, 1982

This document provides the development plan for the Parish of Clarendon. It clarifies the role and responsibility of the local planning authority and provides guidance on how development of the parish should proceed. All activities in this NFE proposed CHP Project that requires local planning authority approval will be properly identified and the appropriate permits and licenses will be secured.

4.4.23. Town and Country Planning (St. Catherine Coast) Parish Development Order, 1964

All development applications are submitted for approval to the Town and Country Planning Authority, through the local Parish Council and then forwarded to the relevant authorities including NEPA and the Environmental Control Division (ECD) of the Ministry of Health. NEPA, the governing environmental agency, may require an environmental impact assessment (EIA) to be considered along with the development plan for the Authority's approval. The ECD imposes guidelines for air, water and soil standards to be maintained after construction.

4.4.24. The Jamaica National Heritage Trust Act, 1985

The Act is administered by the Jamaica National Heritage Trust (JNHT), formerly the Jamaica National Trust. This Act provides for the protection of important areas, including the numerous monuments, forts, statues, buildings of historic and architectural importance in Jamaica.

During this project, an Archaeological and Heritage Retrieval Plan may be implemented to protect any historical or archaeologically significant item encountered. NFE will utilize the services of the JNHT should any archaeological remains be found during the construction activities at the port and pipeline.

4.4.25. The Public Health Act, 1975

This Act controls and monitors pollution from point sources. Any breaches of this Act would be sent through the Central Health Committee which takes action through the Ministry of Health, Environmental Health Unit (EHU). The EHU has no direct legislative jurisdiction, but works through the Public Health Act to monitor and control pollution from point sources. Action against any breaches of this Act would be administered by the Central Health Committee. The functions of the department include:

- The monitoring of waste water quality, including regular water quality analysis, using water standards published by NEPA;
- Monitoring of occupational health as it relates to industrial hygiene of potentially hazardous working environments;
- Monitoring of air pollutants through its laboratory facilities.

In addition, there are various sections of this legislative instrument which governs and protects the health of the public. Relevant sections under the Public Health Act of 1985, are Sections 7.- (1) *A Local Board may from time to time, and shall if directed by the Minister to do so, make regulations relating to (0) nuisances and 14.- (1) The Minister may make regulations generally for carrying out the provisions and purposes of this Act, and in* *particular, subject to section 7, but without prejudice to the generality of the foregoing, may make regulations in relation to (d) air, soil and water pollution*.

Aspects of the project related to odour have been considered since odour is a part of the Air Emissions regulations to be promulgated in 2004. NFE will conduct ambient air quality monitoring in the project area during pre-construction, construction, and operation phases.

4.4.26. Disaster Preparedness and Emergency Management Act, 2001

The principal objective of the Act is to advance disaster preparedness and emergency management measures in Jamaica by facilitating and coordinating the development and implementation of integrated disaster management systems. NFE will establish procedures and guidance documents in respect of disaster preparedness and emergency management as done at other production facilities globally. These measures will be tailored, as necessary, to the Jamaican situation with assistance from various agencies

4.4.27. Factories Act

The Factories Act regulates factories and makes conditions for their inspection. The major points under this act that may affect this project are:

- The safe means of approach or access to, and exit from, any factory, or machinery
- The fencing and covering of all dangerous places or machines;
- Life-saving and first aid appliances;
- Securing safety in connection with all operations carried on in a factory
- Securing safety in connection with the use of cranes, winches, pulley-blocks and of all engines, machinery, mechanical gear, and contrivances generally
- The periodic inspection, testing and classification, according to age, type or condition, of boilers
- The duties and responsibilities assignable to any person generally, and in particular to employers, owners, and managers in charge of factories, in connection with any one or more of such regulations;

- The proper ventilation of any factory, having regard to the nature of the process carried on therein;
- The sanitation, including the provision of lavatory accommodation (having regard to the number of workers employed) at any factory

4.4.28. National Solid Waste Management Authority Act, 2001

The National Solid Waste Management Authority (NSWMA) under this Act has the responsibility to manage and regulate the solid waste sector. It includes requirements for licences for operators and owners of solid waste disposal facilities (in addition to permit requirements of NEPA).

NFE under agreement with Jamalco will implement the necessary arrangements for solid waste management and disposal for all solid waste generated from this proposed project. NFE will recycle, as much as possible, the materials used within its operation.

4.4.29. Occupational Safety & Health Act, 2003 (Draft)

This Act oversees the prevention of injury and illness resulting from conditions at the workplace, the protection of the safety and health of workers and the promotion of safe and healthy workplaces.

Sampling of sections from the Draft Act that are relevant to this project, include:

4. (1) This Act applies to all branches of economic activity and to all owners, employers and workers in all such branches.

5. (1) The owner of every industrial establishment or mine which carries on business on or after the appointed day shall, subject to subsection (8), apply to the Director in the prescribed form to be registered under this Act.

18. (1) Provides a description of the duties of employers, outlining the need for quality work areas and work environments, procedures and guidelines that will result in safe and healthy workplaces.

19. (1) discusses the duties of employers at construction sites in terms of employee safety and health during work activities.

25. (1) an employer shall make or cause to be made and shall maintain an inventory of all hazardous chemicals and hazardous physical agents that are present in the workplace.

26. (1) this section provides guidelines and procedures for employers to follow in terms of identification of hazardous chemicals. This includes labeling and identification protocols.

30. (1) Basically, this section of the Act requires an employer to provide training of its employees with a potential for exposure to hazardous chemicals or physical agents.

It is expected that this Draft Act will be passed and ultimately Gazetted in the near future. NFE has an understanding and appreciation for the contents of this policy. NFE also has its own occupational, safety and health policies that it regulates and reports on, this policy will be extended to the proposed project. NFE will under an agreement with Jamalco, comply with all Jamalco's Occupational Safety and Health Policies.

4.4.30. The Road Traffic Act, 2016

This act involves the rules surrounding road usage in Jamaica. The act provides for the establishment of an Island Traffic Authority whose duty is to regulate and control traffic on roads. The act also provides for the classification of motor vehicles permitted to use the roads as well as the restriction on driving motor vehicles. The act also provides for the application for a motor vehicle licence as well as conditions of a driver's licence. The act also provides for the rules of the road and sets out the road code.

4.4.31. Parochial Roads Act

This act involves the jurisdiction of Parish Councils over parochial roads. It sets out under section 4 that each Parish Council shall have the exclusive care, management, control and superintendence of all highways, and of all public roads, thoroughfares, streets, lanes, aqueducts, and bridges for which it is appointed, except such roads as are otherwise governed and regulated under laws of the Island, specially relating thereto, and except the roads under the superintendence of the Chief Technical Director. The act also stipulates that each Parish Council shall appoint a Superintendent of Parochial Roads and sets out his duties. The act also sets out that each Parish Council at any meeting held after the first day of October in each year and before the first meeting in January, allot a sum not exceeding four-fifths of the whole amount applicable within the year for parochial road purposes within such parish, for repairs and maintenance of parochial roads and bridges within such districts respectively. The act also sets out the powers of Parish Councils to contract as to repairs of roads. The act also involves the Parish Council serving notice on landowners where there are to be alterations or new roads or is intended to pass.

4.4.32. The Portland Bight Protected Area

The Portland Bight Protected Area (PBPA) was created on April 22, 1999 (Natural Resources Conservation Authority Act, The Natural Resources Conservation (Portland Bight Protected Area) Order 1999. The PBPA is 250 km^2 (200 $mile^2$) of land and 1,356 km^2 (524 mile2) of marine space with a total of 1,876 km^2 (724 $mile^2$) (See Figure 104).

The complex ecosystem of the PBPA provides habitat for a wide variety of Jamaican wildlife. On the coastline is the largest remaining mangrove system in Jamaica, which together with the extensive seagrass beds provides the largest nursery area for marine fish, molluscs and crustaceans in the island's territorial waters. Beaches on the mainland and on the inshore coral cays are major nesting sites for sea turtles. Manatees are now rare, but many crocodiles inhabit the rivers and wetlands.

Overlooking Portland Bight are four tropical dry limestone forests, the most intact left in Central America and the Caribbean: the Hellshire Hills, Brazilletto Mountain, Portland Ridge and Kemps Hill. Over 50 rare and endemic plants are to be found there, as well as many endemic animals.

Over 50,000 people reside within the boundaries of the PBPA in over 40 communities.

Co-management (or stakeholder management) of natural resources is the approach where representatives of all the stakeholders in a natural resource – including the government – participate in the planning, execution and enforcement of the regulations and strategy for the proper management of that resource.

This is predicated on the notion that civil society participation in local decision-making is critical in implementing and enforcing decisions concerning the resources they use as stated in Principle 10 of Agenda 21.

The National Environment and Planning Agency, the government agency with legal responsibility for managing parks and protected areas, is preparing a legal instrument by which the management responsibility for the PBPA will be delegated to the Caribbean Coastal Area Management Foundation (C-CAM).

The Portland Bight Wetlands and Cays was given Ramsar designation on 2nd February, 2006. Below is a synopsis of the Portland Bight Wetlands and Cays and their importance as outlined by the Ramsar Convention Secretariat, as taken from their website36.

Portland Bight Wetlands and Cays. 02/02/06; St. Catherine, Clarendon; 24,542 ha; 17º49'N 077º04'W. Protected Area. Located on the south coast of the island, just west of Kingston, Portland Bight (or bay) includes some 8,000 ha of coastal mangroves, among the largest continuous mangrove stands remaining in Jamaica, as well as a salt marsh, several rivers, offshore cays, coral reefs, seagrass beds, and open water. The area constitutes a critical

[6] Ramsar Convention on Wetlands http://www.ramsar.org/profile/profiles_jamaica.htm Posted 26 January 2000, updated 10 February 2006

feeding and breeding location as well as a general habitat for internationally threatened species such as the cave frog (*Eleutherodactylus cavernicola*), the Jamaican boa (*Epicrates subflavus*), the endemic hutia or coney (*Geocapromys brownii*), and the West Indian manatee (*Trichechus manatus manatus*). An endemic cactus (*Opuntia jamaicensis*) is also considered endangered under CITES. More than 4,000 fisher families make their livelihoods in the Bight, harvesting mostly finfish but also lobster, shrimp, oysters, and conch. There are important sugar plantations in the surrounding area. Threats are feared from over-hunting and -fishing, pollution from sugar wastes, mangrove destruction for aquaculture, and invasive species. Because of its ecological importance it has been declared a Ramsar Site[7] No. 1597.

[7] Ramsar Site is a wetland site designated of international importance under the Ramsar Convention. The Convention on Wetlands, known as the Ramsar Convention, is an intergovernmental environmental treaty established in 1971 by UNESCO, and coming into force in 1975. Source: *http://www.ramsar.org*

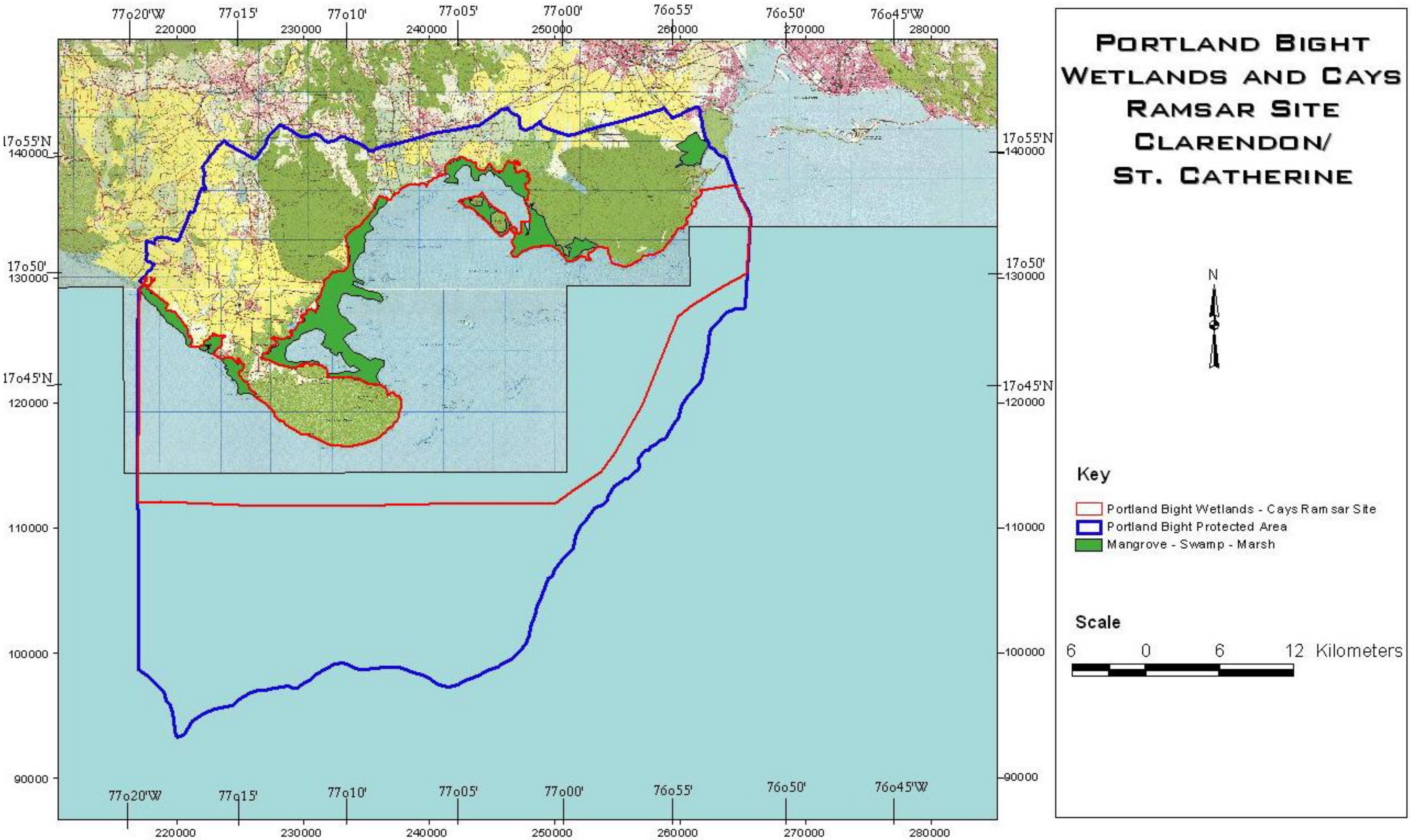


Figure 23: Portland Bight Protected Area Boundary and RAMSAR Boundary

4.4.33. Fishing Industry Act of 1975, Special Order for Special Fishery Conservation Areas

The Fishing Industry Act is the act relating to fishing activities within Jamaica. The act provides for registration and licensing, fisheries protection, prohibited activities and the declaration of an area as a fish sanctuary. The Fishing Industry (Special Conservation Area) Regulations 2012 provide that fish sanctuaries be declared.

4.4.34. The Endangered Species (Protection, Conservation and Regulation of Trade) Act 2000 (Amended 2015)

This act involves Jamaica's obligations under the Convention for the International Trade in Endangered Species of Wild Fauna and Flora. This act also involves the international and domestic trade in endangered species in and from Jamaica.

4.4.35. Harbours Act, 1874

This act involves the regulation of harbours. This act provides for the Minister to have the power to constitute and declare the extent of alter and abolish harbours. The act also provides for the Harbour of Kingston and its extent and special rules governing its use. The Governor General has the authority to appoint a fit and proper person as Harbour Master to any harbour in the island and remove such person and the same person may be appointed Harbour Master of more than one harbour. The act also sets out the duties of the Harbour Master.

4.4.36. The Maritime Areas Act 1996

This act provides that Jamaica is an archipelagic state. It also provides that Jamaica as an archipelagic state Jamaica's sovereignty reaches to the waters enclosed by the archipelagic baselines, as well as the airspace over the archipelagic waters.

During construction activities offences under this act must be noted. Some offenses include the refusal to comply with the instructions and directives of a Marine Officer or to show a licence to a Marine officer and participation in acts which are a threat to peace and safety.

4.4.37. The Docks (Safety, Health and Welfare) Regulations, 1968

These regulations involve safety, health, and welfare at docks, wharfs, and quays. The regulations set out the requirements on shore particularly as it relates to safety as every regular approach over a dock, wharf or quay which persons employed have to use for going to or from a working place at which the processes are carried on and every such working place on shore shall be maintained with due regard to safety. The regulations speak to lighting at docks, means of rescue from drowning, the provision of first aid boxes and their contents, stretchers, the provision of ambulances, first aid rooms, washing and bathing facilities, accommodation for clothing and taking meals. The regulations also speak to proper sanitary conveniences for workers. The regulations also speak to safety provisions on board ships and the precautions to be taken when loading, unloading, or fueling.

4.4.38. The Port Authority (Port Management and Security) By-Laws 2009

Section 10 of the by-laws speak to security measures at port facilities. The Port Authority may after consultation with the minister responsible for national security approve security arrangements for the purpose of supervising and regulating entry and exit from port facilities and the movement of persons, equipment and goods in those premises. Section 11 speaks to the security arrangements at port facilities such as security procedures and other terms and conditions as may be required of users of port facilities including the payment of user fees and reimbursable expenses associated with security provided. Section 20 speaks to control or access to wharf premises as security personnel at port facilities shall take all necessary steps to ensure that only persons holding the requisite authority are allowed to enter those premises.

4.5. National Policy

4.5.1. Jamaica's National Energy Policy (2009-2030)

This policy is designed to promote Jamaica's energy efficiency. The goals of the National Energy policy are as follows:

- Goal 1: Jamaicans use energy wisely and aggressively pursue opportunities for conservation end efficiency.
- Goal 2: Jamaica has a modernized and expanded energy infrastructure that enhances energy generation capacity and ensures that energy supplies are safely, reliably, and affordably transported to homes, communities and the productive sectors on a sustainable basis.
- Goal 3: Jamaica realizes its energy resource potential through the development of renewable energy sources and enhances its international competitiveness, energy security whilst reducing its carbon footprint.
- Goal 4: Jamaica's energy supply is secure and sufficient to support long-term economic and social development and environmental sustainability.
- Goal 5: Jamaica has a well-defined and established governance, institutional, legal and regulatory framework for the energy sector that facilitates stakeholder involvement and engagement.
- Goal 6: Government ministries and agencies are a model/leader in energy conservation and environmental stewardship in Jamaica.
- Goal 7: Jamaica's industry structures embrace eco-efficiency for advancing international competitiveness and moves towards building a green economy.

Jamaica's National Energy policy is designed to develop a modern, efficient, diversified and environmentally sustainable energy sector providing affordable and accessible energy supplies.

4.5.2. Vision 2030

Vision 2030 is a national development plan for Jamaica which seeks to promote four National Goals as associated National outcomes for each goal, to be achieved by 2030, with the objective of developing Jamaica into a country with a lively and stable economy, and society and environment, and greater opportunities for the country's population

4.5.3. Economic Growth & Job Creation

The GOJ in a dedicated effort to drive economic growth and job creation and to increase GDP growth to reduce Jamaica's debt to GDP ratio, has developed a governance structure in which a Ministry of Economic Growth & Job Creation has been created. This Ministry is headed by the Prime Minister of Jamaica, and there are several Ministers without Portfolios with specific accountability for various subjects. This is an innovative approach to governance in Jamaica and represents a new development since Jamaica obtained independence in 1962.

In keeping with this, the GOJ has established an Economic Growth Council under the chairmanship of one of Jamaica's leading entrepreneurs. Growth targets have also been established by the IMF.

Jamaica has experienced relatively poor growth at an average of about 1-2% for the past 20 years. There have been times during the country's first 15 years in which Jamaica has experienced growth rate of up to 11.9%. It is important to note that this high level of growth coincided with the expansion of the bauxite-alumina industry through the start-up of Alumina Partners of Jamaica (ALPART) in 1969, then a consortium of Kaiser Aluminum and Chemical Corporation, Reynold's Aluminum and Anaconda and ALCOA Minerals of Jamaica, which was commissioned in 1971.

Unemployment in Jamaica is very high with about 400,000 unattached youths.

4.5.4. Guidelines and Planning Standards (Natural Gas and LNG)

The World Bank/GOJ/NEPA developed Guidelines for the NG/LNG Sector in Jamaica. This was prepared by IDOM Ingeneria y Consultoria and Conrad Douglas & Associates Limited. The following guidelines related to Natural Gas and LNG Sector in Jamaica were prepared in May 2015:

- Guidelines and Planning Standards- Gas Pipelines and Regulating & Metering Stations, 2015

- Guidelines and Planning Standards- LNG Satellite Plants, 2015
- Guidelines and Planning Standards- Regasification Terminals, 2015
- Guidelines for Developing a Natural Gas Sector Regulatory Framework, 2015

4.5.5. Policy for the National System of Protected Areas 1997

The various types of protected areas in Jamaica should, individually and as part of a comprehensive system, contribute to achieving common environmental, economic, cultural and social goals. The system should be an essential tool for environmental protection, conserving essential resources for sustainable use, helping to expand and diversify economic development and contributing to public recreation and education. There are six general types of areas to encompass the diverse natural resources and landscapes and are comparable to those of the IUCN (International Union for Conservation of Nature) 4:

1. National Nature Reserve/ Wilderness Areas (Equivalent to IUCN Category I)
2. National Park, Marine Park (Equivalent to IUCN Category II)
3. Natural Landmark/ National Monument (Equivalent to IUCN Category III)
4. Habitat/ Species Management Area (Equivalent to IUCN Category IV)
5. National Protected Landscape, or Seascape (Equivalent to IUCN Category V)
6. Managed Resource Protected Area (Equivalent to IUCN Category VI)

4.5.6. Towards an Ocean and Coastal Zone Management Policy in Jamaica June 2000

The Government of Jamaica established the Council on Ocean and Coastal Zone Management in 1998 with a mandate to define national policy, promote co-ordination of administrative and operational functions among government agencies and civil society, and ensure compliance with enacted treaties and protocols. The aim of this policy document is to develop a policy that will "enhance the contribution of economic sectors to the integrated management of coastal areas by developing awareness in sector line agencies and resource users." The policy document deals with overuse and degradation of Jamaica's coastal and ocean resources particularly coral reefs, wetlands, seagrasses, and sand.

4.5.7. Towards a Beach Policy for Jamaica (A Policy on the Foreshore and the Floor of the Sea), 2000 (DRAFT)

The aim and objective of this policy has taken into account, and seeks to balance the different users of the beach –the public, the private sector and fishermen. This policy was created to update existing policies and to develop an overarching policy that considers beach erosion as well beach pollution.

4.5.8. National Policy for the Conservation of Seagrasses 1996 (DRAFT)

A policy on seagrass is essentially: "*to guide the issuing of licences, or permits for activities which directly or indirectly affect these plant communities. These include activities such as dredging, port development, the disposal of dredge spoil, beach development and effluent disposal.*" Though this a draft policy every effort must be made to protect and preserve seagrass communities.

4.5.9. Coral Reef Protection and Preservation Policy and Regulation 1997 (DRAFT)

This policy is designed to protect and preserve coral reefs although it is a draft policy and regulation. It discusses the importance of coral reefs in the marine environment as well as current issues affecting coral reefs. The policy also deals with the conservation of coral reefs. Though this is a draft policy serious efforts must be made to protect and preserve coral reefs from degradation and destruction.

4.5.10. Draft Policy and Regulation for Mangrove & Coastal Wetlands Protection

This draft policy specifically seeks to:

- Provide protection against dredging, filling, and other development;
- Designate wetlands as protected areas;
- Protect wetlands from pollution particularly industrial effluent sewage, and sediment;

- Ensure that all developments planned for wetlands are subject to an Environmental Impact Assessment (EIA);

Ensure that traditional uses of wetlands are maintained.

4.5.11. Jamaica's National Energy Policy (2009-2030)

Jamaica's National Energy Policy (2009-2030) is in keeping with the country's long-term plan to achieve developed country status by 2030 as articulated in Vision 2030 Jamaica – National Development Plan.

The Strategic Framework addresses both supply and demand energy issues the country faces and as such places priority attention on seven key areas:

1. Security of Energy Supply through diversification of fuels as well as development of renewables
2. Modernizing the country's energy infrastructure
3. Development of renewable energy sources such as solar and hydro
4. Energy conservation and efficiency
5. Development of a comprehensive governance/regulatory framework
6. Enabling government ministries, departments and agencies to be model/leader for the rest of society in terms of energy management
7. Eco-efficiency in industries

4.6. International Policy

4.6.1. Agenda 21

In June 1992, Jamaica participated in the United Nations Conference for Environment and Development (UNCED) in Rio de Janeiro, Brazil. One of the main outputs of the conference was a plan of global action, titled Agenda 21, which is a ―comprehensive blueprint for the global actions to affect the transition to sustainable development‖ (Maurice Strong). Jamaica is a signatory to this Convention. Twenty-seven (27) environmental principles were outlined in the Agenda 21 document. Those most relevant to this project, which Jamaica is obligated to follow are outlined below:

- Principle 1: Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.
- Principle 2: States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies.
- Principle 4: In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.
- Principle 8: To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.
- Principle 10: Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes.
- Principle 15: In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.
- Principle 16: National authorities should endeavour to promote the internationalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

- Principle 17: Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

NFE is an international organization. NFE is cognizant of and abides by international treaties and protocols. The principles of Agenda 21 that relate to this project will be applied throughout the project lifespan.

4.6.2. Convention on Wetlands (*Ramsar, 1971*)

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 158 Contracting Parties to the Convention, with 1713 wetland sites, totaling 153 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance.

Jamaica became a signatory to this convention on February 07, 1998. There are three designated Ramsar Sites totaling 37,765 hectares, and are as follows:

1. Black River Lower Morass (Ramsar site No. 919)
2. Palisadoes – Port Royal Wetlands (Ramsar site No. 1454)
3. Portland Bight Wetlands and Cays (Ramsar site No. 1597)

The last is found within the immediate geographic sphere of influence of the proposed development, and totals approximately 24,542 ha.

The treaty outlines guidelines for contracting parties (Governments) in the following areas:

1. Guidelines for the management of groundwater to maintain wetland ecological character (Resolution IX.1 Annex C ii)

2. Principles and guidelines for incorporating wetland issues into Integrated Coastal Zone Management (ICZM) (Resolution VIII.4)
3. Guidelines for international cooperation under the Ramsar Convention Implementing Article 5 of the Convention [adopted as an annex to Resolution VII.19 (1999)
4. New Guidelines for management planning for Ramsar sites and other wetlands (Resolution VIII.14)
5. Guidelines for developing and implementing National Wetland Policies (adopted by Ramsar Resolution VII.6)
6. Guidelines for establishing and strengthening local communities‘ and indigenous people‘s participation in the management of wetlands [Adopted as an annex to Resolution VII.8 (1999)]
7. Guidance for the consideration of the deletion or restriction of the boundaries of a listed Ramsar site (adopted by Resolution IX.6)
8. Principles and guidelines for wetland restoration (Resolution VIII.16)
9. A Conceptual Framework for the wise use of wetlands and the maintenance of their ecological character (Resolution IX.1 Annex A)

4.6.3. Convention on Biological Diversity (Rio de Janeiro, 1992)

Signed by 150 government leaders at the 1992 Rio Earth Summit, the Convention on Biological Diversity is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognizes that biological diversity is about more than plants, animals and microorganisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live.

Jamaica signed to the convention on June 11, 1992 and ratified it on January 6, 1995. Under this treaty, Jamaica is ranked fifth among islands of the world in terms of endemic plants. The country also enjoys a high level of endemism for animal species, as these examples illustrate: 98.2% of the 514 indigenous species of land snails and 100% of the 22 indigenous species of amphibians are endemic to Jamaica. Nearly 30.1% of this mountainous country is covered with forests. Jamaica's highest point, the Blue Mountain Peak, reaches a maximum height of 2,256m. There are 10 hydrological basins containing over 100 streams and rivers, in addition to several subterranean waterways, ponds, springs, and blue holes. The country's rich marine species diversity include species of fish, sea anemones, black and stony corals, mollusks, turtles, whales, dolphin, and manatee.

The activities undertaken by Jamaica derive from seven goals, which are:

- to conserve Jamaica's biodiversity;
- to promote sustainable use of biological resources;
- to facilitate access to biological resources (to promote biotechnology and ensure benefit sharing);
- to ensure safe transfer, handling and use of Living Modified Organisms (LMOs);
- to enhance resource management capacity;
- to promote public awareness, education, and public empowerment; and
- to promote regional and international cooperation and collaboration

The action plan comprises specific projects that have been elaborated with regards to these goals. Those most relevant aspects of this convention to this project, which Jamaica is obligated to follow are outlined below:

- Article 6. General Measures for Conservation and Sustainable Use
- Article 7. Identification and Monitoring
- Article 8. In-situ Conservation
- Article 9. Ex-situ Conservation
- Article 10. Sustainable Use of Components of Biological Diversity
- Article 13. Public Education and Awareness
- Article 14. Impact Assessment and Minimizing Adverse Impacts

4.6.4. United Nations Framework Convention on Climate Change (UNFCCC)

The United Nations Framework Convention on Climate Change (UNFCCC) is an international environmental treaty adopted on May 9, 1992 and opened for signature at the Earth Summit in Rio de Janeiro from 3 to 14 June 1992. It then entered into force on 21 March 1994, after a sufficient number of countries had ratified it. The UNFCCC objective is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". Jamaica ratified the Paris Agreement in 2017.

4.6.5. Montreal Protocol

The Montreal Protocol is an international treaty designed to protect the ozone layer by phasing out the production and consumption of a number of substances that are believed to be responsible for the depletion of the ozone layer. The treaty was opened for signature in September 1987 and entered into force on January 1, 1989. Initially, the protocol was signed by 27 countries when it opened in September 1987, and subsequently ratified by 100 countries. Jamaica ratified the treaty at the 1993 Vienna Convention. As of September 16, 2009, all countries in the United Nations have ratified the original Montreal Protocol.

4.6.6. Kyoto Protocol, 2005

The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits State Parties to reduce greenhouse gas emissions, based on the fact that :

(a) Global warming exists;
(b) Human-made CO_2 emissions have caused it.

The Kyoto Protocol was adopted in Kyoto, Japan on December 11, 1997 and entered into force on February 16, 2005. There are currently 192 parties to the Protocol. Jamaica ratified the treaty on June 28, 1999.

4.6.7. Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region), 1983

The Convention for the Protection and Development of the Marine Environment in the wider Caribbean Region or Cartagena Convention is a regional legal agreement for the protection of the Caribbean Sea.

The Convention was adopted in Cartagena, Colombia on March 24, 1983 and entered into force on October 11, 1986.

The Convention is supported by three technical agreements or Protocols on Oil Spills, Specially Protected Areas and Wildlife and Land Based Sources of Marine Pollution:

1. *The Protocol Concerning Co-Operation on Combating Oil Spills in the Wider Caribbean Region* , which was adopted and entered into force at the same time as the Cartagena Convention;
2. *The Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region* was adopted in two stages, in January 1990 and the Protocol entered into force on June 18, 2000;
3. *The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region* was adopted on October 6, 1999 and entered into force on August 13, 2010.

4.6.8. United Nations Convention on the Law of the Sea (UNCLOS III) 1982

The United Nations Convention on the Law of the Sea lays down a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources. It enshrines the notion that all problems of ocean space are closely interrelated and need to be addressed as a whole. UNCLOS III replaces the Convention on the Territorial Sea and the Contiguous Zone (entered into force on September 10, 1964), as well as the Convention on the Continental Shelf (entered into force on June 10, 1964), and both agreed upon at the first United Nations Convention on the Law of the Sea (UNCLOS I). Jamaica ratified the UNCLOS III on December 10, 1982 on March 21, 1983. 166 countries have joined the convention as at August 2013.

4.6.9. Convention on Fishing and Conservation of the Living Resources of the High Seas 1958

This is an agreement that was designed to solve through international cooperation the problems involved in the conservation of living resources of the high seas, considering that because of the development of modern technology some of these resources are in danger of being over-exploited. It was opened for signature on April 29, 1958 in Geneva.

4.6.10. Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter

The "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972", the "London Convention" for short, is one of the first global conventions to protect the marine environment from human activities and has been in force since August 30, 1975 and is administered since 1977 by the International Maritime Organization. Its objective is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. Currently, 87 States are Parties to this Convention.

In 1996, the "London Protocol" was agreed to further modernize the Convention and, eventually replace it. Under the Protocol all dumping is prohibited unless explicitly permitted; incineration of wastes at sea is prohibited; export of wastes for the purpose of dumping or incineration at sea is prohibited.

4.6.11. International Convention on Oil Pollution Preparedness, Response and Co-operation, 1990

This Convention sets standards for the preparation for and respond to oil pollution which entered into force in 1995. Jamaica is a signatory to the convention and there are 107 parties to the convention as of July 2013.

4.6.12. National Fire Protection Association (NFPA) 59A

This standard was created to provide minimum fire protection, safety, and related requirements for the location, design, construction, security, operation, and maintenance of LNG plants. The following apply:

1. Facilities that liquefy natural gas
2. Facilities that store , vaporize, transfer and handle liquefied natural gas (LNG)
3. The training of all personnel involved with LNG
4. The location, design, construction, maintenance, and operation of all LNG facilities.

It does not apply to the following :

1. Frozen ground containers
2. Portable storage containers stored or used in buildings
3. All LNG vehicular applications, including fuelling of LNG vehicles

5.0. Description of the Baseline Environment

5.1. Introduction

The project will be executed in the Parish of Clarendon and in the Portland Bight Protected Area. The area for development of the Power Station is a vacant un-vegetated section of the existing brownfield alumina refinery.

The topography is flat to gently sloping towards the sea. No significant land clearing is anticipated because all routes will be along existing brownfield infrastructure i.e. main road, train line track, port facilities. It is proposed to use directional drilling in sensitive areas of the marine environment such as hard coral and beneath sea grass beds to facilitate pipe laying without significant underwater open trenching.

The project will extend from an elevation of about 80 m above sea level at the tie-in to the national grid to below sea level for pipework in the sea.

5.2. Physical Environment

5.2.1. Meteorology

Meteorological data for the area was sourced from the National Meteorological Service and supplemented with secondary information from in-house databases. These databases include information from the following close collection points:

- Mocho
- Beckford Kraal
- Osborne Store
- Parnassus
- New Yarmouth
- Old Yarmouth-Fisher
- Old Yarmouth-Quarry
- Salt River
- Morelands
- Mumby
- Heathfield
- Springhead
- Grimmith
- Bog
- Mitchell Town AWS
- May Pen AWS
- Monymusk AWS
- Ebony Park AWS

The locations of the weather collection points are shown in Figure 24 below.

Figure 24: Locations of weather stations

5.2.1.1. Rainfall

In the past, Jamaica has had a cyclic bimodal rainfall pattern linked to its geographic location in the Caribbean, its topography and the effects caused by seasonal variations in atmospheric circulation patterns (Water Resources Authority, 2015). The latter is driven by the heating effects of solar radiation. The rainy season roughly spans April–November with peaks in May–June and September-November and a mid-summer drought that occurs in July-August (See Figure 25 below). There is also a dry period between December to April, with February being the driest month.

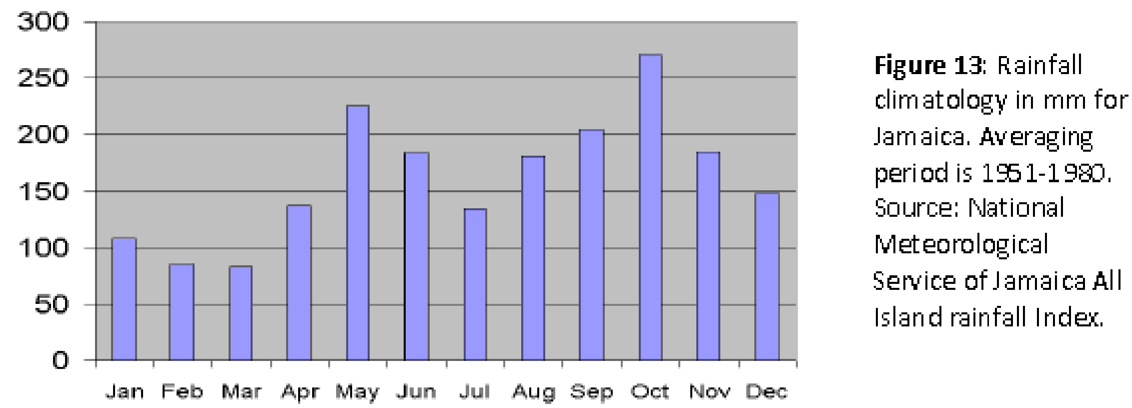


Figure 25: Rainfall Climatology in mm for Jamaica. Averaging period is 1951-1980 Source: National Meteorological Service of Jamaica and (Climate Studies Group, Mona, 2016)

Jamaica's 30-year rainfall average for the period 1951-1980 is shown in Figure 26 below. As shown, the highest rainfall occurs in the north-eastern part of Jamaica with rainfall of up to 5000 mm or more (Climate Studies Group, Mona, 2016). Conversely, the lowest rainfall is observed on the southern coast, with the plains of the south-coast significantly driest (just more than 1000 mm annually). This correlates with the fact that the Blue & John Crow Mountain Range is found in the north-eastern part of the island, which is the highest elevation in the country. In general, the moisture laden north-east trade winds, firstly impacts the north-eastern part of the island and as they rise to higher elevations, condensation and precipitation occurs (See Figure 27 below). In combination with sea breezes this result in the high levels of precipitation recorded (Climate Studies Group, Mona, 2016).

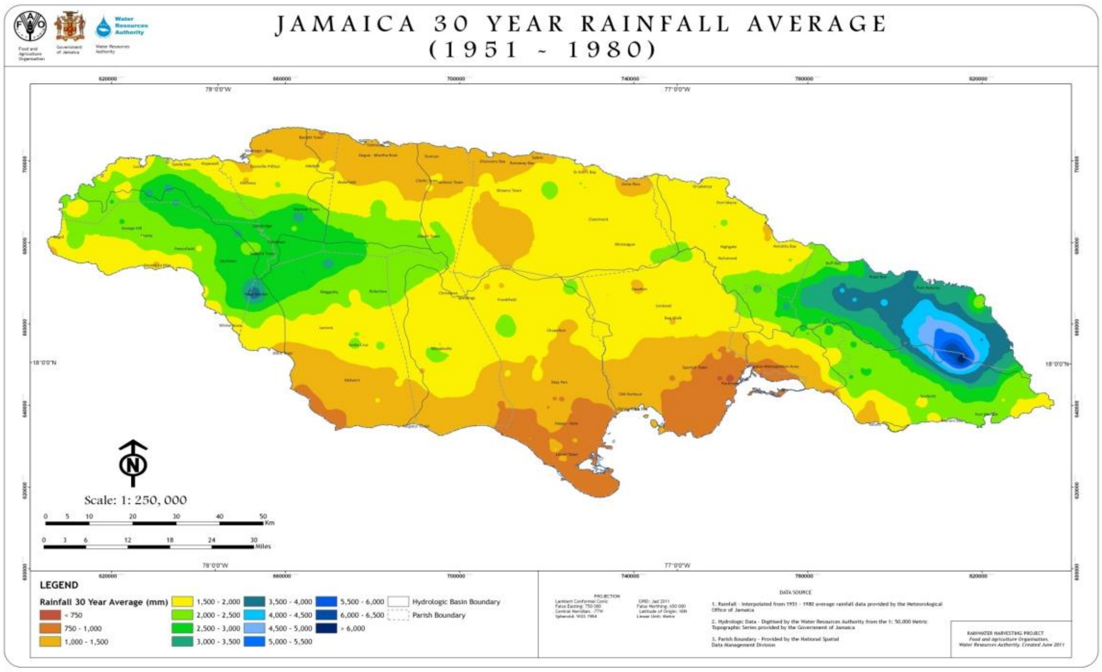


Figure 26: Jamaica 30 Year Rainfall Average (1951-1980) (Water Resources Authority, 2015)

Of the weather parameters, rainfall is the most variable. Island wide, during the period 1951 to 1980, annual rainfall ranged from a maximum of 2593 mm (102.09 in) in 1963 to a minimum of 1324 mm (52.13 in) in 1976, with an average of 1940 mm (76.38 in) annually. The hundred-year (1881-1990) mean annual rainfall is 1895 mm (74.61 in). Historically, the wettest year on record was 1933 with an annual rainfall of 2690 mm (116.54 in) whilst the driest year was 1920 with an annual rainfall of 1299 mm (51.14 in). Figure 5-2 shows the mean long-term mean rainfall for the parish of Clarendon for 1951-1980.

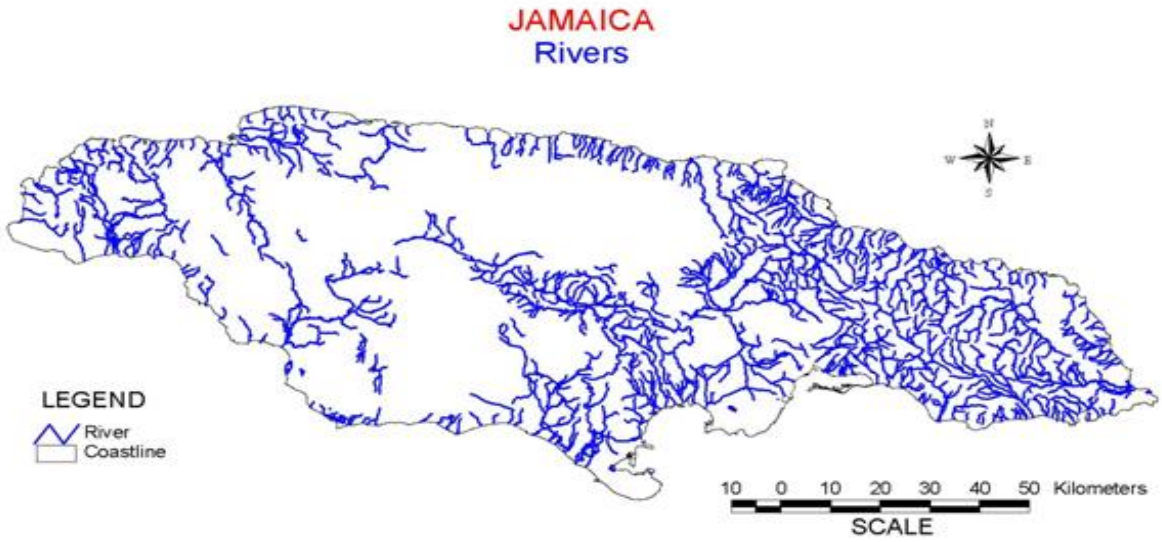


Figure 27: Rivers of Jamaica (Water Resources Authority, 2015)

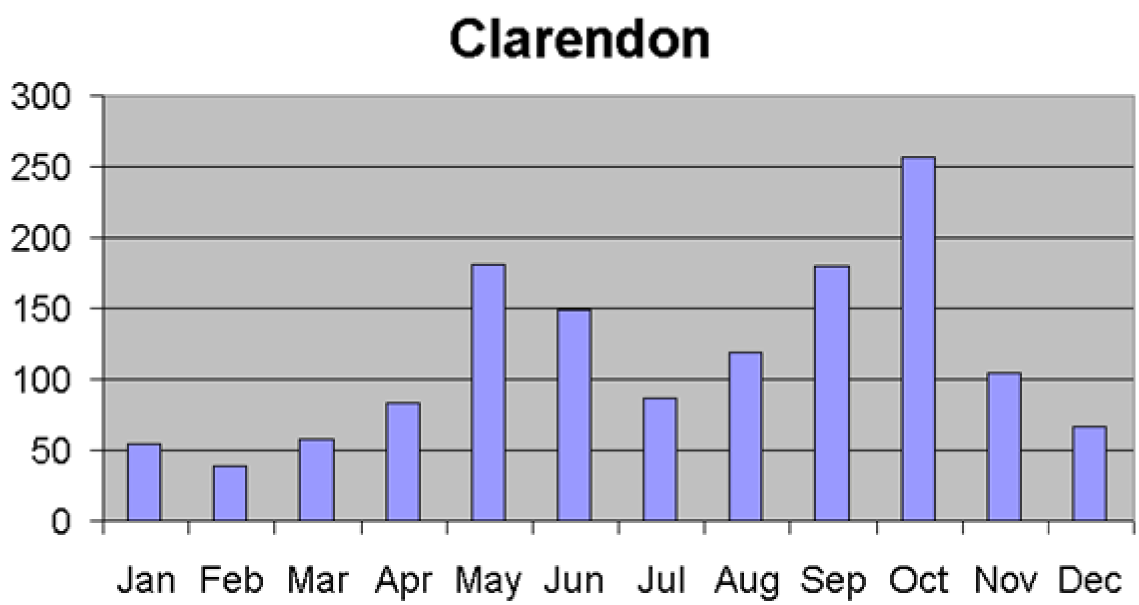


Figure 28: Clarendon Long-Term Mean Rainfall (mm) 1957-1980[8]

Other rain-producing systems are influenced by the sea breeze and orographic effects which tend to produce short-duration showers, mainly during mid-afternoon.

[8] Jamaica Meteorological Service, Climatological Data

The parish of Clarendon receives an annual average of 1378 mm of rainfall per year mainly during the rainy period, between the months of May and November. The driest period occurs from January through March, with less than 58 mm per month.

Figure 29 to Figure 31 below shows the average annual rainfall for Salt River, Mitchell Town and Parnassus the closest available rainfall monitoring sites in the area.

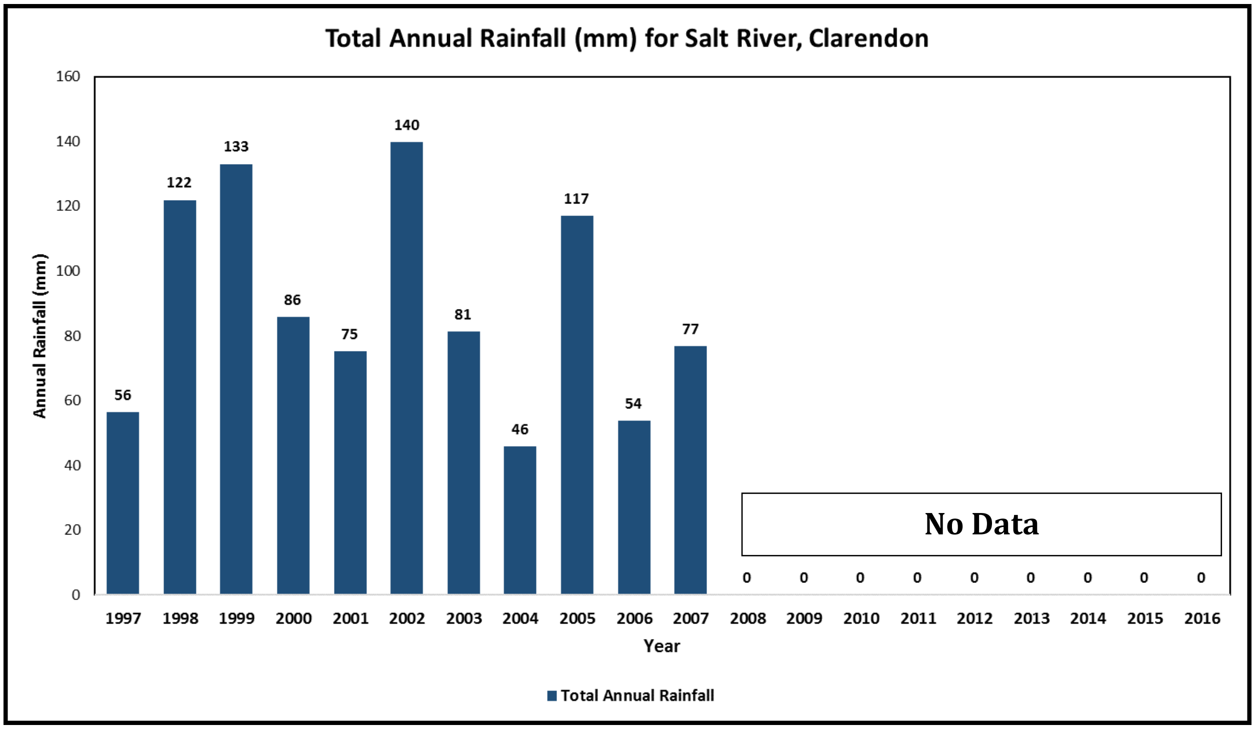


Figure 29: Total Annual Rainfall for Salt River

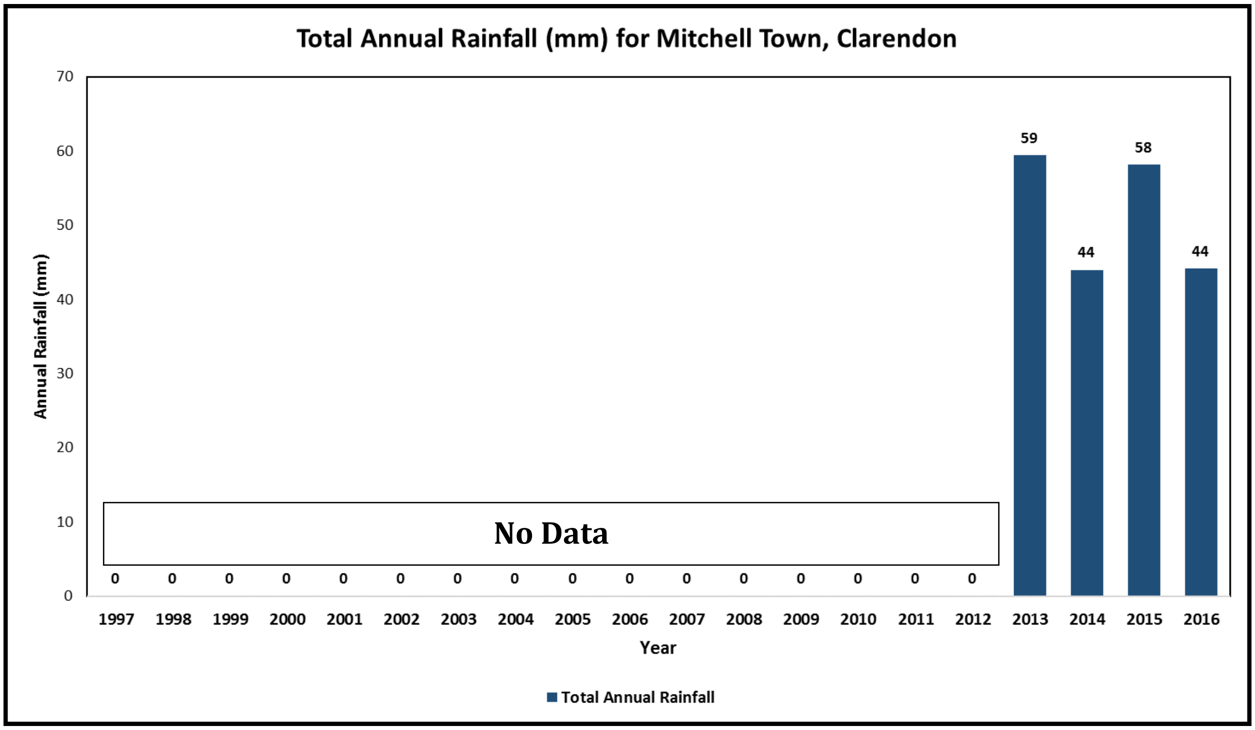


Figure 30: Total Annual Rainfall (mm) for Mitchell Town, Clarendon

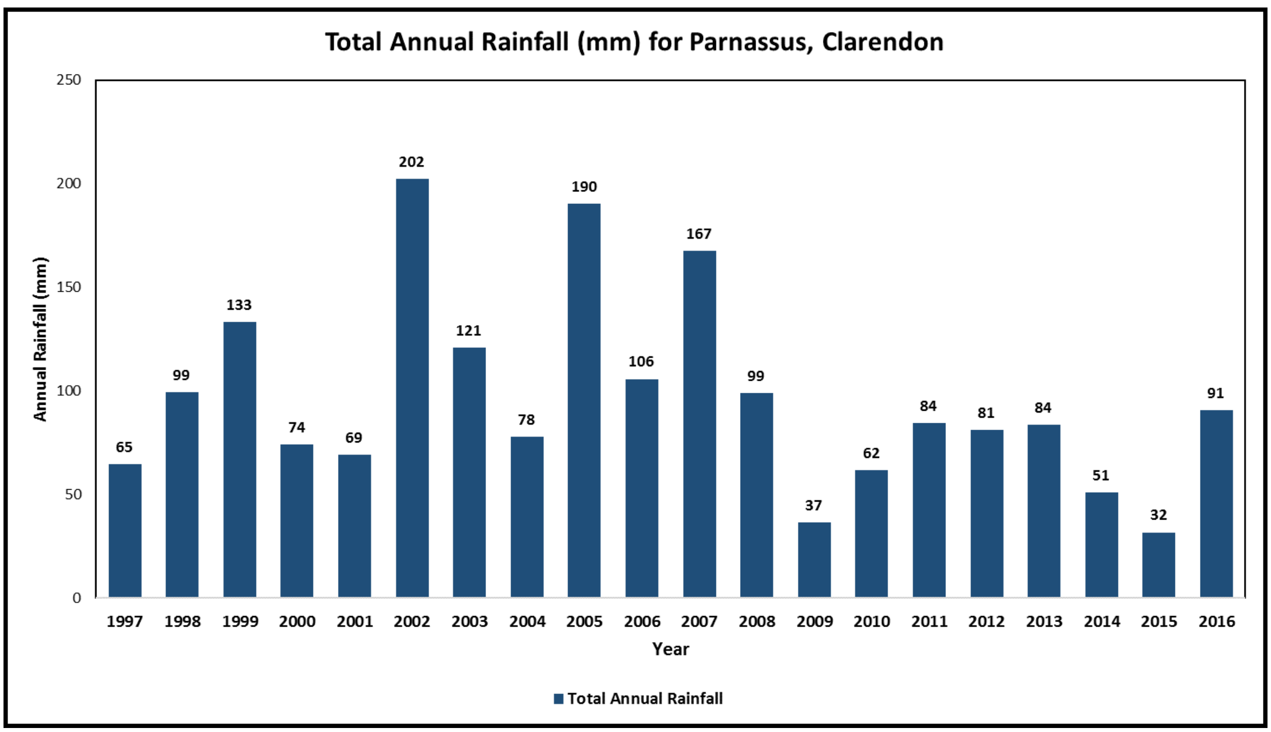


Figure 31: Total Annual Rainfall (mm) for Parnassus, Clarendon

5.2.1.2. Wind

Rocky Point and Brazilletto Mountain experiences the traditional north easterly trade winds that affect the island. Hurricanes are a serious seasonal threat from June to November; since 1886, 21 hurricanes have made landfall in Jamaica, while over 100 have passed within 240 km (150 miles) of the island. Tsunamis are also a possible major risk. The paragraphs below outline the current patterns that affect the area and were re-verified in October-December 2007 and January-February 2008 (Environmental Impact Assessment for the Construction of a Port, Stockpile Area and Transportation Corridor, 2008) and found to be consistent with data presented in the JAMALCO Temporary Barge Docking Facility EIA (2006) and the JAMALCO 2.8 Metric Tonne per year Efficiency Upgrade EIA (2004) prepared by Conrad Douglas and Associates Ltd.

During the morning period, the prevailing winds are from the north. These winds are land driven and are reversed in the evenings. The plate below represents an aerial photograph of the area taken on an early morning in 1991. The area has remained consistent in size and topography as represented, and the conditions are quite similar as verified through ground truthing. The currents affecting the area are influenced by these winds.

Figure 32 below presents the wind rose for the Norman Manley International Airport, Jamaica from 1976 - 2005. The climate reported in the figure illustrates predominant winds from the east through southeast. Fairly constant wind conditions are shown with winds exceeding 20 knots approximately 10% of the time, and 30 knot wind speeds are exceeded only 0.26% (Figure 33 below).

Portland Cottage is the driest and hottest part of Jamaica. This is reason for the establishment of a solar salt facility at Portland Cottage in the past.

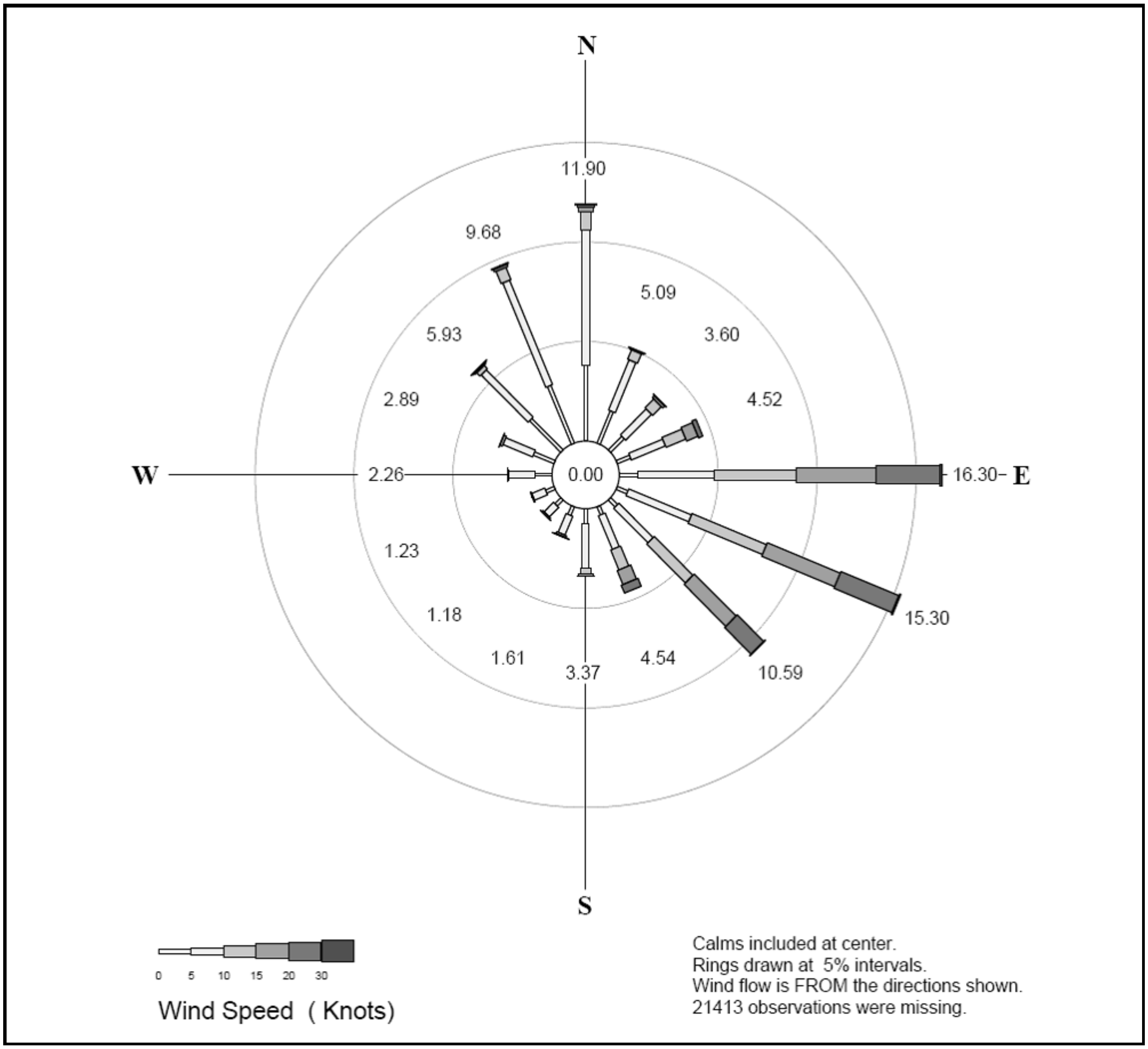


Figure 32: Wind Rose for Norman Manley International Airport, Jamaica (1976-2005)

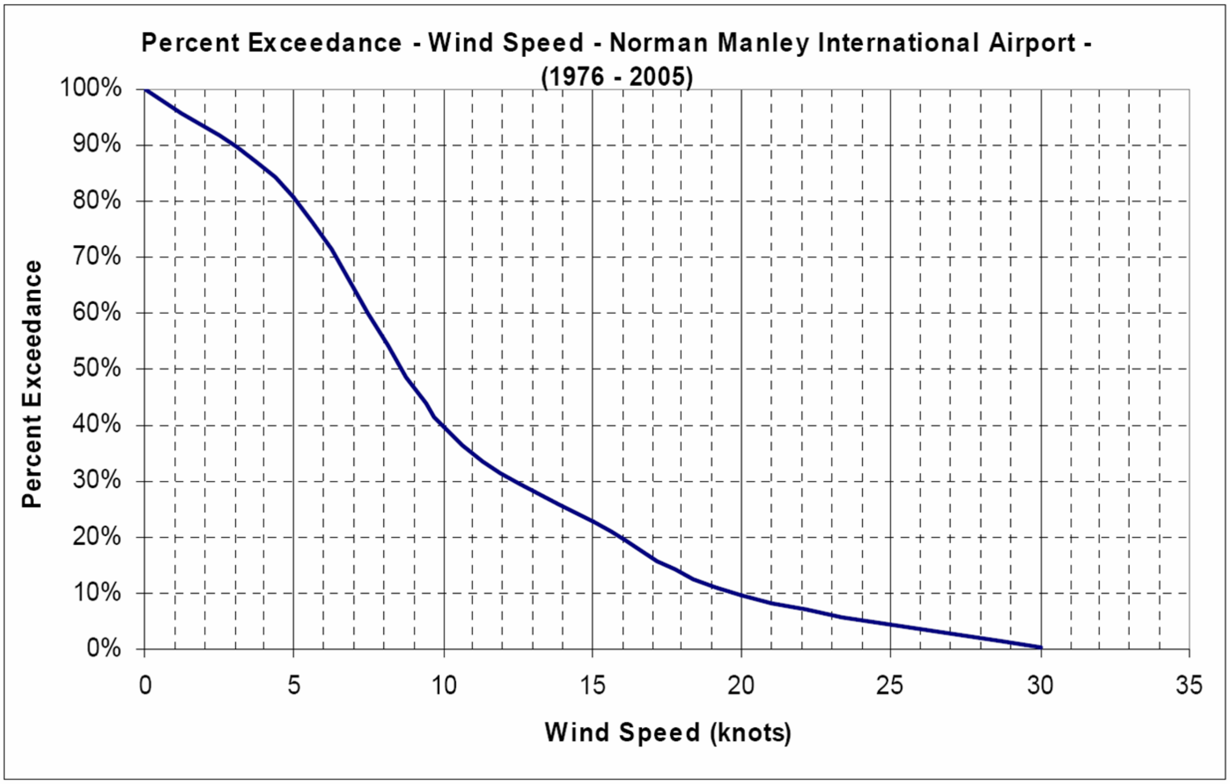


Figure 33: Percent Exceedance - Wind Speed - Norman Manley International Airport (1976-2005)

5.2.1.1. Wind Pattern and Direction

Figure 34 below shows the direction of dominant day and night time winds experienced at the terminal. Sea currents typically move in a direction influenced by the wind.

Wind roses were also created from data supplied from the Meteorological Services of Jamaica. These were overlaid on google maps. The general wind direction and speed from the Monymusk, Mitchell Town and May Pen weather station are shown. The data shows that majority of the wind directions measured were blowing towards the north-west and suggests that any dust generated will generally blow in that direction.

Figure 34: Prevailing Wind Directions at the Marine Terminal (ocean currents are typically influenced by the prevailing wind direction)

Figure 35: Wind Rose for Monymusk, Mitchell Town and May Pen Weather Station overlaid on Google Map

5.2.1.2. Temperature and Relative Humidity

Apart from rapid fluctuations associated with afternoon showers and/or the passage of frontal systems, the island's temperatures remain fairly constant throughout the year under the moderating influence of the warm waters of the Caribbean Sea.

The warmest months are June to August and the coolest December to February. Night-time values range from 18.9 ºC to 25.6 ºC (66 to 78.1 ºF) in coastal areas with inland temperatures cooler. The diurnal range of temperature is much greater than the annual range and exceeds 11.0 ºC or 20 ºF in mountainous areas of the interior.

At elevations above 610 metres (2000 feet), minimum temperature of the order of 10 ºC (50 ºF) have been reported occasionally when active cold fronts reach the island. The project location is within the coastal zone at elevations within the range 0 - 230 m (0 – 750 ft.).

Variations of sunshine from month to month in any area are usually small, approximately one hour. Differences, however, are much greater between coastal and inland stations. Maximum day-length occurs in June when 13.2 hours of sunshine are possible and the minimum day-length occurs in December when 11.0 hours of sunshine are possible. However, the mean sunshine in mountainous areas is less than 6 hours per day, while in coastal areas it is near 8 hours per day. The shorter duration in the hilly areas is caused mainly by the persistence of clouds.

Relative humidity is a term used to describe the amount of water vapour that exists in a gaseous mixture of air and water, expressed as a percentage of the maximum amount of water vapour that could be present if the vapour were at its saturation conditions. Afternoon showers are the major cause of most daily variations in relative humidity. Highest values recorded during the cooler morning hours near dawn, followed by a decrease until the early afternoon when temperatures are highest.

The average monthly % relative humidity (%RH) and temperature experienced on the south coast is given below (Figure 36). These values are tempered by the usual afternoon showers experienced in the hilly interiors. The average annual temperature for this period was 28.34 ºC.

Figure 37 and Figure 38 below outlines the temperature and pressure experienced in the area of the JAMALCO Port for a five (5) week period in 2007 (October 17 – November 21).

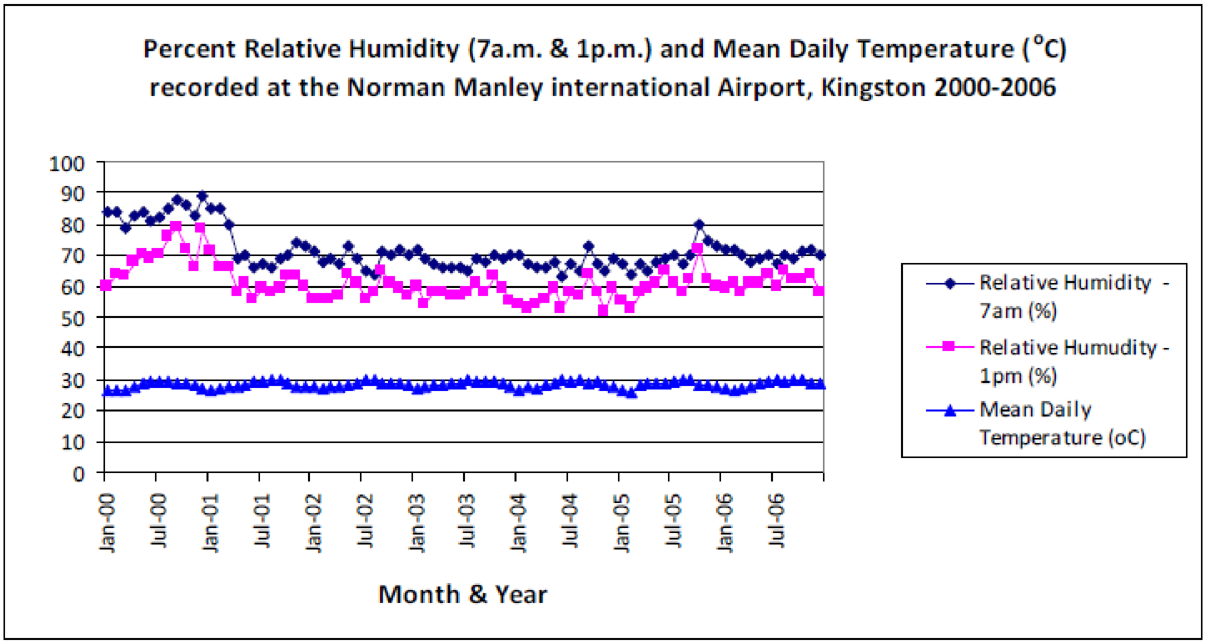


Figure 36: Percent Relative Humidity and mean daily temperature experienced at Norman Manley International Airport, Kingston 2000-2006

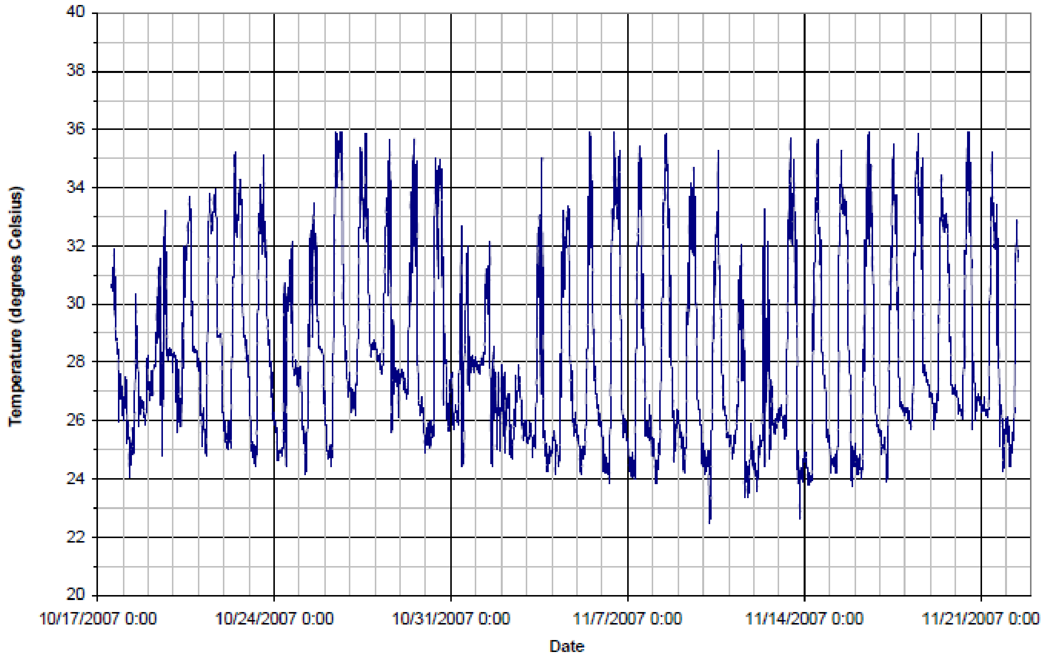


Figure 37: Temperature Chart outlining the temperature profile of the area for a 5 week period

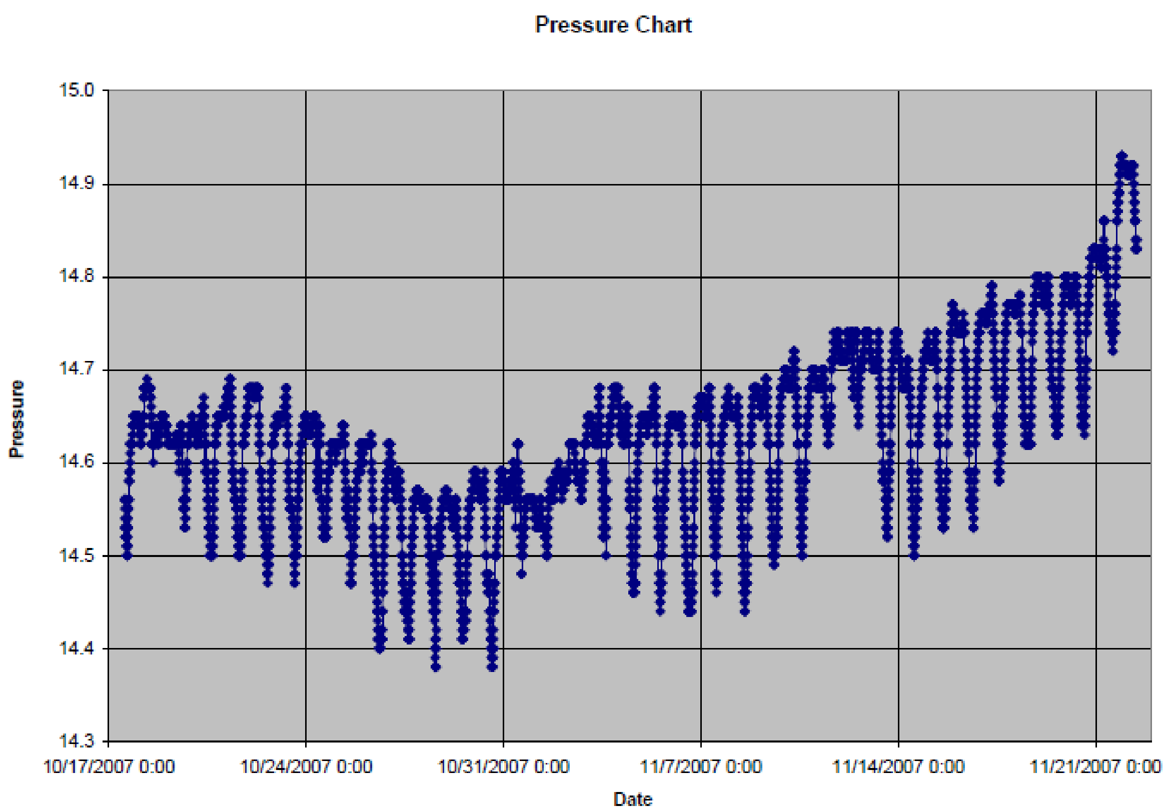


Figure 38: Pressure Chart outlining the Pressure Profile of the area for a 5-Week Period

5.2.2. Audiometric Analysis – Noise Modeling

5.2.2.1. Approach & Methodology

Noise emission models were developed for two (2) proposed, mutually exclusive, Combined Heat and Power (CHP) station layouts. Each layout was proposed with its own unique Gas Fired Turbine and a Heat Recovery Steam Generator (HRSG). The layout also included auxiliary equipment such as pumps and transformers.

The CHP is proposed for location within the fence line (battery limits) of Jamalco which is within the refinery's property boundaries.

The model was designed and run using SoundPLAN Essential ver 4.0 to process the available information from the contractors to develop a basic noise map which identifies areas of potential impact from the operation of the CHP at 100% of installed capacity.

For the purpose of the model, the CHP is formally defined by its major and auxiliary equipment. Major equipment is defined as the gas fired turbine with the HRSG; and the auxiliary equipment is defined as pumps, transformers and heat exchangers.

Each piece of auxiliary equipment was defined using the CAD drawing (provided by the contractors) to:

- spatially reference each piece of equipment and,
- create a reference box from which a reference surface was drawn to define the expected near field measurements for A-weighted sound pressures level 1 m away from the source and 1.5m above the ground.

  For the purpose of this model the near field value was conservatively taken as 85dB(A).

The four (4) gas fired turbines for the Siemens option and five (5) gas fired turbines for the GE option with the HRSG were similarly defined (as above) with the same guarantee for the near field conditions.

Baseline noise conditions were also modelled. These conditions were modelled by assuming that the significant sources of persistent noise in the environment are the movement of steady traffic along the Halse Hall main road, and noise emissions from the Jamalco Halse Hall refinery.

Noise emission from the refinery was modelled by using a Class 1 noise level meter fitted with 1/1 octave filters to determine the noise emission spectra of three (3) unit operations at the Jamalco Halse Hall alumina refinery. These unit operations were identified by EHS personnel as significant sources of noise requiring hearing protection on the plant.

The three (3) unit operations profiled were:

- The Power House
- Calciner
- Digestion

The sampling points were georeferenced during the field measurements. A reference surface was defined for the unit operations for processing by the model and its emission profile defined by the field measurements.

Noise emission from the vehicular traffic along the Halse Hall main road was modelled using intersection count data for the Jamalco Halse Hall intersection with the Halse Hall Main Road. This was supported with intersection count data for the Halse Hall Main Road intersection with the Highway 2000 exit for westbound traffic.

Field measurements were carried out for baseline noise at, and just beyond an estimated boundary where the performance guaranteed far field conditions was 61dB(A). (see attached map). These baseline measurements were taken starting from two (2) points and walking backwards from outside the Jamalco's fenceline and towards Jamalco's southern most property boundary.


New Fortress ENERGY
ESTIMATED BOUNDARY FOR GUARANTEED FAR FIELD CONDITIONS
724160
724240
724320
724400
724480
724560
724640
724720
724800
724880
724960
Baseline Measurement Starting Point No. 2
Env. Receptor No. 3
Baseline Measurement Starting Point No. 1
Env. Receptor No. 2
Env. Receptor No. 1
Legend
CHP Leased Area
Far Field Guarantee
0 30 60 120 180 240
Meters
N

The values predicted by the model at these points were 51.0 and 57.6 (respectively) in the day and 50.5 and 57.5 (respectively) in the night. These were consistent with the average daytime baseline measurements of 56dbA at and near the estimated boundary for guaranteed far field conditions of 61dBA.

A total of five (5) scenarios were run as follows:

1. Existing Baseline
2. CHP with GE Turbine Set – Isolated Case
3. CHP with GE Turbine Set – Cumulative Case
4. CHP with SIEMENS Turbine Set – Isolated Case
5. CHP with SIEMENS Turbine Set –Cumulative Case

The results of the above referenced scenarios were compared against the NEPA Jamaica Noise National Standards (JNNS) for noise emissions measured at the property boundary of land designated as "Industrial"[9]. This standard requires that noise no greater than 75 dBA or 70dBA be emitted across the boundary during daytime (7am to 10pm) or nightime (10pm to 7am) respectively. The model was setup with the following receivers:

- Ten (10) receivers along the leased property boundary of the CHP inside Jamalco
- Two (2) receivers at two (2) points where the performance for the CTGs is guaranteed at 61dbA for far field conditions outside of the battery limits of the plant but within Jamalco's southernmost property boundary.
- Three (3) receivers at residential buildings south of Jamalco's southernmost property boundary.

The receiver positions relative to the leased boundary area are shown in the map below.

---

[9] *Lands designated Industrial Zone shall generally be industrial where protection against damage to hearing may be required, and the necessity for conversation is limited. The land uses in this category would include, but not be limited to, manufacturing activities, transportation facilities, warehousing, mining, and other lands intended for such uses.*

Figure 39: Receiver Locations for Model Prediction

5.2.2.2. Results

The results of the model runs are shown in the tables below.

The following should be noted:

- There is no instance of exceedance of the JNNS standard at the receiver locations when modelled using the guaranteed noise emission.

  Figure 40 and Figure 41 demonstrate the above by showing the predicted noise emission levels at the boundary of the leased area relative to the respective standards for day and night time for the proposed turbine sets.

- The nearest environmental receptors which fall outside of Jamalco's property boundary are not predicted to be impacted by an exceedance of the JNNS standards because of the operation of the CHP.
- The noise emission levels along Jamalco's property boundary outside of the battery limits of the refinery are not predicted to exceed the JNNS are a result of the operation of the CHP.

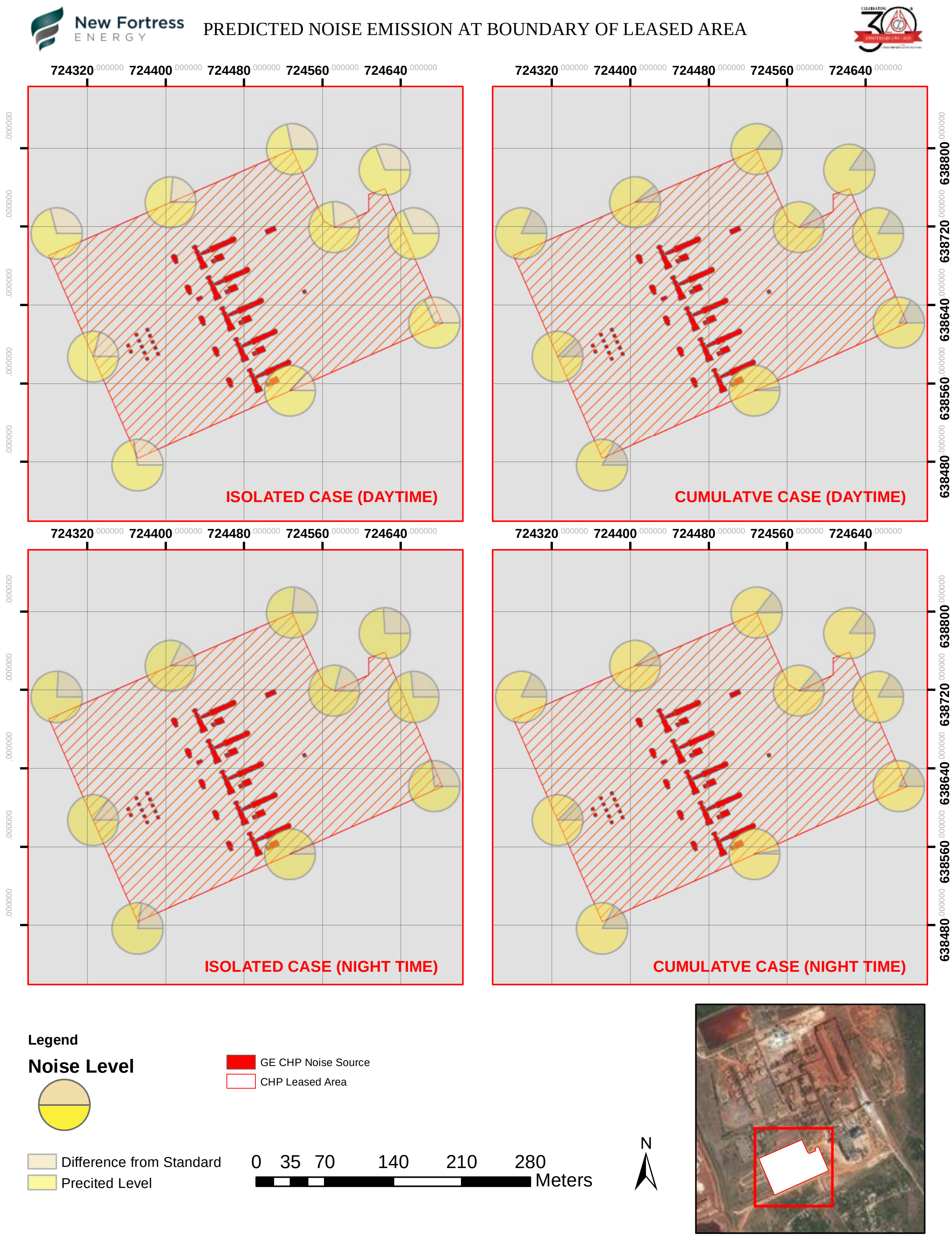


Figure 40: Predicted Noise Emission at Boundary of CHP leased area – GE Turbine Set

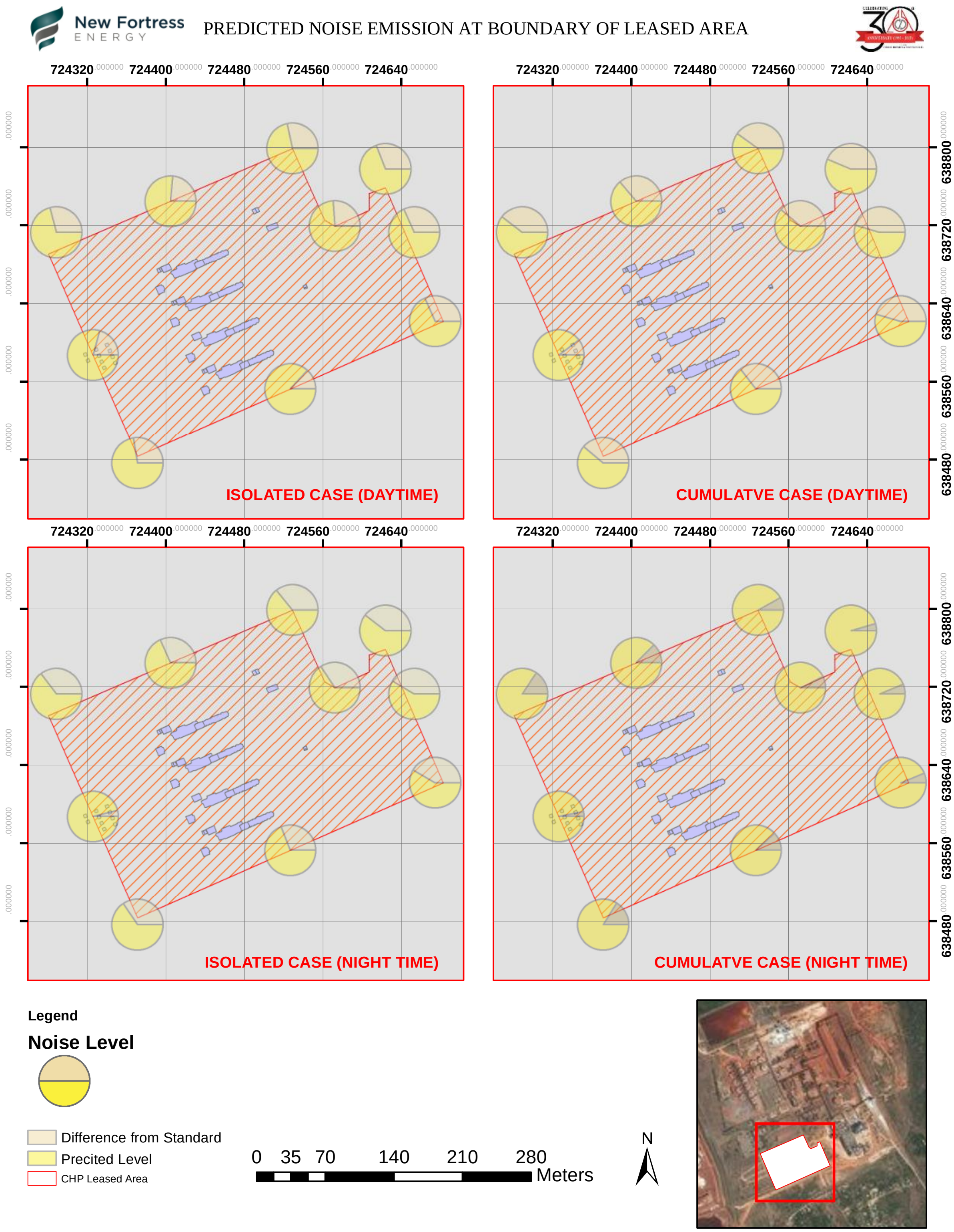


Figure 41: Predicted Noise Emission at Boundary of CHP leased area – Siemens Turbine Set

5.2.2.3. Existing Baseline

Table 4: Existing Baseline

Receiver name	Coordinates (JAD2001)		Height	Level	
	X	Y		Day	Night
	in meter		m	dB(A)	
Baseline: R1	724368.61	638466.43	48.00	51.0	50.5
Baseline: R2	724629.48	638553.12	49.50	57.6	57.5
Env. Receptor No. 1	724193.84	638137.86	49.50	64.4	62.9
Env. Receptor No. 2	724526.35	638372.39	49.50	52.3	52.2
Env. Receptor No. 3	724772.26	638503.67	49.50	57.0	57.0

CHP with GE Turbine Set – Isolated Case: Guaranteed Noise Emission

Table 5: CHP with GE Turbine Set – Isolated Case: Guaranteed Noise Emission

Receiver name	Coordinates (JAD2001)		Height	Level	
	X	Y		Day	Night
	in meter		m	dB(A)	
Baseline: R1	724368.61	638466.43	49.50	53.3	53.3
Baseline: R2	724629.48	638553.12	49.50	53.1	53.1
Env. Receptor No. 1	724193.84	638137.86	49.50	43.1	43.1
Env. Receptor No. 2	724526.35	638372.39	49.50	49.8	49.8
Env. Receptor No. 3	724772.26	638503.67	49.50	47.4	47.4
Lease Boundary: R1	724528.81	638798.88	49.50	53.7	53.7
Lease Boundary: R2	724571.96	638719.49	49.50	55.4	55.4
Lease Boundary: R3	724623.47	638758.68	49.50	51.8	51.8
Lease Boundary: R4	724652.73	638690.28	49.50	52.0	52.0
Lease Boundary: R5	724681.99	638621.89	49.50	51.2	51.2
Lease Boundary: R6	724526.64	638552.67	49.50	65.0	65.0
Lease Boundary: R7	724371.29	638483.45	49.50	54.2	54.2
Lease Boundary: R8	724326.01	638587.27	49.50	59.4	59.4

Receiver name	Coordinates (JAD2001)		Height	Level	
	X	Y		Day	Night
	in meter		m	dB(A)	
Lease Boundary: R9	724280.74	638691.09	49.50	53.2	53.2
Lease Boundary: R10	724404.77	638744.99	49.50	57.3	57.3

CHP with GE Turbine Set – Cumulative Case: Guaranteed Noise Emission

Table 6: CHP with GE Turbine Set – Isolated Case: Guaranteed Noise Emission

Receiver name	Coordinates (JAD2001)		Height	Level	
	X	Y		Day	Night
	in meter		m	dB(A)	
Baseline: R1	724368.61	638466.43		58.9	58.6
Baseline: R2	724629.48	638553.12		60.5	60.5
Env. Receptor No. 1	724193.84	638137.86		66.0	64.6
Env. Receptor No. 2	724526.35	638372.39		58.0	57.8
Env. Receptor No. 3	724772.26	638503.67		58.6	58.6
Lease Boundary: R1	724528.81	638798.88		59.9	59.9
Lease Boundary: R2	724571.96	638719.49		60.3	60.3
Lease Boundary: R3	724623.47	638758.68		59.4	59.3
Lease Boundary: R4	724652.73	638690.28		59.0	58.9
Lease Boundary: R5	724681.99	638621.89		58.0	57.9
Lease Boundary: R6	724526.64	638552.67		68.3	68.2
Lease Boundary: R7	724371.29	638483.45		58.3	58.0
Lease Boundary: R8	724326.01	638587.27		61.2	61.1
Lease Boundary: R9	724280.74	638691.09		57.4	57.2
Lease Boundary: R10	724404.77	638744.99		62.2	62.1

CHP with SIEMENS Turbine Set – Isolated Case: Guaranteed Noise Emission

Table 7: CHP with SIEMENS Turbine Set – Isolated Case: Guaranteed Noise Emission

Receiver name	Coordinates (JAD2001)		Height	Level	
	X	Y		Day	Night
	in meter		m	dB(A)	
Baseline: R1	724368.61	638466.43	49.50	44.9	44.9
Baseline: R2	724629.48	638553.12	49.50	42.3	42.3
Env. Receptor No. 1	724193.84	638137.86	49.50	34.0	34.0
Env. Receptor No. 2	724526.35	638372.39	49.50	40.0	40.0
Env. Receptor No. 3	724772.26	638503.67	49.50	37.4	37.4
Lease Boundary: R1	724528.81	638798.88	49.50	45.0	45.0
Lease Boundary: R2	724571.96	638719.49	49.50	46.0	46.0
Lease Boundary: R3	724623.47	638758.68	49.50	42.3	42.3
Lease Boundary: R4	724652.73	638690.28	49.50	42.0	42.0
Lease Boundary: R5	724681.99	638621.89	49.50	40.9	40.9
Lease Boundary: R6	724526.64	638552.67	49.50	48.4	48.4
Lease Boundary: R7	724371.29	638483.45	49.50	45.9	45.9
Lease Boundary: R8	724326.01	638587.27	49.50	67.2	67.2
Lease Boundary: R9	724280.74	638691.09	49.50	45.3	45.3
Lease Boundary: R10	724404.77	638744.99	49.50	47.9	47.9

CHP with SIEMENS Turbine Set –Cumulative Case: Guaranteed Noise Emission

Table 8: CHP with SIEMENS Turbine Set – Isolated Case: Guaranteed Noise Emission

Receiver name	Coordinates (JAD2001)		Height	Level	
	X	Y		Day	Night
	in meter		m	dB(A)	
Baseline: R1	724368.61	638466.43	49.50	54.1	53.7
Baseline: R2	724629.48	638553.12	49.50	57.4	57.4
Env. Receptor No. 1	724193.84	638137.86	49.50	64.4	62.9
Env. Receptor No. 2	724526.35	638372.39	49.50	52.1	52.0
Env. Receptor No. 3	724772.26	638503.67	49.50	56.8	56.8
Lease Boundary: R1	724528.81	638798.88	49.50	64.2	64.2
Lease Boundary: R2	724571.96	638719.49	49.50	64.8	64.8
Lease Boundary: R3	724623.47	638758.68	49.50	66.9	66.8
Lease Boundary: R4	724652.73	638690.28	49.50	66.6	66.6
Lease Boundary: R5	724681.99	638621.89	49.50	65.6	65.6
Lease Boundary: R6	724526.64	638552.67	49.50	61.7	61.6
Lease Boundary: R7	724371.29	638483.45	49.50	58.8	58.7
Lease Boundary: R8	724326.01	638587.27	49.50	67.8	67.8
Lease Boundary: R9	724280.74	638691.09	49.50	59.1	59.0
Lease Boundary: R10	724404.77	638744.99	49.50	61.2	61.2

5.2.3. Ambient Air Quality Assessment

The primary emissions anticipated from the Combine Heat and Project operations will come from combustion of natural gas in the Combustion Turbine Generators (CTGs). During emergency situations, the combustion of Automotive Diesel in the CTGs will be the source of air pollutants. The facility will be a significant source of pollutant as described under the NRCA Act and its associated Regulations the Air Quality Regulations 1996.

Stack emissions are expected to be continuous as the system being installed is base load. The area is a brownfield site in terms of industrial process with the Jamalco Refinery being in operation for the last 50 years and numerous other emitters of air pollutants.

The air quality impact of the project can only be quantified with measurements of existing ambient conditions.

5.2.3.1. Approach and Methodology

CD&A developed an air quality monitoring plan to assess the status of air quality as it relates to the quality standards set by the regulatory agency. This required the use of active as well as passive method for pollutant concentration measurements.

Jamalco operates a number of air quality monitoring stations as stipulated by the conditions of their air pollutant discharge licenses. These monitoring sites are in close proximity to their refinery and are shown on Map 1. The measurements from these sites are therefore representative of the impact of the Jamalco operations on the surrounding environment.

CD&A therefore decided to do supplementary synoptic measurements to ascertain the weekly average concentration for background areas to the existing refinery and the proposed CHP. Passive air pollution monitors which require no electrical power or protection in the field are very useful devices that can provide this information. The long exposure time provides a reasonable measure of the average concentration of the pollutant of interest over the exposure period.

Ambient air quality measurements were captured using passive monitors at seven (7) locations within the sphere of influence of the proposed project over the period May 15 - 24, 2017. The pollutants measured were NO_2 and SO_2. The passive monitors used were Nitrogen dioxide and sulphur dioxide diffusive air monitors supplied and analysed by Gradko Environmental UKAS accredited in-house method GLM 3.

Monitors were exposed in duplicates at the seven sites and subsequently collected and shipped to England for analysis by ion chromatography. Figure 1 shows the exposure setup.

Figure 42. Passive Monitors exposed along the train line in Clarendon.

Measurement of PM10 concentration was done at one site on the 8 – 9, June 2017. The sample was collected with a micro-volume sampler pulling air through a pre-weighted filter for 24 hours. The filter was then re-weighed after stabilization and a concentration of particulate matter collected determined.

5.2.3.2. Results and Discussion

The results of all samples are presented in Table 1. Below

Table 9: Passive Monitor Results for NO_2 and SO_2 and Active Monitor Result for Particulate Matter

Site Name	Lat	Long	Site Name	SO_2 (ugm^{-3})	NEPA Std
Hall Hall Great House	17°55'52.72"N	77°14'49.09"W	Hall Hall Great House	2.5098	80
Jamalco Sports Club	17°54'33.00"N	77°14'44.94"W	Jamalco Sports Club	4.1652	80
Corn Piece	17°52'26.37"N	77°14'6.53"W	Corn Piece	2.0826	80
Hayes	17°51'20.51"N	77°14'31.30"W	Hayes	2.0826	80
Trainline (Background)	17°51'2.38"N	77°13'30.01"W	Trainline (Background)	2.0559	80
Lionel Town	17°48'26.83"N	77°14'34.08"W	Lionel Town	2.0559	80
Rocky Point Port	17°49'8.68"N	77° 8'43.83"W	Rocky Point Port	7.3425	80

The results of the sampling exercise showed that all areas are within the annual standard set for NO_2, SO_2 and PM_{10}.

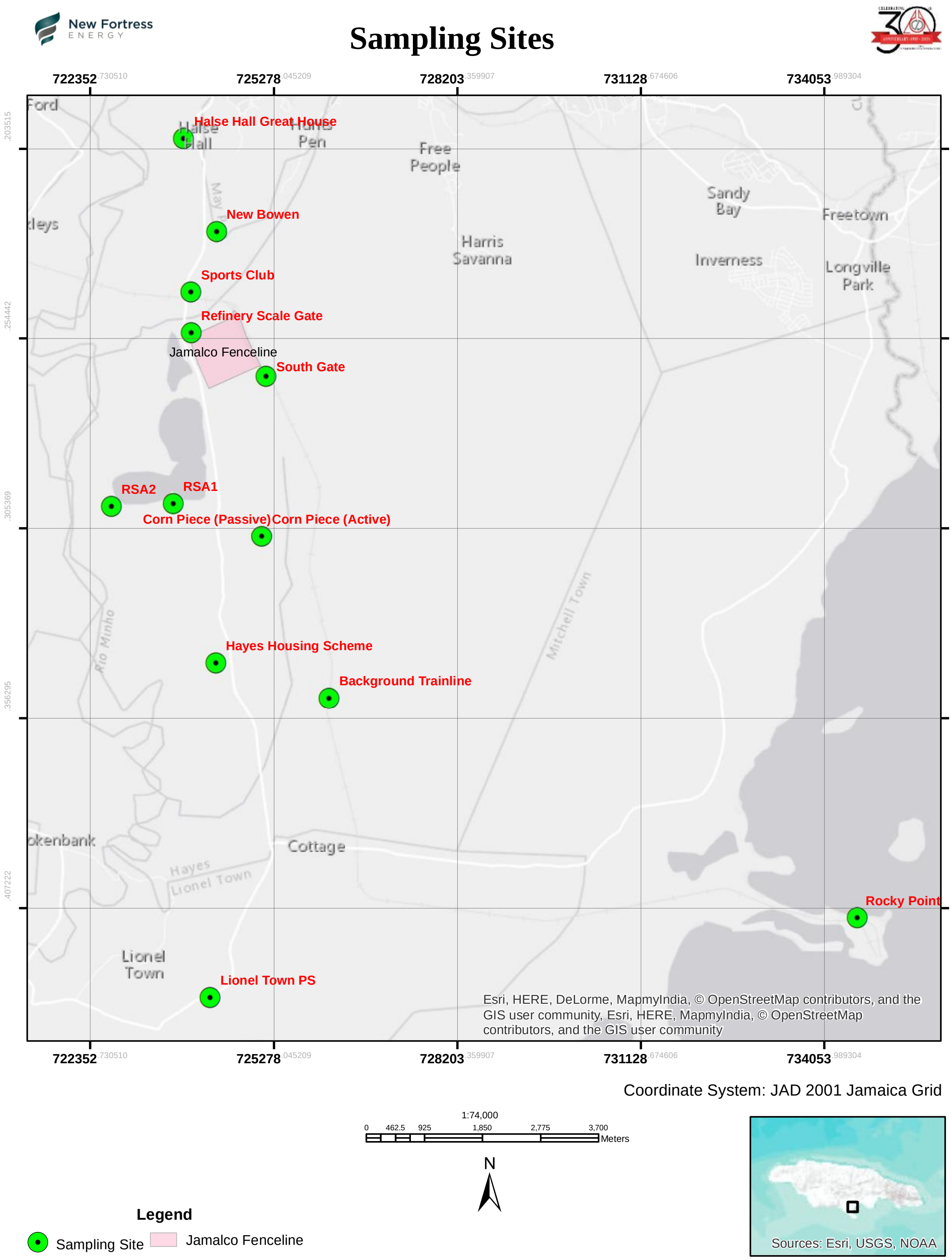


Figure 43. Location map of sampling points for study.

Jamalco's monitoring sites all contain active monitors producing measurement every few seconds that can be averaged on a minutely, hourly, daily, weekly, monthly and annual basis at all sites except for PM measurement at the South Gate. These require special enclosures and power supply for sample collection using pump, sample analysis, data processing and management. Unlike the passive monitors that require long averaging times, these monitors are able to analyse small samples due to very sensitive electronics. Measurements of pollutants concentrations higher that the corresponding standards are regularly recorded in the data set investigated.

The data presented in Table 10 is for the annual averages for each pollutant measured. The averages are within the standard set for annual exposure.

Table 10: Annual Average of Pollutant Concentration from Active monitor data obtained from Jamalco

Name	Lat	Long	SO_2 (ugm^{-3})	NO_2 (ugm^{-3})	PM_{10} (ugm^{-3})
Corn Piece Monitoring Station	7°53'26.15"N	7°14'28.03"W	12.31	9.75	20.26
New Bowens Monitoring Station	17°55'4.45"N	7°14'31.12"W	12.11	7.88	22
Refinery Scale Gate	7°54'11.89"N	77°14'44.81"W	24.14	39.30	
BAM 1020 - RSA1	17°52'43.2"N	77°14'54.5"W			32.67
BAM 1020 - RSA2	17°52'41.9"N	77°15'27.9"W			42
Refinery- South Gate	17°53'49.2"N	77°14'04.2"W			25

The comparison between NEPA annual standards and the values obtained in this baseline assessment of air quality are presented in Figure 44 to Figure 48 below.

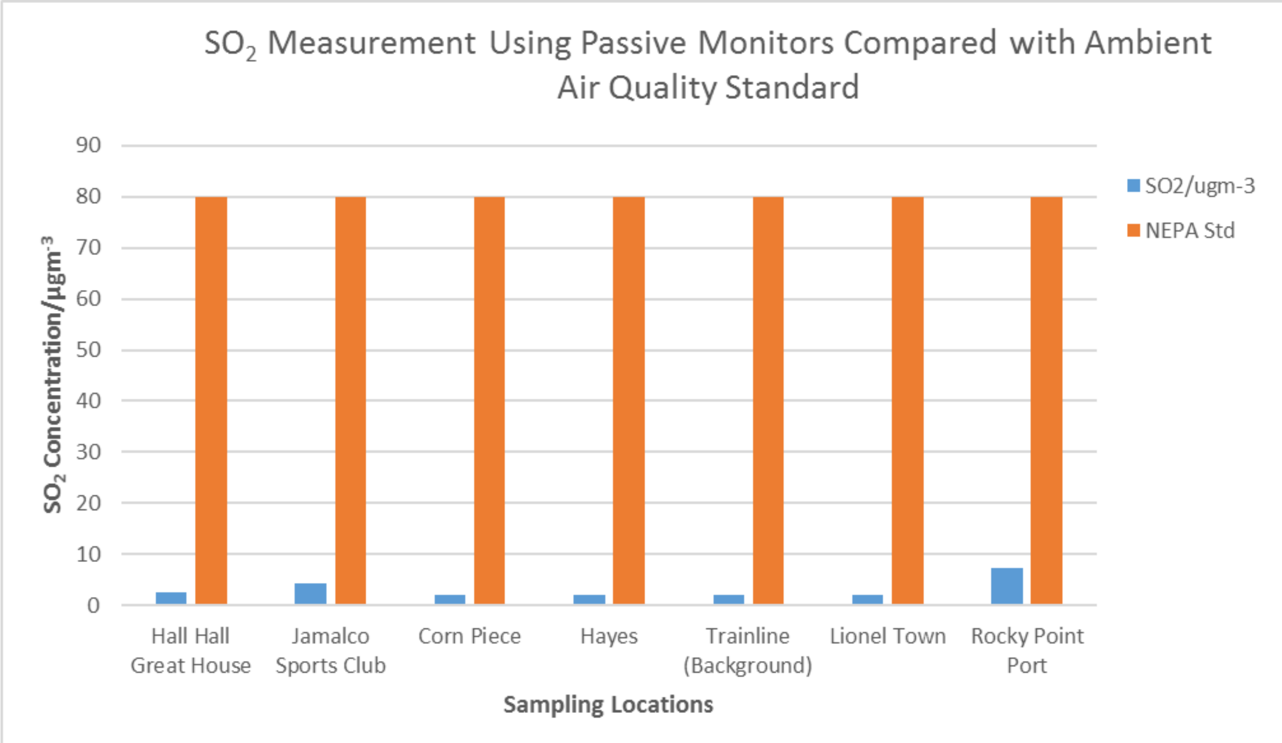


Figure 44: Annual Averaged SO_2 concentrations from Passive Monitors compared to the JAAQS

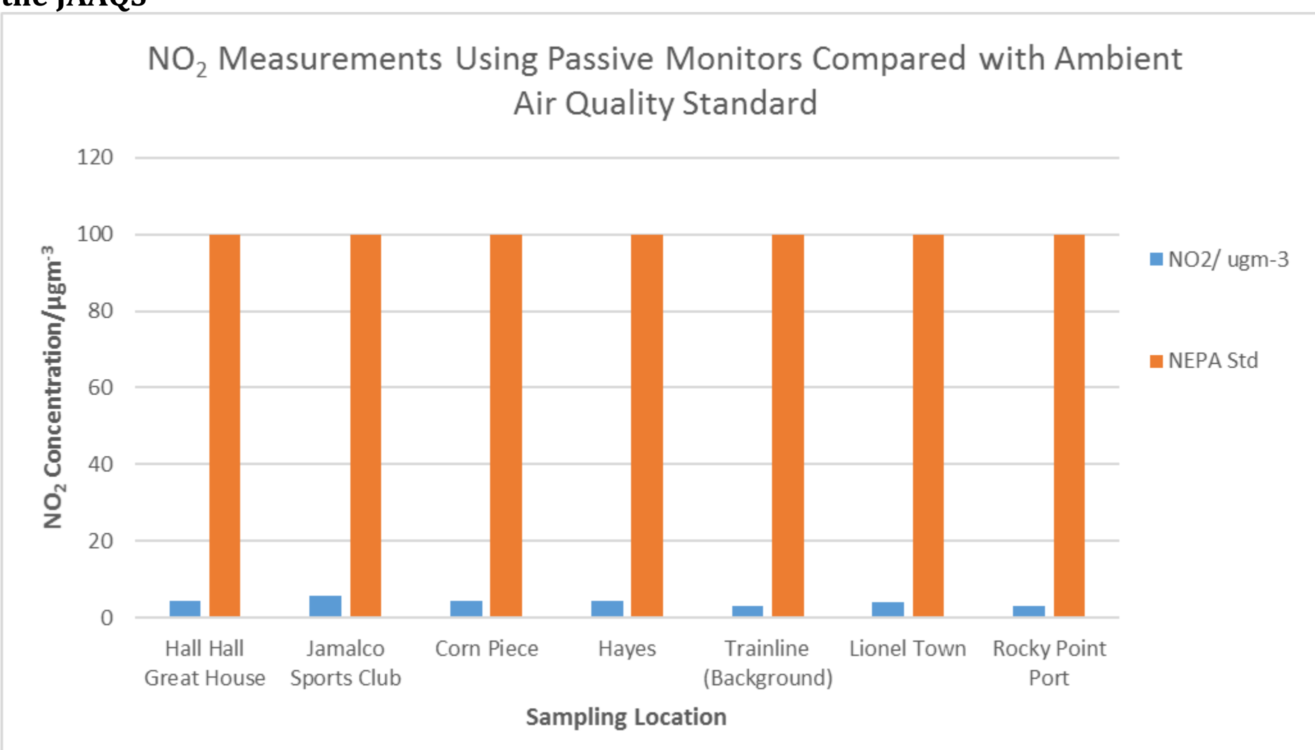


Figure 45: Annual Averaged NO_2 concentration measurements from Passive Monitors compared to JAAQS

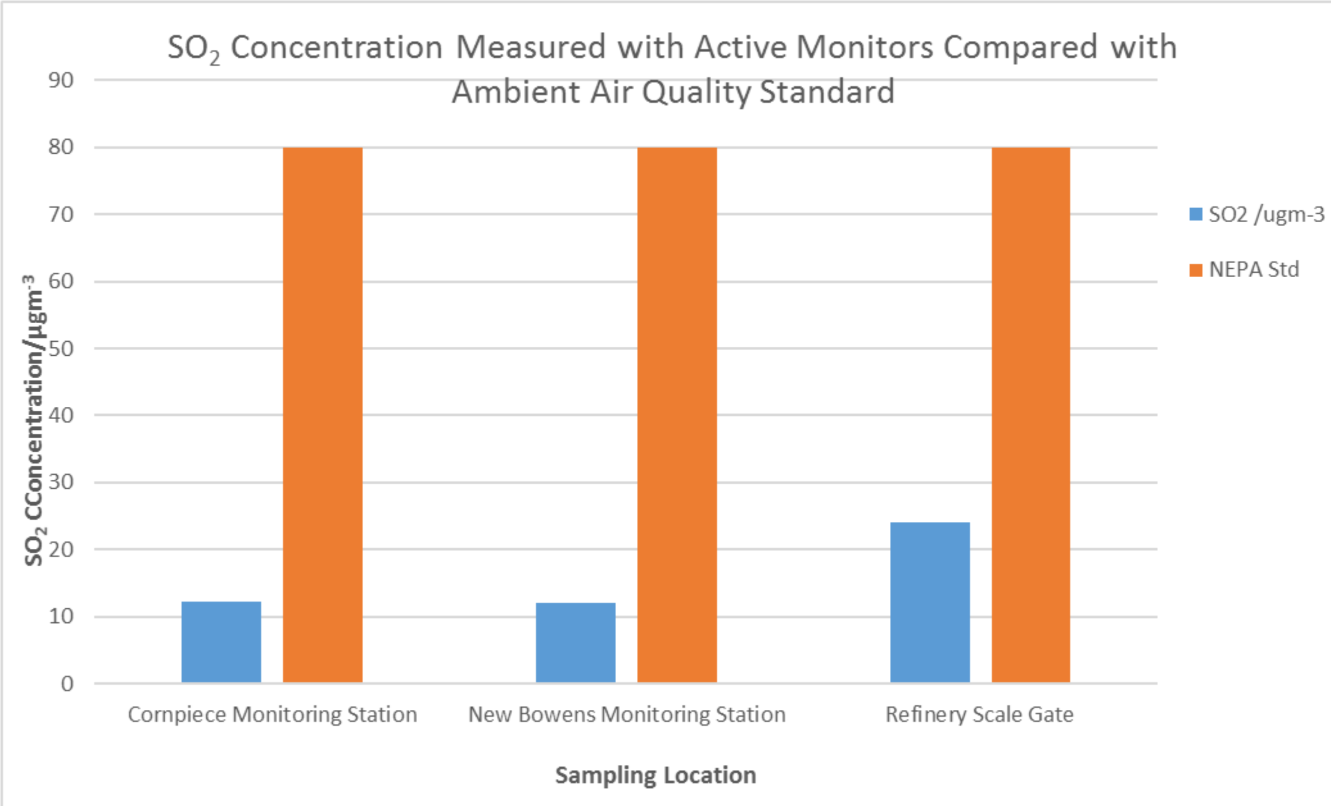


Figure 46: Annual Averaged SO_2 measurements from Active Monitors compared with JAAQS

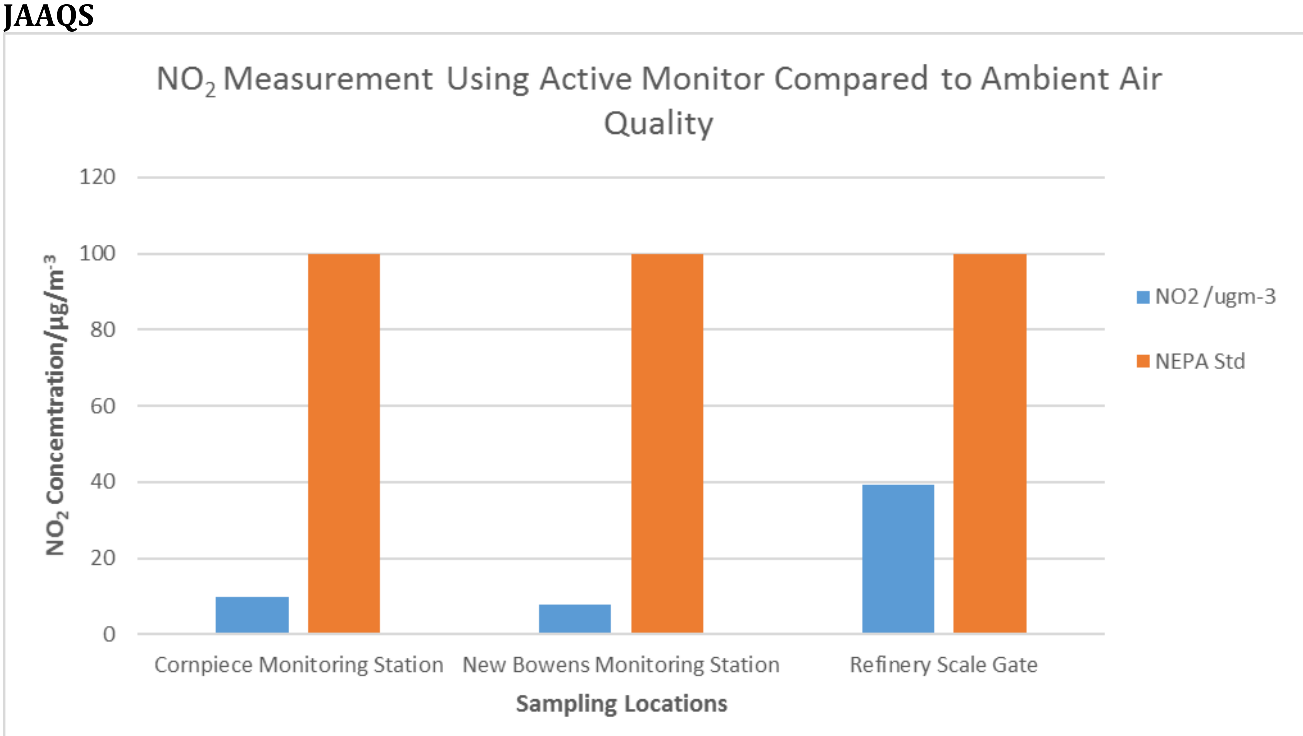


Figure 47: Annual Averaged NO_2 measurement from Active Monitor Compared with JAAQS

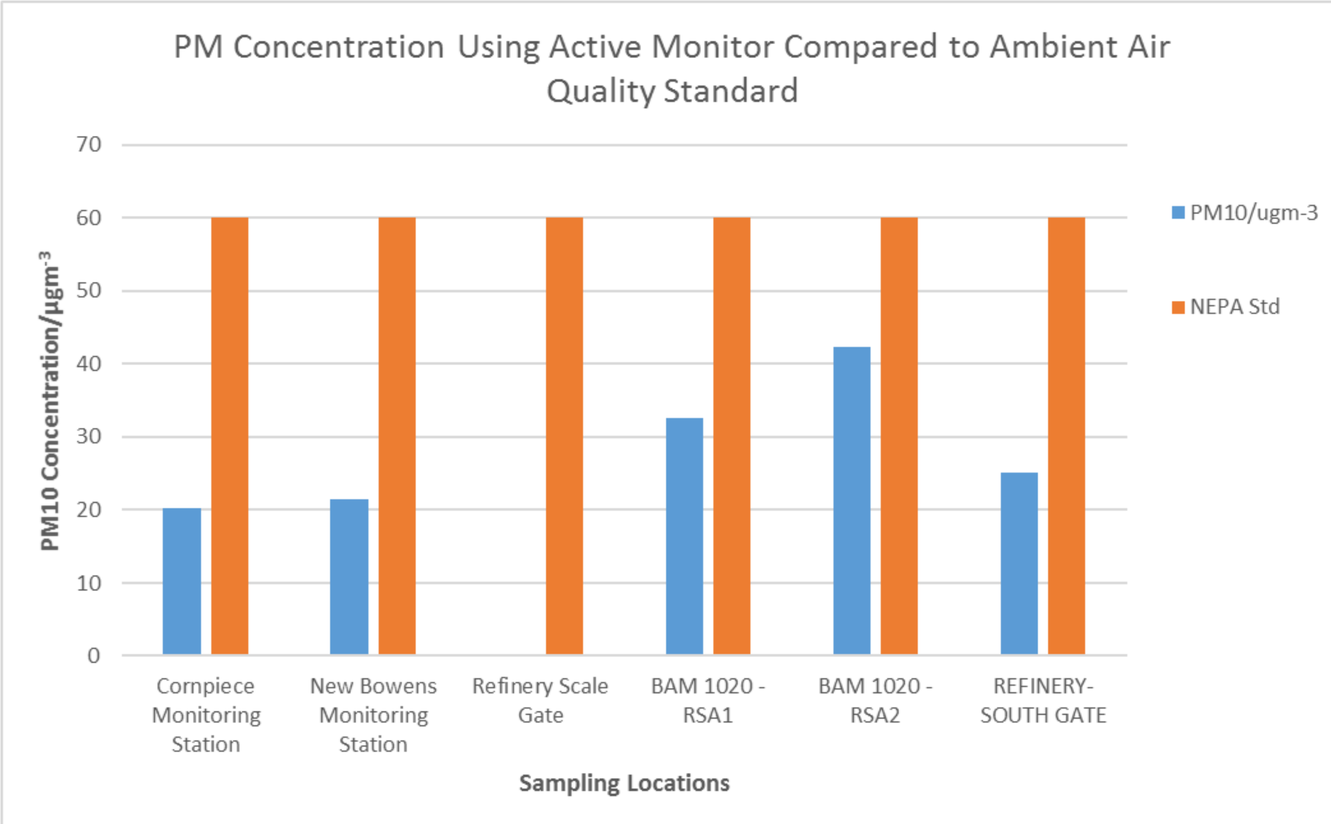


Figure 48: Annual Average PM_{10} measurement from Active Monitor compared with JAAQS

The data collected showed that the annual standards are not breached for any of the pollutants sampled in the baseline assessment.

The typical data obtained from active monitors operated by the EHS Department of Jamalco are presented in Figure 49 to Figure 51 below.

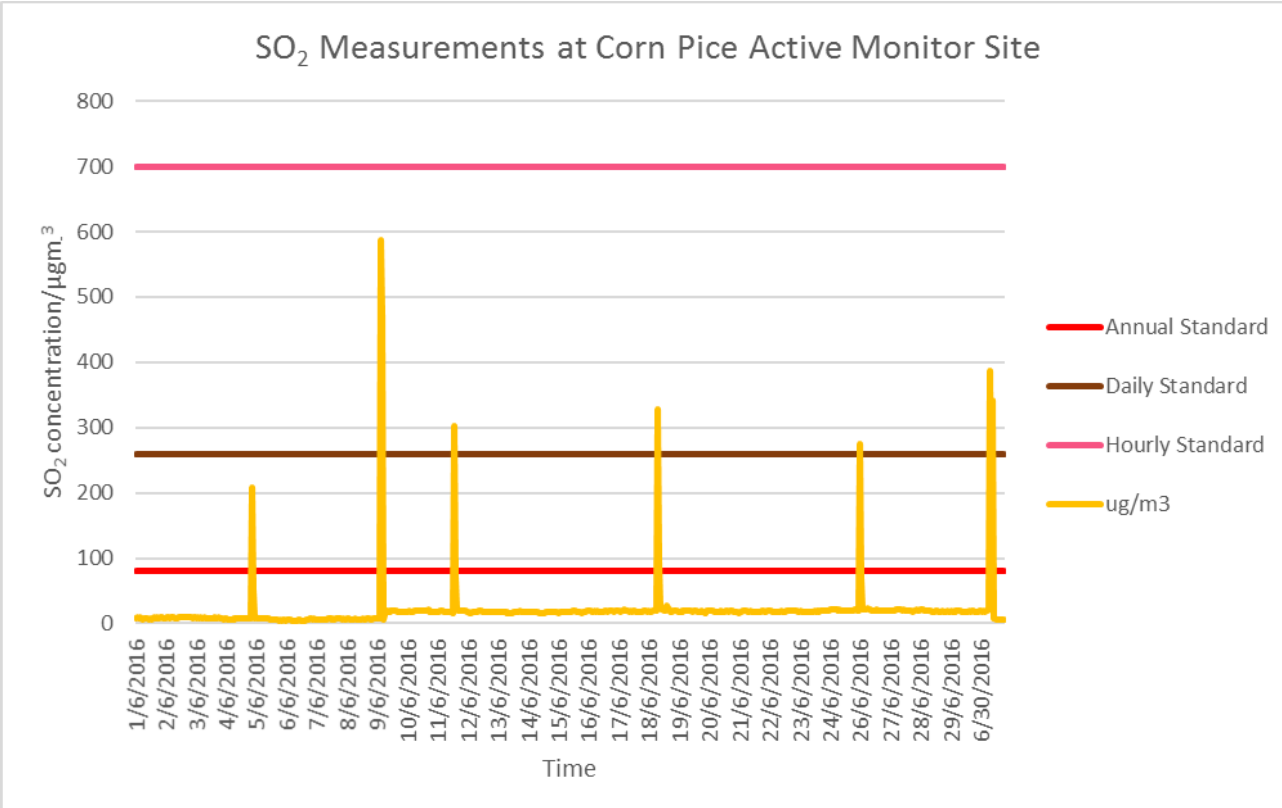


Figure 49: Active monitor SO_2 data collected June 2016 at Corn Piece, Clarendon

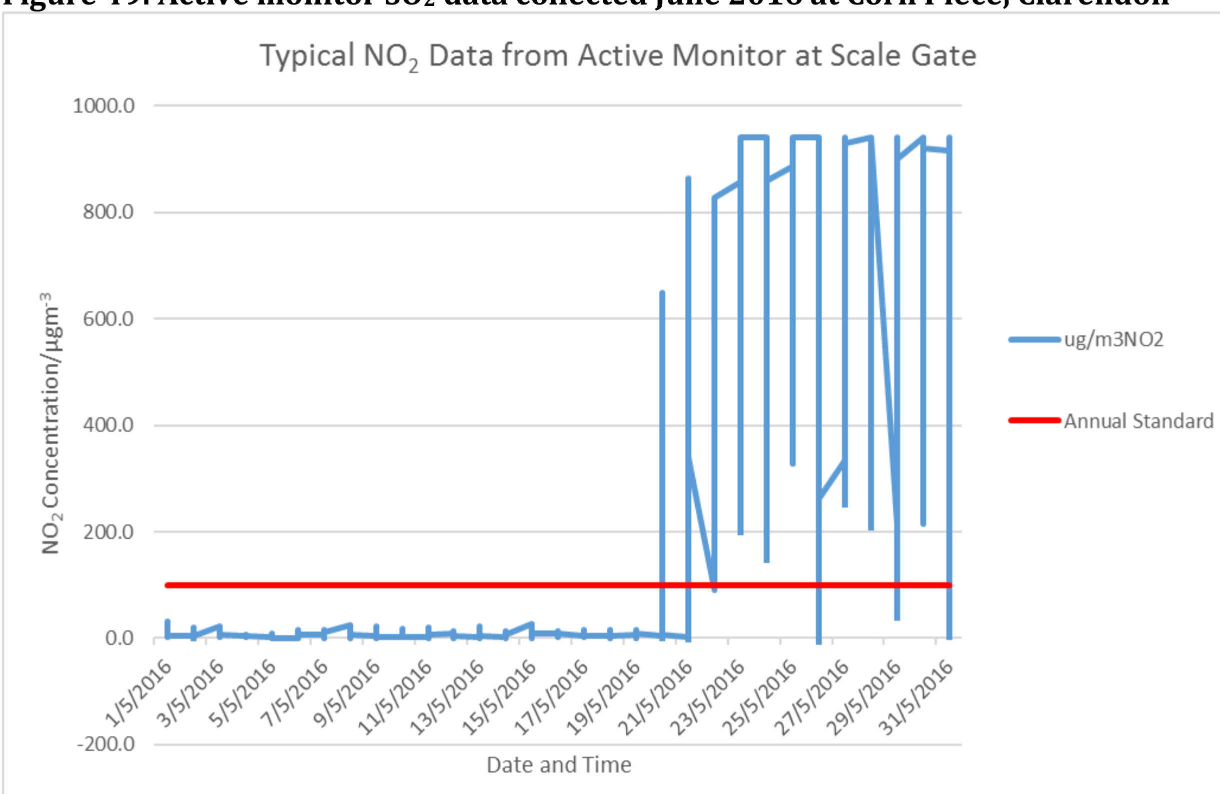


Figure 50: Active Monitor NO_2 data collected in May 2016 at Scale Gate, Jamalco Plant

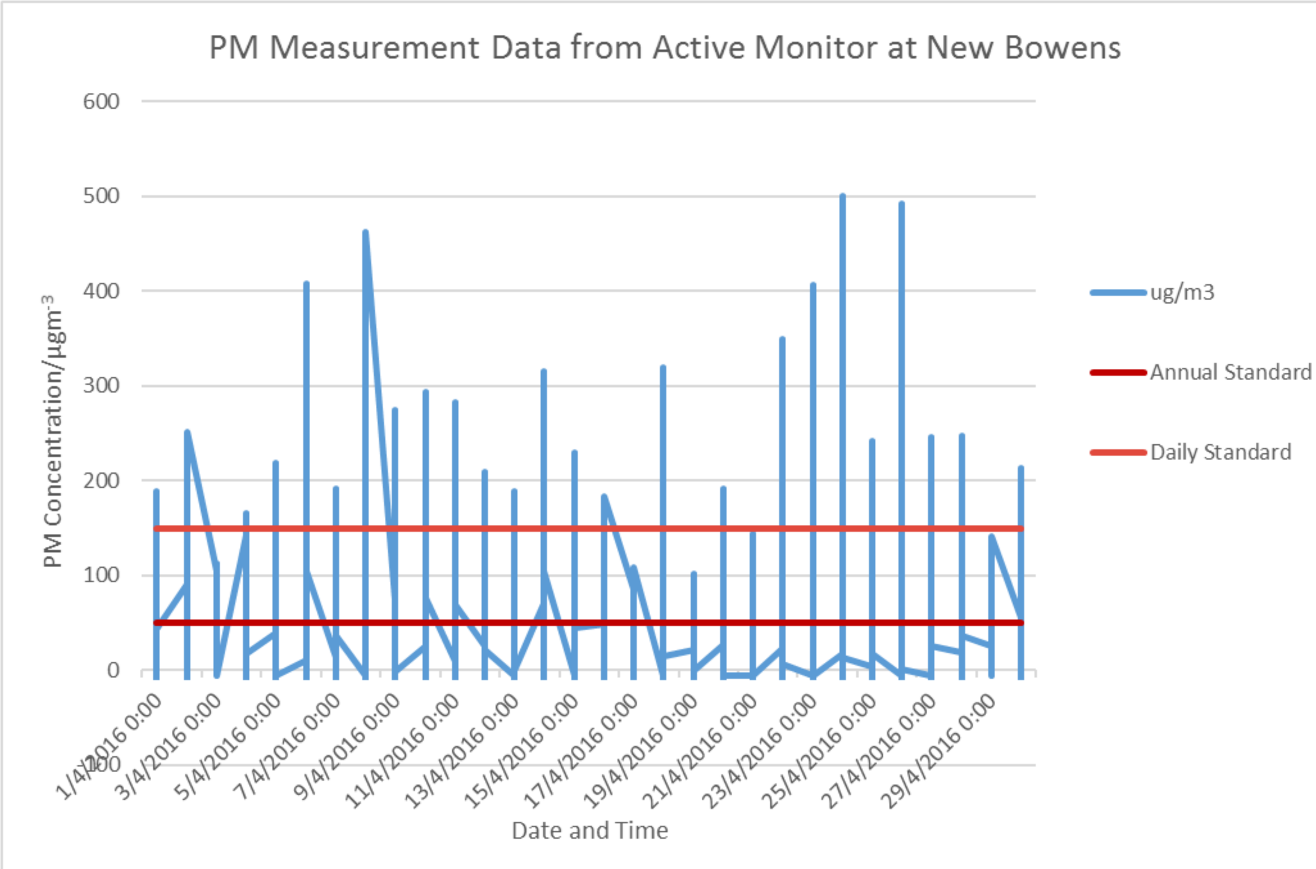


Figure 51: Particulate Matter measurements recorded in April 2016 at New Bowens, Clarendon

The active monitors results show that the JAAQS standards are exceeded on a number of occasions in the vicinity of the Jamalco plant.

The air quality in the airshed is compromised on many occasions due to the existing industrial activities occurring in the project area. The project is anticipated to have a significant positive impact on the quality of air by facilitating the reduction in the use of heavy fuel oil by Jamalco.

The results of the cumulative model run shows exceedance of standards at specified locations in the air shed. The use of natural gas will impact the pollutant emissions of two facilities in the air shed, these area:

1. JPSCo
2. Jamalco

The replacement of HFO by natural gases in these facilities will have significant positive impacts on the overall air quality of the development area.

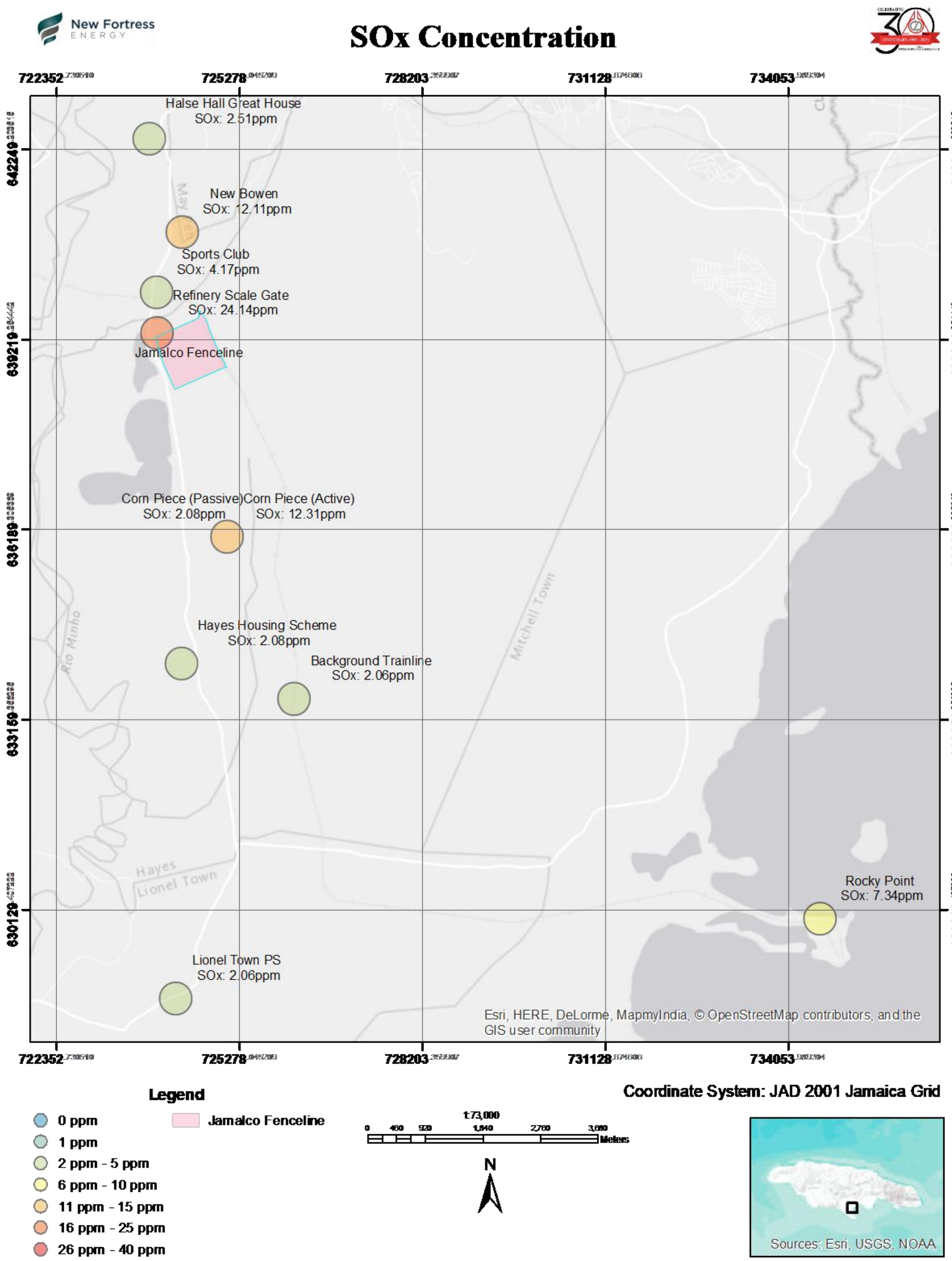


Figure 52. Distribution of SO_2 concentration in the Airshed

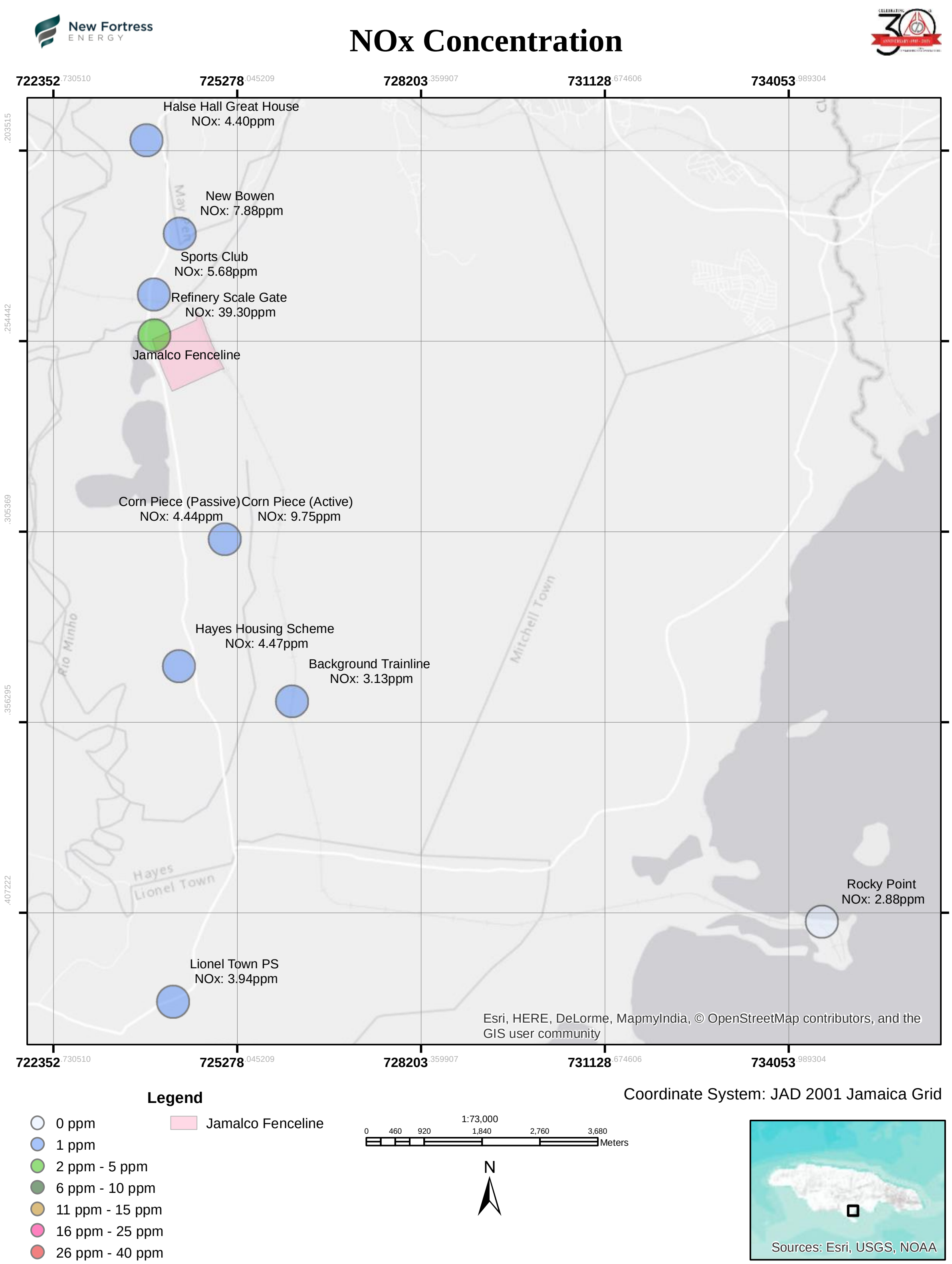


Figure 53. Distribution of NO_2 Concentration in the Air Shed

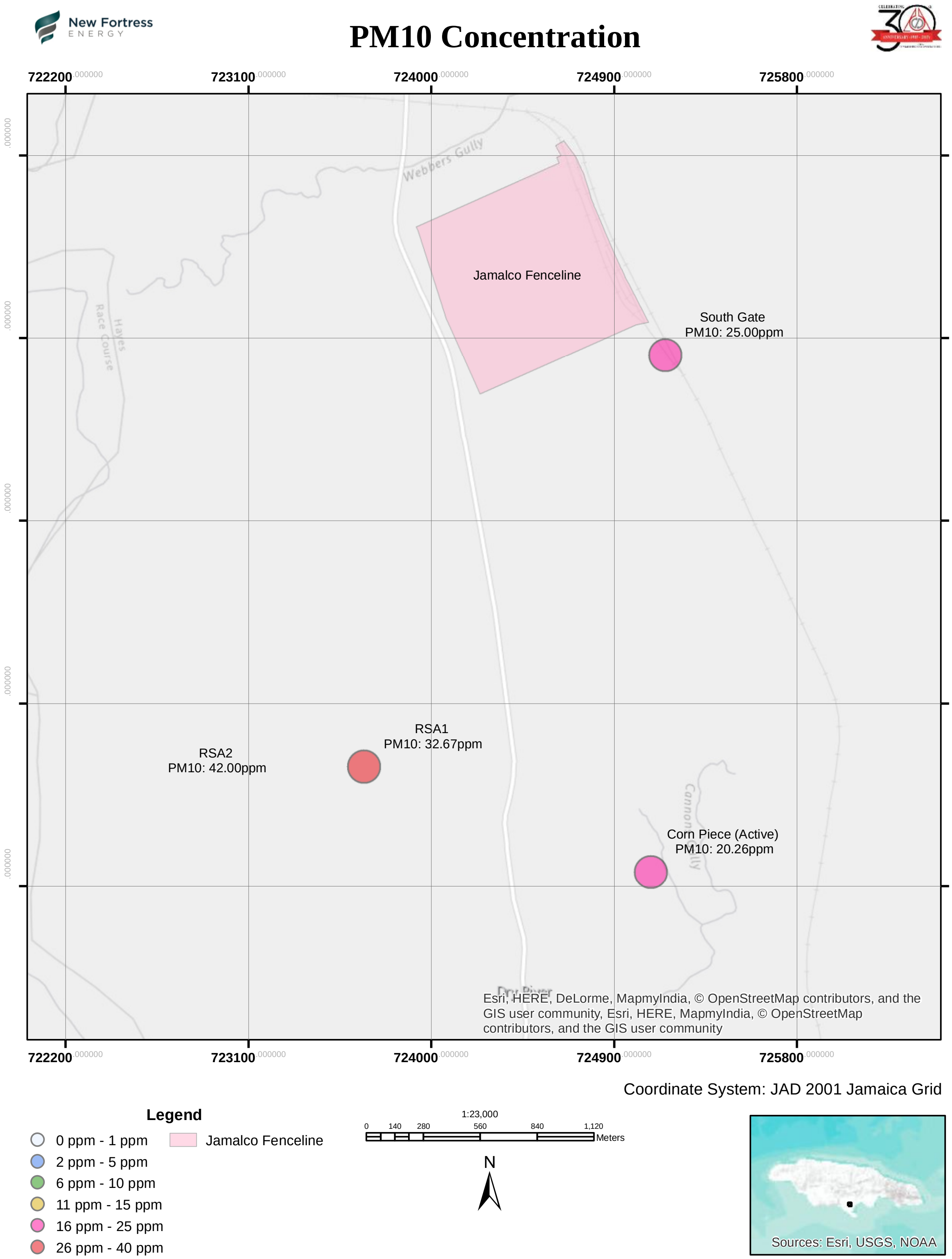


Figure 54: Distribution of PM_{10} concentration in the Airshed

5.2.4. Air Dispersion Modelling

NFE is proposing to install and operate a Combined Heat and Power (CHP) Station (the Project) at the existing Jamalco Clarendon Alumina Works (Jamalco) in Halse Hall, Clarendon, Jamaica. The Project will supply electricity to the national electrical grid, and in addition, provide steam to the Jamalco Facility. Tetra Tech Inc. (Tetra Tech) has been retained to perform the air quality dispersion modeling analyses and application forms in support of the air discharge license.

The CHP Project consisting of dual-fuel combustion turbine generators (CTGs) will have an output of approximately 200 megawatts (MW). NFE is currently evaluating combustion turbines from two manufacturers (GE and Siemens) with similar characteristics and output. Each vendor plant configuration option will include a black start generator to start the CTGs in an emergency when there is no electricity available from the grid. The Project will be fueled by Natural Gas (NG) as the primary fuel and low sulfur Automotive Diesel Oil (ADO) as a back-up fuel. ADO-firing could be up to 6% of operating hours per year if emergency situations affect the supply of NG.

The CHP Project will provide an air quality benefit to the region. Not only is NG a cleaner fuel to burn, but by supplying steam to Jamalco and electricity to the grid, the Project will displace the current use of HFO at Jamalco and at Jamaica Power Service Co. The CHP Project will play a substantial role in reducing all SO_2, NO_2, CO, TSP and PM_{10} impacts in the area, while providing the needed steam and power. The graph below presents the emissions associated with burning heavy fuel oil (HFO) for generating the amount of steam and electricity and the emissions from the CHP Project if ADO was fired full time, and the emissions from the CHP Project if a mix of 94% NG and 6% ADO was fired. The mix fuel scenario will be the primary operating mode for the CHP Project. As depicted in the graph, the expected reduction in emissions per turbine is significant. Note that the emissions of SO_2 from HFO are too large to be shown linearly in the graph; the HFO SO_2 bar would extend approximately 4.5 times higher than shown.

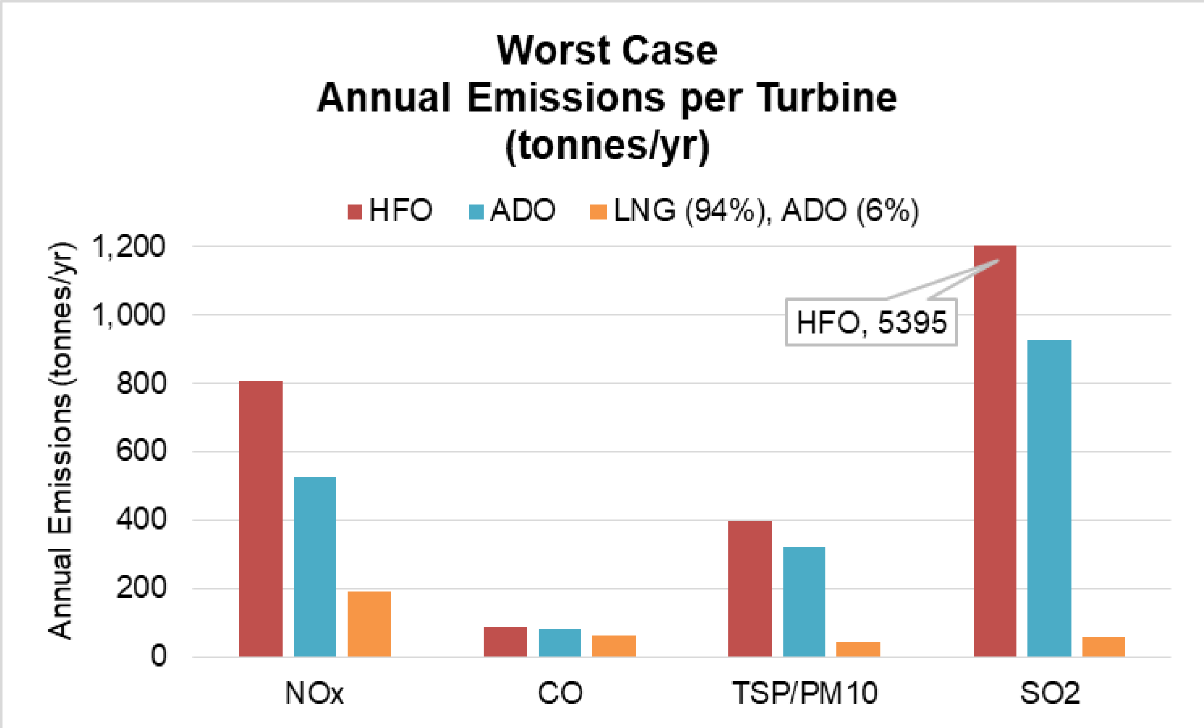


Figure 55: Worst Case Annual Emissions per Turbine (tonnes/yr)

An air quality modeling assessment was conducted using the USEPA AERMOD dispersion model for each vendor plant configuration. The purpose of the modeling analysis is to determine the maximum facility impacts to assess compliance with the Jamaican Ambient Air Quality Standards (JAAQS) and the Priority Air Pollutants (PAP) thresholds. Regardless of which vendor is selected for the turbines, both will result in compliant modeled impacts of the Project as shown in Section 5. Maximum predicted impacts for either vendor option when firing the Mix fuel (94% NG, 6% ADO) are less than 75% of the corresponding JAAQS for all pollutants and averaging periods. Therefore, the air quality impacts due to emissions from the Project are found to be in compliance and no further modeling analysis is required. However, in discussions with the National Environment and Planning Agency (NEPA) Air Quality personnel, the CHP Project has been asked to conduct cumulative modeling assessments for the criteria pollutants including nearby facilities.

Emissions from nine other nearby facilities were included in the cumulative modeling with the CHP Project. Criteria pollutant cumulative impacts were determined, background concentrations were added and the results were compared to the JAAQS. The maximum impacts from the cumulative modeling are dominated by contributions from the other nearby facilities. The cumulative modeling results indicate that the CO impacts are well below the JAAQS while impacts from other pollutants and averaging periods breach the JAAQS. The modeled annual PM_{10} concentration is below the JAAQS, but when added to the ambient background concentration the total PM_{10} concentration is above the JAAQS.

Although the cumulative impacts are exceeding the JAAQS, the CHP Project is not contributing significantly to any exceedances. As shown in Section 5, the Project only maximum impacts for the Mix fuel scenario are below the Significant Air Quality Impact thresholds of 20 μg/m^3 for annual impacts and 80 μg/m^3 for 24-hour impacts as defined in Table 5-4 of the NRCA Guideline Document (NRCA, 2006).

The cumulative modeling provides a baseline for the current conditions, showing that improvement is needed. This highlights the need to mitigate the air quality impacts by switching fuel from HFO to NG, a significantly cleaner burning fuel. Clean projects like the proposed CHP Project are needed to achieve emissions reductions while providing the steam and electricity that is crucial for Jamaica.

5.2.5. Geology & Hydrogeology

5.2.5.1. Geology

The regional geology of Southern Clarendon has been mapped by the Mines and Geology Division (MGD) of the Ministry of Mining and Transport and is contained on Geological Sheets 16, 17 and 20 at a scale of 1: 50,000.

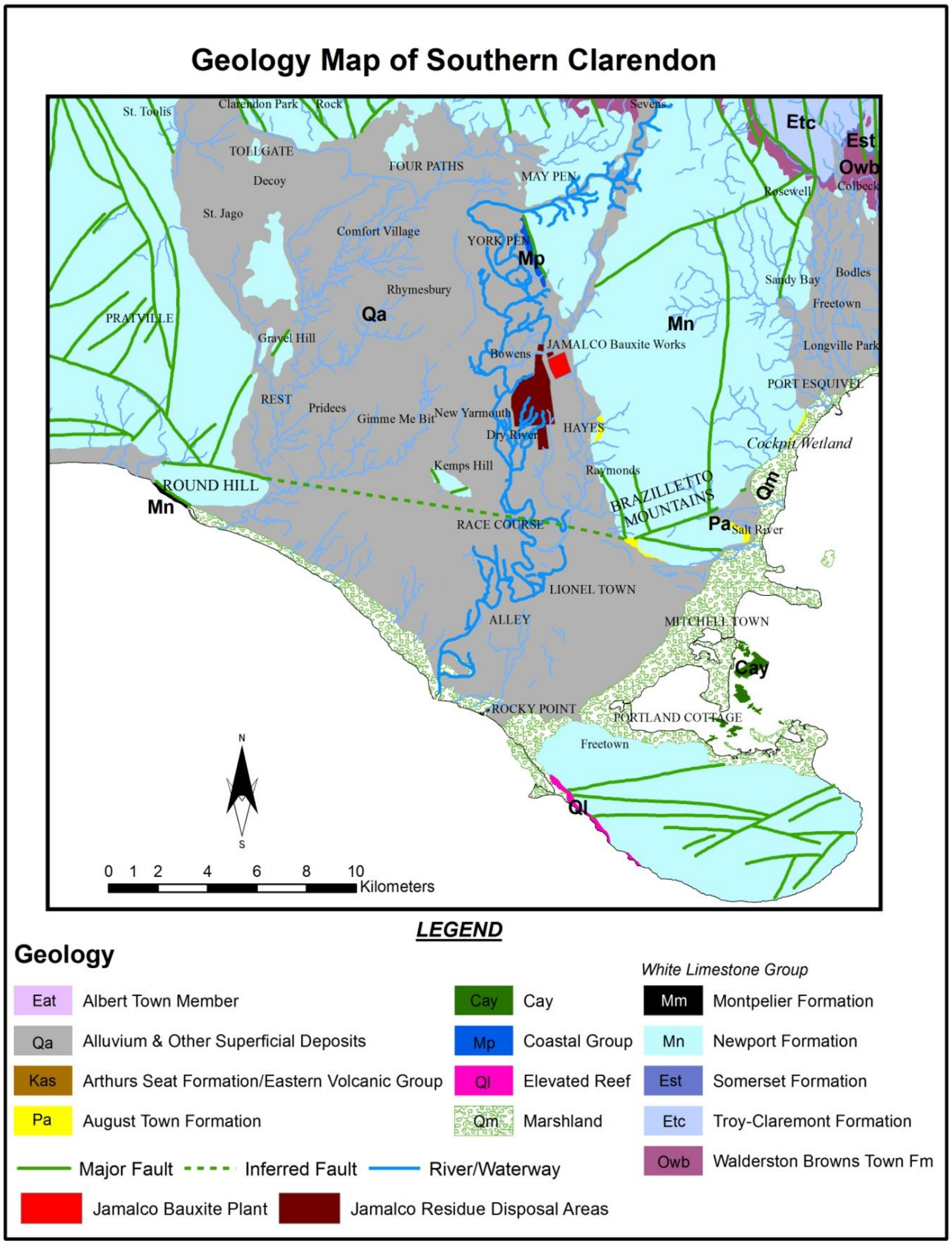


Figure 56: Geology Map of Southern Clarendon

The main features of the geology of the Southern Clarendon area are

- The extensively faulted limestones with high secondary permeability and which underlies the entire southern plains
- The surficial deposits of alluvium (gravel, sand and clay) laid down by the meandering rivers over geologic time atop the limestones
- The faults that shape the structure and topography of Southern Clarendon, and
- The wetlands to the east that forms a buffer between the sea and the eastern ridge of the Brazilletto Mountains

The three main stratigraphic units identified are the unconsolidated Alluvium, the August Town and the Newport Limestone Formations. The stratigraphic units in chronological order are listed in the table below.

Table 11: Stratigraphic Units

Stratigraphic Unit	Geological Age	Geological Time
Alluvium (gravel, sand, clay)	(Quaternary) Recent	11,700 years to present
August Town Limestone Formation	(Tertiary to Quaternary) Upper Miocene to early Pleistocene	5.322 to 2.588 million years ago (mya)
Newport Limestone Formation	Tertiary (Miocene)	23.03 to 5.332mya

5.2.5.2. Limestones

5.2.5.2.1. Newport Limestone Formation

The Newport Limestone consists of poorly bedded relatively pure white to pinkish-brown micrite. It outcrops over almost the entire Southern Clarendon. Three informal stratigraphic units have been recognized (Geological sheet 17);

- a lower one, characterized by corals and larger foraminifera (*Lepidocyclina canellei, Heterostegina antillea*) diagnostic of the Lower Miocene

- a middle rubbly layer, reported to contain quartz in some areas (Geological sheet 17); and
- an upper limestone layer with molluscs and the *foraminifera Archaias spp* and *Miosorites americanus* indicative of a Middle Miocene age (Robinson, 2004).
- The Newport Formation was subsequently included in the Moneague Formation of Mitchell (2004).

Solution features in these limestones consist of joints widened by the dissolution of calcium carbonate by rainwater, the development of conduits within the limestone and there may be cave development. Most large features in the limestones of southern Clarendon consist of vertical shafts, widening laterally into extensive cave complexes in some areas, such as Portland Ridge (Fincham, 1997). Caves similar to those of Portland Ridge have not been reported from the mid southern plains.

The bearing capacity of the limestone bedrock is good, although for large structures the presence or otherwise of caverns/conduits or fissures at shallow depth should be ascertained.

5.2.5.2.2. The August Town Formation

The August Town Formation consists of a sequence of yellow marls and rubbly limestones, fossiliferous with a fauna including oysters and foraminifera that forms a fringe along the southern margin of the Brazilletto Mountain. Lithologically, they range from impure limestone, relatively resistant to weathering, to softer more easily weathered marls and clayey marls that erode into gullied slopes.

5.2.5.2.3. Alluvium

The Alluvium consists mostly of clay with horizons of gravel, coarse to fine grained sand and silt. The alluvium is thickest to the south (the down throw side) of the South Coastal Fault. The thickness of the alluvium has been reported to be over 250metres as a well drilled near Kemps Hill was terminated at 250metres without encountering the limestone.

Wadge, Brooks and Royall in 1983 published work on "*Structure Models for the Lower Vere Plains, Jamaica*" and concluded that the thickness of the alluvium was of the order of 650m.

5.2.5.2.4. South Coastal Fault

The south coast fault trends west to east across Southern Clarendon with hydraulic continuity with the sea at Milk Pen in the west and at Salt River in the east. This was postulated by Versey and Prescott in 1958 based on the abrupt thickening of the alluvium, known from the lithologic logs of wells drilled, south of a line joining Round Hill in the west and the Brazilletto Mountain to the east. Wadge, Brooks and Royall in the structural model mentioned above also concluded that the displacement along the northern boundary of the south coastal fault is approximately 2.5km and 1.2km on the southern boundary during the Plio-Pleistocene. Tectonic activity associated with the south coastal fault has been responsible for the Round Hill to the west, the Kemps Hill in the centre and the Brazilletto Mountain to the east of the southern plains.

5.2.5.2.5. Cockpit Wetland

East of the Brazilletto Mountain is a large wetland (The Cockpit Wetland) that extends from the Bowers River in the north to the Salt River in the south. The wetland is located on the downthrown side of a fault that runs north to south along the eastern edge of the Brazilletto Mountain. The White Limestone is at depth beneath the wetland atop which the impermeable Coastal Limestone Formation, peat and an alluvium have been deposited (See Figure 57 below.

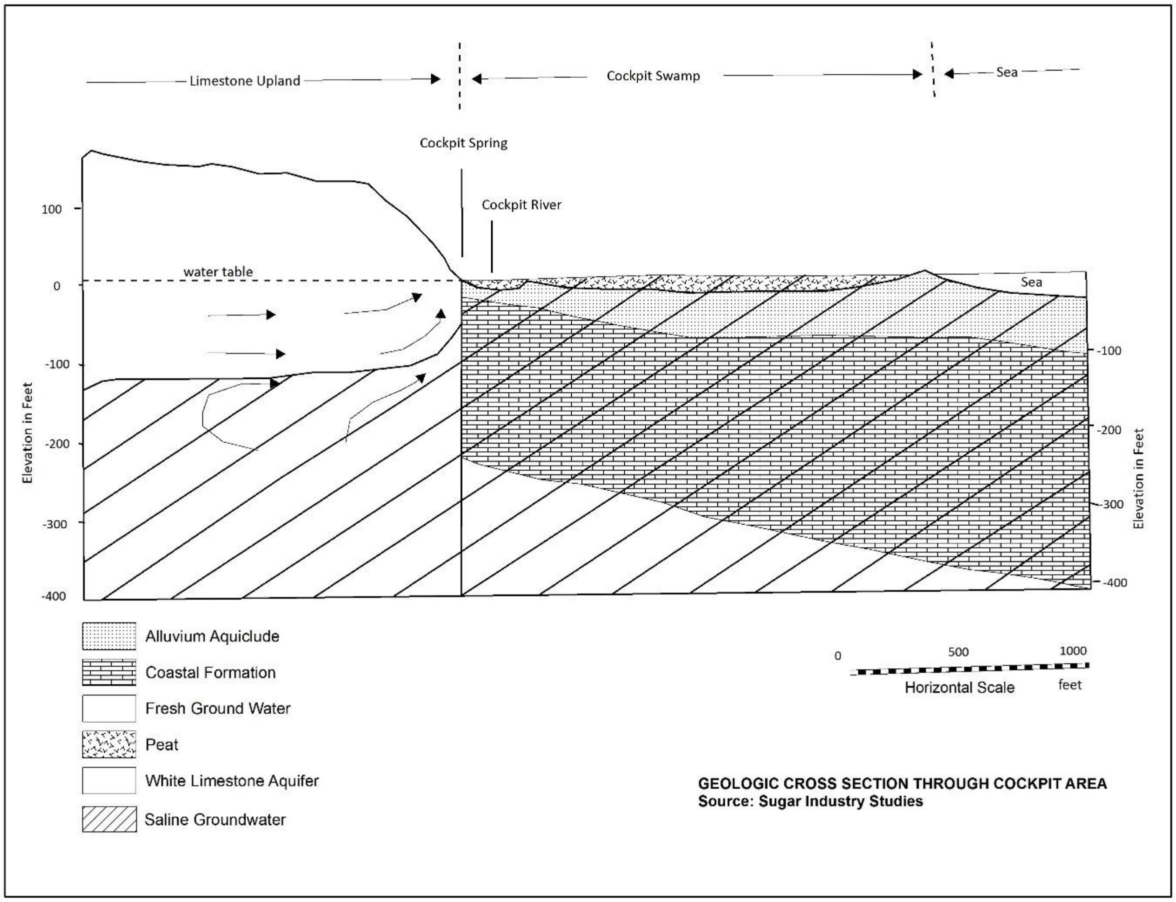


Figure 57: Geologic Cross Section Through Cockpit Area

A series of springs along the fault zone some (5.5km seepage zone) supplies water to the wetland. The Cockpit River drains water from the wetland to the sea. North of the river mouth a beach has been built up, by the deposition of sand by littoral drift, between the wetland and the sea. This beach rises between 1 to 1.5 metres above sea level and is backed by a dry strip of land before giving way to the wetland. South of the mouth of the Cockpit River the wetland abuts directly with the sea.

The wetland provides water for domestic uses by the local population, who enlarge the pools formed by the springs feeding the wetland, for drinking, washing and bathing. The spring flows have been captured since 1913 for use as an irrigation source for sugar cane at Morelands and Hillside Farms west and south of the Brazilletto Mountain.

5.2.5.2.6. Structure

The area around the centre of the plains, including the site of the bauxite/alumina plant at Halse Hall, is a large syncline or limestone depression crisscrossed by several faults The lateral and vertical movements along these faults are responsible for the variation in lithology encountered during the drilling of the monitor and production wells on the plains i.e. lower, middle or upper Newport Limestone Formation. Faults that cross the area and trend northeast to southwest and northwest to southeast truncate at the boundary of the alluvium. The faults are buried beneath the alluvium covering the limestone but if extrapolated would meet north of the Webbers Gully at New Bowens housing scheme. One fault trending northwest to southeast passes east of the bauxite/alumina plant and has incised a deep channel within the limestone. The thickened alluvium encountered in the drilling of Hanbury No 2R well and Monitor Well #3 mark this fault zone. This fault reappears at Raymonds to the south of Hayes Township where it abuts onto the South Coastal Fault.

The UNDP/FAO Water Resources Assessment of the Rio Minho-Milk River Basin, Annex II-Water Resources Appraisal divides the Clarendon Basin into 3 units and treats each unit as being separate. The boundary between Units B and C was given as a groundwater divide at the western edge of the Brazilletto Mountains until it intersects the South Coastal Fault, which structurally is the southern boundary of the limestone formation of the Clarendon Plains. The fault that is located east of the plant at the western edge of the Brazilletto Mountain is possibly the eastern boundary of Unit B.

Cross sections drawn in a north-south and east-west direction across the Halse Hall area show the following:

- The erosional (wavy) surface of the limestone
- The variation in thickness of the alluvium
- The basal clay layer at the limestone/alluvium boundary; and
- The water table in the limestone aquifer.

The cross sections are shown as figures 2 and 3.

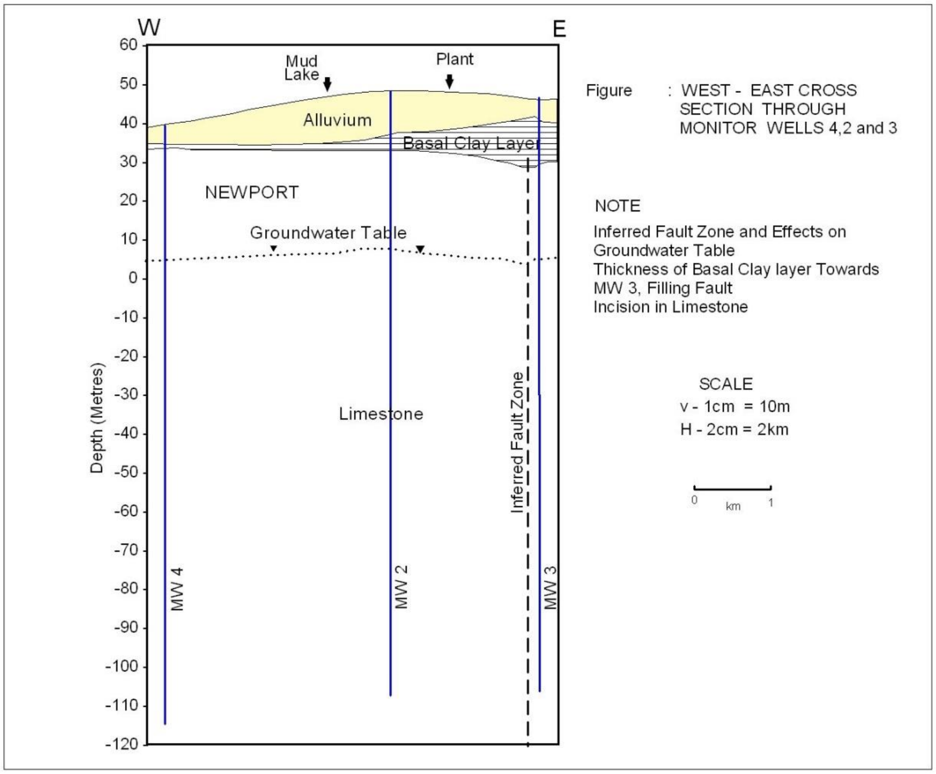


Figure 58: Cross Section of Monitor Wells

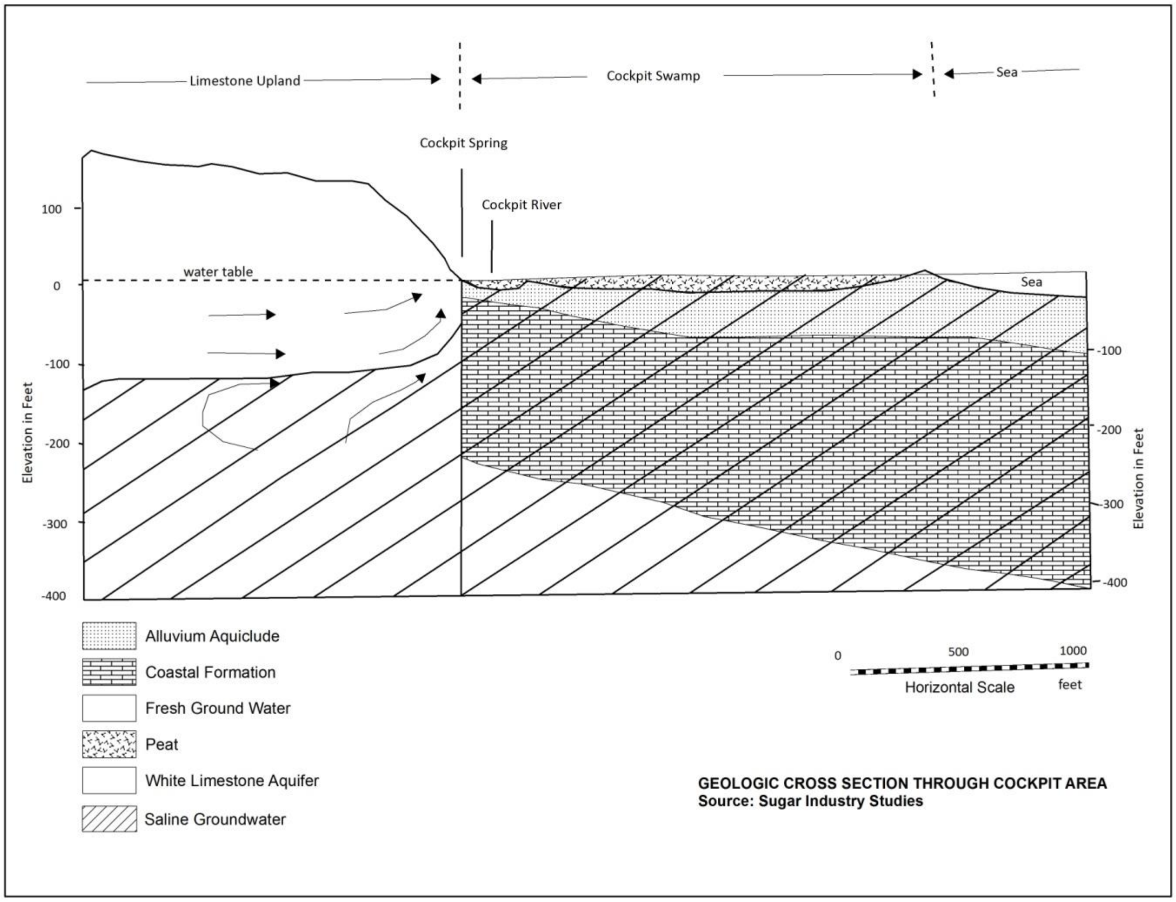


Figure 59: Geological Cross Section Through Cockpit Area

5.2.5.2.7. Topography and Drainage

Topographically South Clarendon is of low relief with gentle rolling hills especially on the Harris Savanna. The Brazilletto Mountains form the high ground rising to 250 metres above mean sea level to the east of the parish. The Rio Minho flows in a north-south direction east of New Yarmouth sugar factory and west of the Residue Storage Areas (RSAs) for the bauxite-alumina processing plant at Halse Hall and is the major surface water drainage system. Seasonal gullies such as Webbers Gully and Grimmett Gully flow to the Rio Minho during the wet season. The only other perennial streams are the Bowers and Salt Rivers which are located to the northeast corner of the parish close to Old Harbour and to the east close to Rocky Point respectively. The Rio Minho flows from the impermeable rocks of the Central Inlier located north of May Pen but loses its flow, except during the wet season, to the limestone aquifer via sinkholes at Sevens. Outside the rain season there is no flow past

May Pen and Halse Hall. Flow returns at Alley just before the river enters the sea at Carlyle Bay. The Water Resources Authority in 2005 carried out a hydrologic and hydraulic analyses to develop a flood plain map of the reach of the Rio Minho between May Pen and the coast-Carlyle Bay. The results indicate that the 100year flood event would not impact on the RDAs.

The Webbers Gully, a tributary of the Rio Minho, drains the area north of the bauxite/alumina plant. The Webbers Gully is seasonal and carries storm water from the northeast section of the basin into the Rio Minho. During high rainfall events when the Rio Minho is in spate its stage is higher than that of the Webbers Gully with the result that the gully cannot enter the river and will overtop its banks with resultant flooding. The flood plain map by the WRA indicates that the storm lake of the bauxite/alumina plant would be affected by the flooding from the Webbers Gully (backwater effect) of the 100year event.

The Webbers Gully was straightened to facilitate the construction of the No. 1 RSA (mud lake) and the Clear Lake. The Webbers Gully flows between the northern dike of the No. 1 RSA and the southern edge of the Clear Lake. One monitor well (#8) is located just south of the Webbers Gully before it joins the Rio Minho.

5.2.5.3. Hydrogeology

5.2.5.3.1. Hydrostratigraphy

The parishes of Clarendon and Manchester together form the Rio Minho Hydrologic Basin that consists of the Rio Minho, the Milk River and the Gut River-Alligator Hole Watershed Management Units (See Figure 60 below).

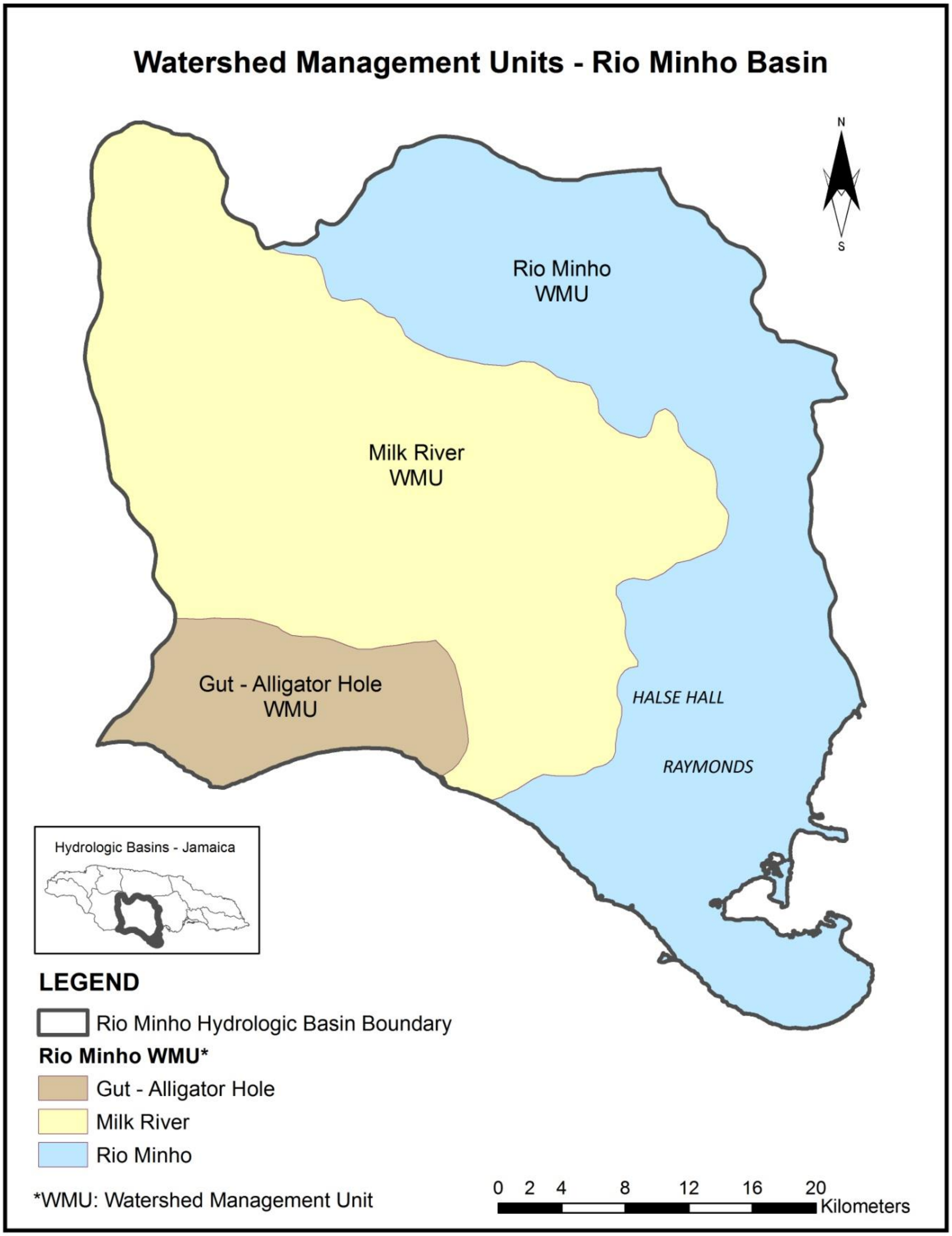


Figure 60: Waterhshed Management Unit

The Rio Minho Hydrologic Basin extends over an area of 1,814.3 km^2 (See Figure 61 below) and is the largest of the hydrologic basins in Jamaica. The Basin is subdivided into 3 Water Management Units (WMUs) and three (3) hydrostratigraphic units (Figure 62 below).

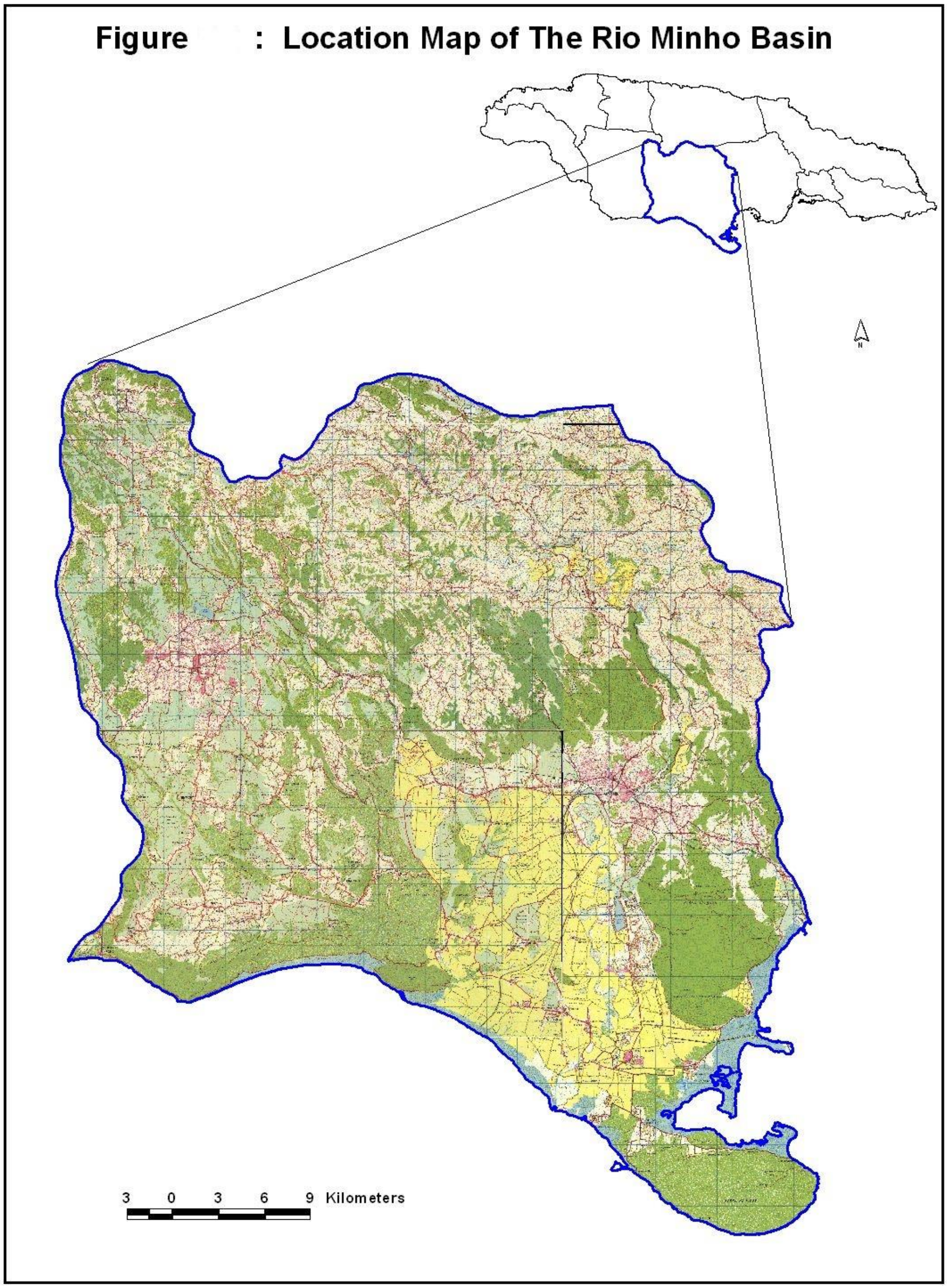


Figure 61: Location Map of Rio Minho

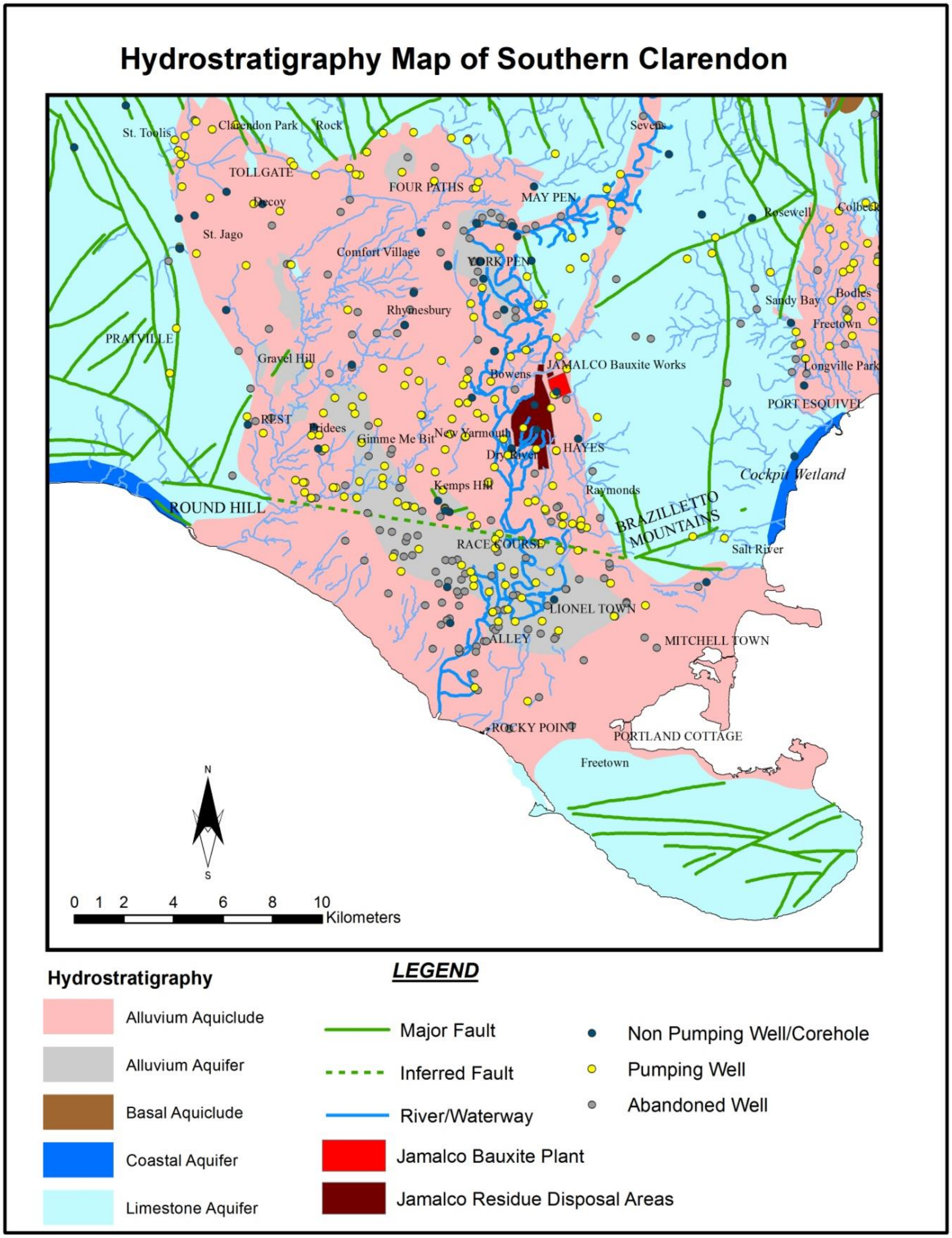


Figure 62: Hysdrostratigraphy Map of Southern Clarendon

Table 1 below summarizes the area for each catchment.

Table 12: Areas of the Hydrostratigraphic Units of the WMUs of the Rio Minho Hydrologic Basin

WMUs	Hydrostratigraphic Units (km²)			Total	Percent
	Basement Aquiclude	Limestone Aquifer	Alluvium Aquifer (Aquiclude)		
Rio Minho	338	298.1	153	789.1	43.5
Milk River	15	697	170	882	48.6
Gut River-Alligator Hole River		143	0.2	143.02	7.9
Total	353	1138.1	323.2	1814.3	
Percent (%)	**19.46**	**62.73**	**17.81**		**100**

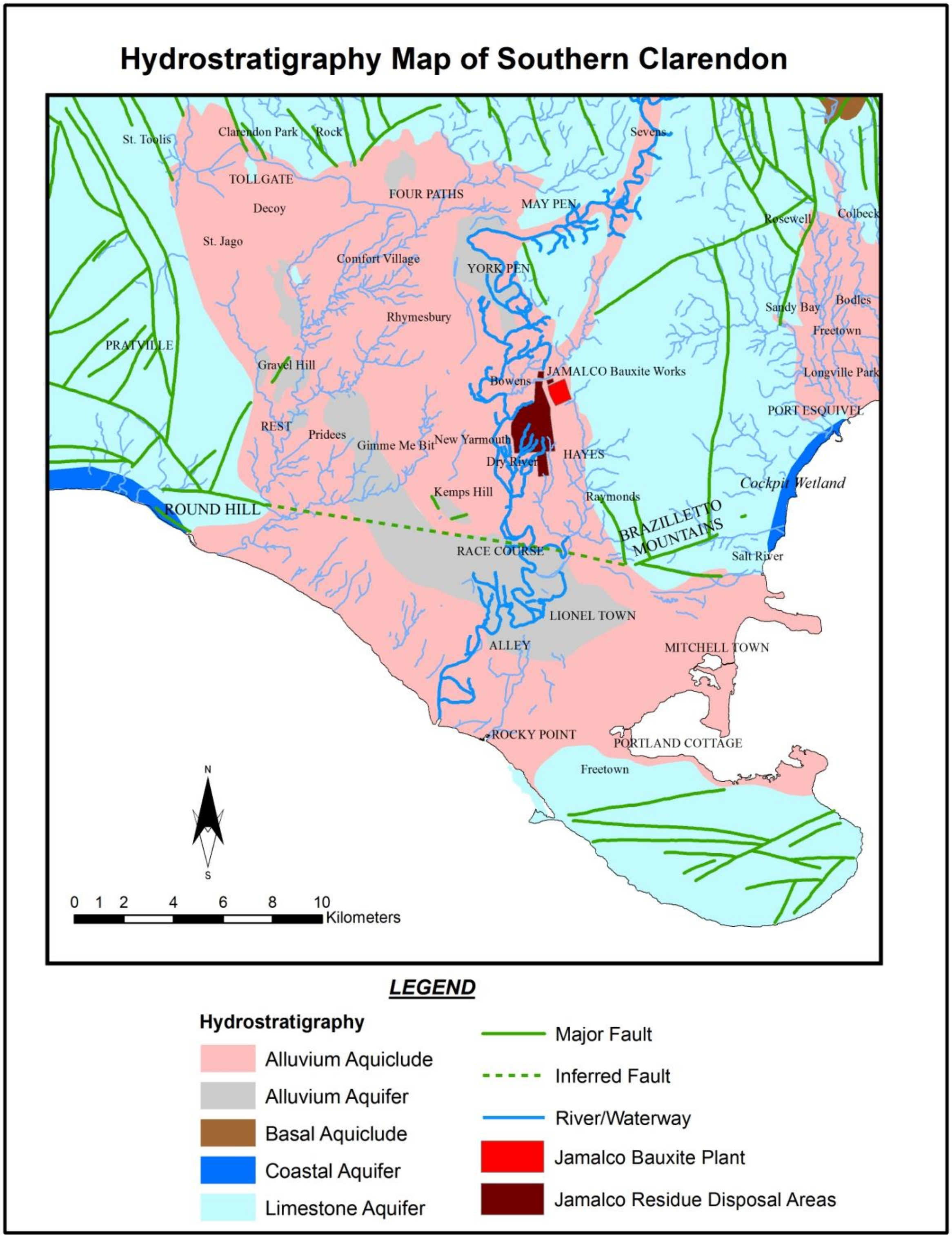


Figure 63:Hydrostratigraphy Map of Southern Clarendon

The Rio Minho WMU is the eastern-most unit with an area of about 798.3 km^2. Basal aquiclude outcrops over 42% of the area in the northern part of the unit and forms the catchment for the Rio Minho and other rivers in the area. A limestone aquifer dominates the southern, western and eastern parts of the basin, whereas the central eastern part and all that area south of the South Coastal fault contains the alluvial aquifer. The limestone aquifer is mainly recharged by rainfall as well as the Rio Minho which sinks above May Pen into the aquifer during non-rainy seasons. Discharge from the aquifer mainly takes place as springs at Cockpit and Bowers Rivers

The Milk River WMU measures about 512.1 km^2 and consists almost entirely of aquifers with the limestone aquifer accounting for almost 64% (327.7km^2) and the alluvium aquifer for about 33% (169km^2) of the total area. Aquiclude covers just 3% (15.4km^2).

The Gut River - Alligator Hole WMU, with an area almost equal to the Milk River WMU, consists almost entirely (99.9%) of limestone aquifer. The aquifer discharges into the sea supporting the wetlands at Canoe Valley and also supports year-long flow in four streams.

5.2.5.3.2. Hydrogeological Characteristics

Although the White Limestone acts as a single hydrogeological unit, the Newport Formation covers most (63%) of the Rio Minho basin to a considerable depth. It outcrops in the hills of the Brazilletto Mountain to the east and to the west at Spring Plain-Porus and underlie the alluvium of the plains, where it is the principal source of groundwater. The exact thickness of the limestone is not known but the UNDP/FAO water resources project estimated that in the southern area of the basin the thickness exceeds 1,200 metres as proven by an exploratory oil well drilled at Portland Point.

The Newport Limestone Formation is the major aquifer that provides water to the wells that support irrigation, domestic and industrial water in the parish. All the monitor and production wells drilled by the Sugar Company of Jamaica, New Yarmouth Ltd, National Irrigation Commission, National Water Commission, Jamalco, Windalco and other private well owners penetrated the upper to middle horizons of the Newport Limestone as marked by the abundance of fossils such as gastropods, corals and bivalves. The wells are in fact only partially penetrating the aquifer and abstracts water from the top 60 metres (200 feet) of the aquifer.

The permeability of the aquifer is high as evidenced by the loss of circulation (drill water) and the drop of the drill string during the drilling of the exploratory wells under the UNDP/FAO water resources project and other drillings as cavities/conduits were encountered and the high yield/low drawdown of the wells when tested. The wells drilled across the basin encountered the water bearing horizons at 13 to 16 metres below sea level. The saturated thickness of the limestone across the basin is estimated to be in excess of 150 metres as proven by the Vernamfield exploratory well drilled into the central limestone syncline/depression atop which the bauxite/alumina plant at Halse Hall is located.

The alluvium atop the limestone consists mostly of sands, gravels and clays. The alluvium also fills the fault-incised channels in the underlying limestone. One such channel approximates the course of the Rio Minho. The coarser sediments are concentrated within the buried channel and along the course of the Rio Minho. Monitor Well 5 located on the banks of the Rio Minho west of the RSA proved a thickness of 17 metres of coarse sand and gravel with clay between 15 to 17 metres depth. Examination of the lithologic logs from the monitor wells drilled around the bauxite/alumina plant at Halse Hall indicates a basal layer of clay separating the alluvium from the underlying limestone so there is no mixing of water between the alluvium and the limestone formations. The Alcoa No. 1 borehole located at E4655 N3618 encountered 10 metres of white sticky clay atop the limestone. The alluvium in the central section of the Clarendon Plains is dry and no regional water table was encountered during the drilling of the monitor and production wells. The alluvium is unsaturated and functions as an aquiclude (Geomatrix Jamaica Ltd. 1995).

5.2.5.3.3. Surface Water

The Rio Minho, the Webbers Gully, the Bowers River and the Salt River are the main constituents of the surface water hydrologic system in the central and eastern section of the Clarendon Plains. The Milk River is the main system in the west.

The Rio Minho, located west of the RSAs, flows in a north south direction. The Webbers Gully, a tributary of the Rio Minho, drains the area between New Bowens and the plant site. It joins the Rio Minho at Old Bowens flowing north of Monitor Well 8.

The Rio Minho and the Webbers Gully are seasonal in flow. The Rio Minho is seasonal between May Pen and Alley. The river loses its flow-an average of 20 million cubic metres per year (MCM/yr)-just north of May Pen (at North Hall) to the limestone aquifer. At Alley the river again becomes perennial and is sustained by wet season surface water throughflow from the Upper Rio Minho sub-basin (111 MCM/yr) and perennial inflow of irrigation return water (22 MCM/yr), totaling 133 MCM/yr average discharge to the sea. There is no significant contribution to the Rio Minho from the limestone aquifer throughout its passage across the Clarendon Plains to the sea.

Ponding of water occurs along the course of both surface water systems. The ponding indicates the effectiveness of the basal clay layer in preventing vertical movement of water through the alluvium to the limestone aquifer. However, along the Webbers Gully in the vicinity of the clear lake and in the Rio Minho above and below the highway bridge near Glenmuir there are outcroppings/surface exposures of limestone. Surface flow as well as any contaminant can enter the limestone aquifer through these surface exposures of limestone.

The Salt River and Bowers River to the east of the Brazilletto Mountain are perennial streams that transport flow from springs and the Cockpit Wetland to the sea. The rivers are saline due to the encroachment of seawater along the invert level of the rivers and through the wetland from high seas, storm surges and high tides.

The Milk River flow is sustained by the drainage of water from the Porus Graben and discharges groundwater via springs at Porus and St Toolies-St Jago. However, the pumping of groundwater by Windalco and the NWC from their well fields at Porus rapidly declines the water table and the springs dry up in the absence of rainwater recharge to maintain aquifer storage. The reliable yield of the Milk River is zero.

5.2.5.3.4. Ground Water

Ground water is water that is stored within the saturated section of the limestone formation. The natural level of the water i.e. the water table, marks the upper section of this zone of saturation. Rainfall is the sole source of recharge to the ground water system but artificial, intentional or unintentional, inflows can also contribute and may affect ground water type and quality. The impact will depend on several factors and may include.

- Hydrostratigraphy
- Permeability
- Water levels
- Flow direction

As stated earlier the two main hydrostratigraphic units within the Rio Minho Basin (Clarendon Parish) are the limestone aquifer and the alluvium aquifer/aquiclude. In the central area north of the south coastal fault the alluvium is dry and functions as an aquiclude which does not yield water to wells.

A hydrostratigraphic unit is a geologic formation (or series of formations), which demonstrates a distinct hydrologic character. An aquifer is a geologic formation or group of formations that readily and perennially yields water to a spring or well. An aquiclude is the opposite of an aquifer.

The alluvium overlies and confines the limestone aquifer within the basin. The full penetration of the alluvium during the drilling of the monitor wells around the bauxite/alumina plant proved its lack of water. In the drilling of the monitor wells and production wells the limestone aquifer has been partially penetrated. Around the Halse

Hall area the penetration was to a thickness of 135 metres out of a reported thickness of 1350 metres-10% only. Yet this drilling of the monitor wells was the deepest drilling to have been done in the area. The confinement of the aquifer was evident where artesian rises in the water level of up to 14 metres were noted (Geomatrix 1995).

Ground water is ponded within the karstic Clarendon Plains limestone aquifer by clayey alluviums on the downfaulted southern block of the South Coastal Fault. Along its southeastern boundary alluviums and underlying coastal aquicludes act as a barrier to direct outflow to the sea.

The alluvium south of the South Coastal Fault functions as an aquifer in places and as an aquiclude in other places. Where it functions as an aquifer it is tapped by the Sugar Company of Jamaica using tube wells to provide irrigation and domestic water to its operations at Monymusk. The thickness of the alluvium in this area was determined in 1978 using a gravity survey (Bouguer Anomaly) to be a maximum of 650 metres (Wadge, Brooks and Royall 1983).

5.2.5.3.5. Well Locations and Yields

The seasonal character of the main rivers in the Basin combined with the high-water demand especially for agricultural purposes account for the heavy reliance on groundwater. Wells tapping the limestone aquifer produce water for agricultural, domestic and industrial uses. At present over 80% of the water supplied in the basin is from groundwater.

Located east of the Rio Minho River within the Clarendon Plains sub-division from the north (Mineral Heights) to the south (Raymonds) there are 28 production wells tapping the limestone aquifer. Two wells have been lost in the past five (5) years to the expansion of the Residue Storage Areas (RSA) and Run-off Water Storage (ROW) systems at Halse Hall associated with the bauxite/alumina plant. However, four wells that have been out of commission have been replaced with new wells also due to the expansion of the bauxite operations.

The wells are owned by:

a. SCOJ
b. Jamalco
c. the National Water Commission

The location of these wells along the South Coastal fault that is open to the sea at the western and eastern ends and the high permeability associated with the fault and the ponding of groundwater behind the fault influenced the locations. The wells are high producers.

The total licensed abstraction for the wells owned by Jamalco total 90,646 cubic metres per day (m^3/d); that for the National Water Commission totals 36,852m^3/d; that for the Ministry of Education (Vere Technical well) totals 1,690 m^3/d and the historical abstraction for the Sugar Company of Jamaica (SCOJ) totals 126,096m^3/d. One well, Quaminus 2, is shared between the NWC and the SCOJ. The NWC purchases water from this well to meet the demands of the Hayes New Town.

In addition to the 28 production wells there are sixteen (16) monitor wells located around the bauxite/alumina plant and RSAs.

The 16 monitor wells were drilled in 3 phases. Phase 1 saw 8 wells being completed in 1994 with a further 4 wells in phase 2 being completed in 1997. Two of the original 12 wells were destroyed due to plant expansion and these have been replaced. A further 4 wells to monitor the ROWs were constructed in phase 3 in 2010.

On the western side of the Rio Minho there are as many wells abstracting from the limestone aquifer. These include

- New Yarmouth 8 No. wells
- Robinson Brothers (now operated by New Yarmouth) 4No. wells
- Waterwell and Engineering Construction (now operated by New Yarmouth) 4No. wells

- Vernamfield (now operated by New Yarmouth) 4No. wells
- Rowington and Ramble (now operated by New Yarmouth) 8No. wells
- National Water Commission (NWC) 13No. wells
- National Irrigation Commission (NIC) 18No. wells
- Sugar Company of Jamaica 7No. wells
- Windalco 5No. wells
- Private owners (farmers) 2No. wells

This list totals 73 wells and the abstraction exceeds that from the eastern side of the Rio Minho.

The total licensed or historical entitlement of abstraction from the limestone in the area east of the Rio Minho is 255,284m^3/day.

Table 13: List of Limestone Production Wells East of the Rio Minho

Name of Well	Name of Owner	Water Use	Yield (m^3/day)
Great House	Jamalco	Private Domestic	250
Sam Wint	Jamalco	Agriculture	7,560
Halse Hall (Block B)	Jamalco	Agriculture	11,160
Howards (Block A)	Jamalco	Agriculture	10,880
Dry River 2R	Jamalco	Industrial	15,000
Dry River 3	Jamalco	Industrial	9,815
Dry River 5R	Jamalco	Industrial	9,815
Hanbury	National Water Commission	Public Supply	13,640
Hanbury 2R	Jamalco	Industrial	10,902
Production 1	Jamalco	Industrial	15,264
New Bowens	National Water Commission	Public Supply	3,272
Hayes Public	National Water Commission	Public Supply	6,858
Mineral Heights	National Water Commission	Public Supply	6,541
Curatoe Hill	National Water Commission	Public Supply	6,541
Vere Technical	Ministry of Education	Agricultural/Domestic	1,690
Hayes Common 1	Sugar Company of Jamaica	Irrigation	11,088
Hayes Common 2	Sugar Company of Jamaica	Irrigation	13,944
Hayes Common 3	Sugar Company of Jamaica	Irrigation	10,224
Hayes Common 5	Sugar Company of Jamaica	Irrigation	11,088
Quaminus 1	Sugar Company of Jamaica	Irrigation	15,936
Quaminus 2*	Sugar Company of Jamaica	Irrigation	8,184

Cotton Tree Gully 2	Sugar Company of Jamaica	Irrigation	9,168
Cotton Tree Gully 3	Sugar Company of Jamaica	Irrigation	9,096
Damlands 4	Sugar Company of Jamaica	Irrigation	2,760
Raymonds 2	Sugar Company of Jamaica	Irrigation	6,072
Raymonds 3	Sugar Company of Jamaica	Irrigation	9,168
Raymonds 4	Sugar Company of Jamaica	Irrigation	10,200
Dry River 1	Sugar Company of Jamaica	Irrigation	9,168

*- well shared between SCOJ and NWC.

In addition to the 28 production wells there are Sixteen (16) monitor wells located around the bauxite/alumina plant and RSAs.

The 16 monitor wells were drilled in 3 phases. Phase 1 saw 8 wells being completed in 1994 with a further 4 wells in phase 2 being completed in 1997. Two of the original 12 wells were destroyed due to plant expansion and these have been replaced. A further 4 wells to monitor the ROWs were constructed in phase 3 in 2010.

5.2.5.3.6. Cockpit Wetland

The Cockpit Wetland is maintained by the Cockpit Springs that occur along a 5.5 kilometre line of groundwater seepage extending from Tarentum in the south to Bowers in the north. The springs issue as overflow from ponded limestone storage at the fault controlled junction of the outcrop of the limestone aquifer and the low permeability aquiclude. No blueholes or spring upwelling occur on the downthrown side of the fault in the wetland itself. This is consistent with the assumption that the thickness of low permeable formation (aquiclude) is such that it is capable of ponding water behind it in the adjacent limestone aquifer.

The existence of this low permeable sequence implies a barrier between the limestone aquifer storage and the sea with no direct hydraulic continuity between them. However, it may be possible that the limestone aquifer storage is in direct hydraulic continuity with the sea at depth below the low permeable sequence. Natural groundwater discharge from the limestone aquifer storage between Tarentum and Freetown maintain perennial flow in the Cockpit and Bowers Rivers. The rivers drain an eight (8) km^2 area of coastal wetland

The Cockpit Canal diverts water from the Cockpit River which partially drains the coastal wetland into which the springs discharge. The northern section of the wetland is drained by the Bowers River.

The Cockpit Canal was constructed after the failure of the Milk River Scheme in 1913. Its initial flow measurements in 1927 indicated a discharge not less than 15,290m^3/hr. or 366,989m^3/day. Over the years, the flows have declined and it is now estimated at 6,116m^3/hr. or 146,795m^3/day. The decline in the flow can be correlated to the development of groundwater up gradient of the springs and which has also led to increases in salinity of the Cockpit Springs.

Water quality data shows that the chloride concentration of the springs vary depending on location. The springs in the center of the seepage zone and the Bowers Spring at the northern end exhibits lower salinity than those at the southern end. This may be due to the elevation at which the springs discharge. The salinity concentration in terms of chloride varies between 400 mg/l to 690 mg/l which is significantly above the ambient chloride concentration of less than 30 mg/l. Chloride concentration greater than 1000mg/l for the springs have been reported.

The locks at the mouth of the Cockpit River were destroyed but the River was effectively dammed at the seaward end. This dam has been built up by the deposition of sand by littoral drift and substantial barrier has been developed which is approximately 0.5m above sea level. No flow from the Cockpit River now goes to sea.

The chloride concentration of the springs is lower than that of the Cockpit Canal and the wetland. This may be due to the seepage of seawater into the wetland and eventually into the canal. Attempts to shut off the canal from the wetland using piles with marl dumped behind have not been successful. There are 3 possible sources of saline contamination of the canal. These are:

- Saline groundwater from the more saline springs to the south
- Saline water trapped within the wetland when the river was dammed; and

- Direct seawater contamination of the wetland

The Cockpit Canal links up with the Salt River at Salt River and water that is not pumped to the high-level canal goes to sea in the Salt River.

5.2.5.3.7. Pipeline Route

The proposed transportation corridor for the transport of NG from Rocky Point to the Jamalco alumina refinery at Halse Hall is by pipeline along the Jamalco brownfield rail road alignment.

The pipeline route will encounter reef material and high-water table as it follows the train line from the port to the railroad crossing on the road to Mitchell Town/Portland Cottage. The depth to water at Mitchell Town varies between 1 to 1.5 metre below ground. However, a high water table of 0.4m below ground has been recorded. The groundwater encountered will be saline and this must be considered in the selection of the pipe material. The route will then turn north crossing the alluvium aquifer and passing near the alluvial wells at Morelands, Mcleod and Hillside where the water table at Morelands is 2.83m below ground and at McLeod 4m below ground. The lithology of the wells in the area indicates sand and gravels. The pipeline will cross the south coastal fault in the vicinity of Raymonds south of the alumina refinery where the Raymonds/Hayes Common well field that tap the limestone aquifer is located. The depth to water at Raymonds is 16.5m below ground. The alluvium atop the limestone at Raymonds varies between 6m to 14.6m in thickness and reflects the wavy erosional surface of the underlying limestone. The alluvium thickens northwards along the north-south trending fault marking the western boundary of the Brazilletto Mountain.

The alluvium deposits, which will be the main geological formation associated with the installation of the pipeline, should not present any major engineering problems. However, the narrow reefal peninsula from the Mitchell Town/Port roads intersection to the port itself may need engineering to overcome structural issues.

5.2.5.3.8. Road Routes

Proposed routes for the transportation of ADO is by road from JPSCo Old Harbour via the Salt River Road or via Highway 2000.

The Salt River route runs along the eastern edge of the Brazilletto Mountain and western boundary of the Cockpit Wetland along the fault that separates the Cockpit Wetland from the Mountain. Running parallel to the Salt River Road is the Cockpit Canal which carries water from the many springs that flow from the Brazilletto down to Salt River where it is lifted by pumps to a high level canal that takes the water to the sugar cane fields for irrigation. Flow from the springs goes down the Cockpit Canal but due to weed growth the flow is impeded and the Brattshill Pumping station has been installed to push the water down the canal to the Salt River pumps and to the high level canal.

Any accidental spillage of material being transported by this route will most likely enter any one or all of the following:

- the pools created by the citizens of Cockpit Village for their washing, bathing and drinking purposes
- the Cockpit River
- the Cockpit Canal and possibly the Cockpit Wetland
- the Salt River
- the Bowers River
- the sea
- aquifer storage through the permeable fault zone and white limestone eventually going to the springs and wetland.

It is recommended that because of the high geological, hydrological and ecological sensitivity of this route resulting from the potential to cause major impacts on the natural resources, in the event of a spill that this is avoided.

5.2.6. Drainage Assessment

The infrastructure associated with this project is distributed over a length of approximately 30 km all within areas that have been disturbed to some extent by human activities. The infrastructure are along roadways and railways and within industrial complex battery limits. It is therefore not anticipated to realize significant changes to runoff characteristics in any of these locations as a result of the development of the project.

The proposed site for the development of the power station is on the brown field site within the Jamalco fenced refinery property. The drainage of the proposed location of the power station facility is presently incorporated in the overall drainage for the Jamalco refinery property

Runoff from the refinery is collected and directed towards a storage pond to the north of the plant. Water collected in this pond is re-used within the plant for industrial processes. There is no net discharge of runoff from the refinery to the environment. The layout of the existing drainage system is sown in Figure 64. Below.

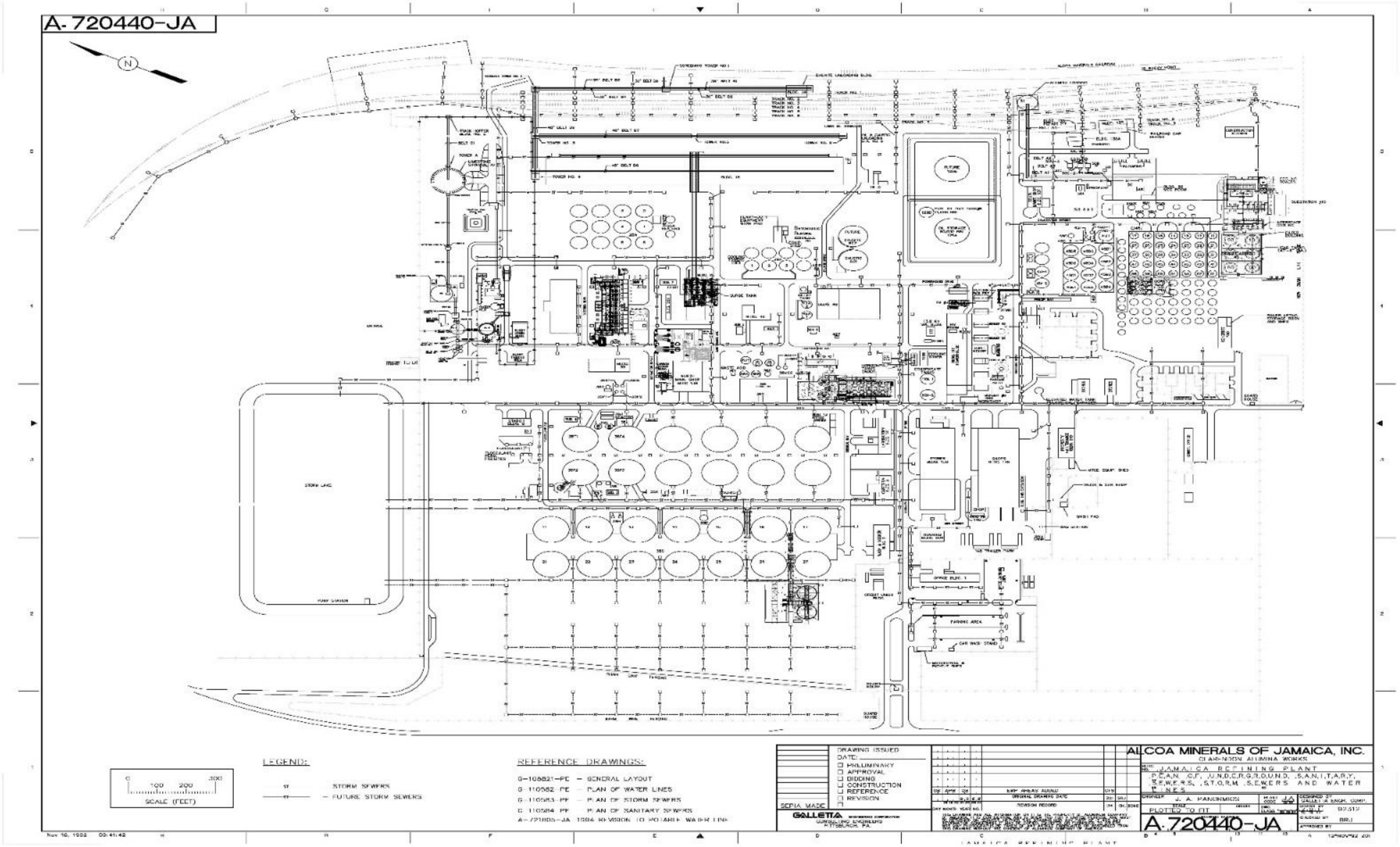


Figure 64. Jamalco Storm Water Layout

The storm-water drainage for the CHP will be tied into the existing Jamalco drainage system. The increase in runoff from the change of use of this approximately 4 hectares out of the 60 hectares that is drained into existing pond is expected to be negligible (no change anticipated in runoff coefficient). The Jamalco has built in capacity for future tie as illustrated on layout in Figure 64.

The major concern for the area in general is the flooding caused by the Rio Minho. The 100-year flood line is shown in Figure 65. From the map it is obvious that the location of the CHP is above the flood level associated with 100-year return storm. The impact of climate change on the intensity and frequency of flood event will be considered by ensuring that floor levels are above this elevation with additional freeboard.

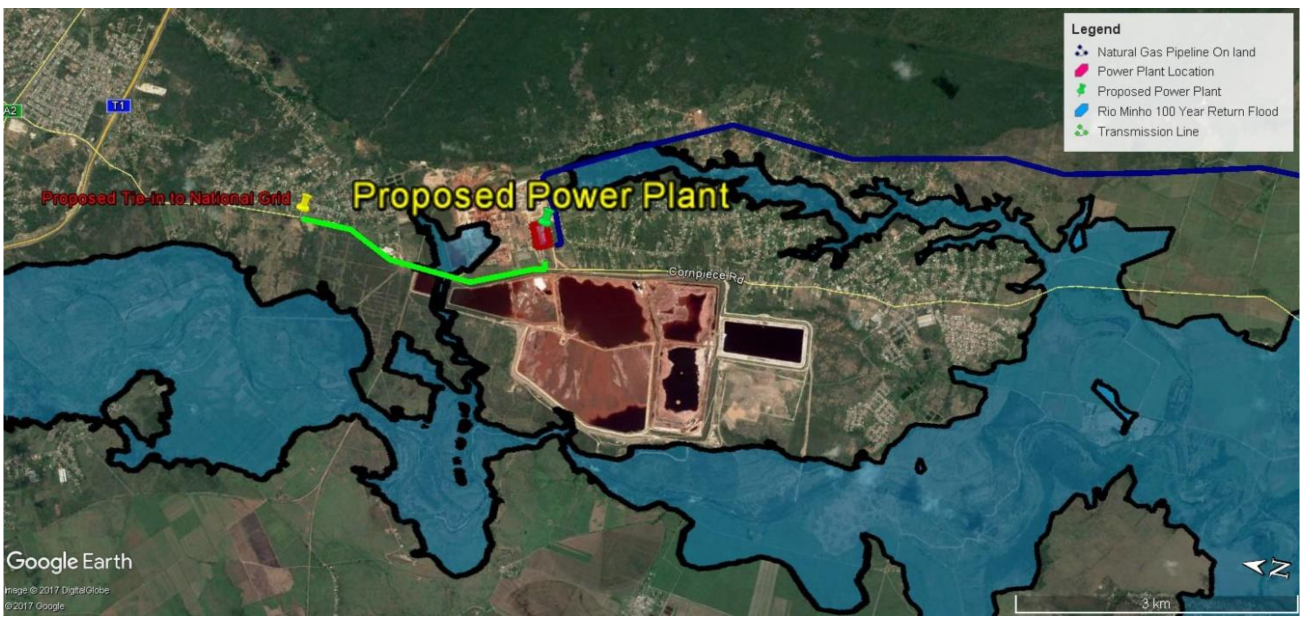


Figure 65: Map showing 100-year flood plain

The auxiliary infrastructure associated with the project include:

1. Underground pipes
2. ADO storage facilities

There is no runoff from the ADO storage bund into the existing drainage systems or environment of the facilities. This is retained in the bund and treated before disposal.

The underground pipelines will be covered with topsoil and landscaped to revert to its original condition as best as possible. These areas will be maintained to ensure assess along the entire length of the pipeline at all times. No impact on runoff is anticipated for the operation of the pipeline.

The concern for drainage is during construction which involves the excavation of trenches that could act as channels if not filled. It should be noted that sections of the proposed pipeline are within the limit of the 100-year flood plain and that there was a flooding incident, which was recorded on August 27, 1984 in close proximity to the proposed pipeline alignment (See Figure 66). Therefore, construction activities must be effectively managed and monitored to ensure that appropriate actions are taken to avoid any negative impact, which could arise from flooding in this area. A disaster risk management plan will be developed and practiced to ensure trenches are modified to avoid major impacts from flooding.

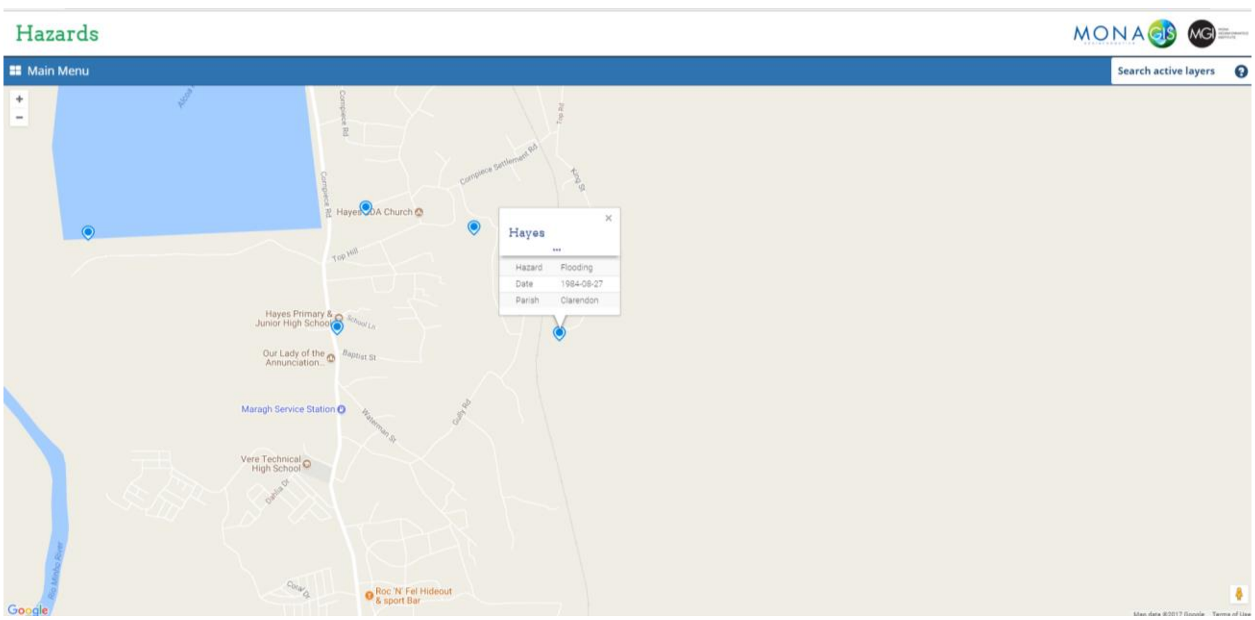


Figure 66: Flood Hazard Map showing recorded flooding incident

5.2.7. Archaeological & Historical Heritage

The parish of Clarendon was named in honour of the celebrated Lord Chancellor of England & Wales. The parish of Vere, now merged in it, was named after Vere, daughter of Sir Edward Herbert, Attorney General to Charles I, and first wife of Sir Thomas Lynch, who, with her two sons, died on her passage from England to Jamaica in 1683. Carlisle Bay, the scene of the principal military engagement with a foreign foe which has taken place in Jamaica during the British occupation, is on the south-west coast of the old parish of Vere.

There are various buildings and monuments of architectural and historic interest in the parish of Clarendon. Some of these are listed below:

- Taino Sites
- Halse Hall Great House
- Churches, Cemeteries, Tombs'
- St. Peter's Church, Alley
- Clock Tower
- May Pen Clock Tower

5.2.7.1. <u>Taino</u>

In Clarendon, they lived in Portland Ridge (the part of the parish that juts out into the sea) as well as in the Braziletto Mountains and on Round Hill. There was also a village on the banks of the Rio Minho near Parnassus Estate and the others were on the banks of the Milk River.

5.2.7.2. <u>Halse Hall Great House</u>

This is one of Jamaica's historic Houses. This architectural masterpiece is now owned and used by Jamalco. The lands on which the house was erected were given to an English officer, Major Thomas Halse in 1655 and were passed from him to Francis Sadler Halse who played a leading role in the Maroon Wars. It became a more imposing and beautiful two- storey structure in an era of security and prosperity during the late 1740s.

An elaborate arrangement of stone steps ascended to the new entrance, which was flanked by columns and capped with a fanlight. The peaked portico was added later to conform to a popular architectural style; a new wing which harmonizes well with the Great House architecture.

In 1969 the estate was acquired by ALCOA, the house renovated by them. It is now the property of the National Trust.

5.2.7.3. St. Peter's Church Alley

St. Peter's Church, Alley, the 3rd oldest Anglican Church. Built in 1671, it became the Parish church for Vere in 1673 it was extensively damaged by the 1692 earthquake and had to be almost totally rebuilt in 1975.

5.2.7.4. Morgan's Valley and Estate

Sir Henry Morgan, a privateer, buccaneer and former Governor of Jamaica, owned Morgan's Valley and Estate. He lived there while he was Governor of Jamaica.

5.2.7.5. May Pen Clock Tower

May Pen Square is over 80 years old. It was constructed in honor of Dr. Samuel Glaister Bell, a renowned doctor of the parish who lost his life while crossing the Rio Minho after visiting a patient. The May Pen Clock Tower is made of stone. It is approximately twenty-four (24) feet in height, eight feet (8) in width, and eight feet in length. The exact date of its erection has not been ascertained, but it appears to have been constructed after World War II.

5.2.7.6. Natural Site

The Milk River Spa is an internationally famous spa, which is recognized for its therapeutic properties of background radiation.

A historical review of the Portland Bight Protected Area is provided in the figure below.

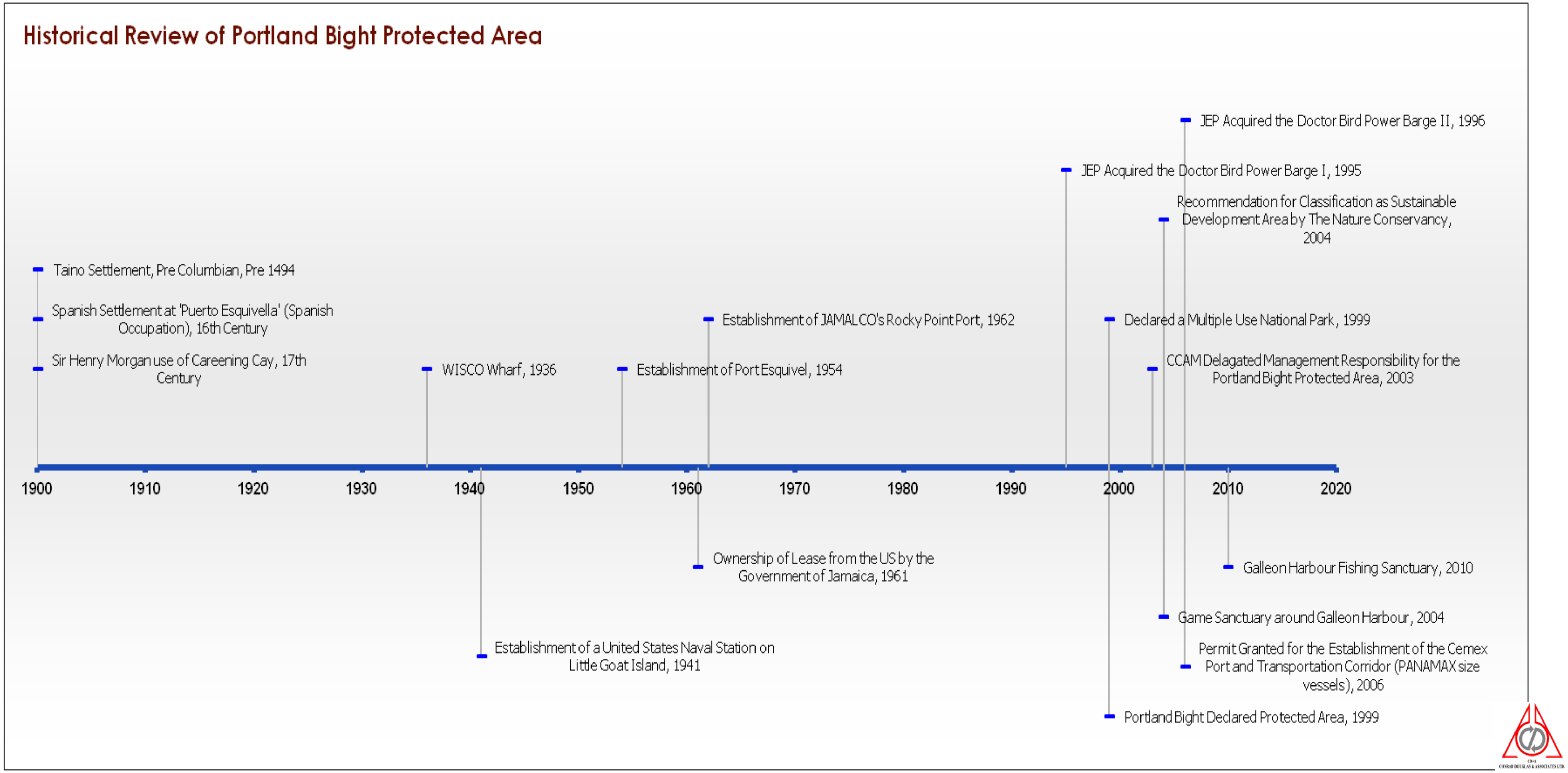


Figure 67: Historical Timeline of Portland Bight, Ridge, Cays and Goat Islands

5.2.8. Electromagnetic Field Assessment

Electromagnetic fields (EMF) are present everywhere at various levels and may be described in terms of electric fields and magnetic fields. Electric fields are created by differences in voltage while magnetic fields are created when electric current flows. Exposure to EMF can be from electrical devices, x-ray devices, power cables, among other sources.

This assessment measured the baseline EMF generated in proximity to JPSCo power lines along the Halse Hall Main Road. Commonly, the EMF generated from alternating current power lines operates at a frequency of 50 or 60 cycles per second (50 or 60 Hz) and fall within the category of super low frequency (SLF). SLF has the characteristics of frequency ranging between 30 hertz and 300 hertz. The unit of measurement for EMF are tesla (T) or gauss (G) [10,000 G = 1 T].

5.2.8.1. Approach & Methodology

EMF baseline readings were recorded using a calibrated and certified Triple Axis EMF Meter. Measurements were taken along the Halse Hall main road starting from the location of the proposed CHP site and leading up to the power line located at New Bowens community entrance (See Figure 68).

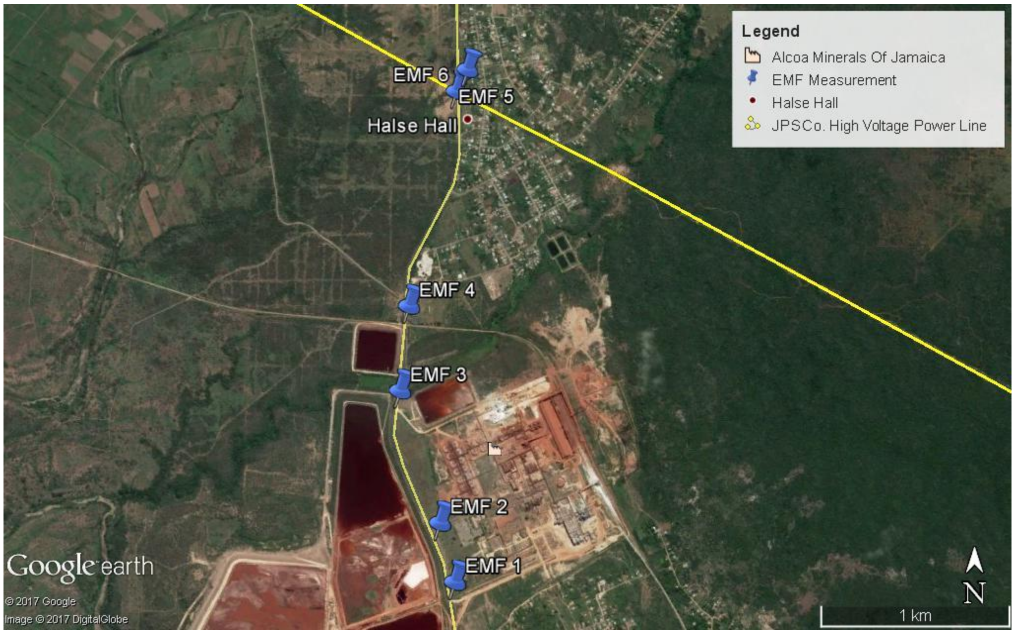


Figure 68: Locations of Electromagnetic Field Measurements

Figure 69: Location of JPSCo High Voltage Power Lines and Pylons. New Bowens community in background

Figure 70: JPSCo High Voltage Power Line and Pylon along Halse Hall Main Road

Figure 71: EMF Measurements being taken along Halse Hall Main Road at New Bowens Community entrance

5.2.8.2. Results

The results of the EMF Assessment are recorded in the table below

Table 14: Results of EMF Assessment

No.	Location	Coordinates	EMF Results (mG)	uT
EMF 1	Proximity to proposed CHP	17°53'41.65"N 77°14'39.27"W	7.28	0.728
EMF 2	Jamalco Bus Stop	17°53'51.62"N 77°14'42.02"W	3.89	0.389
EMF 3	Entrance at CEMEX	17°54'14.21"N 77°14'49.46"W	4.03	0.403
EMF 4	Train line adjacent Jamalco's Sports Club	17°54'28.93"N 77°14'47.93"W	3.20	0.320
EMF 5	New Bowens pylon	17°55'10.43"N 77°14'37.89"W	12.06	1.206
EMF 6	New Bowens Entrance	17°55'14.39"N 77°14'35.84"W	1.45	0.145

5.2.8.3. Discussions

The highest recorded EMF reading was 12.06mG. This was measured at the JPSCo high voltage transmission power line and pylon. It was observed that the measurement decreased with increasing distance from the pylon along the JPSCo power lines which intersects the pylons. In addition, the EMF measurement decreased with increasing distance from the pylon to the New Bowens community.

It should be noted that there are no international standards for EMF. The World Health Organization (WHO) established the International Electromagnetic Fields Project and assessed any risks to health that might exist from exposure to Extremely Low Frequency (ELF) electric and magnetic fields in the frequency range >0 to 100,000 Hz (100 kHz). The group concluded that "*if ELF magnetic fields actually do increase the risk of disease, when considered in a global context, the impact on public health of ELF EMF exposure would be limited*" (Mild & Sandström, Guide Electromagnetic fields in working life A guide to risk assessment, 2015).

5.3. Hazard and Risk Assessment

5.3.1. Traffic Analysis

The development of the CHP project will be done in the Mid Clarendon area, which has the following activities as the main zoning description:

1. industry,
2. agriculture,
3. mining,
4. residential

These zoning descriptions indicate significant use of the road network in the general area by heavy equipment such as trucks, tractors and trailers. They transport sand, bauxite, sugar cane, heavy equipment and deliver goods and produce.

The development of the CHP will not significantly impact road traffic loading during planning, implementation or normal operations. The main impact may be experienced during emergency situations on occasions when road transportation of automotive diesel oil (ADO) may be required from Old Harbour Bay Power plant to Jamalco via the Highway 2000 route. The use of this route will only be necessary in the event of conditions which disrupt the normal transportation corridor such as hurricanes which could induce emergency type operations.

Figure 72: Intersection of Hayes (foreground) and Salt River (background) showing road conditions. Heavy duty vehicle shown using the road.

The rail network will be used for transportation of all equipment and material during construction and operation.

The plant will operate on approximately 216,000 gallons of diesel per day. During the emergency operation this will be supplied by trucks. This equates to approximately 25 trucks making deliveries between Old Harbour Bay and the power station located at Halse Hall.

The loading of the roads are presently below capacity and an addition three trucks per hour over an 8 hour period will not cause overloading or changes in level of service given the present level of service. The latest data from traffic counts for the major intersections along the route are presented below.

TRAFFIC VOLUME FIELD SHEET

Intersection: Halse Hall Rd / Highway 2000

Date: March 10, 2014

Weather:

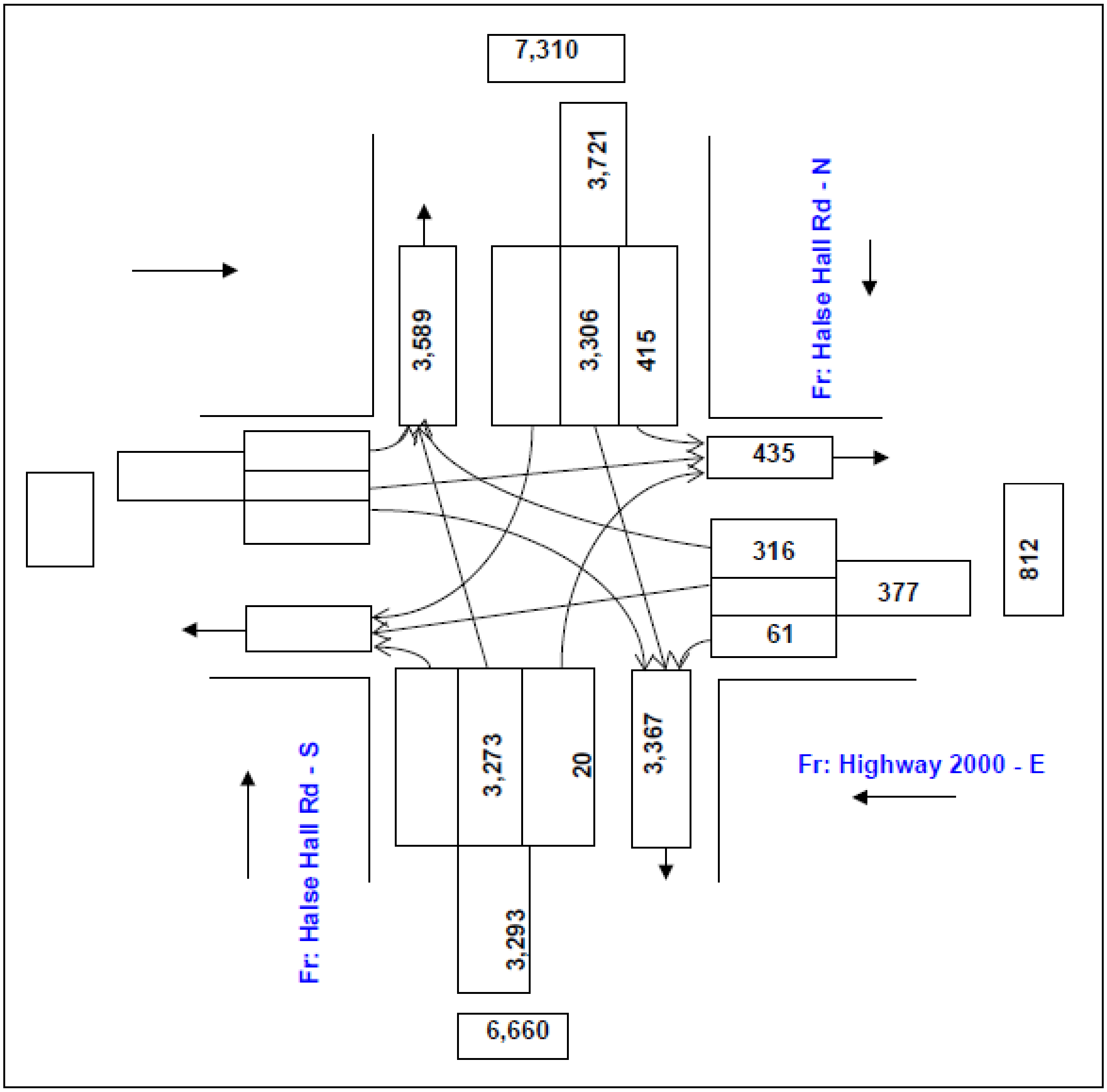


Figure 73: Traffic Volume Field Sheet for Halse Hall Road and Highway 2000 Intersection - 2014

TRAFFIC VOLUME FIELD SHEET
Intersection: JAMALCO / Hayes / May Pen
Date: March 17, 2006
Weather:

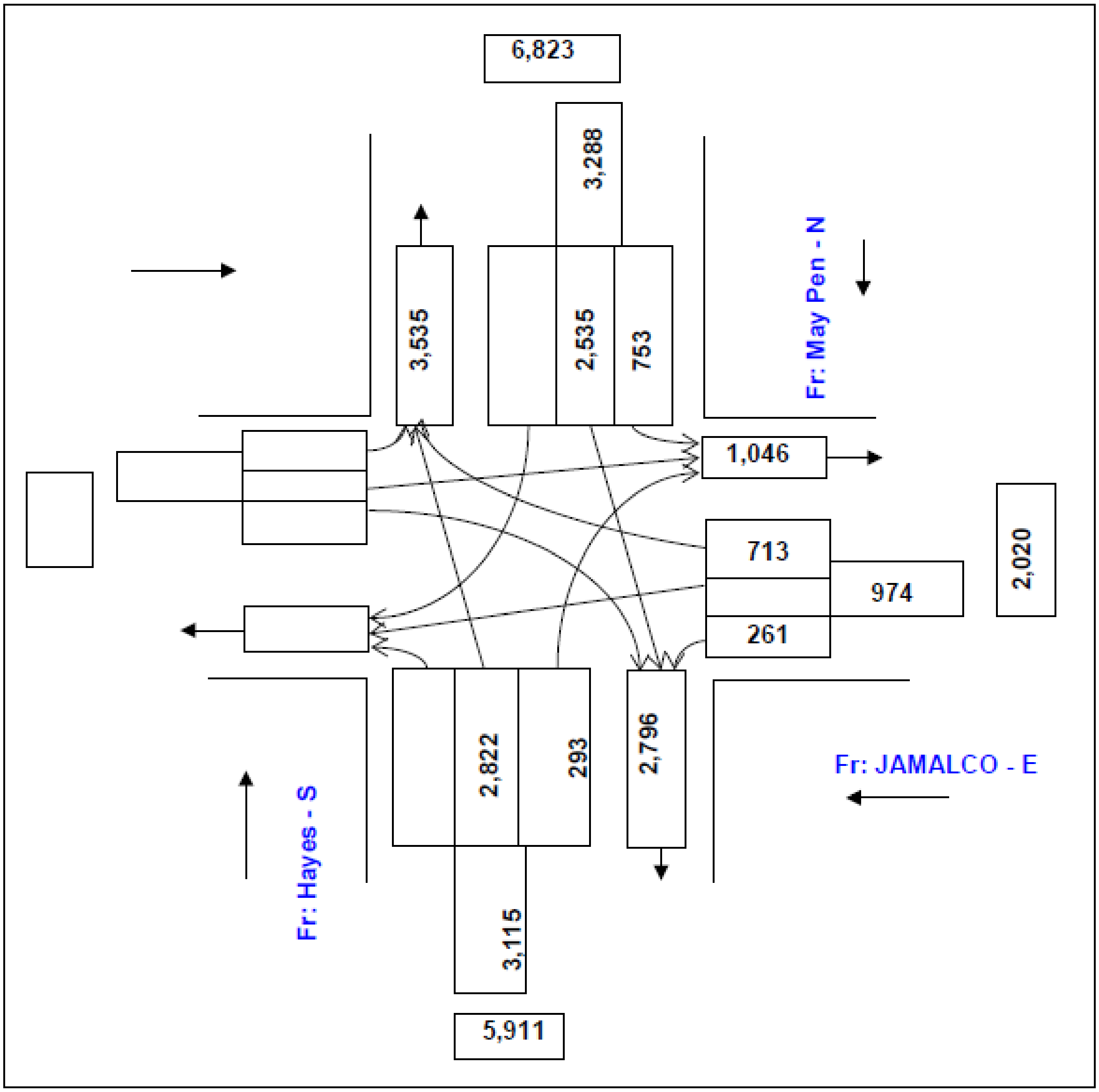


Figure 74: Traffic Volume Field Sheet for Jamalco, Hayes, May Pen Intersection -- 2006

The addition of 25 trucks to the loading increases traffic flow is approximately 0.8%. This is insignificant to the overall flow. The latest data for truck movement in the area are presented below:

TRAFFIC VOLUME FIELD SHEET
Intersection: Halse Hall Rd / Highway 2000
Date: March 10, 2014
Weather:

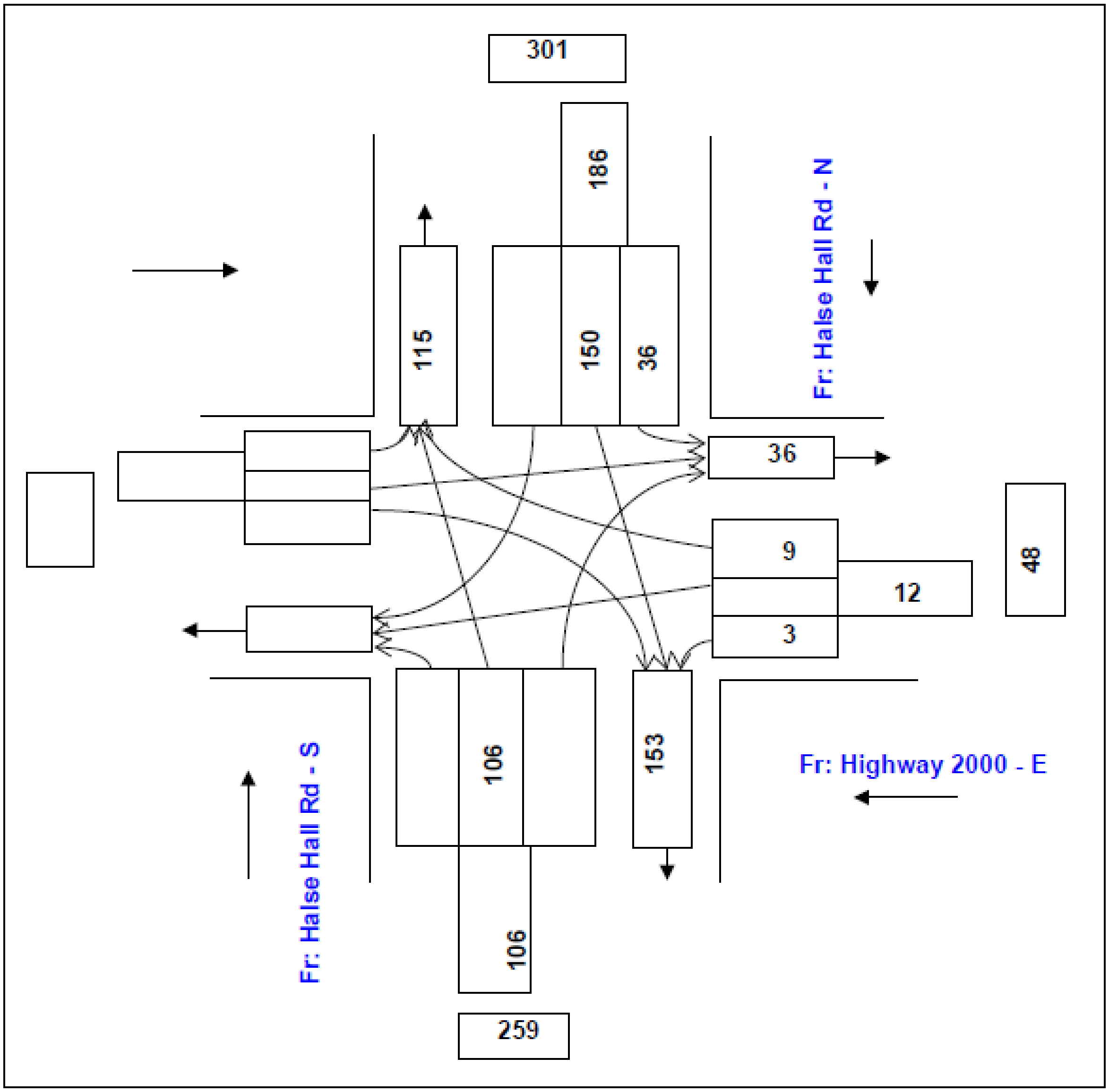


Figure 75: Traffic Volume Field Sheet for Halse Hall Main Road and Highway 2000 Intersection - 2014

TRAFFIC VOLUME FIELD SHEET

Intersection: JAMALCO / Hayes / May Pen

Date: March 17, 2006

Weather:

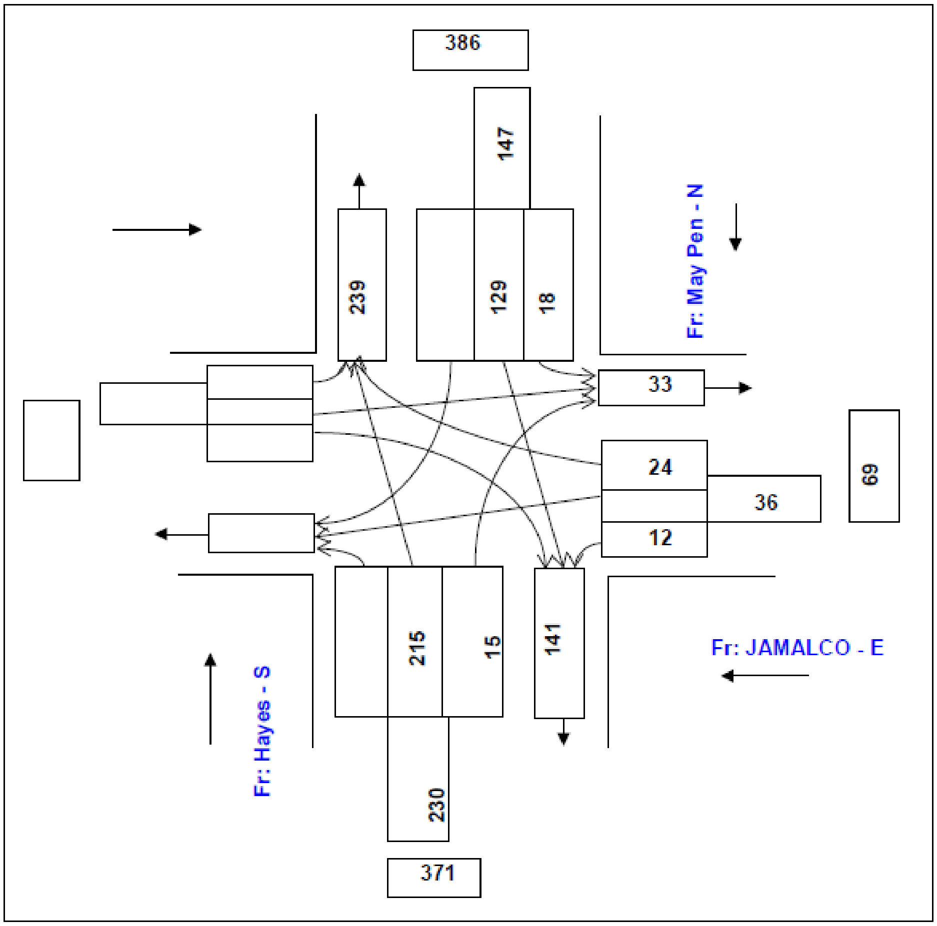


Figure 76: Traffic Volume Field Sheet for Jamalco, Hayes, May Pen Intersection - 2006

The construction traffic impacts will be limited to the infrequent movement of heavy equipment in the communities as pipelaying proceeds along the rail lines. The use of railway transportation should minimize the need for transportation along the main road.

The overall impact on vehicular traffic during operations of the plant will be an increase in the number of vehicles due to:

1. New workers driving vehicles
2. Delivery of office supplies
3. Office vehicles – inspections, repairs, and maintenance

We anticipate that 20 workers will be onsite which could increase light duty vehicle by about 10 cars and the company is anticipated to have a fleet of 5 pickups and two heavy duty vehicles. This increase is insignificant to the overall trips per day for the area and the level of service for the roadway will not be adversely impacted.

Jamalco has no current unresolved issues.

Increasing the number of signs along the main road leading up to the location of the truck crossing and placing a flagman to control the movement of vehicles would reduce the probability of accidents and incidents.

The Traffic Management Plan will take into account trucking activities by Jamalco, which occurs from time to time. Traffic management provisions will be considered for all sources of traffic.

5.3.2. Seismic Activity & Earthquakes

Figure 77 and Figure 78 show regional and local epicenters for earthquakes over the period 1998-2001. Local earthquake activity for the study area during this time was low. However, large earthquakes can seriously affect an area even though the epicenters are at a distance.

An investigation of the historical records carried out for an earlier EIA for the JAMALCO Hayes plant and RSAs (Conrad Douglas and Assoc. Ltd) of seismic activity in this area has shown that the adverse effects of earthquakes have been experienced there:

The well-documented 1692 Port Royal earthquake had disastrous effects in the Lower Vere Plains, with modified Mercalli intensities of MM(X) being experienced in Alley and Salt River, both of which lie at about a 10 km radius from the study area.

The following quote from a newspaper clipping written by the local Rector illustrates: *"all brick and stone building were thrown down and water spewed out of the chasms opened in the ground by the earthquake so that even dry gullies ran water". The St. Peter's Anglican Church in Alley built in 1671 was destroyed beyond repair. However, the Halse Hall Great*

House, where alluvial thicknesses are comparatively low, survived the 1692 earthquake, as well as subsequent ones."

For these reasons the risk from earthquakes needs to be derived from activity over the region, rather than locally. Figure 79 to Figure 80 indicates the likely maximum effects of an earthquake (horizontal accelerations and ground motion) with a 10% probability of exceedence in any one 50-year period.

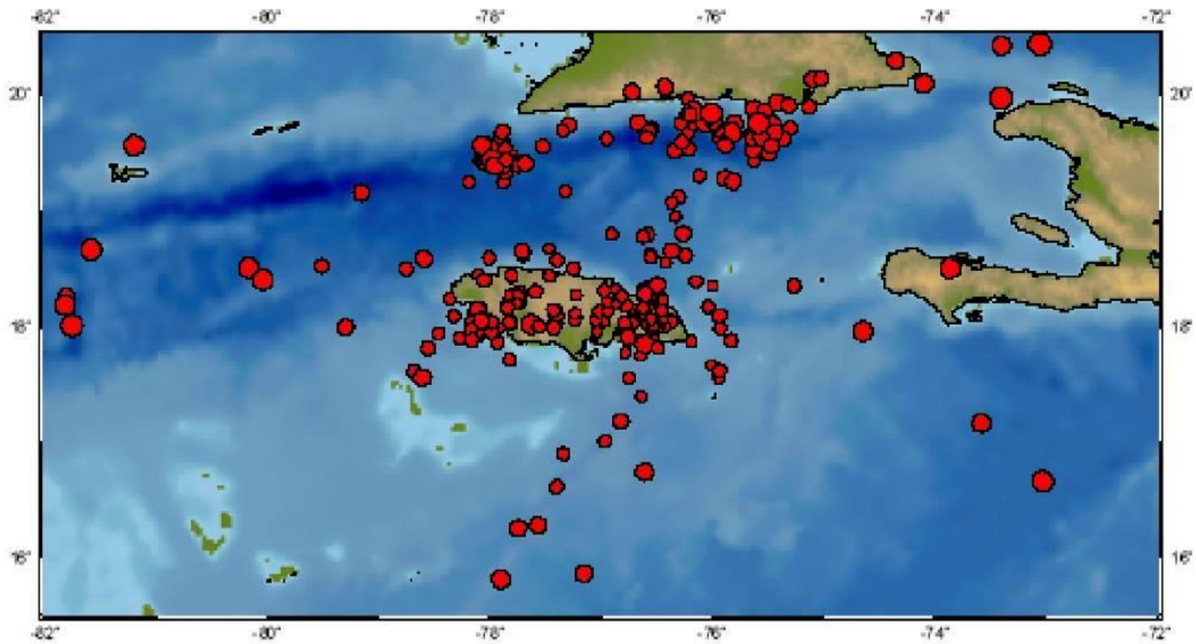


Figure 77: Figure 12 Epicentres of earthquakes occurring between 1998 and 2001 in the vicinity of Jamaica (Source: The Earthquake Unit, UWI*)*.

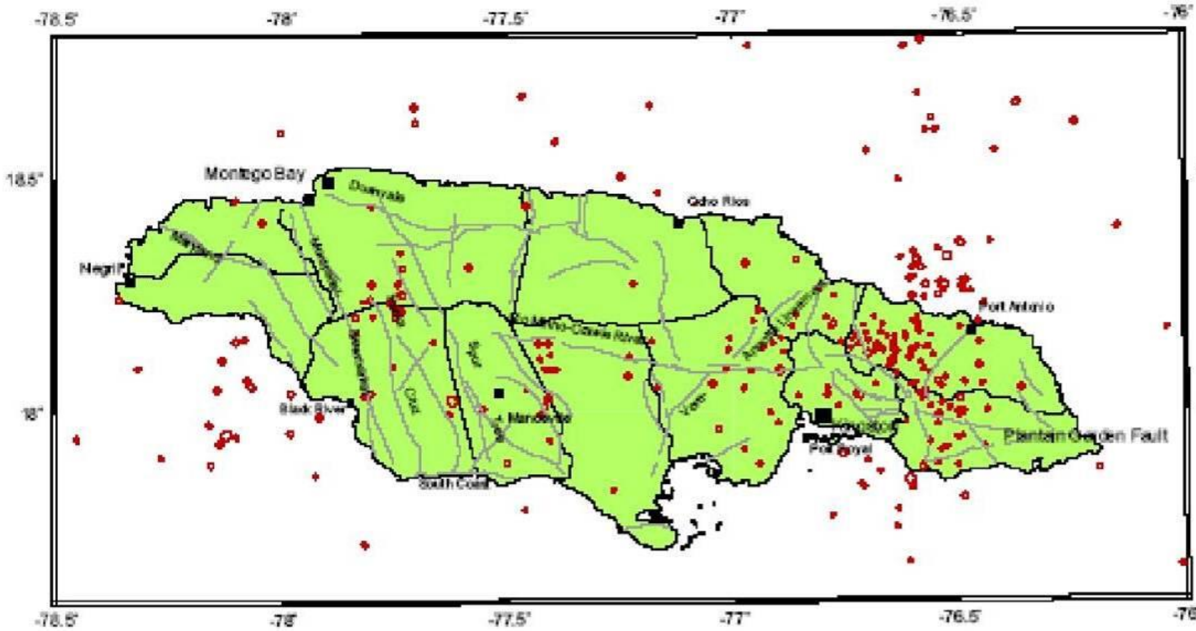


Figure 78: Epicenters of earthquakes occurring between 1998 and 2001 located in and around Jamaica. ***(Source: The Earthquake Unit, UWI)*****.**

Table 15: Earthquakes known to have occurred in the parish of Clarendon between 2003 and 2007

Year	Month	Day	Time (EST)	Mag., Mt	degrees N	degrees W	depth, km	Sub-area	Sub-area name	Epicentre location	Intensity, EMS
2005	January	11	5:27a.m.	3.2	17.89	-76.88	10	21	Kingston Offshore	Offshore Helshire Hills, St. Catherine	Reports from St. Andrew (Red Hills III) and St. Catherine (Cumberland II, Greater Portmore)
2005	March	18	2:06a.m.	3.6	17.82	-77.29	10	25	South Coast fault Zone	South-Central Clarendon	Reportedly felt in May Pen III, Clarendon
2005	June	13	10:58p.m.	5.1	18.22	-77.42	5	9	Dry Harbour Mountains	Near Aenon Town, Clarendon	Reportedly felt in Clarendon (Aenon Town VII, Top Alston VII), Manchester (Silent Hill VII), Trelawny (Wait-a-bit VII, Lemon Walk VII)
2005	June	13	6:21a.m.	3.3	18.25	-77.43	10	9	Dry Harbour Mountains	Near Aenon Town, Clarendon	Reportedly felt by two individuals in Aenon Town III, Clarendon
2004	May	2	4:55a.m.	3	18.03	76.95	10	15	Rio Minho-Crawle River Fault zone	Approx. 5km north of Spanish Town, St. Catherine	Few residents of havendale III, Meaddowbrook III and Forest Hills III, Bull Bay III, St. Andrew
2004	August	10	12:19p.m.	4	18.17	77.22	10	15	Rio Minho-Crawle River Fault zone	Near Kellits, Clarendon	Reports from central and eastern parishes

Source: Earthquake Unit – UWI Mona www.mona.uwi.edu/earthquake/

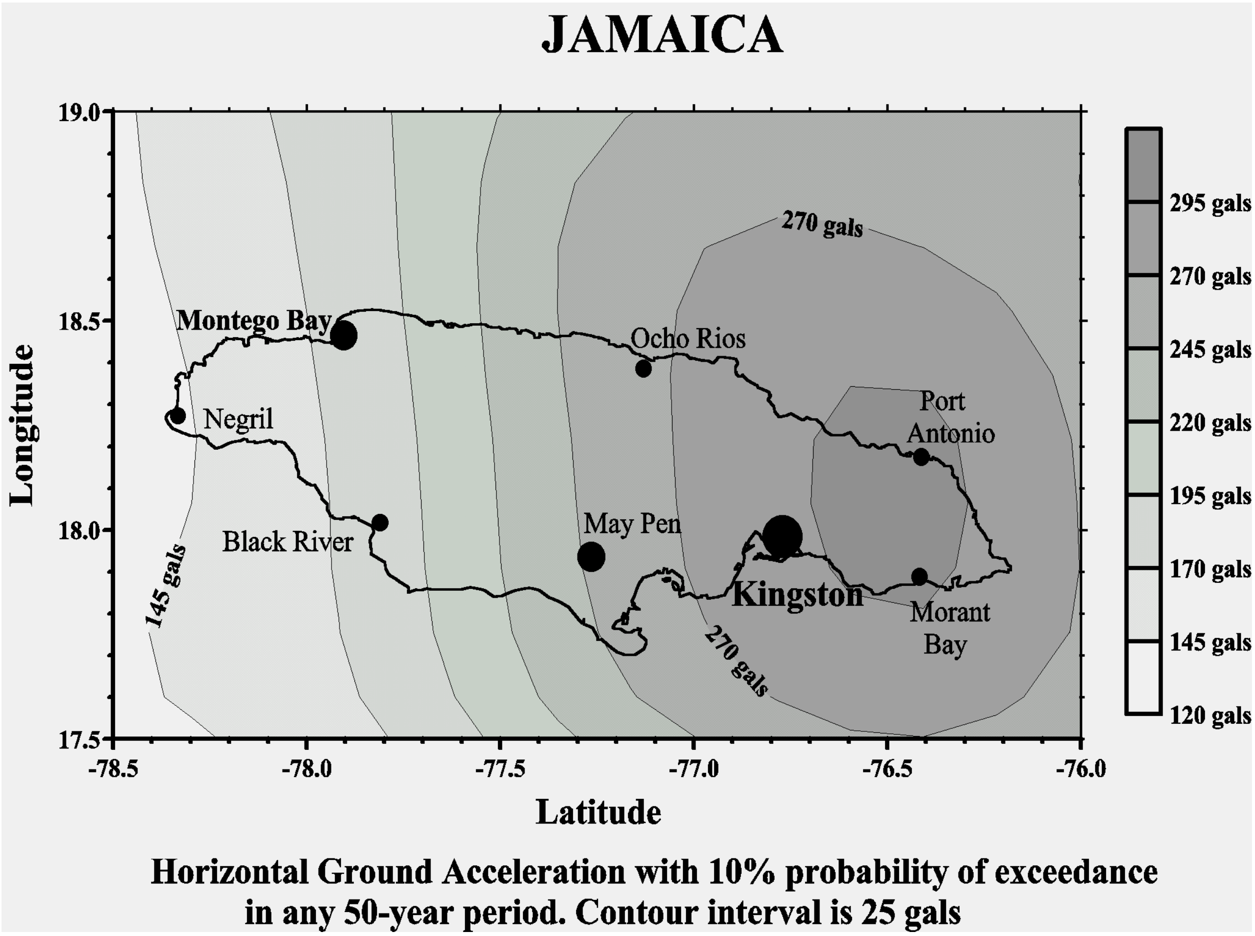


Figure 79: Horizontal ground acceleration with 10% probability of exceedance in any 50-year period. Contour interval is 25 gals.

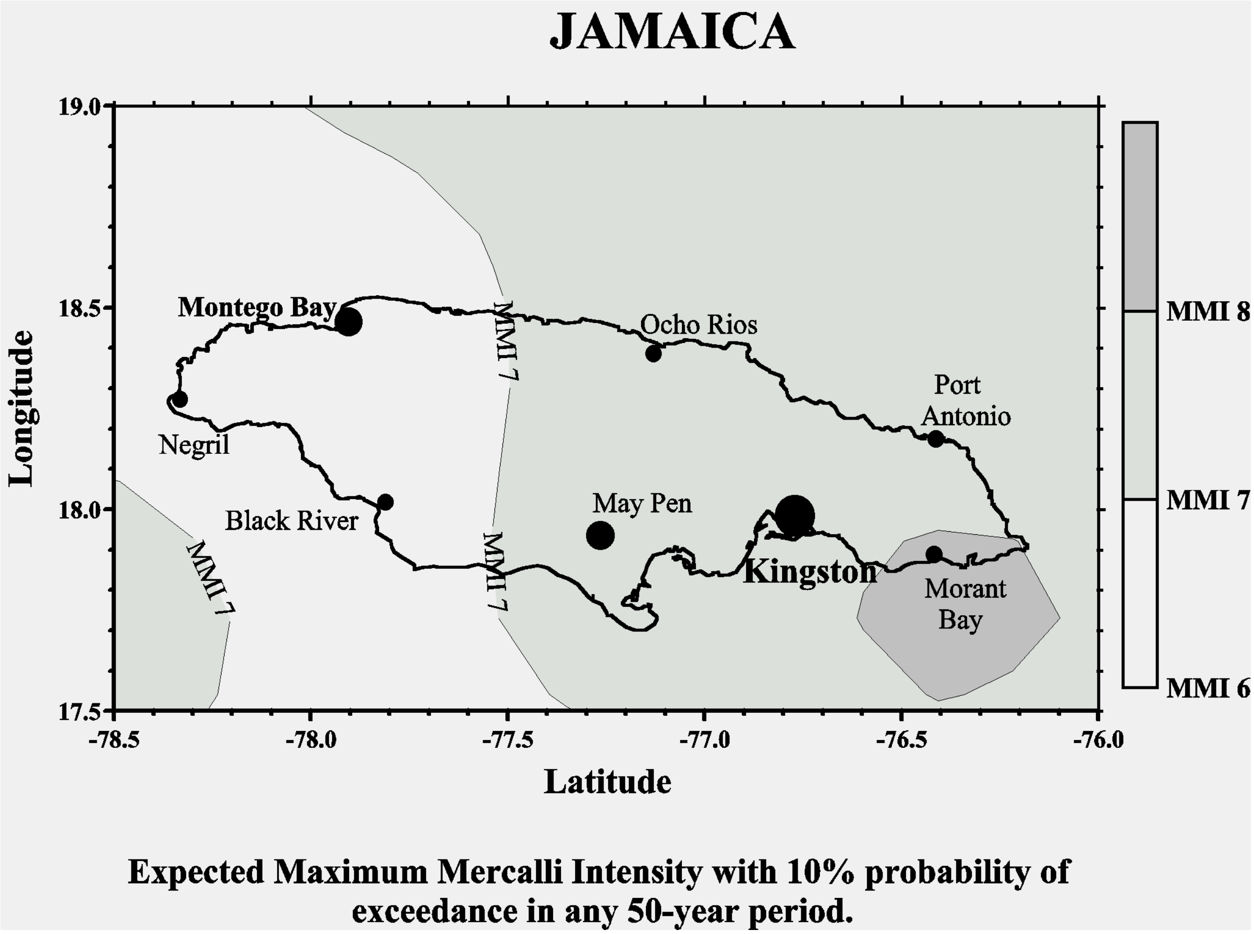


Figure 80: Expected maximum Mercalli Intensity with 10% probability of exceedance in any 50-year period.

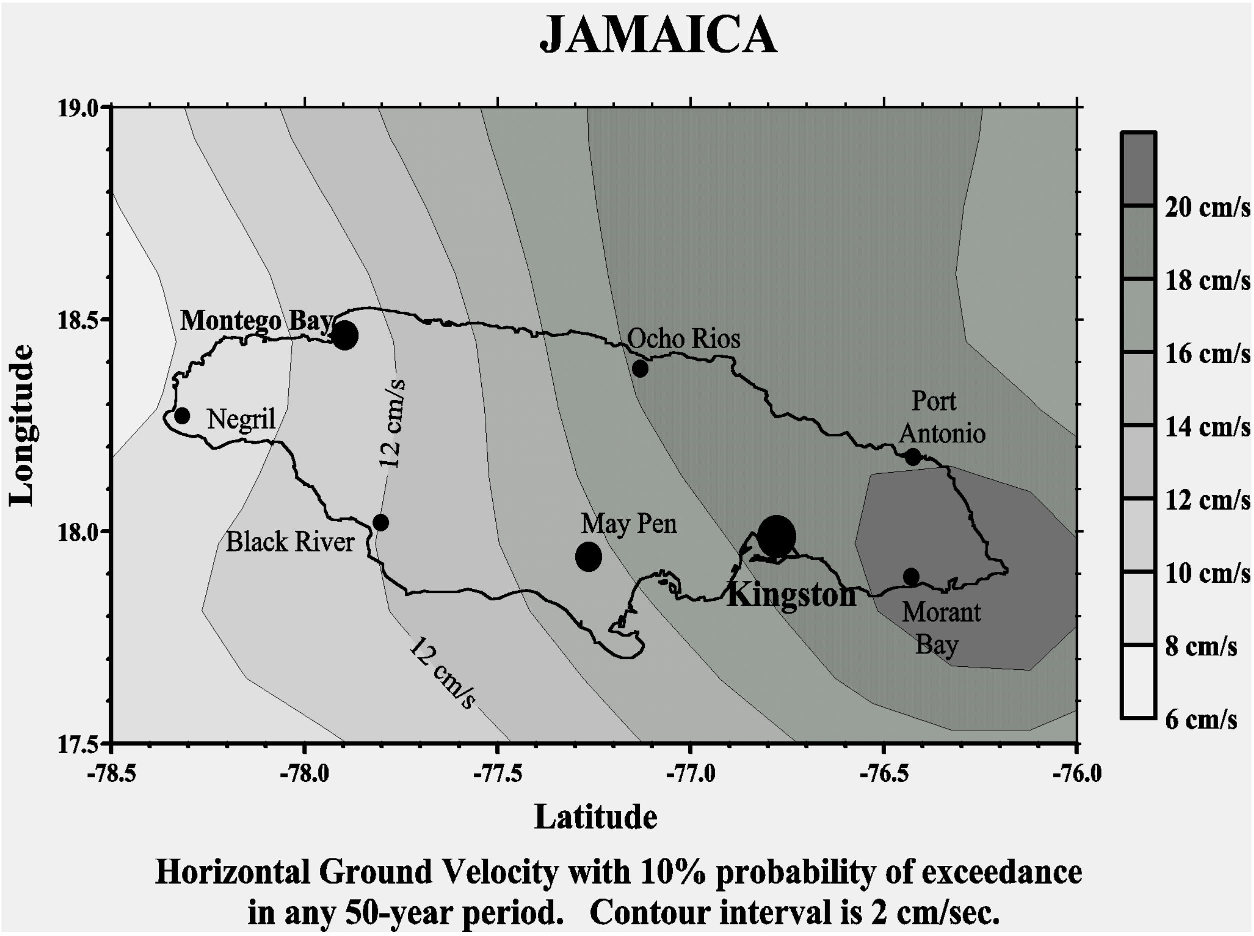


Figure 81: Horizontal ground velocity with 10% probability of exceedance in any 50-year period. Contour interval is 2 cm/sec.

In the vicinity of the CHP, this indicates horizontal ground accelerations of between 245 and 270 gals, and velocities of between 14 and 16 m/s occurring with a 10% probability of exceedance in any 50-year period. These motions would probably be associated with an earthquake of Mercalli Intensity between 7 and 8.

5.3.3. Landslide

There appears to be no historical records of landslides in the district. While no detailed assessment of the landslide susceptibility has been carried out in southern Clarendon to date, the landslide susceptibility map of southern Clarendon (Figure 63) indicates low susceptibility levels at Hayes. This can be attributed to the flat lying nature of the topography, the presence of fairly easily drained alluvial soils, and the relatively dry climate.

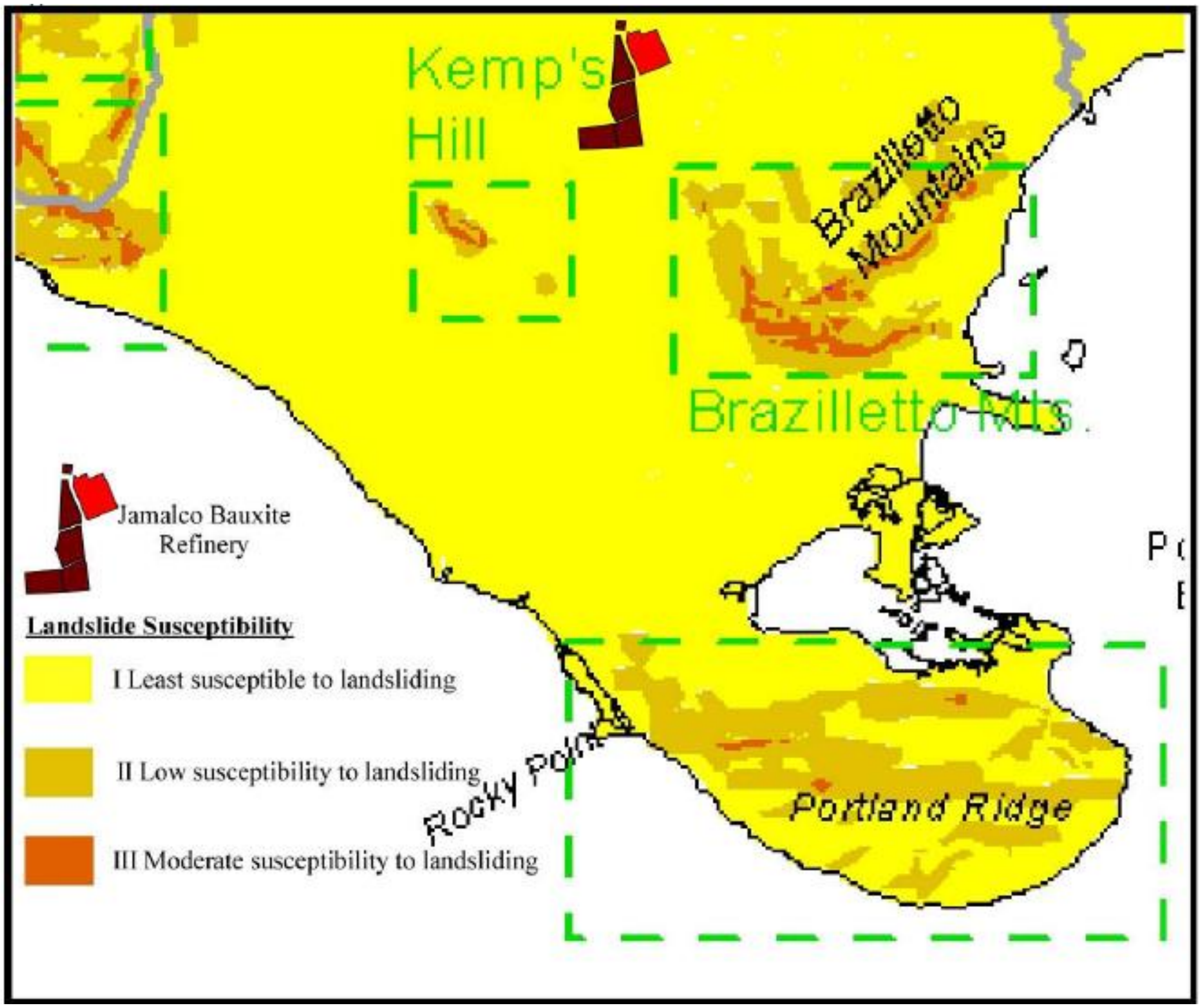


Figure 82: Landslide susceptible map of Clarendon

The historical landslides in the project area is shown in Figure 83 below. The last recorded landslide event in Corn Piece was on October 25, 1998.

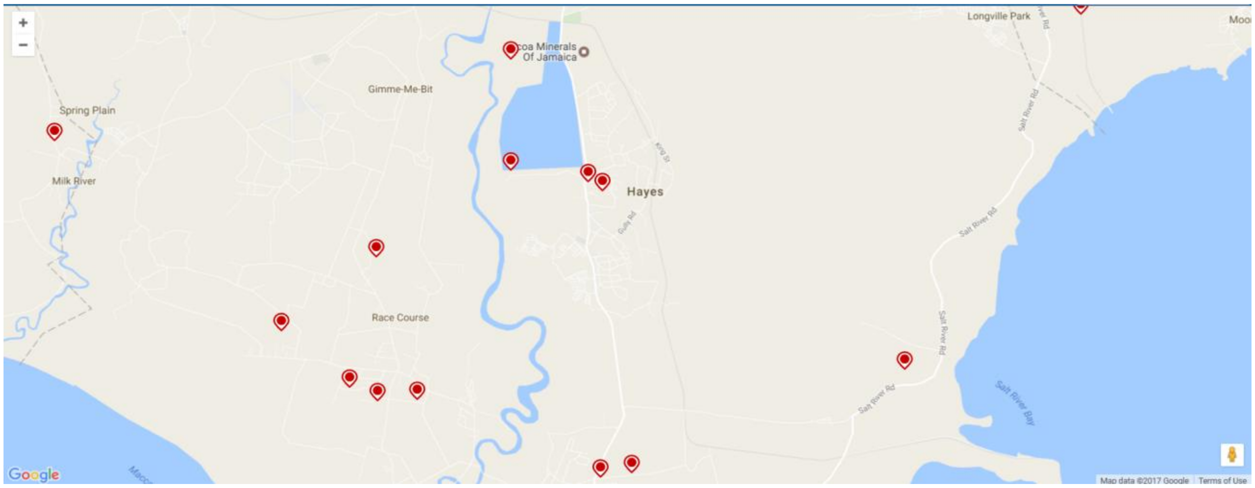


Figure 83: Historical landslides in the Project Area

5.3.4. Hurricanes, Storm Surge & Tsunami

Hurricanes are a serious seasonal threat and these normally occur from June to November annually. Since 1886, 21 hurricanes have made landfall in Jamaica, while over 100 have passed within 240 km (150 miles) of the island. Tsunamis are also a major risk.

Using Norman Manley International Airport in Kingston as a reference point location: 17.93N, 76.78W, all recorded tropical storm and hurricane activity over a period of 100 years are considered to estimate any trends related to the hurricane activity and the return period of such activities to the island[10]. This can be done confidently as Jamaica is a small island and is likely to be affected wholly regardless of the point of approach of a tropical depression or storm system.

So far this year, no hurricanes have affected the island. However, the island was last affected in 2012 by Category 1 Hurricane Sandy passing directly over the eastern parts of the island and in 2008 by Tropical Storm Gustav passing the southern parts of the island. The last major hurricane was hurricane Dean, a category 4; although it has been forecasted that the island would have experienced either category 2 or 3 conditions owing to the

[10] StormCarib – Caribbean Hurricane Network http://stormcarib.com/climatology/

offshore route. Prior to this, the last major hurricane was in 1988; hurricane Gilbert, a category 3.

Analyses of tropical systems passing within 60nm (= 60mi.) of the island is shown below. Figure 84 below shows the storm track for tropical systems passing by for the period 2000-2009.

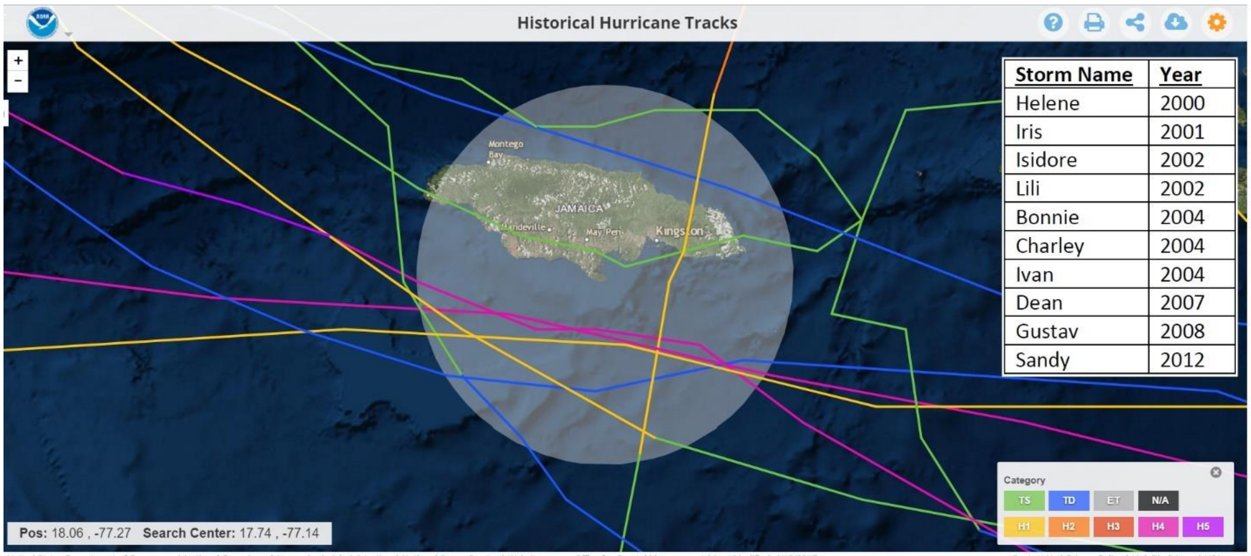


Figure 84: Hurricane Storm track for the Period 2000-2017[11]

5.3.5. Riverine & Flash Flooding

Specific records of flooding in the Rio Minho floodplain date back to 1886, reported in the Tri-Weekly Gleaner, June 19, 1886 (Rowe, 2004, in preparation), when heavy rains in June of that year led to what was believed to be the worst flooding on record for that river. The river was 40 ft (12.2 m) deep at the May Pen bridge, some 4 ft higher than the previous record, and did immense damage to roads and property. Affected localities included Halse Hall and Parnassus and Caswell Hill.

The worst flood event of the 20th century occurred in 1986, when rainfall within the Rio Minho catchment caused the river to overflow its banks to cover wide areas of the Rio Minho Alluvial Fan. The approximate extent of this flood event is inserted on Figure 6.

[11] https://coast.noaa.gov/hurricanes/?redirect=301ocm

According to the Water Resources Authority, this event had an estimated return period of 100 years.

The most notable feature of the flood water extent is that north of Kemps Hill the flooding was confined to a relatively narrow floodplain, whereas south of Kemps Hill the flood waters spread out over a wide area. This is a reflection of the fact that the river is incised into the upper part of the fan, while in the southern, Vere Plains part, it is not. It is suggested that this may be a function of continuing movements along the South Coast Fault.

Storm surges from hurricanes Ivan (September 2004) and Dean (August 2007) were recorded along most of the edge of Portland Bight, including the stretch of coast from Port Esquivel to Rocky Point Port and Portland Cottage.

With respect to the plant and RSA area (Figure 62), the risk from flooding is low, due to the fact that these are constructed on the high terrace of the well-drained, relatively thin Hayes Gravels. During the June 1986 flood event the only part of the plant that was flooded was the low-lying storm lake at the northern end of the RSAs.

Figure 85 below shows the historical floods in the project area. Four (4) major flooding events were recorded at Corn Piece. The latest recorded flooding event occurred on October 31, 1985, while the earliest recorded event occurred on September 11, 1979.

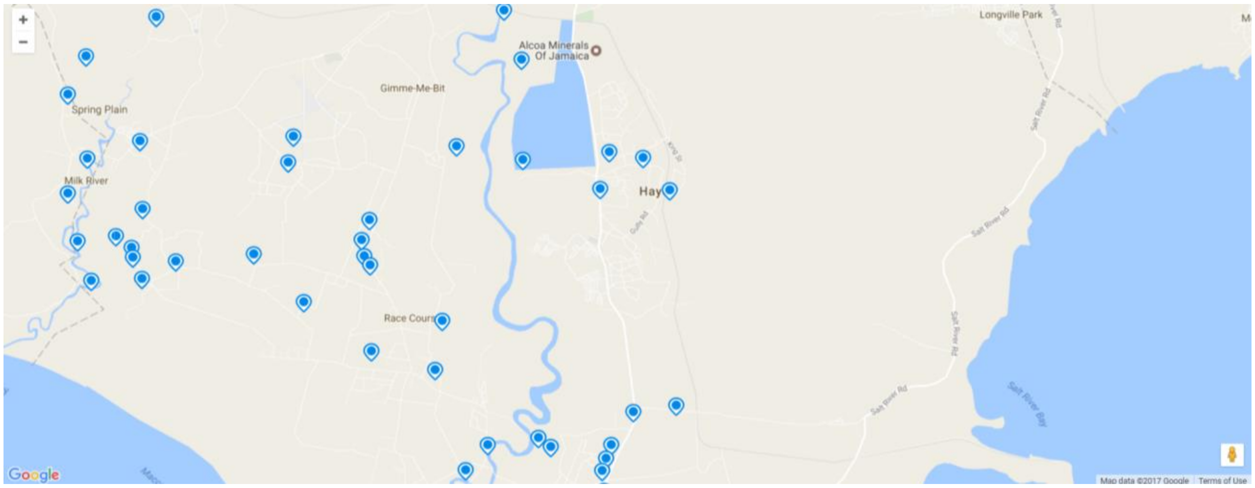


Figure 85: Map showing Historical Floods in the Project Area. Source: *Mona Geoinformatics*

5.3.6. Climate Change Analysis of CHP Project.

The climate of Jamaica is predicted to depart from its present norm by as early as 2023. The city of Kingston is one of the first cities anticipated to reach this milestone[12] [13] A city hits "*climate departure*" when the average temperature of its coolest year from then on is projected to be warmer than the average temperature of its hottest year between 1960 and 2005. These departures are predicted to be seen earliest in the tropics. These regions, unfortunately, coincide with the most societies most vulnerable to the impacts of these departures. The anticipated/predicted changes in climate must therefore be taken into consideration for the development of projects that is expected to be operational and functional when these changes occur. This should assist in managing the vulnerabilities associated with developments in a developing nation as well as the added pressures of the impact of the changing climate.

The Second National Communication of Jamaica To The United Nations Framework Convention On Climate Change[14] predicts that Jamaica's outlines a general increase in CO_2 emissions from Jamaica over the reporting period and the increasing trend was expected to continue into the future. The energy sector is the main contributor of this Greenhouse gas. The predictions of concern are:

1. Increased in the number of heavy rainfall days
2. Increase in the number of consecutive dry days
3. Increase in atmospheric temperature by 1.5 degrees by 2050
4. Rise in sea-levels - 0.21-0.48 by 2100
5. Increase evapotranspiration rates

12 Climate Departures and Accelerated Warming the Challenges to Poverty Alleviation and Reduction Efforts in 2035

13 Mora C, Frazier AG, Tong EJ, Longman RJ, Kaiser LR, Dacks RS, Walton MM, Fernandez-Silva I, Stender YO, Anderson JM, Sanchez JJ, Ambrosino CM, Giuseffi LM, Giambelluca TW (2013) The projected timing of climate departure from recent variability. Nature 502, 183-187.

14 The Second National Communication Of Jamaica To The United Nations Framework Convention On Climate Change, Government of Jamaica, 2011

The CHP is proposed to be operational for, at a minimum, the next 25 years therefore its planning, construction and operation must be climate proofed. The project will be analysed in terms of it various components along with the objectives and anticipated outcomes. The impacts of climate (the prediction outlined above) on the achievement of these objectives and outcomes will be analysed and the strategies to limit the impact of climate on the project put forward. These strategies will guide the project development and implementation.

The objectives of project can be broken out into four main categories. These are outlined below:

1. **Infrastructural**:
    a. Install and operate a 200 MW power station for the next 25 years
    b. Install a pipeline to supply Natural Gas to the facility from a Floating Storage and Regasification Terminal
    c. Install a transmission network deliver electrical power to the national grid
2. **Operational**:
    a. Supply NG to the power station for its operational lifetime
    b. Generate electrical power and steam at the Combined Heat and Power Facility
    c. Supply electricity generated from the power plant to the national grid for the operating life of the power plant
    d. Supply steam from the power station to Jamalco for the operating life of the plant impressive
3. **Economic:**
    a. Reduce cost of electricity supplied to the national grid
    b. Reduce cost of steam generation for Jamalco
4. **Social:**
    a. Provide employment for community members
        i. Temporary
        ii. Permanent

b. Improve local human resources for management and operation of gas fired power station

5.3.6.1. Indicators of Success

1. All infrastructural aspects of the project installed and commissioned within planned timeline.
    a. Construction and commissioning is proposed to last for 19 months
2. Products supplied to recipients/customers on an efficient and timely basis as needed.
    a. 94% availability of power station
    b. Baseload supply to JPSCo meeting PPA standards. OUR standards met 100% of the time.
    c. Steam supplied to meet at least 90% of Jamalco's demand at least 95% of the time
    d. Un-interrupted supply of NG – on average 35,000 m^3 per hour
        i. Industry standards met for delivery of product
3. Price of electricity supplied to grid lower that JPSCo generating cost
4. Jamalco's operating cost decreases
5. 425 persons employed for construction phase
6. 20 persons employed permanently
7. Project replicated in a number of locations across the island.

Climate and climate change can impact all the objectives and success indicators as outlined below:

Infrastructural:

1. Active hurricane seasons can:
    a. delay construction
    b. Damage infrastructure during construction
    c. Impact transportation of parts and equipment

2. Temperature increase can:
    a. Compromise health and safety of workers during construction period
    b. Reduce working time for days
    c. Increase need for rehydration
3. Droughts can:
    a. Dry out earth material changing its characteristics making excavation and embankments unstable
    b. Reduce water availability for workers and project activities
    c. Increase dust generation during construction
4. Extreme rainfall events can:
    a. Flood work site causing work stoppages
    b. Restrict workers mobility resulting in work stoppage
    c. Lead to site contamination
5. Sea Level rise can:
    a. Contaminate well contamination due to saline intrusion. This results in reduce water availability for workers and site activities
    b. Current uncertainty resulting in sediment plume affecting sensitive ecosystems

Operational:

1. Ground level oxygen concentration change can:
    a. Reduce efficiency of combustion
    b. Increased CO production
2. Active hurricane season can:
    a. Disrupt supply of NG from FSRT
    b. Damage power station infrastructure
        i. Stacks – pollutant dispersion compromised
    c. Damage to distribution network
    d. Reduced electricity demand from national grid
    e. Reduction in steam demand

f. Compromise the transportation of fuel

3. Temperature increase can cause:
    a. Change in ambient temperature affecting intake air temperature
    b. Staff exhaustion
    c. Increased demand for cooling (nationally increase electricity use)
4. Droughts can cause:
    a. Shortage of water for operation of facilities
    b. Reduction in farming resulting in increased unemployment and possibility of theft of equipment and fuel
5. Extreme rainfall events can cause:
    a. Site flooding
    b. Worker marooning
    c. Site contamination
6. Sea Level Rise can cause:
    a. Well contamination – water unavailable for operations
    b. Onshore pipeline to be flooded
    c. Increase in the need for channel maintenance

Economic

1. Active hurricane seasons can:
    a. Disrupt LNG supply that could impact pricing
    b. World price for LNG fluctuation as sources are impacted
2. Temperature increase can:
    a. Increased cost for health and safety of workers during operation period
    b. Reduce working time increasing operational cost
    c. Increase need for rehydration increasing cost of operations
    d. Increase demand for cooling therefore improving economics of the plant
3. Droughts can
    a. Dry out earth material changing its characteristics making excavation and embankments unstable

   b. Reduce water availability for workers and project activities
   c. Increased dust generation during normal operations
   d. Additional wetting for dust suppression increasing cost for operations
4. Extreme rainfall events
   a. Work site flooding – work stoppages reduced productivity
   b. Workers mobility restricted – work stoppage
   c. Site contamination clean-up cost will be elevated
5. Sea Level rise
   a. Increase cost for water demineralization.
   b. Increase maintenance costs for pipeline maintenance.

Social

1. Active hurricane seasons (high intensity hurricanes) can:
   a. Damage homes and roads – reduced access to work. Workers are absent from work
2. Temperature increase
   a. Increased cost for Health and safety of workers during operation period
   b. Reduce working time for days
   c. Increase need for rehydration
3. Droughts can:
   a. Reduce ability to address hygiene issues
   b. Reduce access to work
   c. Increase spread of communicable disease
4. Extreme rainfall events
   a. Work site flooding – work stoppages
   b. Workers mobility restricted – work stoppage
   c. Site contamination
5. Sea Level rise
   a. Well contamination – saline intrusion – reduce water availability for workers and site activities

5.3.6.2. Adaptation Strategies

Infrastructural

1. Active hurricane seasons:
    a. Designing infrastructure with consideration for increased intensity hurricanes
        i. Improved factors of safety
    b. Disaster preparedness plan prepared and practised
2. Temperature increase:
    a. Shaded Resting areas for workers, misting equipment, cool drinking water available for all work crews. Shower facilities
    b. Shaded working areas as much as possible
    c. Sick bay available and accessible.
    d. Foremen trained to detect heat exhaustion symptoms. Instituting structured rest time for labourers
3. Droughts:
    a. Design fill material for pipelaying and foundations to be robust in dry and wet conditions
    b. Plan for backup water supplies.
    c. Rehabilitate excavated areas as soon as possible
    d. Additional wetting for dust suppression
4. Extreme rainfall events:
    a. Updated rainfall intensity curves used for designs
    b. Drain capacity and protection designed to convey 100-year flood.
    c. All Floor level about 100-year flood level
    d. Drainage system maintenance plan developed and executed
5. Sea Level rise:
    a. Design infrastructure floor level to be above the predicted 2100 sea level
    b. Monitor currents in the vicinity of the facilities.

c. Plan dredging and pipelaying activities for execution in the shortest possible time with the least disrupting equipment

Operational

1. Active hurricane seasons:
    a. Designing infrastructure with consideration for increased intensity hurricanes
        i. Improved factors of safety for stacks, enclosures
    b. Disaster preparedness plan prepared and practised
        i.
2. Temperature increase:
    a. Proper access roads maintained for reduced walking to inspect pipe
    b. Shaded working areas as much as possible
    c. Sick bay available and accessible.
    d. Supervisors trained to detect heat exhaustion symptoms. Instituting structured rest time for labourers
3. Droughts:
    a. Develop and document and implement water management plans.
    b. Design fill to be robust in dry and wet conditions
    c. Plan for backup water supplies.
    d. Rehabilitate excavated areas as soon as possible
4. Extreme rainfall events:
    a. Updated rainfall intensity curves used for designs
    b. Drain capacity and protection designed to convey 100-year flood.
    c. All Floor level about 100-year flood level
    d. Drainage system maintenance plan developed and executed
5. Sea Level rise:
    a. Design infrastructure floor level to be above the predicted 2100 sea level

    Monitor currents in the vicinity of the facilities

Socio-Economic

1. Active hurricane seasons:
    a. Disaster preparedness plan prepared and practised
        i. Training of staff and community
        ii. Public Education
2. Temperature increase:
    a. Training and education
3. Droughts:
    a. Provide access to water for workers
    b. Incorporate workers in water management planning.
4. Extreme rainfall events:
    a. Training and education.
    b. Implementation of disaster response plans

This project fits in line with the mitigation strategic outlined in the SNCC –"Establishment of a system to identify and replace old inefficient electricity equipment and (especially) generating units/plants with more fuel efficient and cost efficient technologies and plants;" and "*Natural gas technology for electricity production, especially for the bauxite alumina industries*".

The project will result in a decrease in carbon dioxide emissions with the replacement of the use of heavy fuel oil (HFO) by Jamalco.

The systems implemented to enhance efficiency of the use of methane (transport to and combustion in the turbines) will ensure that methane (a greenhouse gas) is not released into the atmosphere. The double use of the products of the combustion of the methane (the hot gases) will result in reduced demand for fossil fuels and subsequently a reduction in CO_2 emissions.

5.4. Biological Environment

5.4.1. Terrestrial Assessment

The overall objective of this study is to provide information on the floral and avifaunal biodiversity and abundance within the proposed development site which is defined by a 30m buffer on either side of the railway line. Emphasis was placed on the following specific objectives:

- To provide an inventory of the floral and avifaunal species within the study area, that is, species diversity and abundance.
- To capture represented habitats, ecologically important areas and forest types within the footprint of the development.
- To detect the disturbances within study area.
- To make recommendations where necessary, on the mitigation measures for potential environmental impacts.

The limit of the assessment extends 30m north and south of the railway line, an area that includes for the purpose of the ecological impact, the community of Hayes. The environment within the zone of influence is described in terms of ecological attributes. This includes an evaluation of coastal and terrestrial ecology and land use types.

5.4.1.1. Methodology

5.4.1.1.1. Preliminary Assessments

Preliminary assessments were conducted prior to undertaking the field assessment. This entailed:

- Analysis of aerial photographs, satellite imagery and 1:50,000 metric maps, as well as land use habitat types.
- Satellite images, retrieved from Google Earth.
- On April 8th 2017, a reconnaissance survey was conducted to confirm satellite imageries of the proposed study area and also to observe the topography. This was important as it aided in the determination of the most appropriate methodology to

be utilized for assessments. GPS points were taken at each location within the study area where the land use and ecological features changed.

5.4.1.1.2. Habitat Assessment

On the 16 April 2017 field assessments were conducted. It should be noted that environmental parameters such as relative humidity, light and temperature were not captured during this survey. The following steps were used in the field:

5.4.1.1.3. Floral Assessment

- A 100m transect line was established parallel to the railway line and 30m north and south of the railway were assessed for floral and avifaunal species. Only one transect was established due to the homogeneity of the area and the remaining study area was surveyed using a windscreen survey approach. No plots were established during the assessment. Images of the study area were taken along with GPS coordinates.
- An inventory of all the species established within the 30m study area was developed. The percentage cover for each species was determined using the DAFOR Abundance Scale (Table 16 below).
- The study area was also qualitatively assessed for disturbances *inter alia* trails, invasive alien species (IAS). Logging and land clearance.

5.4.1.1.4. Avifaunal Assessment

- Selected sites along the entire length of the railway were assessed for avian species (See Figure 86).
- Within the 30m north and south of the railway line, avian species seen or heard were recorded and an approximate time of 10 minutes was spent at each site.

Figure 86: Bird Survey Points along the proposed development site.

The DAFOR scale was applied to estimate the relative abundance of each plant and avian species identified.

Table 16: DAFOR Scale

Value	Percentage Cover (%)
D - Dominant	>75%
A - Abundant	51-75
F - Frequent	26-50
O - Occasional	11-25
*R - Rare	1-10

***Individuals occurring seldom or only once, cover ignored and assumed to be insignificant**

5.4.1.2. Results

The JAMALCO railway line (study area) was assessed for avifaunal and floral species diversity, species abundance, IAS and disturbances. The habitat type was observed to change along the entire length of the railway. Four main habitat/cover types were noted from the Port towards the processing plant namely, wetland, shrub land, agricultural lands (sugarcane) and residential area, respectively. The site was dominated by Black mangrove in the wetland area and Brazil Macca in the shrub land areas. The area referenced as agricultural land was sugarcane fields bordered by the Hayes community to the north.

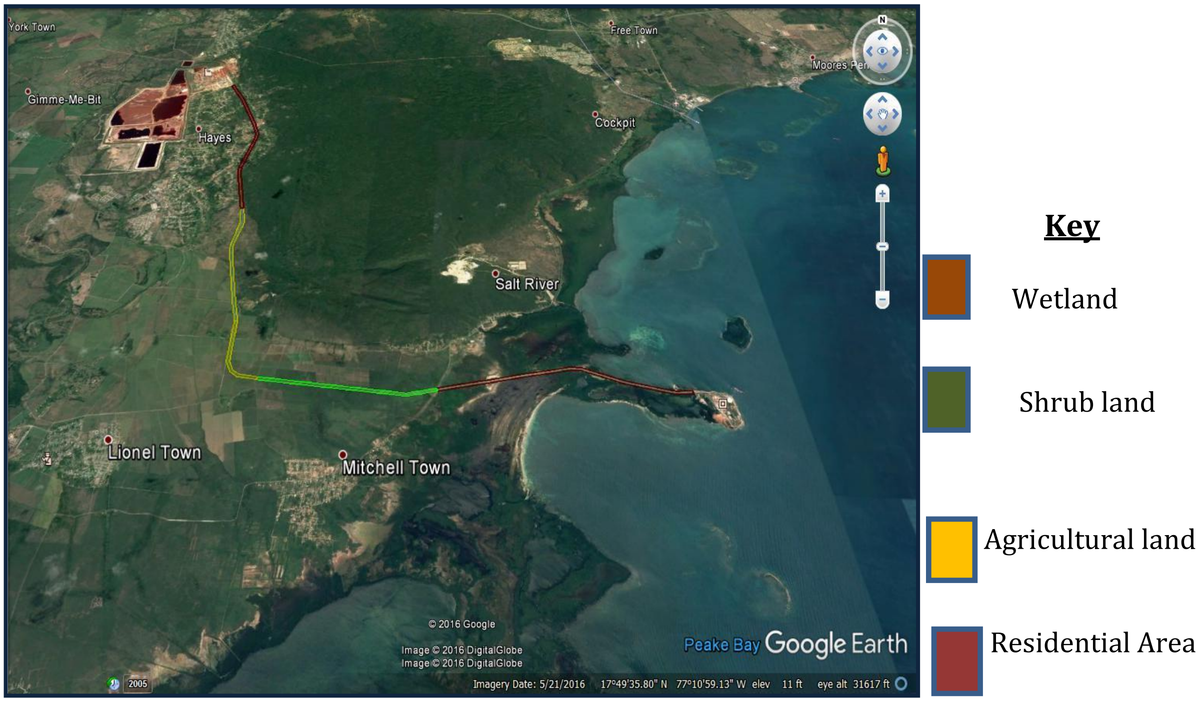


Figure 87: Land use cover types along railway line within proposed development site

There were difficulties accessing some areas of the habitats due to the dense vegetation cover viz., wetlands and shrub land. These areas were observed using binoculars and foot patrol.

Figure 88: Dense vegetation cover along periphery of the shrub land zone

5.4.1.2.1. Flora

Four main habitat/cover types were noted from the Port towards the processing plant namely,

1. wetland,
2. shrub land,
3. agricultural lands (sugarcane) and
4. residential area, respectively.

The site was dominated by Black mangrove in the wetland area and Brazil Macca in the shrub land areas. The area referenced as agricultural land was sugarcane fields bordered by the Hayes community to the north.

A total of 12 plant species were recorded; 6 trees, 2 herbs, 2 shrubs and 2 grass species. One invasive species, the Lead Tree (*Leucaena leucocephala*) was recorded. However, no endemic species were observed. *Avicennia germinans* (Black Mangrove – see Figure 89), *Mimosa* *bimucronata* (Brazil Macca) and *Rhizophora mangle* (Red Mangrove see Figure 89) are listed on the International Union for Conservation of Nature (IUCN) Red List for Threatened Species as '*Least Concern'* whilst the other species were listed as "*Not Assessed*" (

Table 17). Though listed as "*Least Concern*", its importance in the value of the PBPA as a RAMSAR-designated location cannot be ignored.

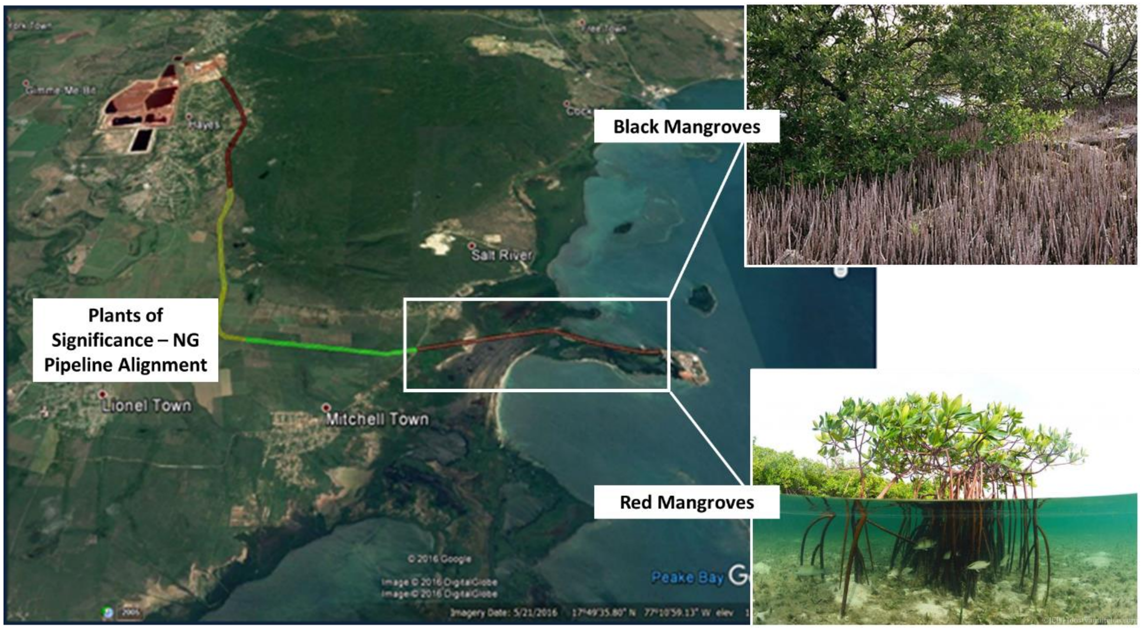


Figure 89: Plant Species of Significance observed at the NG Pipeline Alignment

Table 17: Species list of site assessed (invasive species highlighted in gray)

Family	Scientific Name	Common Name	Habit	DAFOR	IUCN status
Aizoceae	*Sesuvium portulacastrum*	Seaside Purslane	Herb	A	
Avicenniaceae	*Avicennia germinans*	Black Mangrove	Tree	D	Least Concern
Cactaceae	*Cephalocereus swartzii*		Shrub	R	
Caesalpiniaceae	*Haematoxylum compechianum*	Logwood	Tree	O	
Malvaceae	*Thespesia populnea*	Seaside Mahoe	Tree	F	
Mimosaceae	*Mimosa bimucronata*	Brazil Macca	Shrub	D	Least Concern
	Leucaena leucocephala	Lead tree	Tree	A	
Moraceae	*Crecropia peltata*	Trumpet tree	Tree	F	
Poaceae	*Panicum maximum*	Guinea grass	Grass	O	
	Sporobulus virginicus		Grass	A	
Rhizophoraceae	*Rhizophora mangle*	Red mangrove	Tree	A	Least Concern
Verbenaceae	*Stachytarpheta jamaicensis*	Vervine	Herb	O	

5.4.1.2.2. Avifauna

A total of 17 bird species were observed during the survey (Table 3). *Stetophaga ruticilla* (American Redstart) was the dominant species within the study area while *Egretta caeulea* (Little Blue Heron), *Vireo altiloquus* (Black-whiskered Vireo), *Pandion haliaetus* (Osprey), *Coccyzu minor* (Mangrove Cuckoo) and *Myiarchus stolidus* (Stolid Flycatcher) occurred only once during the assessment.

Columba leucocephala (White-crowned Pigeon) is listed on International Union for Conservation of Nature (IUCN) Red List for Threatened Species (2017) as 'near threatened' whilst the others species were listed as 'least concern'.

Table 18: Bird species list from the survey (residents and endemics).

Proper name	Code used	Scientific name	Status	DAFOR
Cattle Egret	CARG	*Bubulcus ibis*	Resident	F
White-winged Dove	WWD	*Zenaida asiatica*	Resident	F
Black-whiskered Vireo	BWVI	*Vireo altiloquus*	Migrant	R
Osprey	OS	*Pandion haliaetus*	Migrant	R
Common Ground Dove	COGD	*Columbina passerina*	Resident	F
Gray Kingbird	GRKI	*Tyrannus dominicensis*	Migrant	O
Mangrove Cuckoo	MACU	*Coccyzuz minor*	Resident	R

Stolid Flycatcher	**STFL**	***Myiarchus stolidus***	**Endemic**	**R**
Yellow Warbler	YEWA	*Dendroica petechia*	Resident	O
Little Blue Herron	LBH	*Egretta caeulea*	Resident	R
Loggerhead Kingbird	LOKI	*Tyrannus caudifasciatus*	Resident	F
Northern Mockingbird	NOMO	*Mimus polyglottos*	Resident	A
Turkey Vulture	TUVU	*Carthartes aura*	Resident	O
Zenaida Dove	ZEDO	*Zenaida aurita*	Resident	F
White-crowned Pigeon	**WCPI**	***Columba leucocephala***	**Resident**	**O**
Yellow-faced Grassquit	YEFC	*Tiaris olivacea*	Resident	F
American Redstart	AMRE	*Stetophaga ruticilla*	*Migrant*	D

Note: Endemic species in Bold Red. Threatened Species in Bold Green – see Figure X

Bird species diversity was higher within the wetland areas and there was a significant reduction in diversity as surveys progressed towards the remnant sugar cane and scrub lands.

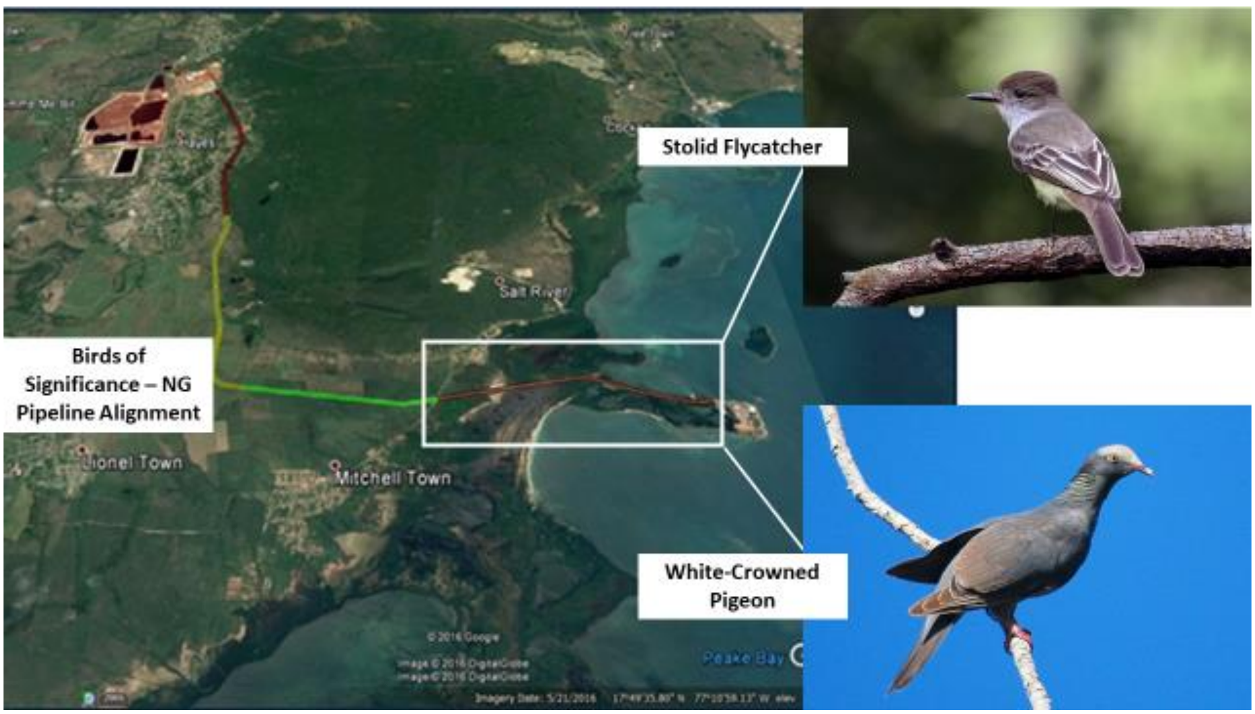


Figure 90: Birds of Significance observed along Proposed Pipeline Alignment

5.4.1.3. <u>Discussion</u>

During the assessment carried out within the study area, it was observed to have experienced various anthropogenic disturbances (Table 19). The study area can be categorized as a disturbed area with various habitat cover types mentioned in section 3. Within the wetland areas, logging was observed with some degree of land clearance for charcoal burning (Figure 91).

Table 19: Types of disturbances observed in the study area

Types of Disturbances	Presence/ Absence
Trail	√
Invasive Alien Species (IAS)	√
Logging	√
Clearing	√
Erosion	
Grazing/ Browsing	
Informal settlement	
Charcoal Burning	√

Figure 91: Tree species logged within the study area

5.4.1.3.1. Flora

Floral species diversity may be classified as low for the areas surveyed as only 12 plant species were recorded. Historically sections of the study area are known for its sugarcane fields, which have become overgrown with the Brazil Macca and the invasive Lead tree. The noted disturbances within the area reduce its terrestrial ecological value, and if logging and land clearance persist, the ecosystem functions and services will be totally lost.

Black mangrove and red mangrove were the two species of mangroves recorded in the area. Additionally, along the seaward side; north of the railway line, red mangrove seedlings were observed to be regenerating (Figure 92). This means that the potential for regrowth is strong, given the right conditions.

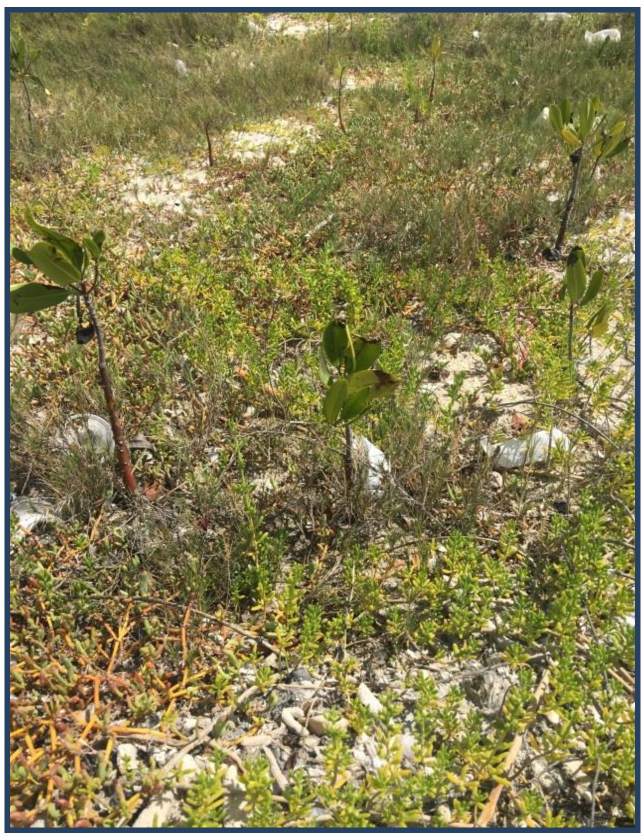


Figure 92: Red Mangrove seedlings along coastline within the study area

Figure 93: Mangrove die-off north (left image) and south (right image) of the railway line

Figure 93 above illustrates a typical section of the coast and terrestrial environment, north and south of the proposed project area. During the time of the assessment, vast mangrove die-off was observed along the coastline and also landward. This may have resulted from increased hyper salinity of the area, natural disaster or hydrological issues related to the flushing of the mangrove forest.

5.4.1.3.2. Avifauna

Seventeen (17) bird species were observed during the survey of the proposed site (Table 3). These species were distributed throughout the study area and are known to be typical of this type of landscape. The species diversity was higher within the wetland areas; there was a significant reduction in diversity as we moved towards the remnant sugar cane lands. Only one endemic bird species was observed during the survey. However, common residents were frequently observed. The homogeneity of the cover type saw frequent repetition of species as we moved through the zones along the proposed pipeline route.

The establishment of the pipeline will be along a disturbed pathway and as such is not expected to impact significantly on the avifauna of the area as disturbance to the landscape will be minimal. Access is anticipated to be limited to the existing service roads for the railway.

While the white-crown pigeon is listed as near threatened on the IUCN Red List for Threatened Species (2017), this species is also listed as one of the game bird species that may be hunted during the prescribed hunting season in Jamaica. It should be noted that the various IUCN categories are assigned to a species based on information from all its native range and the threat on the species within this range. All the other species are listed as “least concern” and are widely distributed throughout the region. The development will have no significant impact on their population numbers.

While the activities associated with a project of this nature should not be intrusive, the impact on the avifauna is expected to be very minimal. The birds are expected to relocate during construction activities and the plant species likely to be disturbed or removed are not endemics.

5.4.1.3.3. Environmental Impacts

This section describes impacts associated with the installation of the proposed fuel pipeline to be installed adjacent to the railway line that connects the JAMALCO’s bauxite processing plant located at Hayes Clarendon, to the Port at Rocky Point. These are typically temporary, short-term impacts. They can include such impacts as loss of vegetation; reduce water quality, noise, dust, and erosion and sedimentation. These impacts are discussed in this section along with mitigation measures that could be used to minimize them.

Based on the identification of the environmentally sensitive areas; Salt Harbour Special Fisheries Conservation Area, which extends northward of Rocky Point towards Port Esquivel (Figure 94), efforts should be focused on avoidance of impacts from the proposed development. A Special Fisheries Conservation Area can be defined as “no fishing zones reserved for the reproduction of fish populations. By conserving these areas it is envisioned that there will be a gradual increase in fish population. It is also documented that by designating such areas it alleviates threats to the fish populations such as overfishing, habitat degradation and land based nonpoint-source pollution (Ministry of Agriculture, 2017).

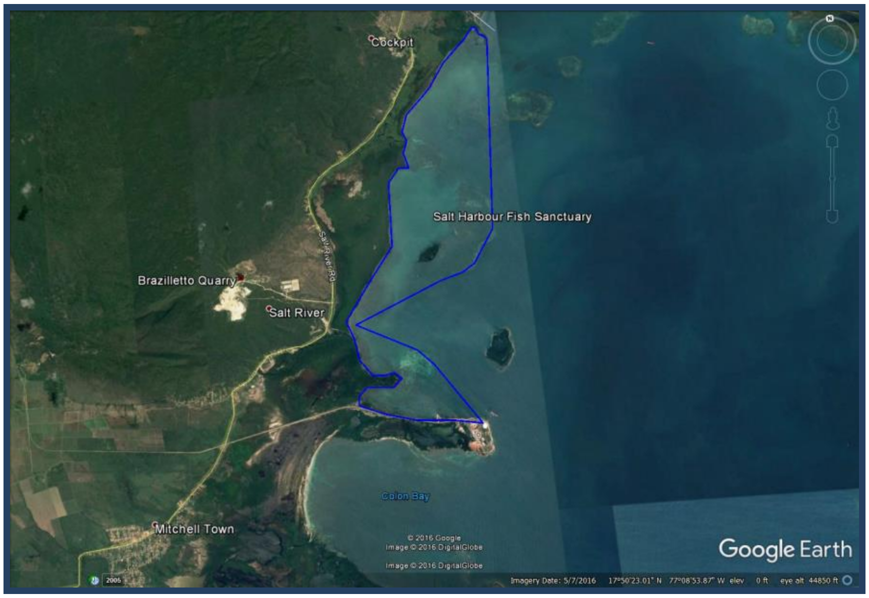


Figure 94: Location of the Salt Harbour Special Fisheries Conservation Area in relation to the proposed development site

It is of vital importance that during construction activities, along this section of the corridor that abuts the Salt Harbour Special Fisheries Conservation Area, the necessary mitigation measures be implemented to avoid run-off into the sanctuary.

It is important that construction best management practices are implemented to prevent significant negative impacts on the water quality of the marine environment. The area within the study site zoned as wetlands area had healthy stands of mangroves in some sections and mangrove die-off in others. However, any construction activity within this area may further result in the destruction or alteration of the site's hydrology, vegetation, biotic functions and hydric soils. Additionally, a loss of and/or reduction of the wetland species would cause erosion, decreased ability to store storm and flood waters, decreased ability to recharge groundwater, and reduced ability to filter and purify surface water.

Excavation along the conveyance routes for the installation of the pipeline is recommended to be conducted during the dryer season to avoid potential erosion and sedimentation flows into the marine environment. If this is not possible and construction occurs within the wet season then the necessary mitigation measures should be implemented, that is, installation of silt fences, adequate wetting of the area and street cleaning. Of particular concern with the proposed development is the impact of sedimentation can have on both rearing and spawning habitat of fish within the Salt Harbour Special Fisheries Conservation Area.

Increased sediment loading of the marine environment especially the fish sanctuary, could harm benthic biota through increased turbidity and would decrease light transmission in the water near excavation sites and reduce fish habitat. Maintaining vegetative cover appropriately during construction will minimize erosion of excavated soil and sediment loading.

Where avoidance is not possible, impacts should be minimized to the greatest extent possible. Whenever unavoidable adverse impacts occur, the use of compensatory mitigation maybe appropriate. Table 20 below proposes the following mitigating measures to avoid, minimize, and or compensate for the impacts mentioned above.

Table 20: Potential environmental impacts as a result of the proposed development and its associated mitigation measures

Environmental Impacts	Mitigation
Vegetation Loss	• Routes for the installation of the pipeline should be carefully selected to avoid sensitive wetland areas. • Limit vegetation clearing to what is necessary to construct the pipeline. Only trees and shrubs within the footprint of construction and tree limbs extending into the clearance area should be removed. No mangrove vegetation should be removed, if possible. • Develop a wetland mitigation plan for those wetland areas that cannot be avoided during construction
Water Quality	• Careful design, proper construction practices and maintenance of pipeline • Implementing an erosion and sediment control plan, following best management practices.
Increased sediment loading	• Implement an erosion and sediment control plan and following best management

Environmental Impacts	Mitigation
	practices • Ensure proper disposal or storage for reuse, of excavated materials • Install silt screens • Always cover stockpiles
Increase runoff	• Limit vegetation clearing as this will aid in the absorption of storm water and runoff
Oil Spills	• Implement the best management practices to avoid oil spills into the marine environment. These practices include proper storage, use, and cleanup of all construction-related chemicals.
Soil erosion	• Install Erosion features such as silt fences. • Minimize the use of heavy equipment on shorelines or in other sensitive areas.
Noise	• Ensure that noise levels are in compliance with NEPA's day and night guidelines, noise level during working hours and 24 hours noise level standards.
Contamination of ground water	• Install adequate technology for early detection of oil leakage

5.4.1.4. Conclusion

The Rapid Ecological Assessment (REA) has indicated that the land use and habitat types along the proposed development route consists of wetlands, agriculture (sugar cane) with shrub-land and remnant sugar cane. Within this area is the Salt Harbour Special Fisheries Conservation Area, which is considered an environmentally sensitive area (Fish Sanctuary). This sanctuary is an area reserved for the reproduction of fish populations. Therefore, mitigation measures for the proposed development and the associated potential impacts should be geared towards avoiding or minimizing impacts to the greatest extent possible. Whenever unavoidable adverse impacts occur, the use of compensatory mitigation may be appropriate.

In terms of plant species, within the study area, the remaining mangrove species are of particular importance and efforts should be made to prevent the loss of any further mangroves. Although sections of the area is experiencing a die-off which was evident in the extremely dry and saline environment, the causes are unknown and therefore the development should not result in any impacts on the hydrology of the area. The healthy stands of mangroves along the sanctuary coast still provide ecosystem services to the fish population.

5.4.2. Marine Assessment

5.4.2.1. Introductions

The objective of this Marine Assessment is to evaluate the physical, chemical and environmental parameters surrounding the proposed routes of a Natural Gas (NG) pipeline to originate from a Floating Storage and Regasification Terminal (FSRT) (see Figure 95) to be accommodated at an approximate position of N17°50’44.77” W77°07’02.23” in the Portland Bight and to run on the seafloor along a line approximated on Figure 96 below. The marine component of the line will terminate on the shore of JAMALCO’s Marine Terminal, after which, it will run above ground along an alignment parallel to the railway line running from the terminal to the JAMALCO’s processing plant. Here, the line will terminate at a Natural Gas fired power station to be located there.

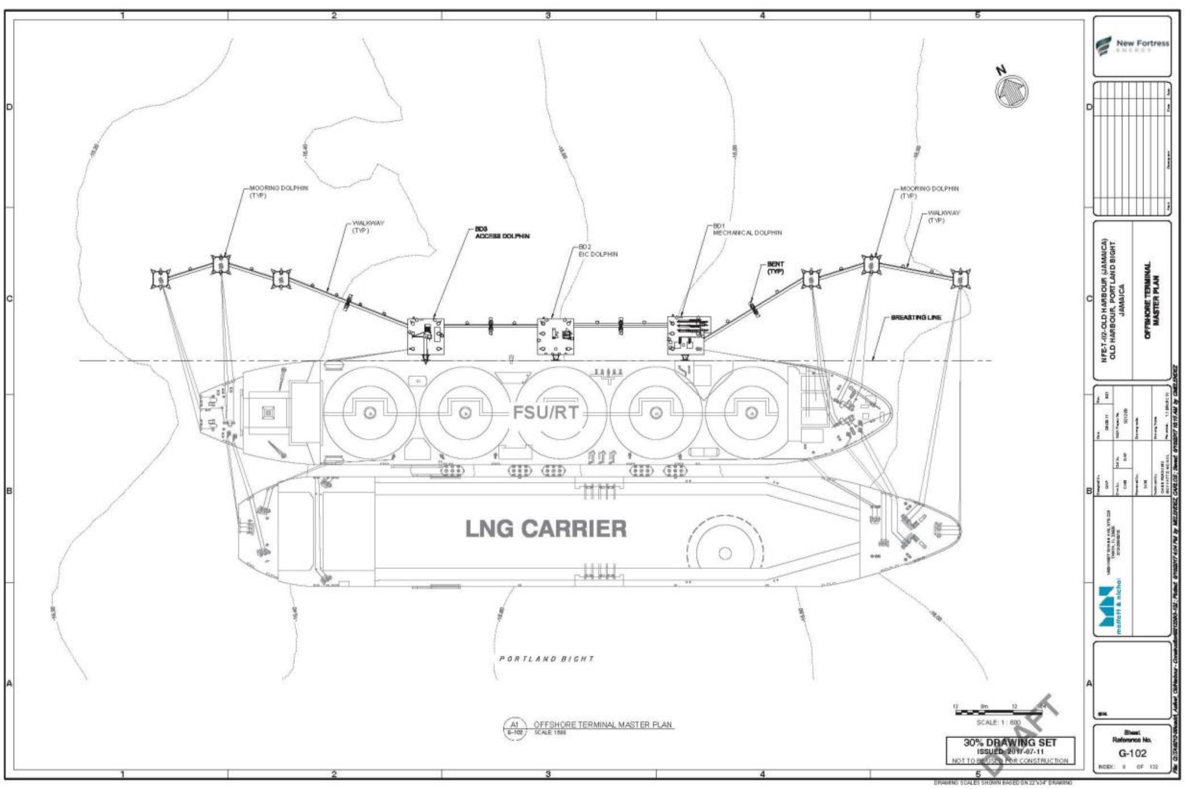


Figure 95: Proposed Floating Storage and Regasification Terminal Plan

Figure 96: Proposed NG pipeline to the JAMALCO Marine Terminal – Portland Bight

For the landward NG pipeline component, it is assumed that a working corridor will constitute the land transport corridor study area.

5.4.2.2. Approach & Methodology

The following approaches and methodologies were used in carrying out this marine assessment:

1. The marine environment surrounding the marine section of the proposed pipeline.
2. Aerial imagery of the land-based alignment of the proposed pipeline
3. The ADO road routes from the JPSCo Old Harbour Bay plant to the JAMALCO plant
4. The coastline extending from Rocky Point to Portland Cottage and Salt River.

For item 1, specific emphasis was placed on the collection of site data for environmental features present within the areas defined on Figure 97 to Figure 99 below, since these represent areas of interest and areas of potential direct impact both during the construction of the line and if there is an issue over an extended period of time with the proposed pipeline during operations.

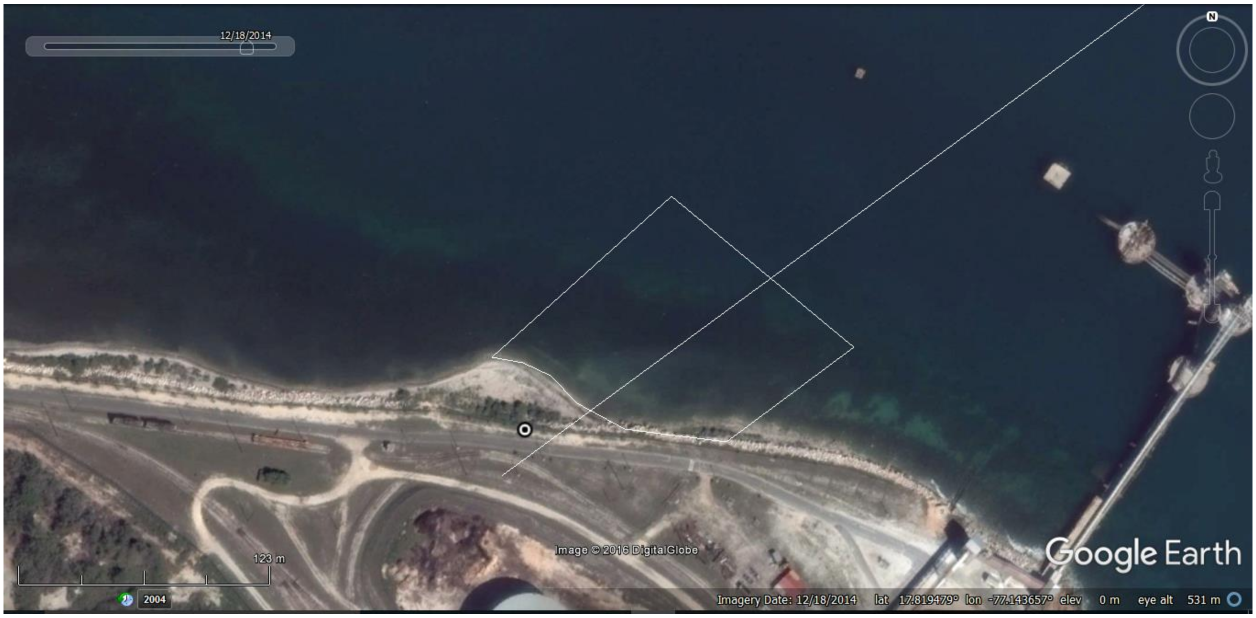


Figure 97: Area of Immediate Interest Adjoining Shoreline at JAMALCO

Figure 98: Area of Immediate Interest Adjoining Cay Near Pipeline

Figure 99: Water Quality Sample Locations Along Proposed Pipeline

Aerial photography/videography as well as satellite imagery was used for the description of natural and human resources present the alignments described for items 2-4 above.

5.4.2.2.1. Literature Review:

The following technical/legal documents and website sources were used as technical references for assessment works associated with this Marine Assessment:

- The Natural Resources Conservation Authority Act – The Portland Bight Protected Area Order 1999.
- Information Sheet on RAMSAR Wetlands – Portland Bight Jamaica (JM1597RIS) 2005 and associated map
- www.c-fish.org Portland Bight Protected Area Fish Sanctuaries
- Portland Bight Protected Area Climate Change Action Plan (2013)
- 2014 Coral Reef Assessment Portland Bight Protected Area Jamaica
- Environmental Sensitivity Mapping, JAMALCO Alumina Terminal October 2014 – environmental descriptions related to the immediate environment surrounding the JAMALCO marine terminal

- Environmental Impact Assessment NFE South Holdings Ltd LNG Terminal and Pipeline Project Old Harbour Bay – September 2016
- Floral & Avifaunal Assessment For The Proposed Installation Of Pipeline From Jamalco To Rocky Point, Jamaica - April 2017

5.4.2.3. Field Data Collection:

5.4.2.3.1. Aerial Imagery Collection

Google Earth satellite imagery of the study area were used for initial aerial imagery photo analysis for the areas listed in the Terms of Reference listed above, with the specific areas of study being illustrated on Figure 100 below. Analysis and spatial data presentation was supported by the use of a Geographical Information System (GIS[15]) software.

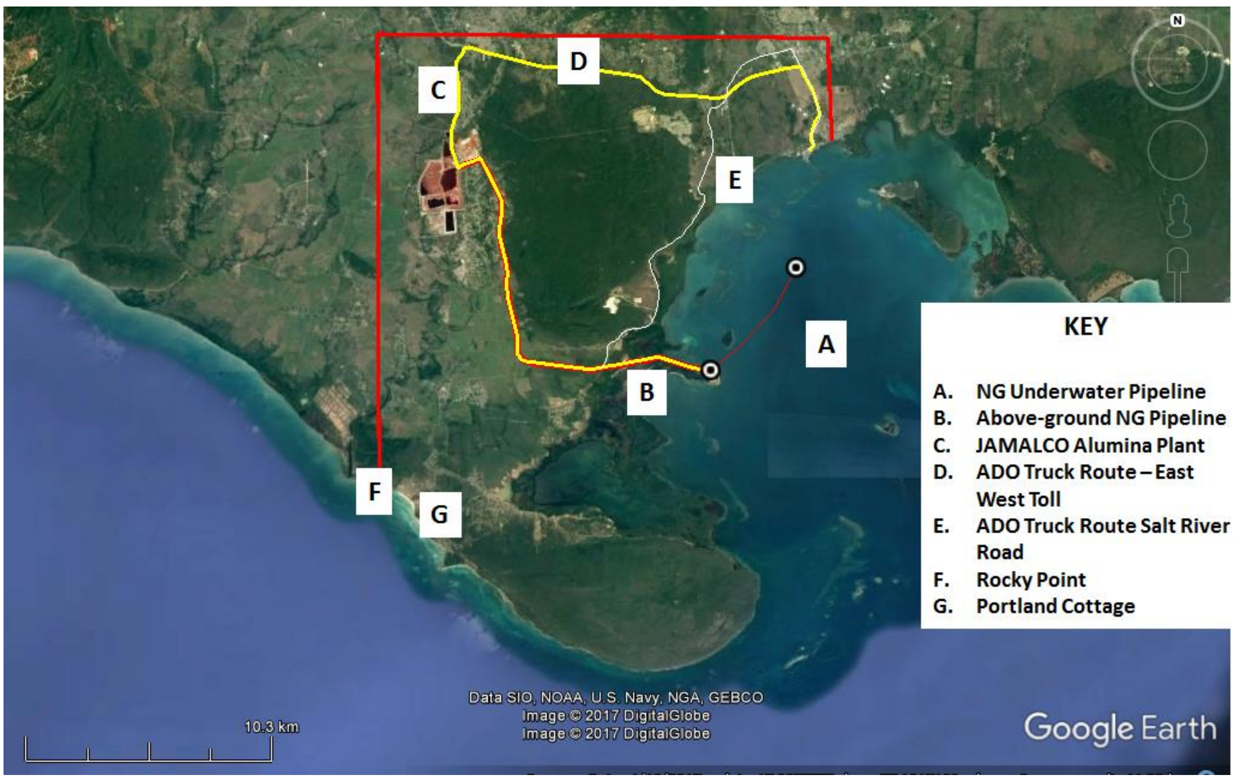


Figure 100: Aerial Imagery Study Areas Defined on Google Earth Imagery

[15] www.mapmaker.com

5.4.2.3.2. Water Quality and Seafloor Sediment Character

Water Quality sampling - four (4) surface and four subsurface samples were taken from each sample location and analyzed for the following parameters:

- Total Coliform (MPN/100 ml)
- Faecal Coliform (MPN/100 ml)
- Nitrate (mg/l)
- Available Phosphate (mg/l)
- Biochemical Oxygen Demand (BOD)
- Total Suspended Solids
- Fats Oil and Grease (FOG)

Sample areas were located as outlined on Figure 101 below.

Figure 101: Marine Sample Locations

5.4.2.3.3. Flora/Fauna Character

The interpretation and analysis of aerial imagery resulted in the generation of terrestrial and marine lifeform spatial characterization maps. These were then used in the interpretation of environmental issues and impacts that could emanate from the implementation and operation of the proposed pipeline. Further, ground truthing was conducted, both in the marine environment defined in Figure 101 above and along the land-based alignment of the proposed natural gas line from the port to the JAMALCO plant. Ground truthing methods are outlined below:

5.4.2.3.4. Marine Environment:

Fish population assessment methods developed for the Atlantic and Gulf Rapid Reef Assessment protocols[16] were used for the evaluation of fish populations, using the population standards described in the 2014 Coral Reef Assessment Portland Bight Protected Area Jamaica as a reference for comparison.

For benthic assessments, underwater video capture methods were used[17], with estimates of percentage coverage being obtained through the use of Coral Point Count research software[18].

Visual and video data was collected along a single transect line represented on Figure 102 and Figure 103 below, with each transect being approximately 100 meters in length.

[16] http://www.agrra.org/training-tools/fish-training/
[17] Safuan, M., Boo, W.H., Siang, H.Y., Chark, L.H. and Bachok, Z. (2015) Optimization of Coral Video Transect Technique for Coral Reef Survey. ***Open Journal of Marine Science***, 5, 379-397. http://dx.doi.org/10.4236/ojms.2015.54031
[18] http://cnso.nova.edu/cpce/index.html

Figure 102: Location of Video/AGRRA Survey Transect Line Run Across Reef at Salt Island

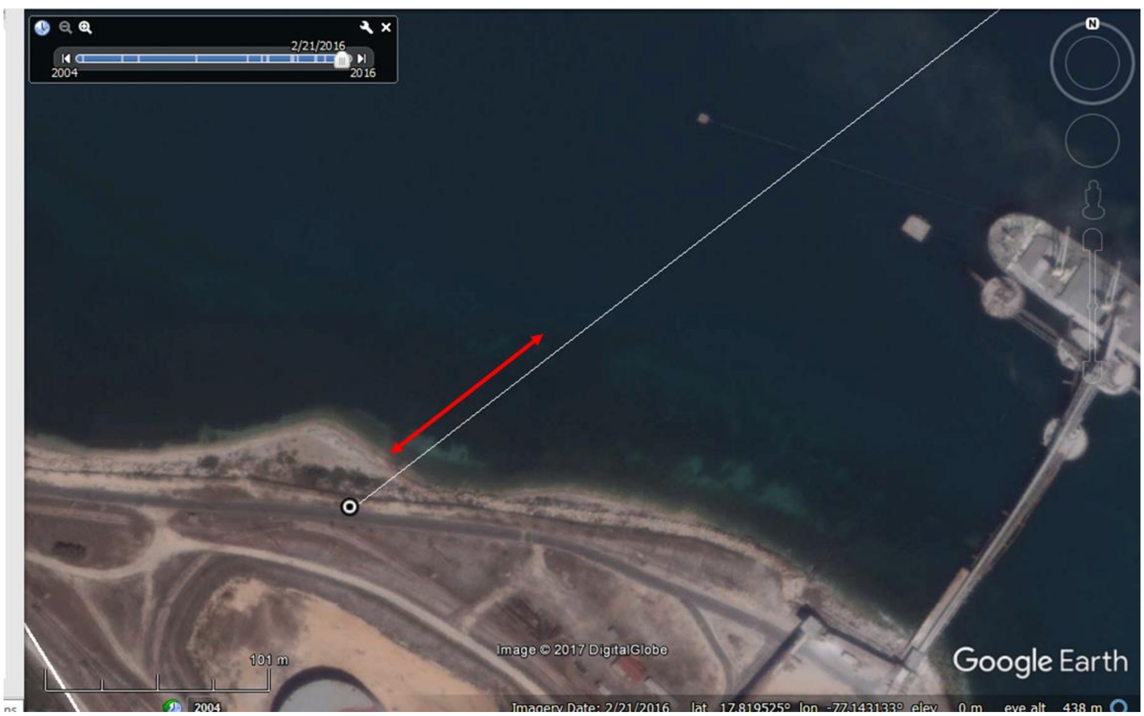


Figure 103: Location of Video/AGRRA Survey Transect Line Run Across Shallow Seagrass Margin at Marine Terminal

5.4.2.3.5. Oceanographic Character

Webber, Webber and Williams (2003[19]) evaluated the impact that meteorological, bathymetric and fluvial influences had on circulatory patterns within the Kingston Harbour and concluded that, where the harbour was influenced predominantly by fluvial discharge processes (Hunts Bay and Outer Harbour), the circulatory patterns there were driven by density/salinity influences. Additionally, where the harbour was influenced by wind forces, circulatory patterns tended to align themselves with the dominant direction of wind movement.

The conclusions of Webbers and Williams were applied to the Portland Bight study area which, to some extent, shared characteristics similar to that of the Kingston Harbour in that:

- The Bight, and many sections of the bight are semi-enclosed like the Kingston Harbour.
- The Bight receives multiple point sources of fresh water along its periphery.
- The Bight's bathymetry is a combination of shallows and deep channels.
- The Bight experiences extensive wind influences during the course of both day and night.

Therefore, the overriding premise used in the evaluation of circulatory patterns in the Portland Bight and, more specifically, in areas adjoining the NG pipeline was that wind and density influences were the dominant forces influencing seawater movement in the area. With this in mind, the climatic/oceanographic factors (wind, currents) influencing the sea environment along the proposed marine pipeline alignment was deduced, for the most part, from the interpretation of these characters from features observed on time-series Google Earth satellite images of the area. Wind direction was deduced from interpretation of wave crest orientations and floating features (secchi disc)while current movement patterns were deduced from turbidity patterns observed on the imagery.

[19] Bulletin of Marine Science 73(2):273-298, 2003

5.4.2.3.6. Environmental/Socio Economic Risk Analysis

Environmental/Socio-economic sensitivity mapping criteria developed by the International Petroleum Industry Environmental Conservation Association (IPIECA[20]) were used to categorize both shorelines and land routes associated with the alignment of NG/ADO corridors within the study area. These categories were then represented spatially to illustrate varying levels of sensitivity to the proposed development.

[20] www.ipieca.org

5.4.3. Results and Findings

5.4.3.1. General Importance of the Portland Bight:

In 1999 the Government of Jamaica enacted the Natural Resources Conservation (Portland Bight Protected Area - PBPA) Order, which declared the Portland Bight area as a protected area under the Natural Resources Conservation Authority (NRCA) Act and which defined the boundary of the area. It is the largest protected area in the island covering an area of 1880 square kilometers.

The management of the area was divested to the Caribbean Coastal Area Management Foundation (CCAM), a non-governmental organization formed in 1997 and whose mandates includes "Working with communities to develop sustainable livelihoods, encourage wise use of natural resources, promote community involvement in decision-making and to protect the cultural heritage and biodiversity of the area."[21].

Further to the gazette and the delegation of environmental management, the PBPA was further recognized when, through the effort of the NRCA and CCAM, the wetlands existing in the area were declared as being of international importance through designation under the Convention on Wetlands of International Importance (RAMSAR Convention) in 2006. The boundaries for both the protected area and the RAMSAR site are as defined on Figure 104 below.

In 2009 three Fish Sanctuaries were declared within the PBPA under the Fisheries Act to help to ensure that fisheries management within the PBPA was fostered, considering the value of the fisheries there. These were the Galleon Harbour (17.1 square kilometers), Salt Harbour (10.7 square kilometers) and Three Bays sanctuaries (12.0 square kilometers - see Figure 105). Of the three Fish Sanctuaries, the Salt Harbour sanctuary is the closest to the proposed marine pipeline development component (see Figure 106).

[21] https://www.facebook.com/pg/Caribbean-Coastal-Area-Management-Foundation-266327140059377/about/?ref=page_internal

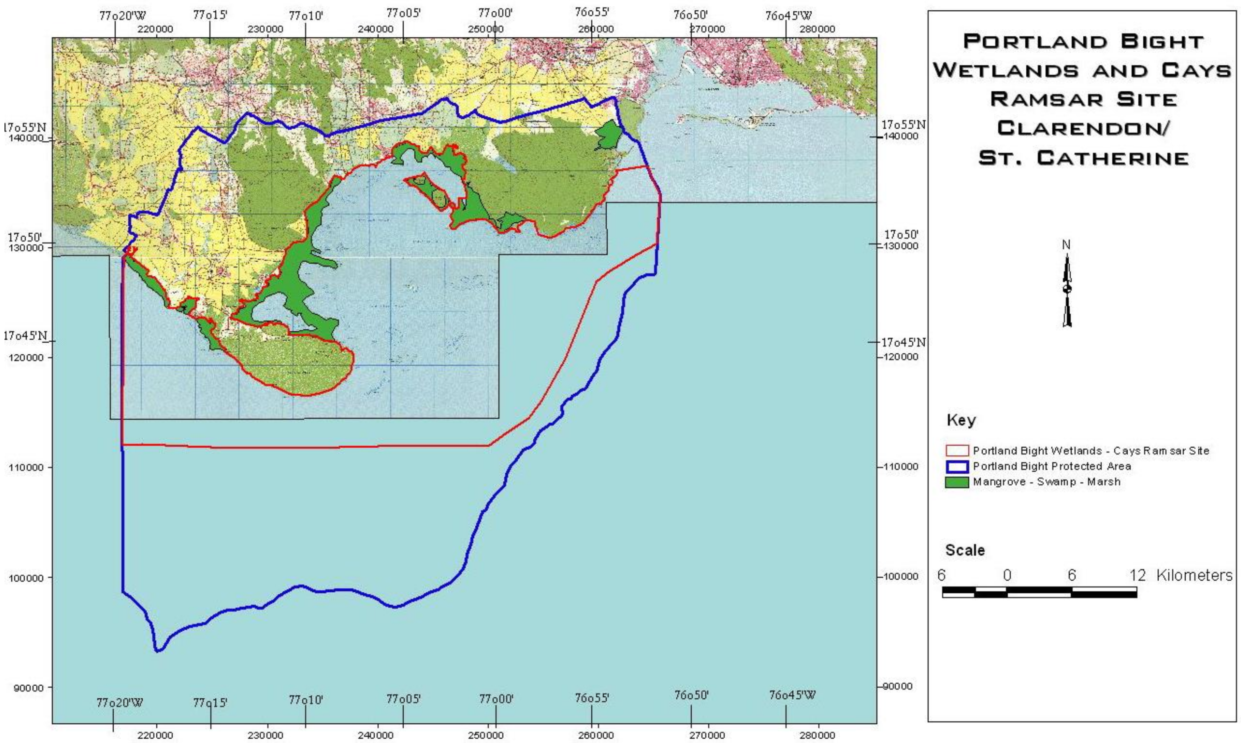


Figure 104: Portland Bight Protected Area Boundary and RAMSAR Boundary

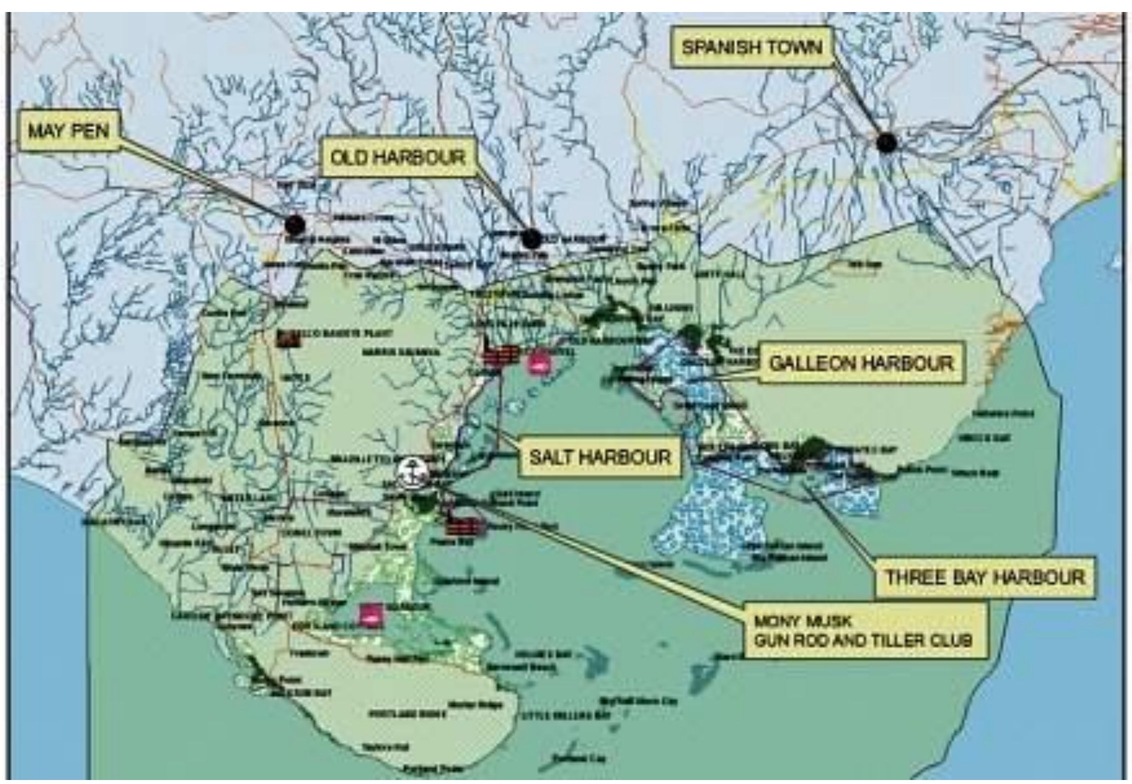


Figure 105: Locations of the Portland Bight Protected Area Fish Sanctuaries

Figure 106: Location of the Salt Harbour Fish Sanctuary in Relation to the Proposed NG Pipeline

5.4.3.2. Terrestrial/Coastal Environment

According to the CaMPAM Network[22] description of the PBPC, the Bight covers a total surface area of approximately 1876 square kilometers. Within the borders of the PBPC are various coastal geological features, including cliffs, terraces, beaches, rocky shores, cays and caves. Hydrological features of importance within the borders of the PBPC include the inflows contributed by the Salt, Bowers and Black rivers (and numerous other drainage systems – see Figure 107, Figure 108 and Figure 109 below), marshes dominated with growths of Cat Tails (*Typha domingensis*), the Common Reed (*Phragmites australis*) and Sawgrass (*Cladium jamaicensis*) as well as other floating and submerged plantforms. Additionally, wooded wetlands comprising of Red Mangroves (*Rhizophora mangle*), Black mangroves (*Avicennia germinans*), White mangroves (*Laguncularia racemose*) and

[22] http://campam.gcfi.org/campam.php

Buttonwood Mangroves (*Conocarpus erectus*) are also present. The stands of Mangrove wetlands represent the largest of such stands in the island.

The terrestrial habitat of the PBPC is dominated primarily by dry Limestone forests, which cover approximately 41% of the total land surface area, as well as disturbed alluvial forests and former agricultural lands. The limestone forest areas contain 24 endemic species of birds, including the Banana Quit (*Coerba flaveola*), Black-Billed Parrot (*Amazona agilis*), Jamaican Euphonia (*Euphonia Jamaica*) and the Jamaican Lizard Cuckoo (*Saurothera vetula*), in addition to at least 5 species of possibly threatened lizards (including the endangered Jamaican Ground Iguana – *Cyclura collei*) and three possibly threatened species of snakes. Meanwhile, the wetland forests are known to support the regionally threatened West Indian Whistling Duck.

5.4.3.3. Marine Environment

The marine environment of the PBPC includes coral reefs, 14 small coral-ringed cays and seagrass beds comprised primarily of Turtle Grass (*Thalassia testudinum*), but also including Shoal Grass (*Halodule wrightii*) and Manatee Grass (*Syringodium filiforme*). These seagrass beds represent the largest areas of seagrass growth in the island.

The combinations of these natural environments, as well as the wetland environments, support a fishery (comprised of various species of fish and invertebrates) that is so important, that over 4,000 active fishermen in the Old Harbour Bay and adjoining areas depend on it for their livelihoods.

Figure 107: Drainage Features of Importance within the Borders of the PBPC – (Yellow Lines)

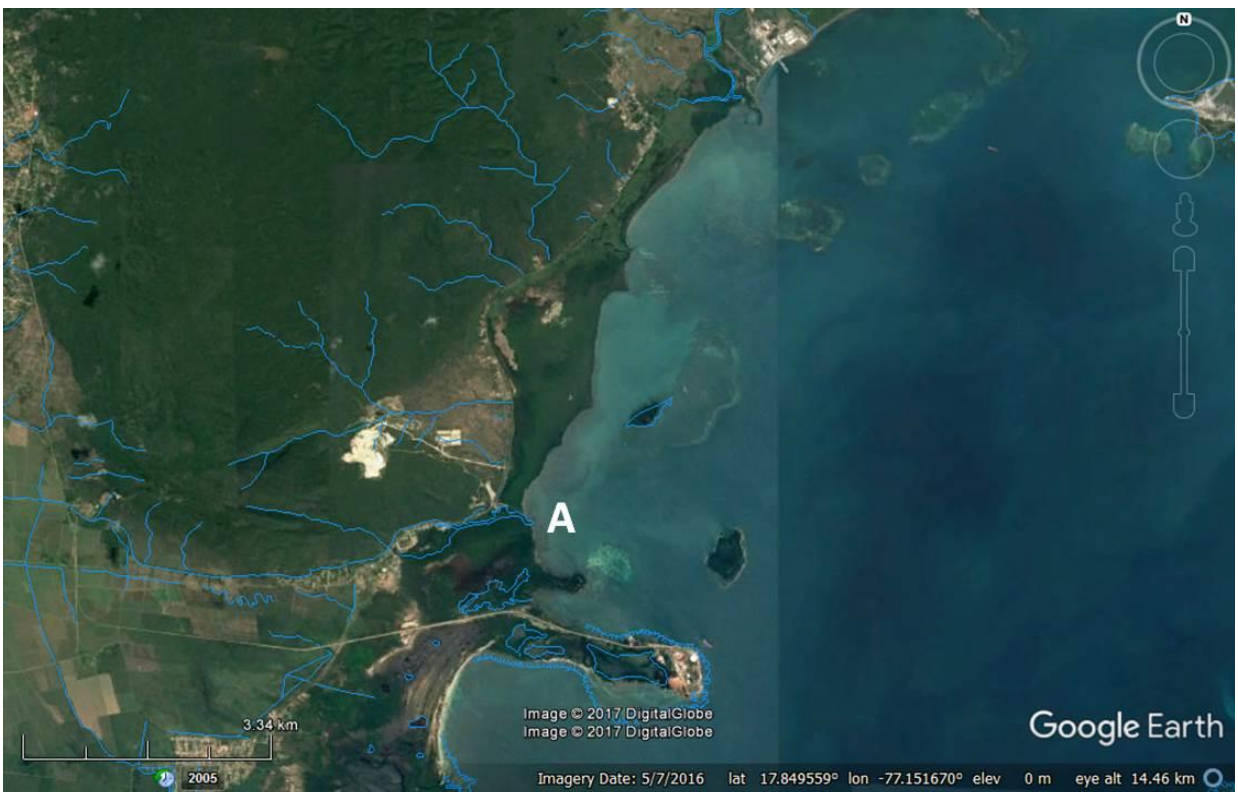


Figure 108: Close-up of Drainage Features of importance within the borders of the PBPC Near to the Proposed Pipeline – (Blue Lines | A – Salt River)

Figure 109: Hydrological Features of Importance Adjoining Proposed Development Area - Wetlands[23]

Hawksbill Turtles (*Eretmochelys imbricata*), Green Turtles (*Chelonia mydas*) and the Crocodile (*Crocodylus acutus*), endangered marine reptiles, as well as the West Indian Manatee (*Trichechus manatus manatus*), an endangered marine mammal, live in the PBPC marine environment.

Recently conducted coral reef and fisheries monitoring surveys conducted in the PBPA revealed that live coral cover on reefs in the PBPA ranged from 11-28%, with isolated areas of high cover of up to 35%. Seventeen species of corals were found over the PBPA reefs, including critically endangered species such as the Staghorn and Elkhorn Corals (*Acropora cervicornis* and *Acropora palmata*). The reefs are regarded as being in reasonable health when compared to both national and regional standards.

[23] 23 Picture source - https://www.facebook.com/Caribbean-Coastal-Area-Management-Foundation-266327140059377/

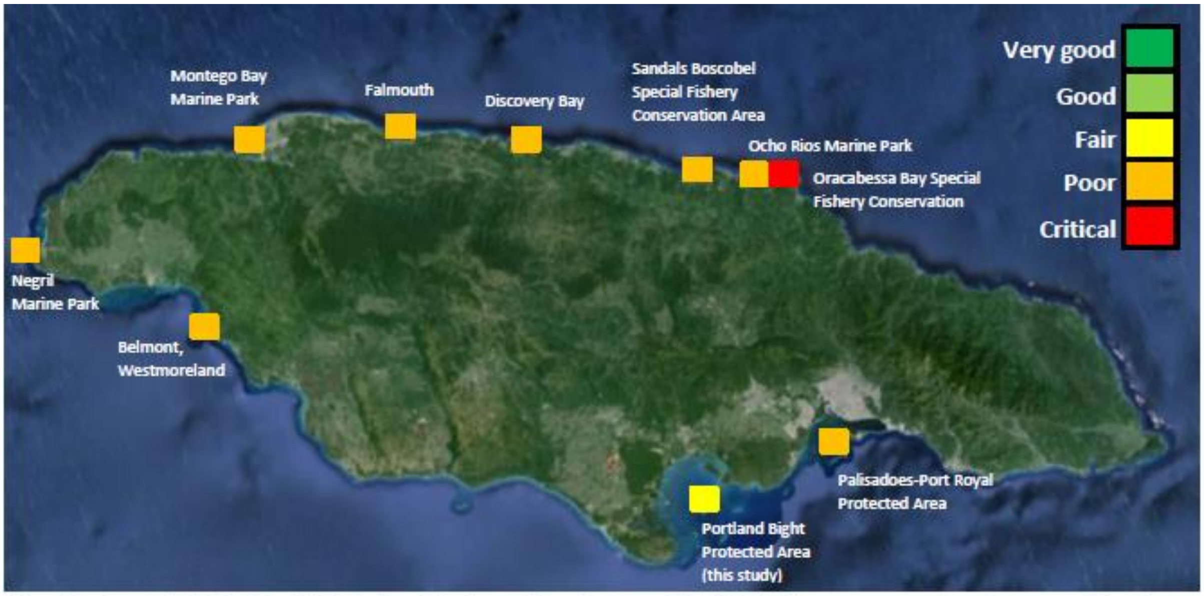
Where fish populations are concerned, the monitoring surveys showed that, of the target species examined (Parrotfish, Surgeonfish – herbivores, Grouper, Grunt and Jack - carnivores):

- Fish Biomass[24] - "At the regional level, except for surgeonfishes, fish biomass on the Portland Bight coral reefs is low to extremely low in all surveyed fish groups".
- Fish Density[25] - "The densities of (small) parrotfish, surgeonfish and grunt on the Portland Bight reefs are substantially higher than regional averages, but densities of snapper and jack were below average and grouper were absent".
- Fish Size[26] - "Large-sized fishes, both parrotfishes and snappers, were rare or absent across the PB reefs".

The National Environment and Planning Agency (NEPA), in 2014, conducted a national assessment of coral reef health, using indices developed by the Healthy Reefs Initiative[27]. Rankings ranging from Very Good to Critical were applied to ten reef systems evaluated around the island, as illustrated on Figure 110 below[28]. The PBPA reefs ranked as Fair and had the highest ranking of the 10 reefs evaluated, underscoring the relevance and importance of reef systems in the Bight in general and the relevance and importance of any reef systems that may be adjacent to the proposed pipeline alignment.

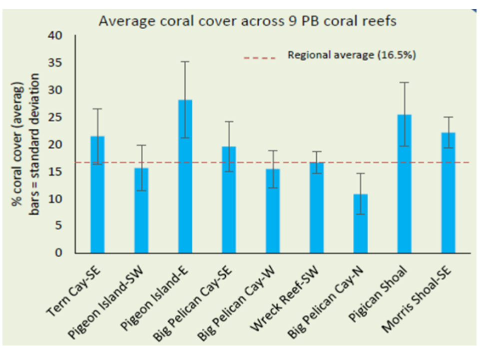
Both the percentage coverage and the fish density and size values measured during the 2014 survey were used as a standard reference for the comparison of data collected for the Salt Island and Marine Terminal survey areas. Figure 111 below illustrate these standard values.

[24] Found by counting the number of fish in a given area, and measuring their sizes – grams of fish per unit reef area.
[25] The number of individual reef fishes within a given area
[26] Comparison of average length of target species as compared with regional data.
[27] www.healthyreefs.org
[28] Extracted from Report Entitled Environmental Sensitivity Mapping – JAMALCO Alumina Terminal: Prepared by Conrad Douglas and Associates Oct 2014.



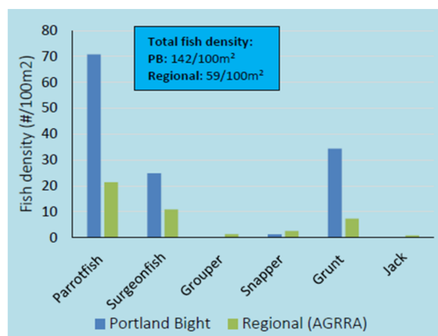
Map of Jamaica with the Coral Reef Health Index ranking for each location surveyed by NEPA in their most recent national assessment[7]. Note the added ranking of the Portland Bight Protected Area (this study, ranking scheme following method in NEPA report[7]).

Figure 110: Coral Reef Health Index Ranking for Jamaica



A

B



Fish size (centimetres)			
centimetres (cm)	Portland Bight	Regional (AGRRA)	PB in comparison to regionally
Parrotfish length (cm)	7.9 (0.7)	14 (3.5)	Low
% Parrotfish >20cm	2	22 (9)	Extremely low
Snapper length (cm)	14.5 (1.6)	26.5 (8)	Low
% Snapper >40 cm	0	12 (18.5)	Absent at PB

C

Figure 111: 2014 Coral Reef Assessment PBPA Study Data Standards: (A | Coral Percentage Coverage, B | Fish Density, C | Fish Size)

5.4.3.4. Aerial Imagery Interpretation

5.4.3.4.1. Marine Pipeline Alignment and Surrounding Areas

Figure 112 illustrates spatially the various coastal and marine life forms distributed around the alignment of the proposed marine pipeline alignment. Figure 113 shows a closer view of these resources in relation to the marine pipeline and further illustrates those resources that are within 300 meters of the proposed alignment.

Figure 114 and Figure 115 zoom in even closer to the points along the alignment that are closest to important coastal and marine resources within the PBPA.

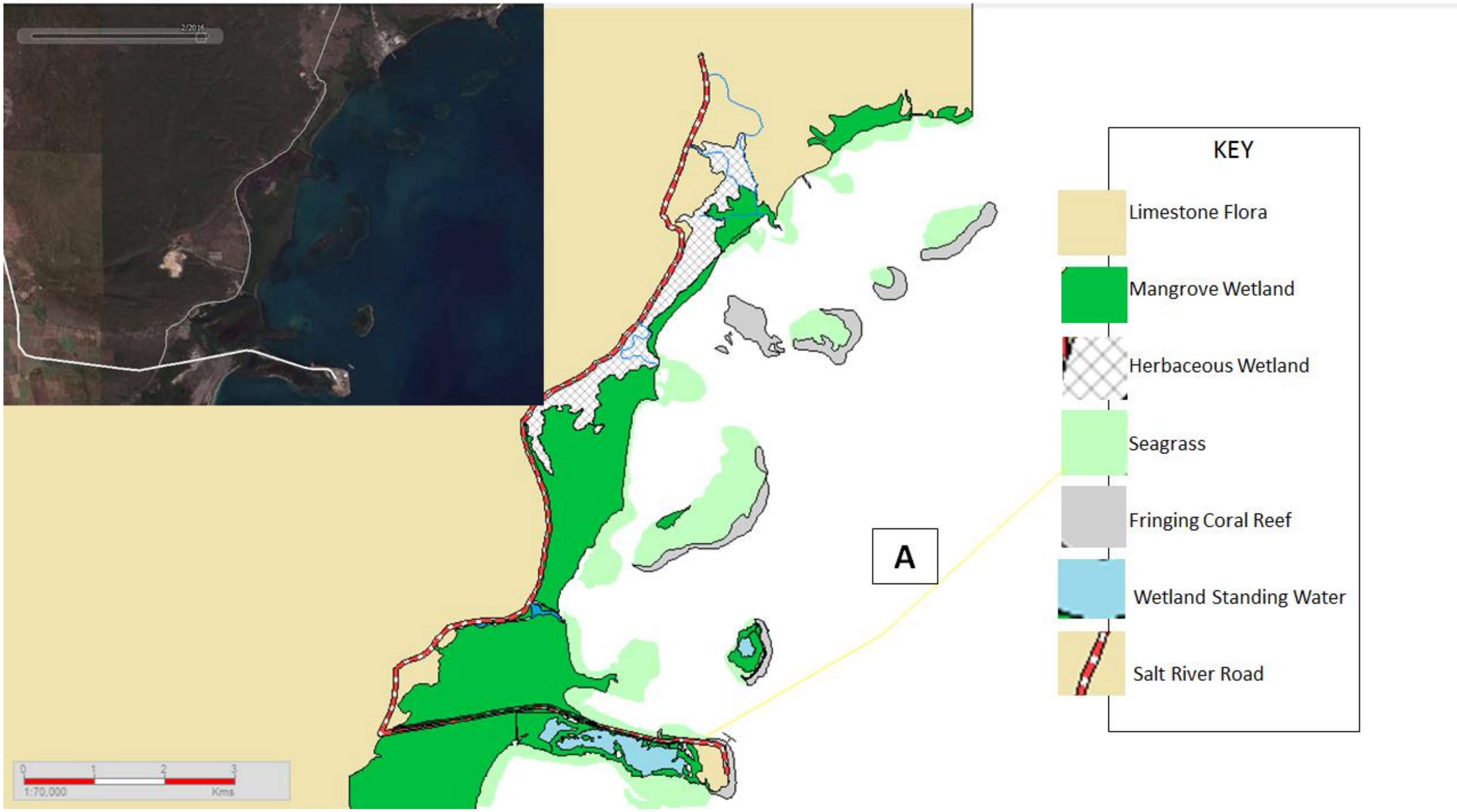


Figure 112: Spatial illustration of the Various Coastal and Marine Life forms Distributed around the Alignment of the Proposed Marine Pipeline (positioned at A).

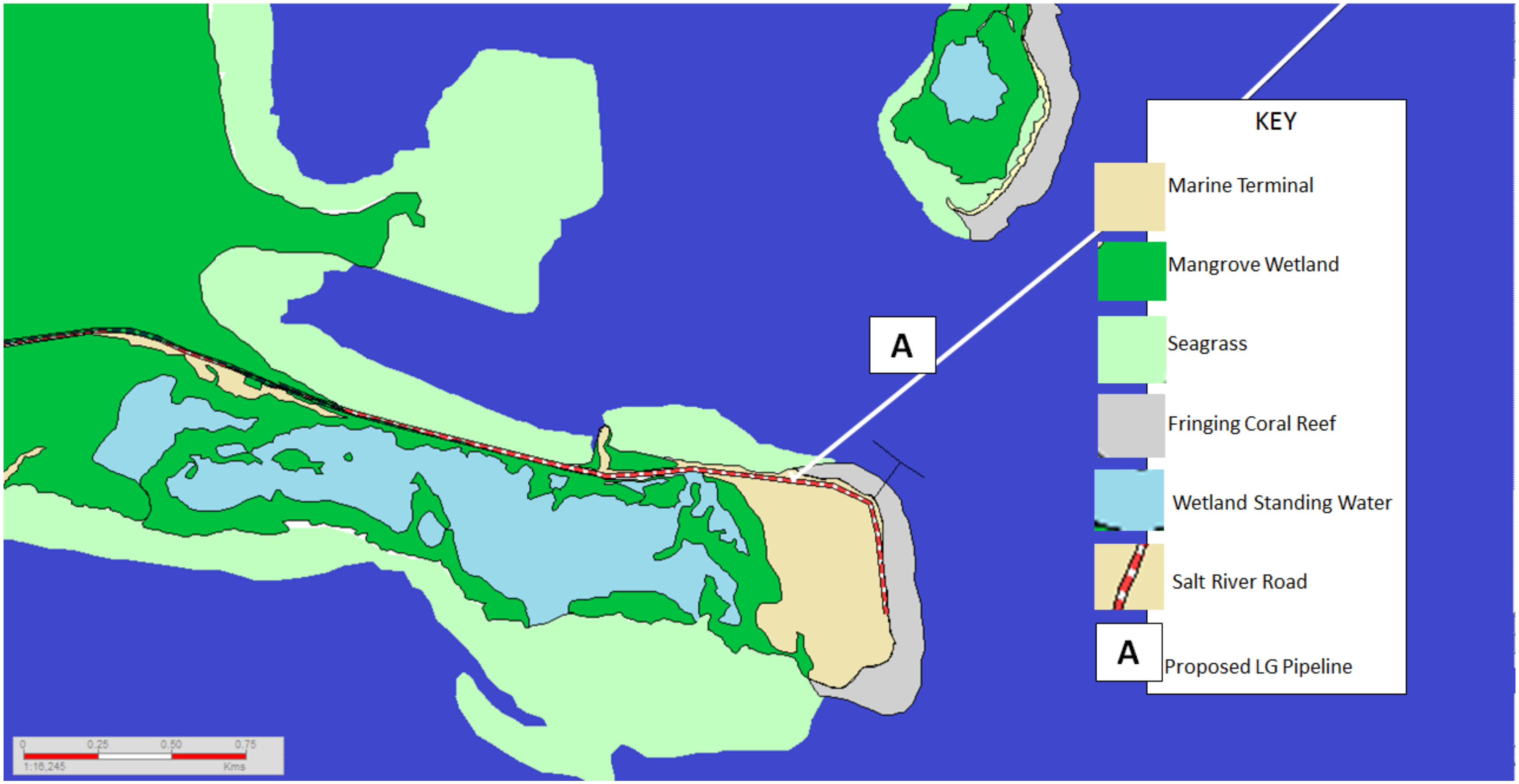


Figure 113: Closer View of Environmental Resources that are within 300 meters of the Proposed Pipeline

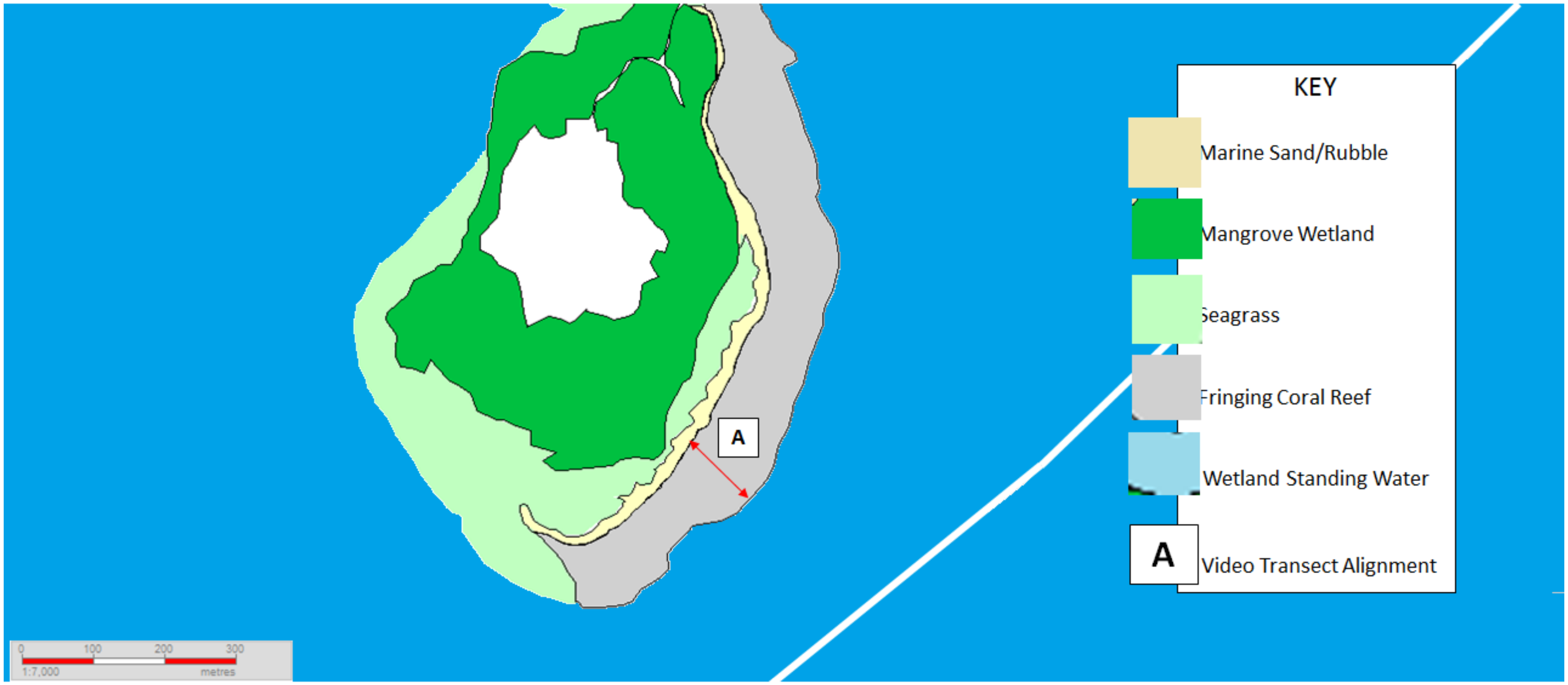


Figure 114: Spatial Representation of Critical Coastal and Marine Life forms Associated with Salt Island Adjacent to the Proposed NG Pipeline as well as Video Survey Route (A)

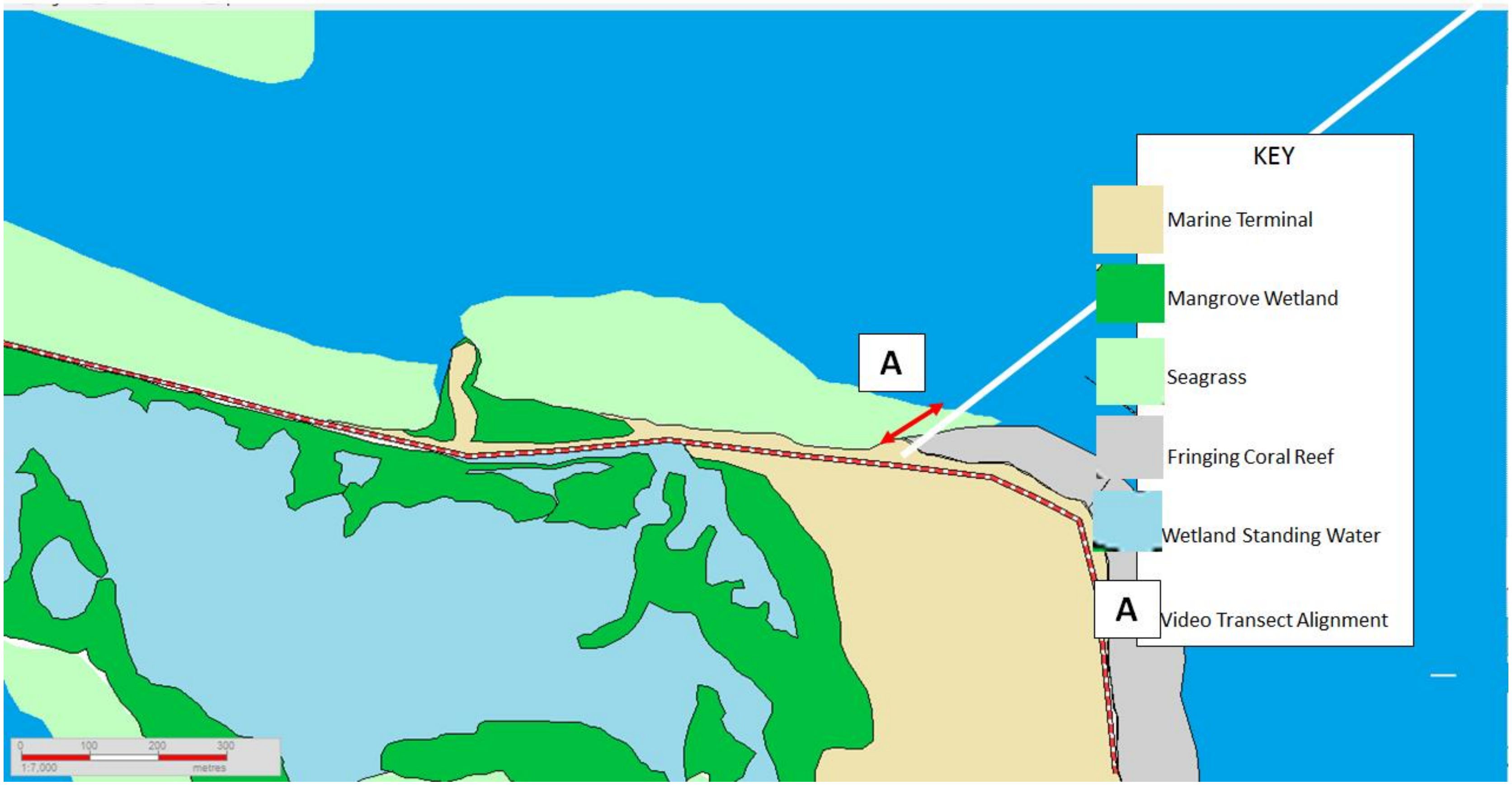


Figure 115: Spatial Representation of Critical Coastal and Marine Life forms Associated with the JAMALCO Marine Terminal as well as Video Survey Route (A)

5.4.3.4.2. Aerial Imagery Interpretation – Terrestrial Automotive Diesel Oil Truck Route Salt River Main Road.

Figure 116 to Figure 118 below illustrate spatially the various environmental features that exist adjoining the Salt River main road. Note that the main road immediately adjoins these features for a distance of approximately 6 kilometers. Environmental features of significance were as described under section 3.1.1 above, with both marsh dominated and wooded wetland dominated vegetation being present.

5.4.3.4.3. Aerial Imagery Interpretation – Terrestrial Pipeline to JAMALCO.

Figure 119 to Figure 121 below shows a characterization of vegetation types immediately along the alignment of the proposed land route for the NG pipeline leading to the JAMALCO processing plant.

5.4.3.4.4. Aerial Imagery Description – Terrestrial Automotive Diesel Oil Truck Route East-West Toll Road.

Figure 122 to Figure 124 below describe the proposed terrestrial ADO route, which would traverse the East-West toll roadway. The proposed route initially traverses residential areas similar to that of the proposed Salt River roadway route. However, this route then follows the toll road which avoids any areas of significant environmental importance.

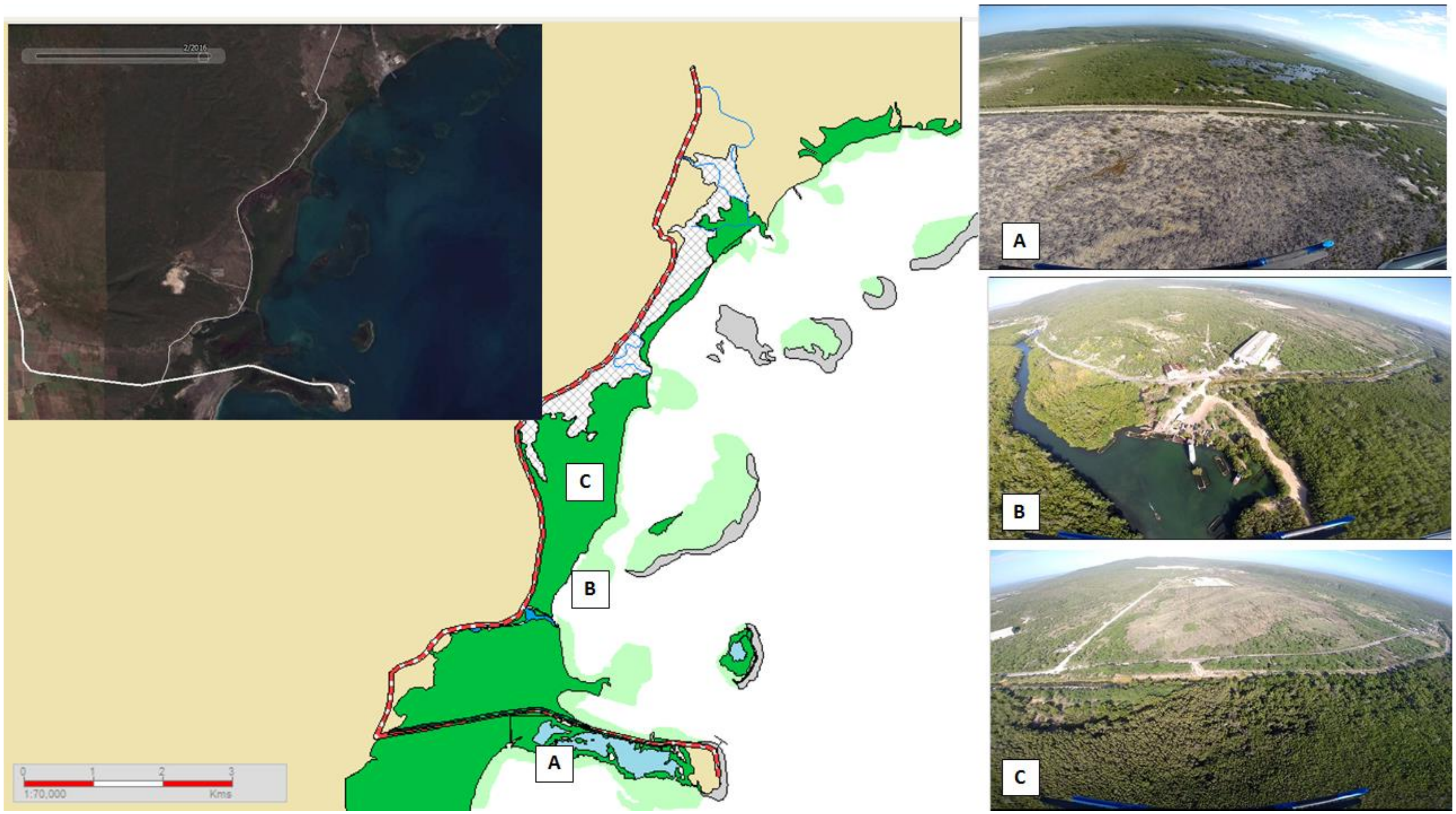
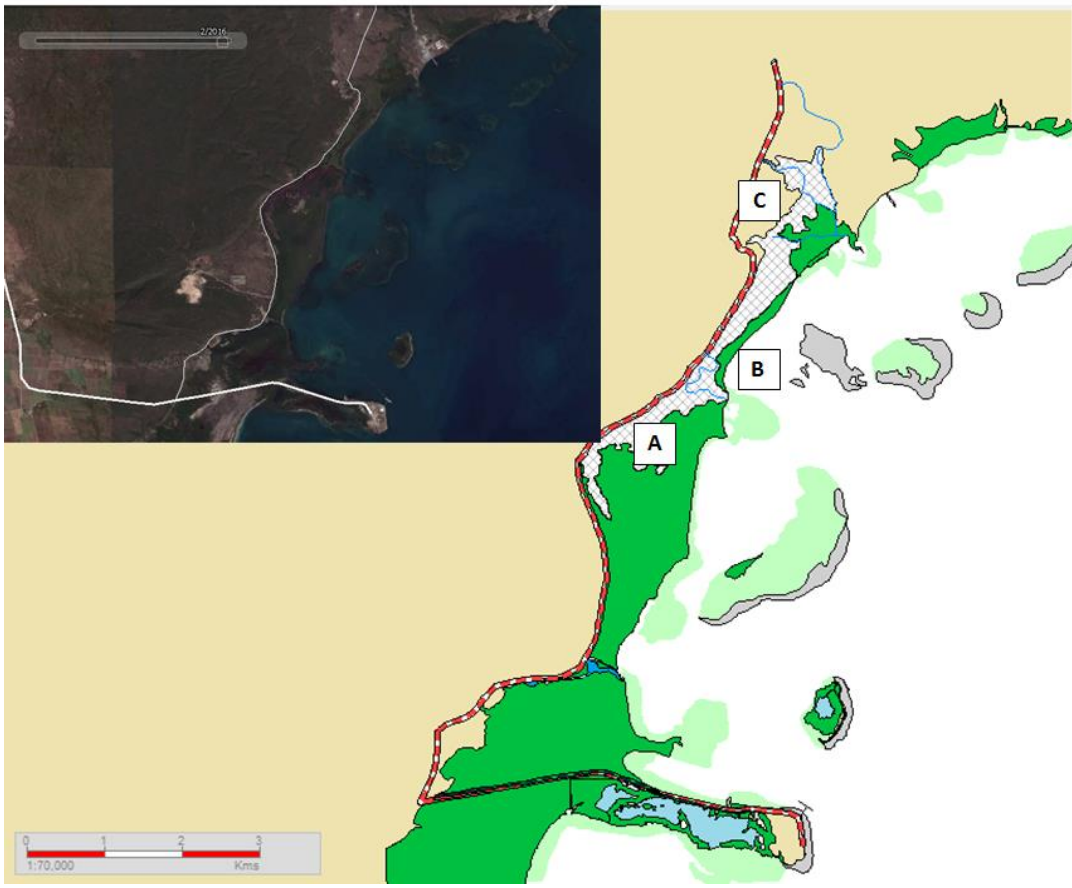


Figure 116: Wetland Features along the Alternative Proposed Salt River ADO Truck Route - (A) Mangrove wetland lifeforms (B) Mangrove wetland and the Salt River (C) Mangrove wetland lifeforms



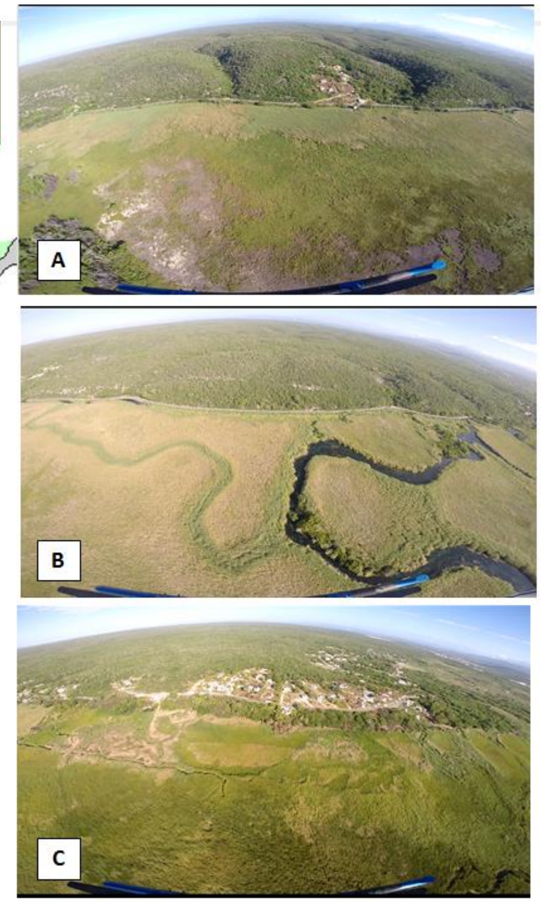


Figure 117: Herbaceous wetland lifeforms and human settlements along proposed alternative Salt River ADO truck route

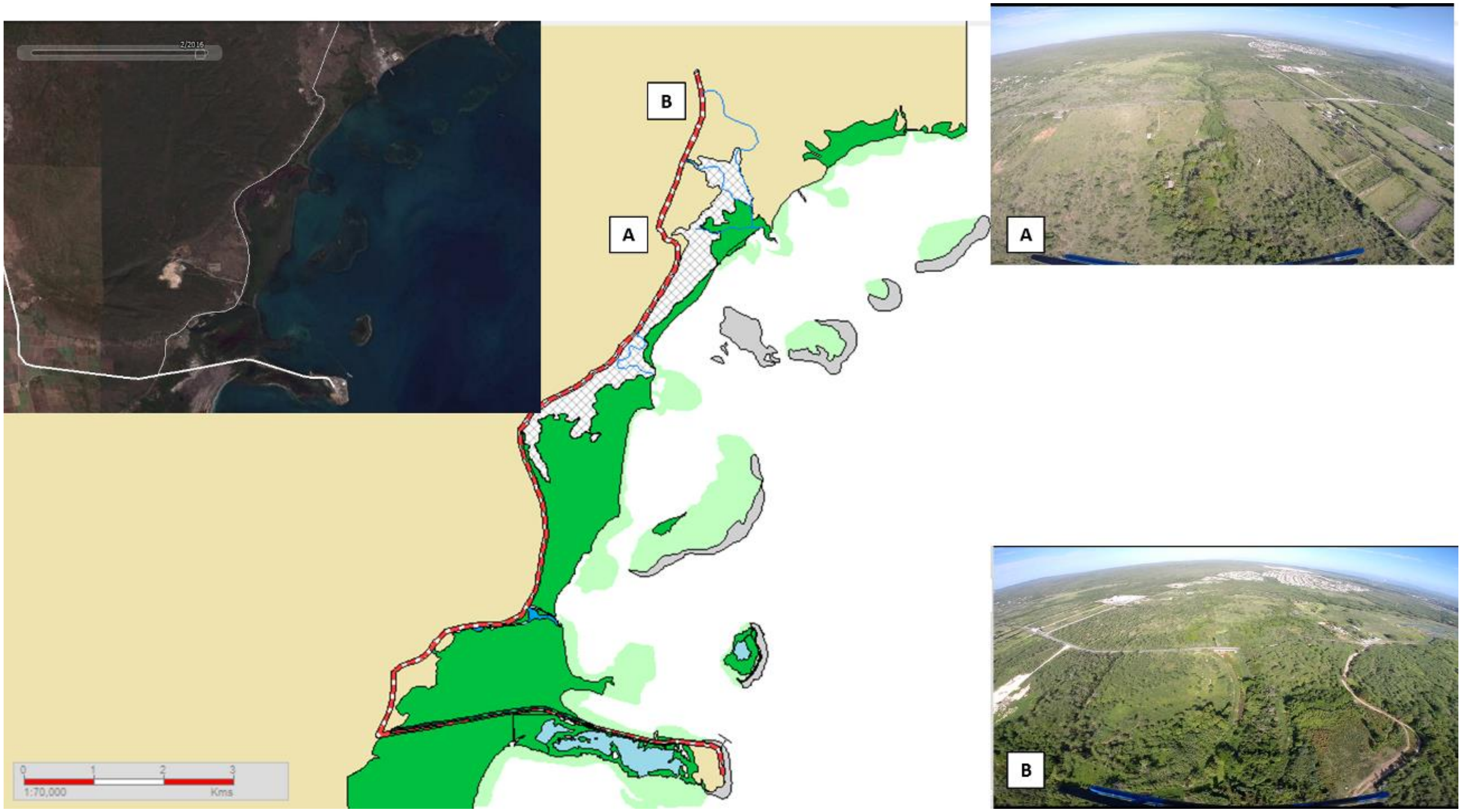


Figure 118: Bridges across drainage features connecting to wetland lifeforms along proposed alternative Salt River ADO truck route

Figure 119: Vegetation Types Along the Proposed NG Pipeline Alignment to JAMALCO Processing Plant.

Figure 120: Mangrove wetland lifeforms immediately adjoining proposed land-based NG pipeline route

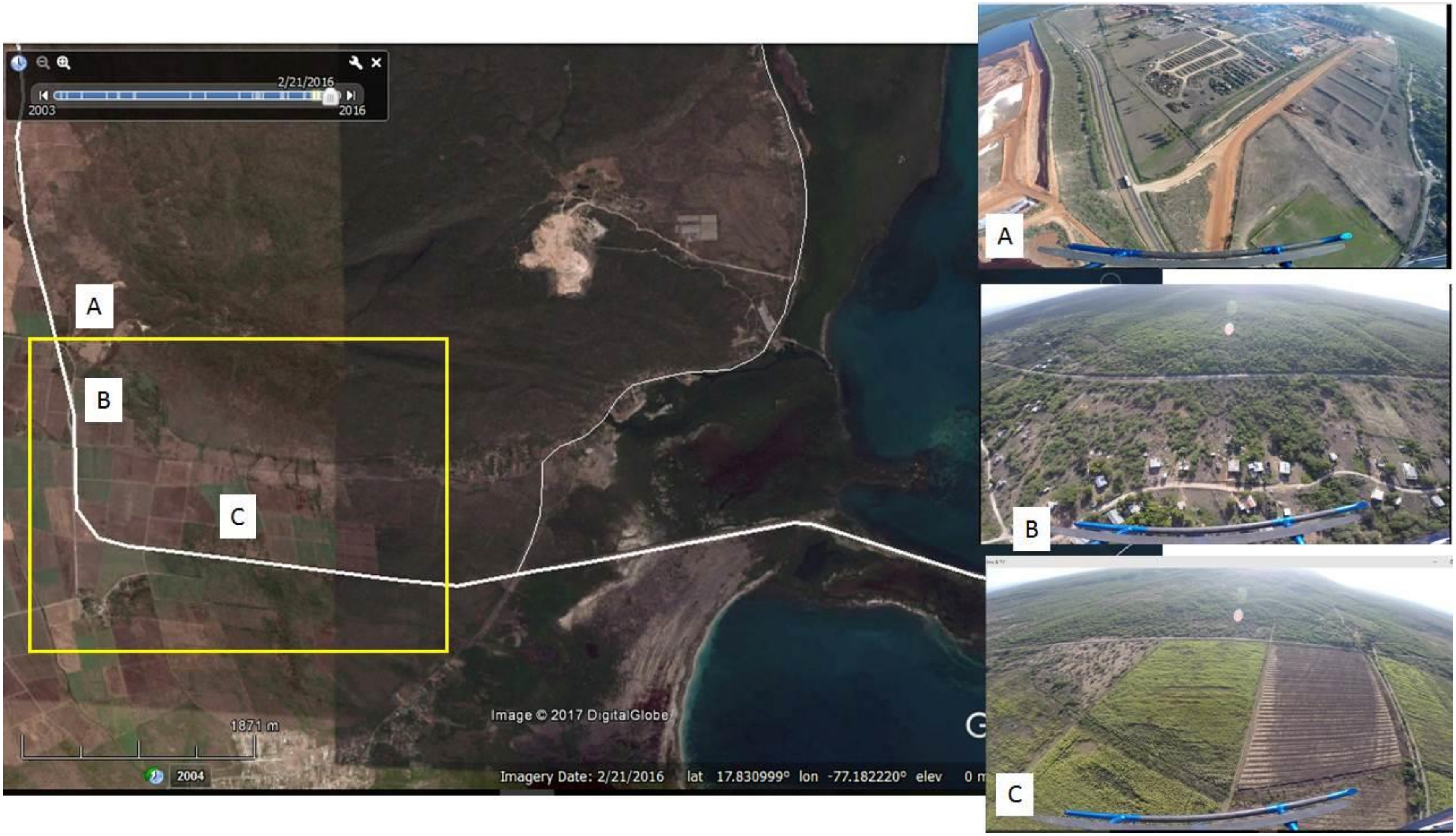


Figure 121: JAMALCO alumina refinery (A) residences (B) and agricultural lands (C) adjoining proposed NG pipeline

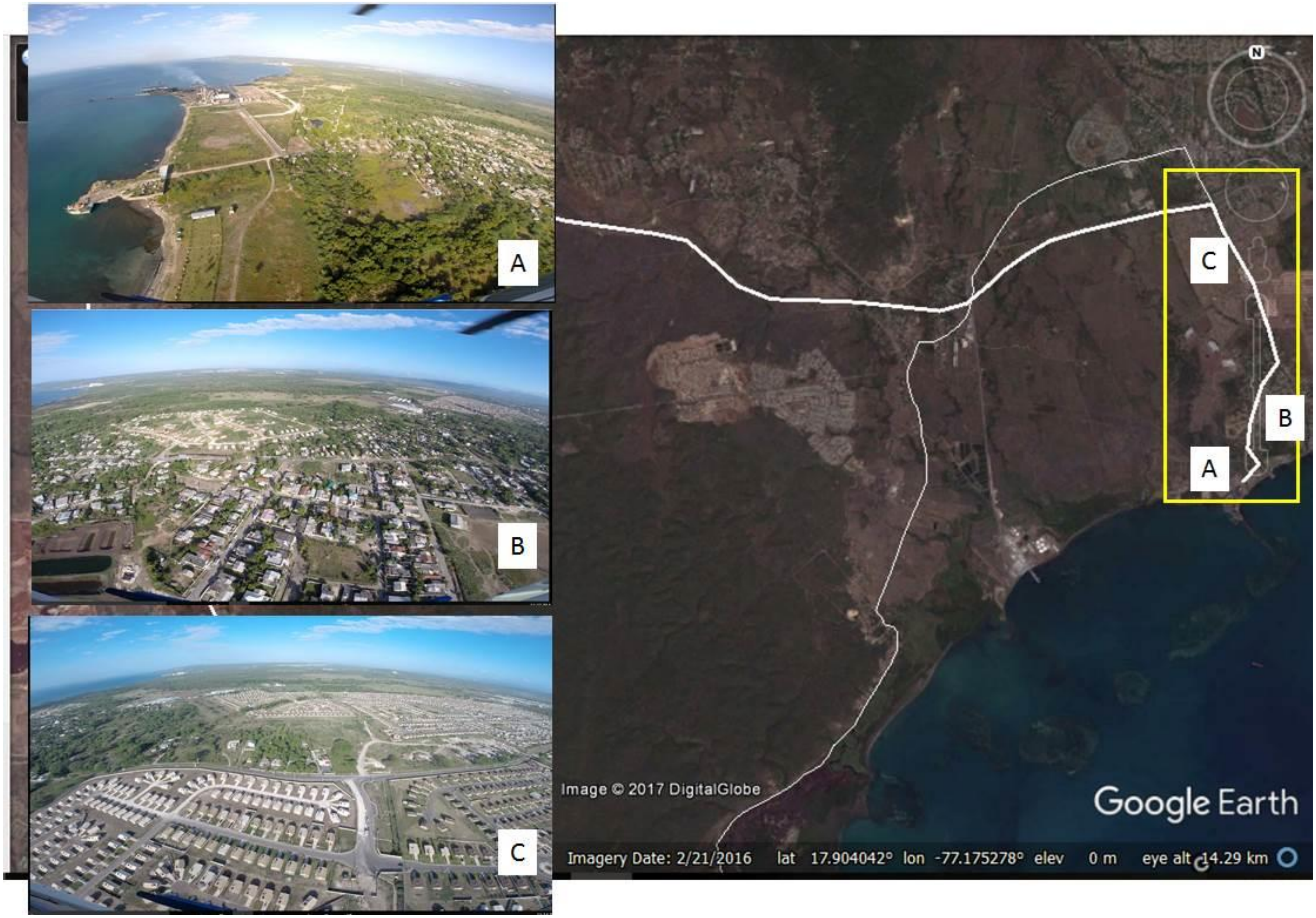


Figure 122: Proposed ADO Truck Route to Toll Road Showing Residences Along the First Stages of the Route Departing from the Old Harbour Bay Power Station.

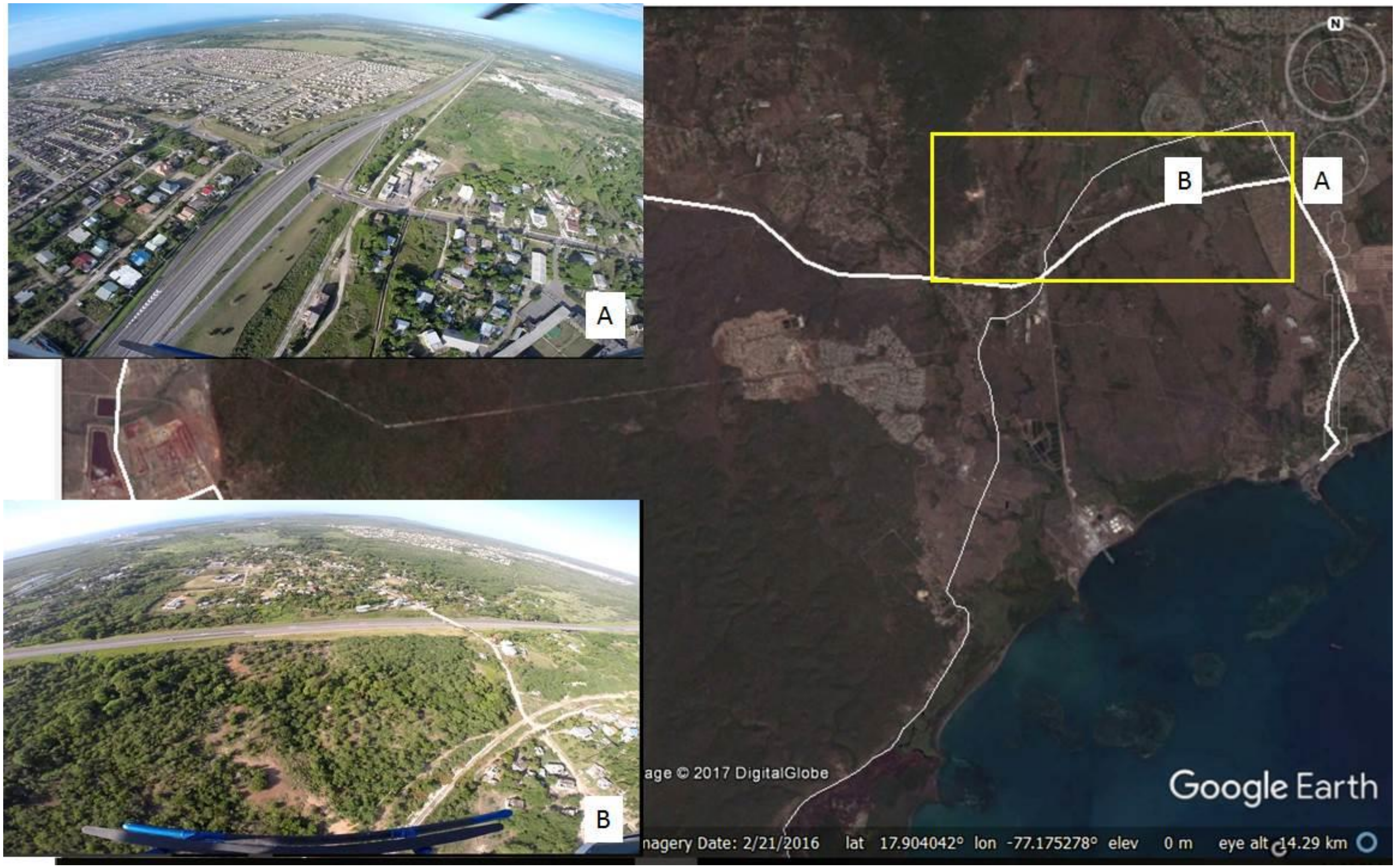


Figure 123: Proposed Highway 2000 ADO Truck Route Showing Toll Junction With New Harbour II Housing Development, and Open Lands Along the Mid Stages of the Route Departing from the Old Harbour Bay Power Station to JAMALCO.

Figure 124: Proposed Highway 2000 ADO Truck Route From Toll Road Onto Main Road to Hayes and JAMALCO Facility (A-C).

5.4.4. Marine and Terrestrial Assessments

5.4.4.1. Salt Island Assessments

The transect assessed at the Salt Island location (see alignment on Figure 114 above) showed a transition from coarse *Halimeda sp* platelet dominated sands, branching coral rubble and gorgonians (primarily *Pseudopterogorgia sp*) at a depth of approximately 5 meters to seaward, onto reef substrates that were primarily dominated by turf algae.

The reef framework appeared to have been generated by extensive growths of Elkhorn Coral (*Acropora palmata*) that had been historically impacted by storm and other physical stresses. The branching coral structures were no longer clearly distinguishable and, for the most part, were loosely assembled on the seafloor (see Figure 125 to Figure 127).

Very scattered growths of massive corals, primarily the Mustard Hill Coral (*Porites asteroids*) were observed, however, it was estimated that attached life form percentage coverage along the transect were as broken down below:

1. Hard Coral – 2%
2. Soft Coral -8%
3. Turf Algae – 55%
4. Macro-algae – 30%

It was clear from the assessment that hard coral percent coverages along the transect surveyed were very low. Coral sizes observed were also low, generally less than 20 centimeters in diameter. When compared with the percent coverage ranges observed during the 2014 study (11-25%) it can be concluded that the coral coverage on the reefs fringing the Salt Island are generally very low.

The character of fish populations observed on the transect, on the other hand, were comparable with the 2014 study data. An estimated 133 individuals per 100 square meters of seafloor area surveyed was determined, with the following breakdowns applying:

1. Parrotfish – 83

2. Grunt -39
3. Surgeon Fish - 11

The Parrotfish, like the data reviewed for the 2014 PBPA coral reef study, was the dominant fish surveyed, with the Princess Parrotfish (*Scarus taeniopterus*) being the most frequently observed. The Grunt was the second most frequently observed fish on the transect, with the French Grunt (*Haemulon flavolineatum*) dominating. No Snappers, Jacks or Groupers were observed.

Fish sizes were also comparable to the 2014 PBPA coral reef study. Parrotfish sizes were on average 10cm in length and all of the Princess Parrotfish seen exhibited juvenile characteristics.

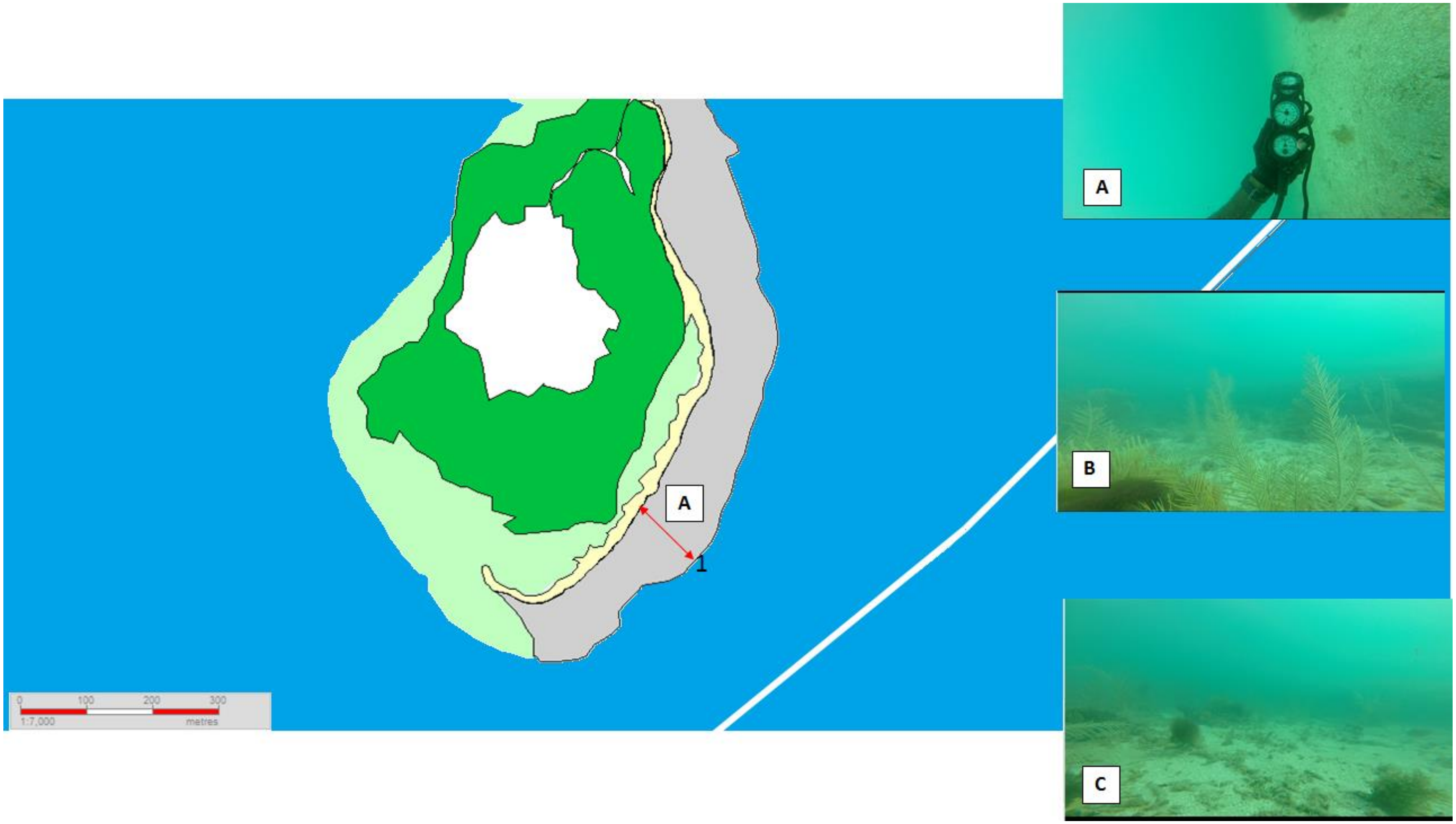


Figure 125: Figure 8C: Benthic Descriptions – Salt Island Marine Transect (A -1) Start of transect at seaward limit of reef - 5 meters depth, (B) Sand and soft corals – Gorgonians (C) Branching Coral Rubble

Figure 126: Figure 8D: Benthic Descriptions – Salt Island Marine Transect (A -2) (A and C) Dead Elkhorn Coral framework now supporting turf and macro-algae (B) Herbivorous fish-life

Figure 127: Figure 8E: Benthic Descriptions – Salt Island Marine Transect (A -3) Adjoining Reef Crest < 2 meters depth (A) Surface image showing exposed reef rubble and Island (B) Elkhorn coral framework dominated by turf and macro-algae (C) Herbivorous fish life

5.4.4.2. Marine Terminal Assessments

The transect assessed near to the shoreline of the Marine Terminal (see alignment on Figure 115 above) showed a transition from algae-covered coral rubble (apparently of a Staghorn Coral origin) and Gorgonians (primarily *Pseudopterogorgia sp*) at a depth of approximately 3 meters to seaward, onto soft sediments that were primarily dominated by Turtle Grass (*Thalassia testudinum*).

There were scattered massive coral assemblages, in excess of a meter in diameter, observed within the seagrass bed reef framework, formed primarily from growths of the Massive Starlet Coral (*Siderastrea siderea*). Individual examples of the Lesser Starlet Coral (*Siderastrea radians*), with diameters of less than 10cm, were also observed within the seagrass area.

Overall, it was estimated that attached lifeform percentage coverages along the transect were as broken down below:

1. Hard Coral – 1%
2. Soft Coral -1%
3. Macroalgae – 1%
4. Seagrass (*Thalassia sp*)– 97%

The transect area was primarily devoid of fish life, with the exception of individual Princess Parrotfish observed hiding among the seagrass blades and at the coral heads, where numerous juveniles were observed. No counts were taken, however, juveniles observed were primarily as listed below:

1. Princess Parrotfish Parrotfish (*Scarus taeniopterus* - DOMINANT) (See Figure 128)
2. Sergeant Major Fish (*Abudefduf saxatilis*) (See Figure 128)
3. Dusky Damselfish (*Stegastes adustus*)
4. Four-Eye Butterflyfish (*Chaetodon capistratus*)
5. Surgeon Fish (Acanthurus bahianus)
6. Black-Bar Soldierfish (*Myripristis Jacobus*)

7. French Grunt (Haemulon flavolineatum)
8. Porkfish (Anisotremus virginicus)

Fish sizes observed were generally less than 10 centimeters in length. Figure 138 to Figure 140 below describes the character of the environment through which transect studies were conducted.

Figure 128: Typical example of Princess Parrotfish Parrotfish (*Scarus taeniopterus* - DOMINANT) and Sergeant Major Fish (*Abudefduf saxatilis*)

5.4.4.3. Species Observed Around Rocky Point Port from 2014 Assessment

The information in this section was extracted from a study previously carried out by Conrad Douglas & Associates Limited in 2014. The study area was around the Rocky Point Port.

Attached lifeforms observed within the various substrates included the following:

1. **Soft Substrates**: Seagrasses – specifically Turtle Grass (*Thalassia testudinum*- **D**) on sandy (soft) substrates.
2. **Hard Substrates**: Various types of green and brown algae (**D**), Corals, specifically massive corals such as the Symmetrical Brain Coral (*Diploria strigosa*-**R**).
3. **Seagrass** (*Thalassia testudinum* -**A**) and **algae** (*Derbesia sp*-**F**) **on hard/ rubble substrates**.
4. **Tube and encrusting sponges** (**D**) as well as the **Soft Coral** *Pseudopterogorgia sp* (**R**) growing on submerged man-made surfaces, such as the support pilings for the

mooring island and submerged pipelines between the mooring island and the facility.

Free-swimming lifeforms were observed among both the reef and man-made structures at the Marine Terminal. These lifeforms included:

1. Spotted Eagle Rays ***Aetobatus narinari*** - **1**
2. Southern Stingrays ***Dasyatis americana* -** **1**
3. Snook ***Centropomus undecimalis*** - **1**
4. Tarpon ***Megalops atlanticus*** - **1**
5. Barracuda ***Sphyraena sp*** - **1**
6. Hawksbill Turtles ***Eretmochelys imbricata*** - **1**
7. Yellowtail Snappers ***Ocyurus chrysurus*** - **2**
8. Mangrove Snappers ***Lutjanus griseus* -** **2**
9. French Grunt ***Haemulon flavolineatum*** - **3**
10. Atlantic Thread Herring (***Opsithonema oglinum***)**4**
11. Dusky Damsel Fish ***Stegastes adustus*** - **3**
12. Sergeant Major Fish ***Abudefduf saxatilis*** – **3**
13. Striped Parrotfish ***Scarus iserti*** - **3**
14. Porcupine Fish ***Diodon antennatus*** - **1**
15. Lionfish ***Pterois sp*** - **2**
16. Yellowhead Wrasse ***Halichoeres garnoti*** - **2**

Examples of these free-swimming species are illustrated in Figure 135 to Figure 137.

Figure 129: Spatial Distribution of Seafloor Substrates within Study Area

Figure 130: Ground truthing Video Transect Sites (A-D) for Seafloor Substrate Identification within Study Area

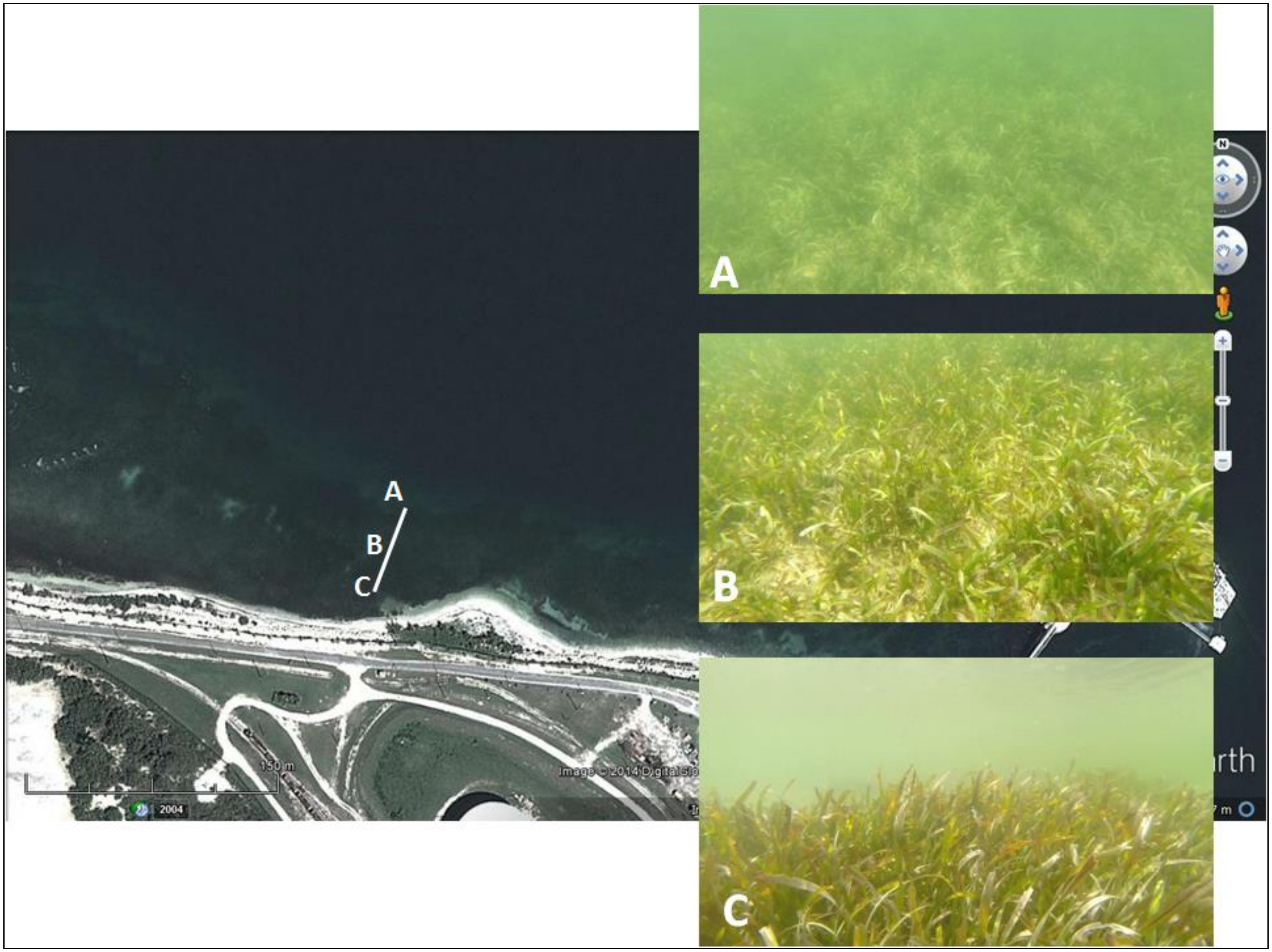


Figure 131: Ground truthing Video Transect at Site **A.** Showing Seagrass (Turtle Grass - *Thalassia testudinum*) Resources on Sandy Seafloor Substrates

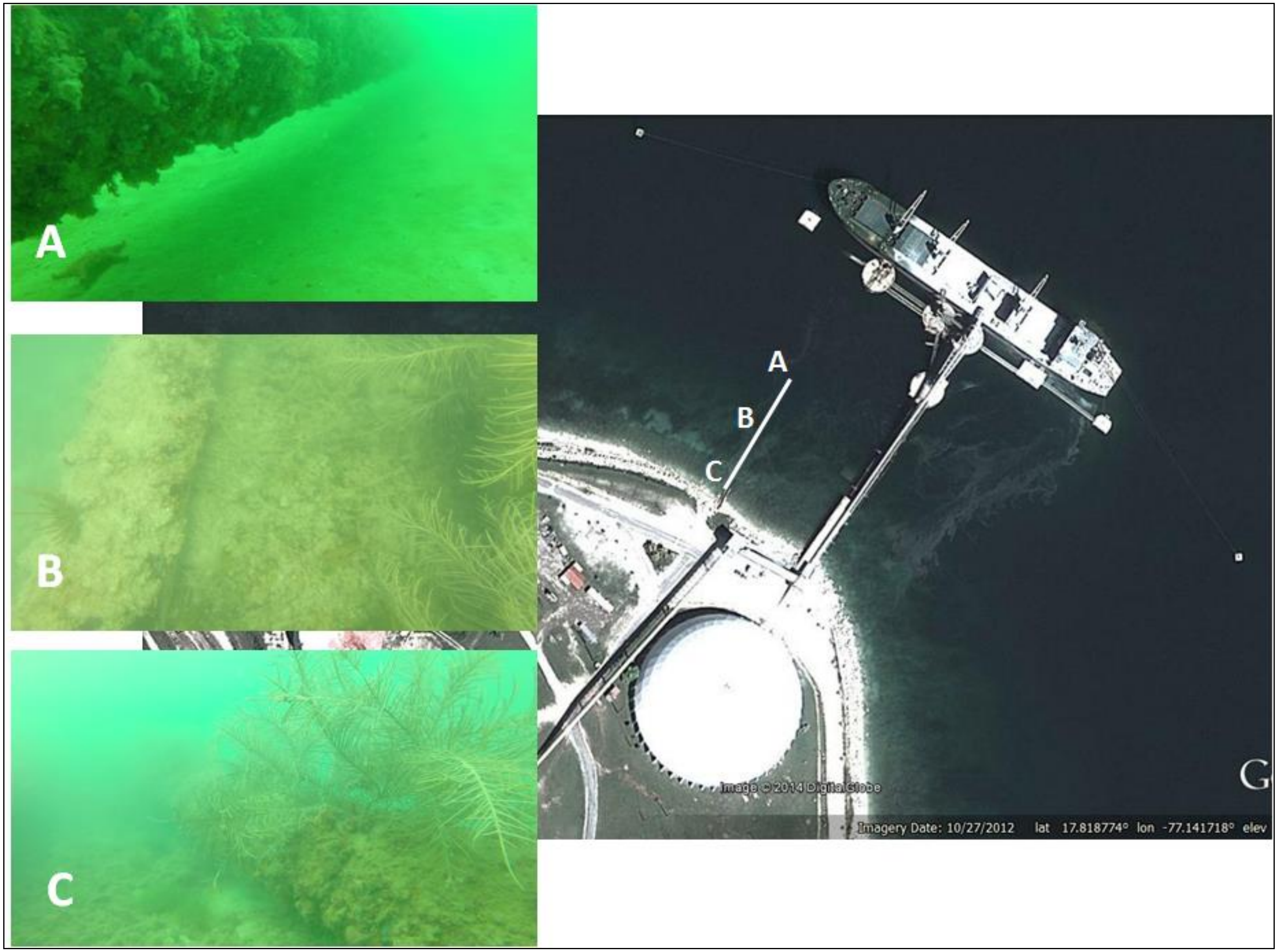


Figure 132: Ground truthing Video Transect at Site **B** showing Sponges and Soft Corals (*Pseudopterogorgia sp*) growing on Submerged Pipelines. The Pipelines were suspended over both soft and hard substrates.

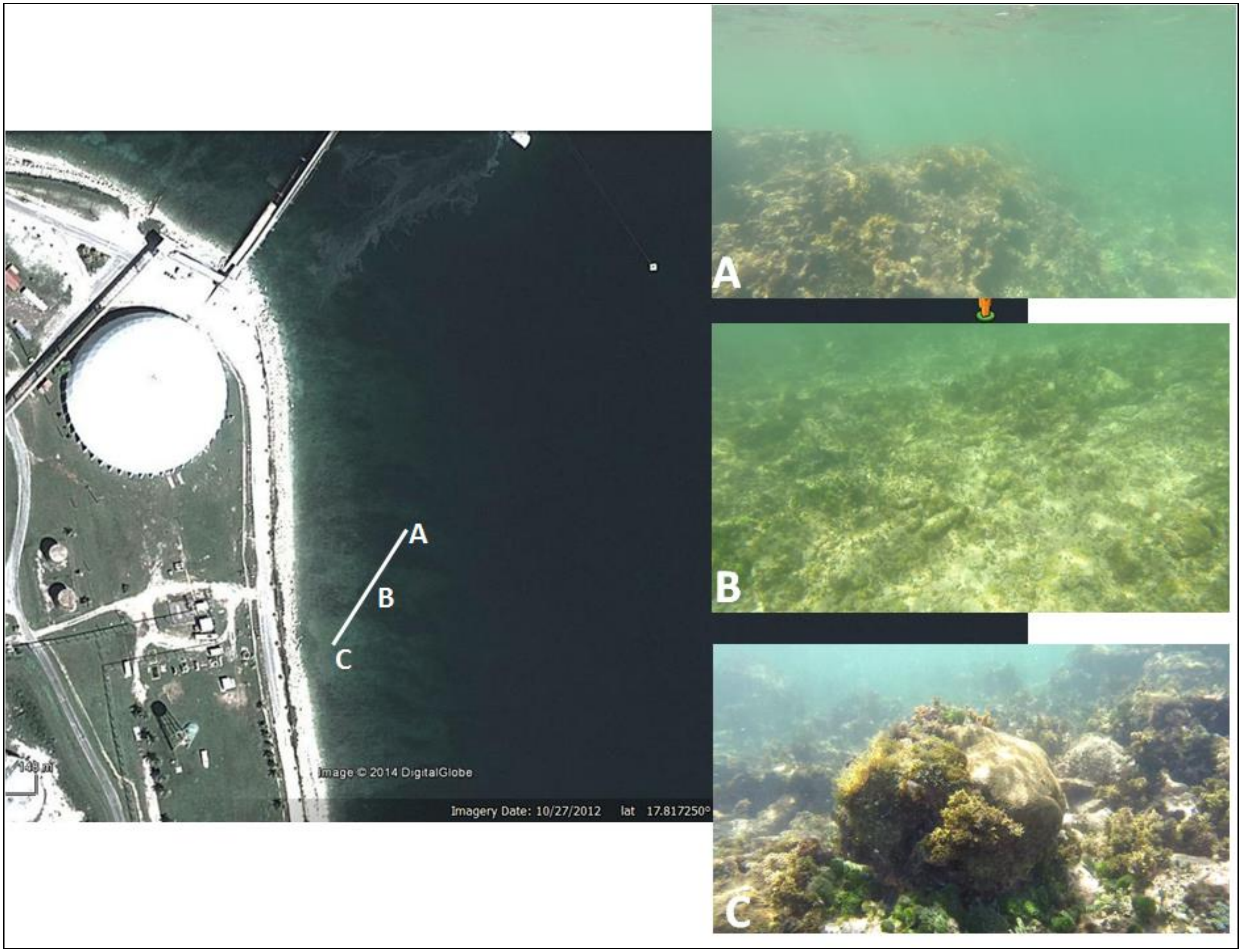


Figure 133: Ground truthing Video Transect at Site C showing Coral Reef Resources on Hard Seafloor Substrates (C-Symmetrical Brain Coral *Diploria strigosa*)

Figure 134: Ground truthing Video Transect at Site D showing **Sandy Substrates (A)** transitioning into **Hard Substrates (B)** and then into **Rubble Substrates with Seagrass and Algae (C)**.

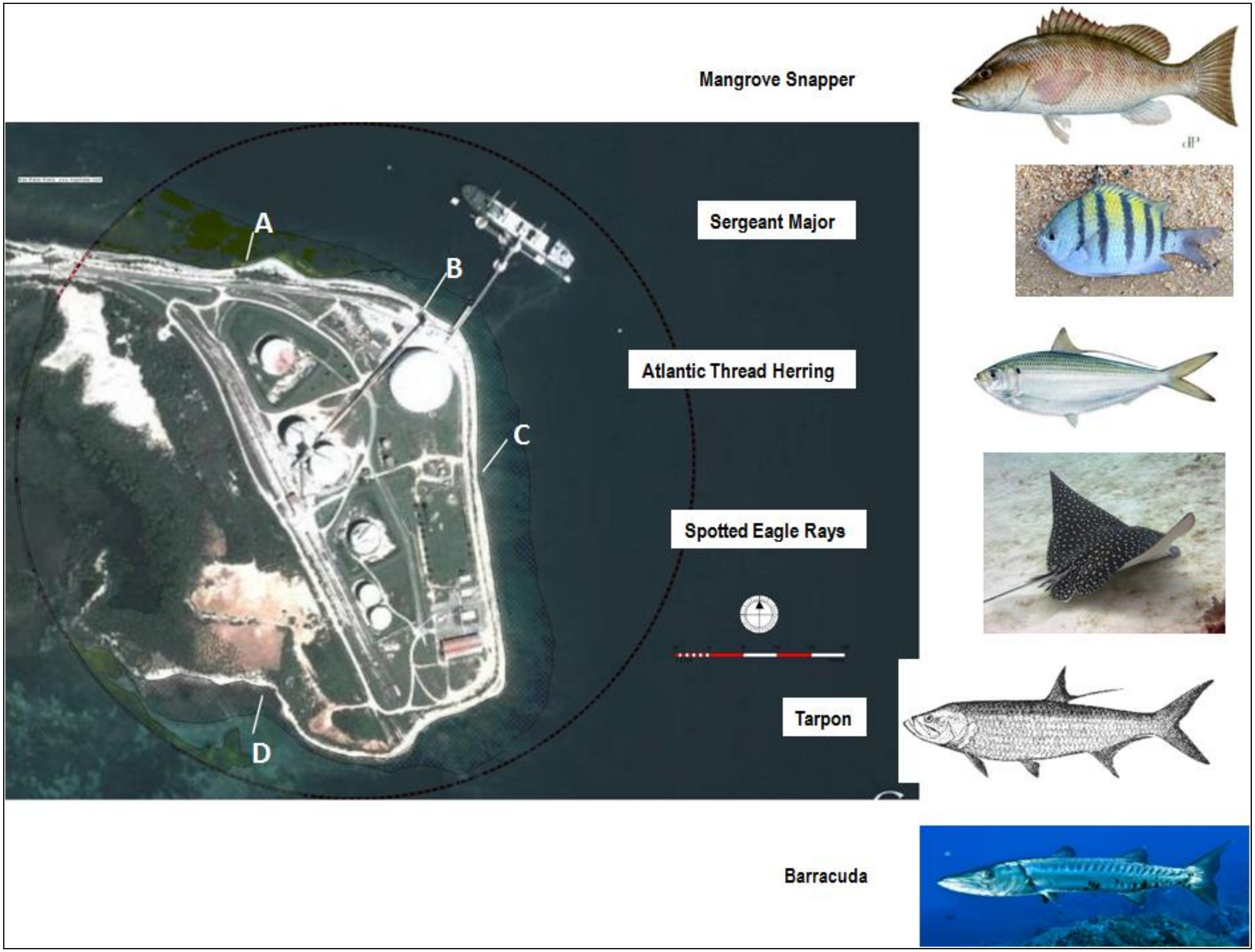


Figure 135: Free-swimming Organisms Observed Within Study Area-1

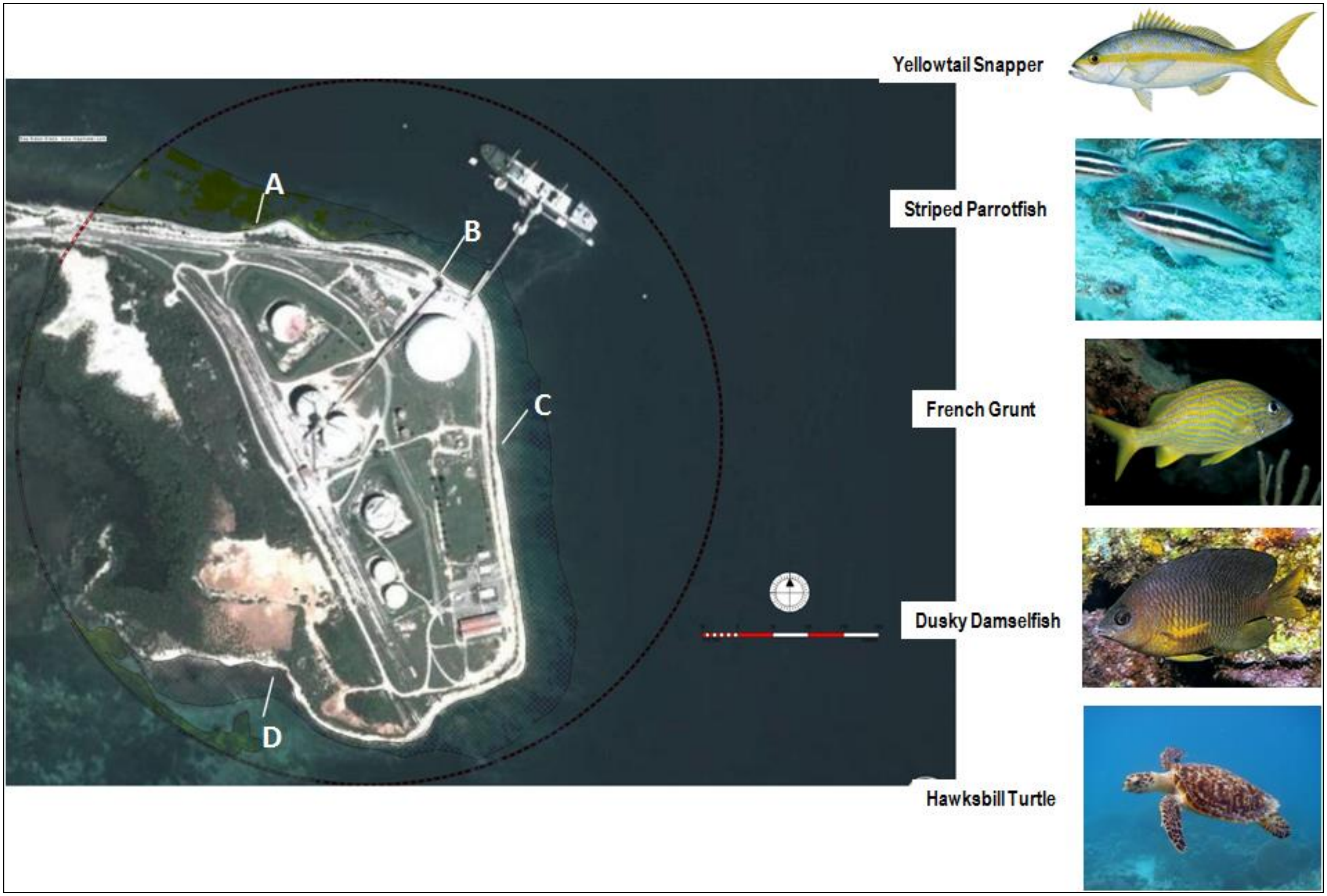


Figure 136: Free-swimming Organisms Observed Within Study Area-2

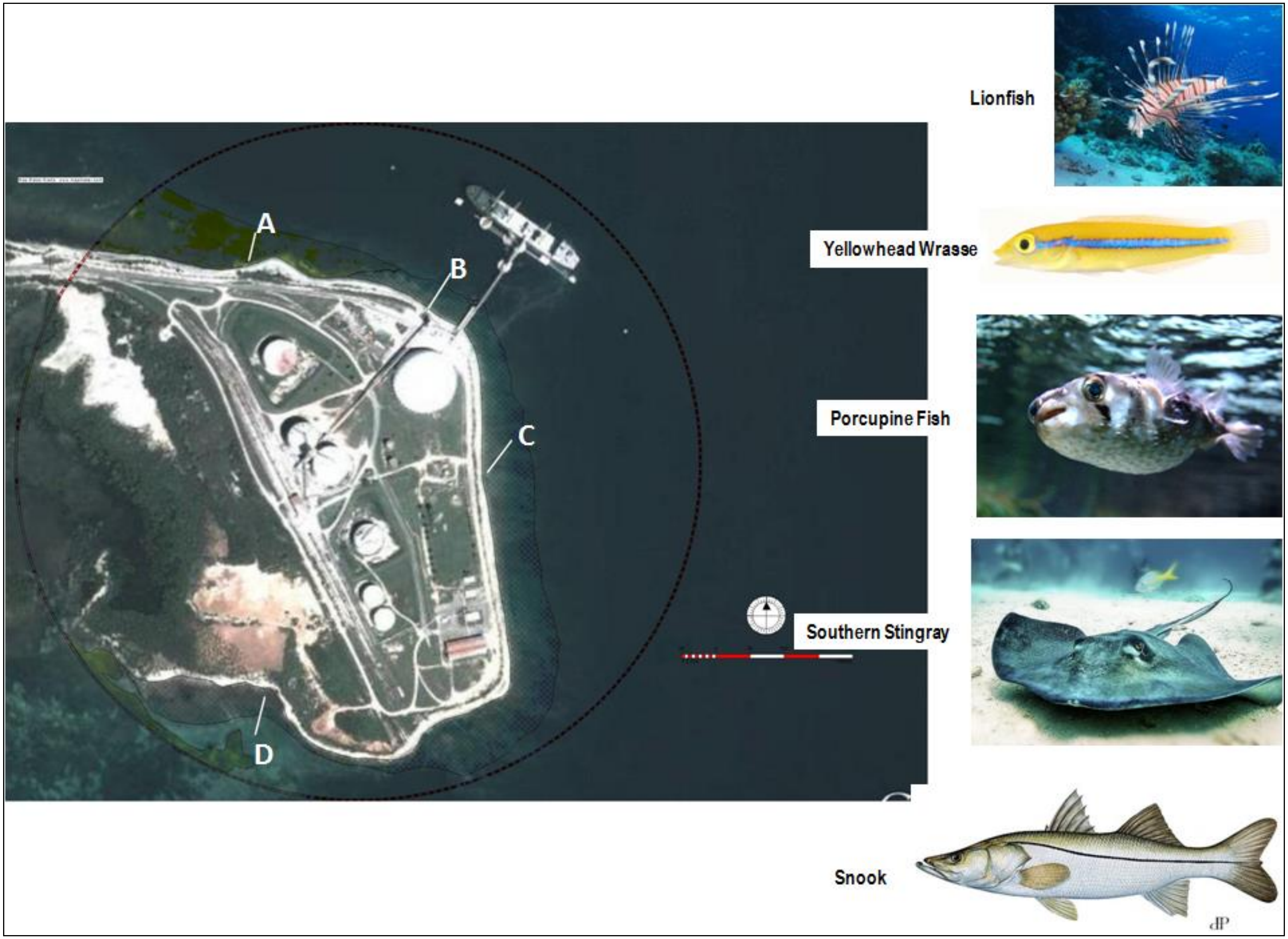


Figure 137: Free-swimming Organisms Observed Within Study Area-3

5.4.4.4. Marine Substrates General Alignment of NG Pipeline

Grab samples and images obtained from a tethered video camera deployed at the marine sample locations defined on Figure 99 above revealed that the substrate along the alignment of the proposed pipeline was dominated by mud, as depicted on Figure 141 below.

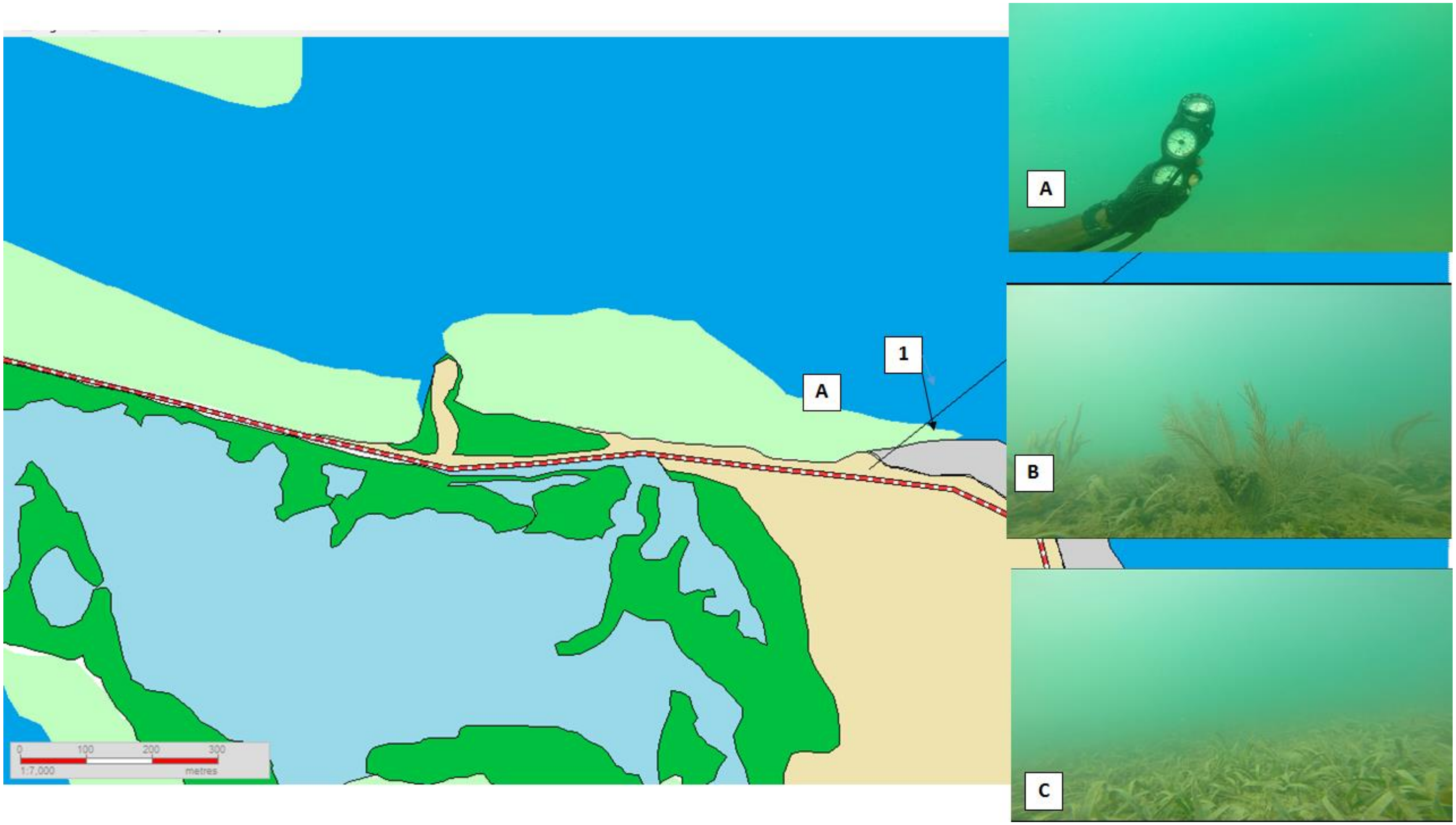


Figure 138: Benthic Descriptions – JAMALCO Marine Terminal Transect (A -1) Start of transect at seaward limit of reef - 3 meters depth, (B) Sand, Branching Coral rubble and soft corals – Gorgonians (C) Sand and Seagrass

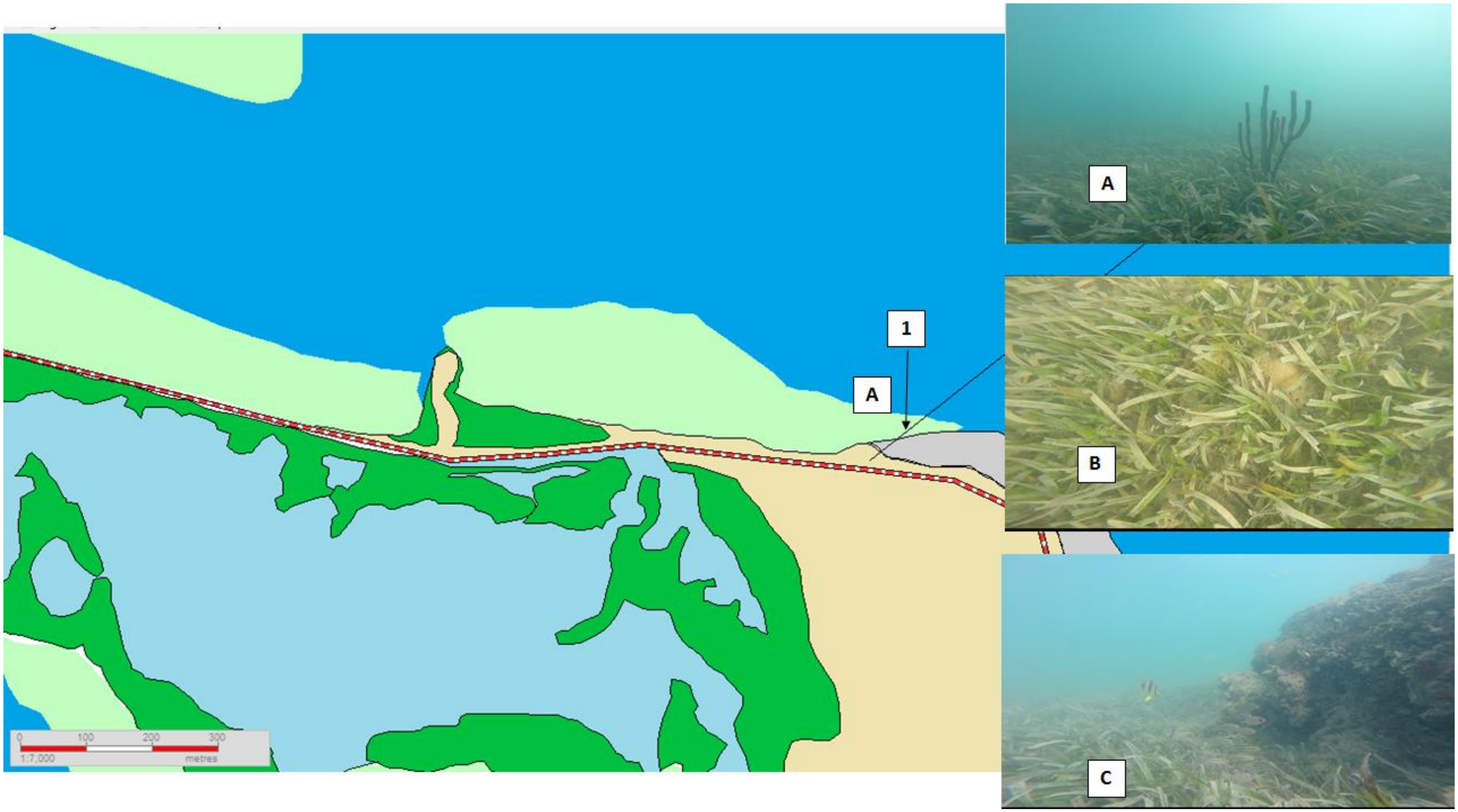


Figure 139: Benthic Descriptions – JAMALCO Marine Terminal Transect (A -1) Middle of transect - 2 meters depth,(A) Seagrass with Solitary Gorgonian (B) Seagrass with Solitary Lesser Starlet Coral (C) Seagrass with Massive Coral Heads

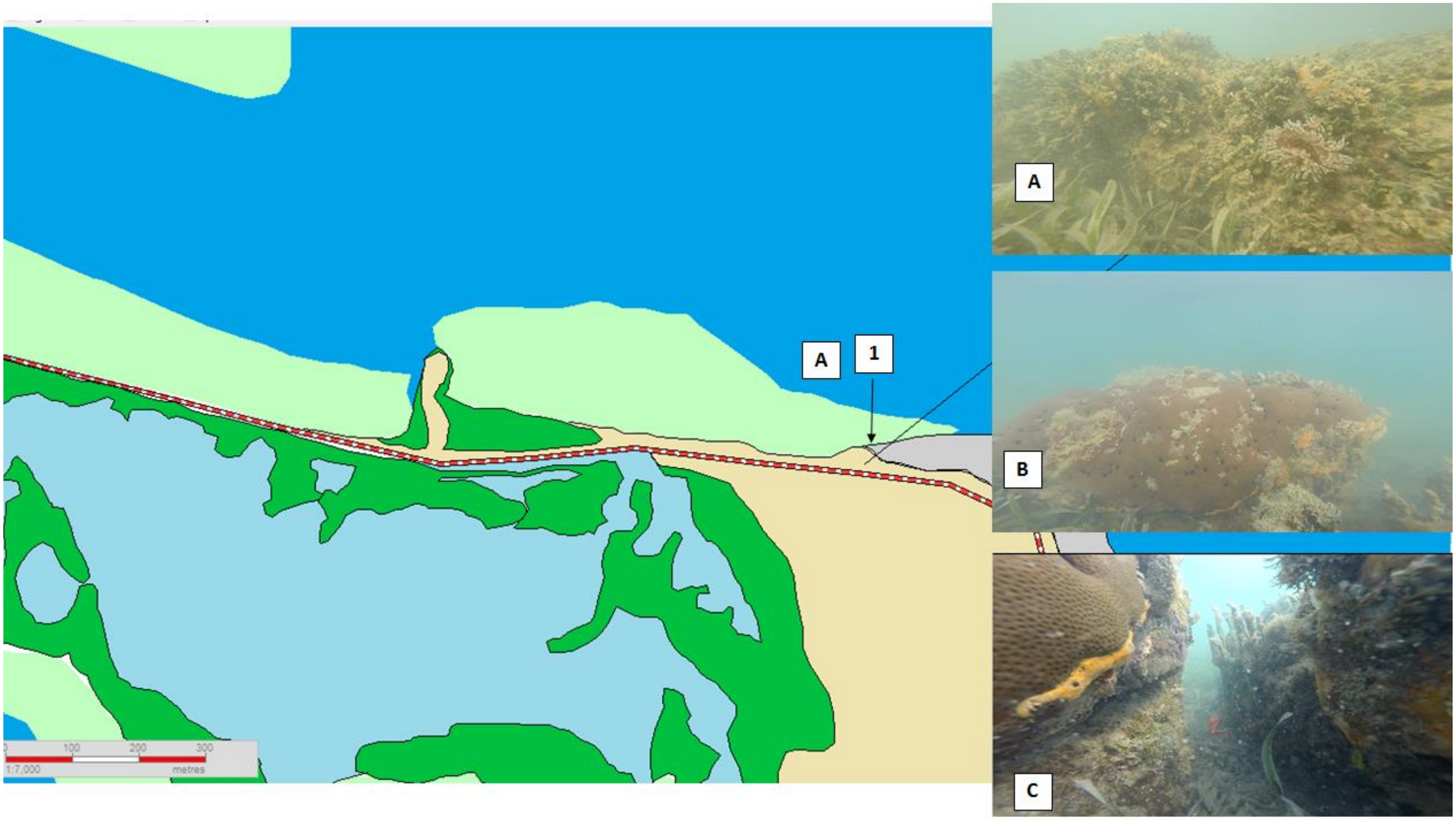


Figure 140: Benthic Descriptions – JAMALCO Marine Terminal Transect (A -1) End of transect < 2 meters depth, (A-C) Seagrass with Massive Coral Heads

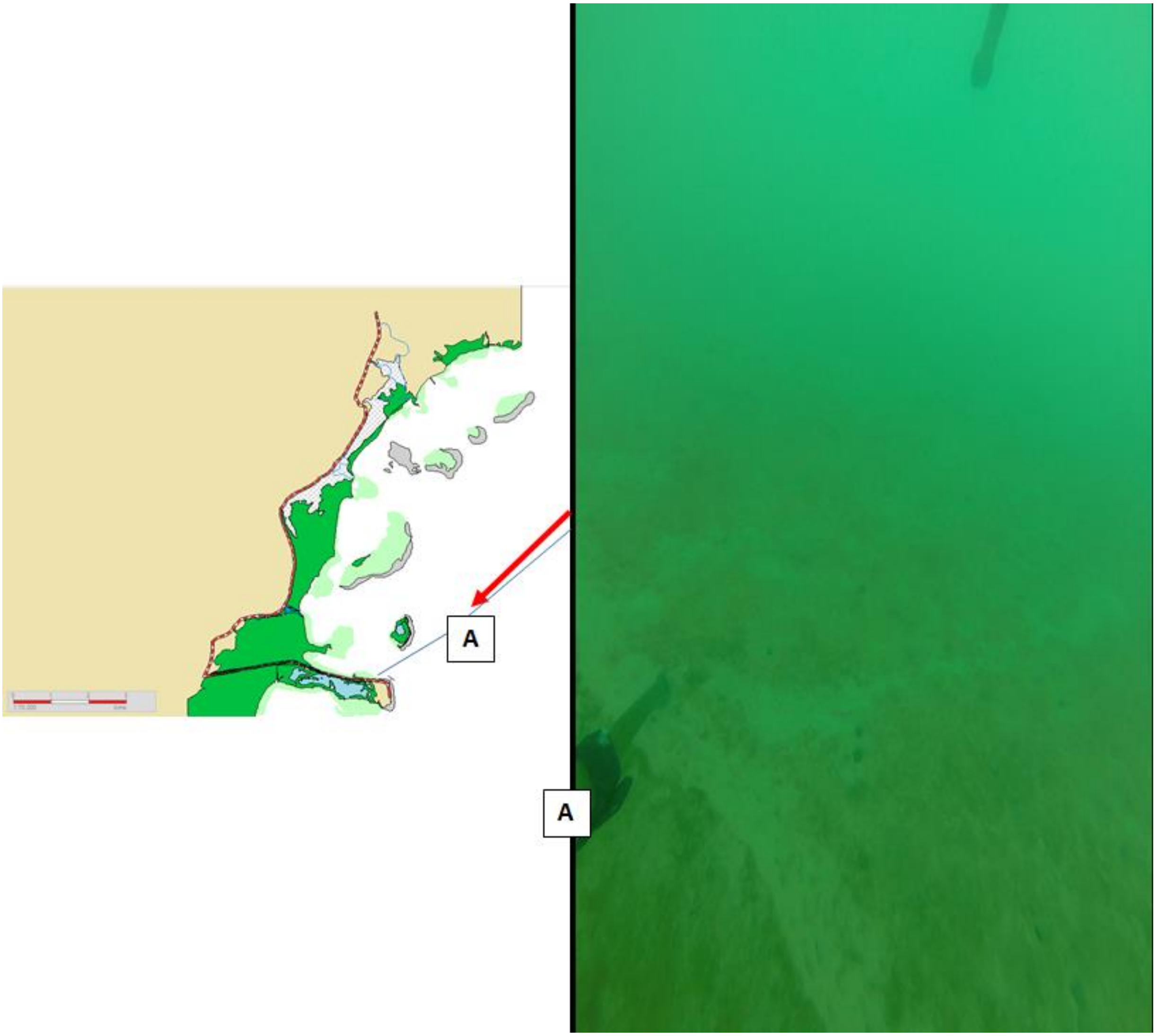


Figure 141: Image From Drop Camera Showing Muddy Character of Seafloor Along Alignment of Proposed NG Pipeline Route

5.4.4.5. Water Quality Assessment

Marine water samples were analysed by the Pesticide Research Laboratory (PRL), an accredited laboratory and analyses carried out for Total Petroleum Hydrocarbon (TPH). A total of eight (8) samples were collected and delivered to the PRL on April 27, 2017. The samples were divided into two sub categories, surface and depth. The test method used was liquid-liquid extraction of hexane, with confirmation by gravimetric analysis.

In addition, samples were collected on April 21 and on April 26, 2017 and delivered to the ISO 17025 accredited laboratory, Scientific Research Council (SRC) and evaluated for the following seven (7) parameters:

- Total Coliform
- Faecal Coliform
- Phosphates
- Nitrate
- Total Suspended Solids
- Fat, Oil and Grease
- Biological Oxygen Demand

Marine water samples were also analyzed in situ using a Horriba Water Quality Checker with an attached probe for measuring water quality at depths of 48ft for S_1, 54ft for S_2, 41ft for S_3 and 28ft for S_4 and for surface measurements for the following water quality parameters:

- Temperature
- Salinity
- Turbidity
- pH

5.4.4.5.1. Evaluation Criteria

Figure 142 below shows the four (4) water quality sampling locations. Samples were taken at the surface and at varying depths. Surface samples are labelled S_x Su while samples taken at depths are labelled S_x.

Figure 142: Water Quality Sampling Site Locations

The National Resources Conservation Authority (NRCA) and the Water Resources Authority (WRA) in December, 1998, developed the Interim Standards for Petroleum in Ground Water and Soil. The Total Petroleum Hydrocarbon (TPH) is similar to the gasoline range organics, which is the classification used by the USEPA to refer to petroleum products within the range C_1 – C_{10} of the carbon chain. Table 21 below shows the Interim Standards for Petroleum in Ground water and Soil. There are no national standards for TPH for Marine Water Quality.

Table 21: Interim Standards for Petroleum in Ground Water and Soil

Petroleum	Ground Water	Soil
TPH	50 ppm	1000 ppm
BTEX	1000 ppm	135 ppm
Benzene	200 ppb	5 ppm
Toluene	-----	30 ppm
Ethyl Benzene	-----	50 ppm
Xylene	-----	50 ppm

Table 22 and Table 23 below show the NRCA's National Trade Effluent Standards, 1995, and the Draft for Jamaica's National Ambient Water Quality Standard for marine water, 2009. These standards were used to compare the parameters listed in the tables below:

Table 22: NRCA's National Trade Effluent Standards, 1995

Parameter	Standard Limit	Unit
Nitrate (as Nitrate or Nitrite)	10	ppm
FOG	10	ppm
Phosphate	5.0	ppm
Biological Oxygen Demand (BOD_5)	< 30	ppm
Total Coliform	< 500	MPN/100mL
Faecal Coliform	< 100	MPN/100mL
Total Suspended Solids	< 150	ppm
Temperature	27 ^oC (+ / - 2 ^oC average ambient temperature)	^oC

Table 23: Draft of Jamaica's National Ambient Water Quality Standard (Marine, 2009)

Parameter	Standard Range	Unit
Phosphate	0.001 – 0.003	ppm
Nitrate	0.007 – 0.014	ppm
BOD_5	0.0 – 1.16	ppm
pH	8.00 – 8.40	
Total Coliform	2 – 256	MPN/100mL
Faecal Coliform	< 2 - 13	MPN/100mL

5.4.4.5.2. Results

The results from the analysis conducted by the PRL on May 1, 2017, from the samples of the marine water collected using the method of liquid-liquid extraction with hexane, and confirmation by gravimetry to determine the values of TPH in each sample are shown in Table 24 below.

Table 24: Results from PRL on the values of TPH in each sample

Sample Name	Quantity (L)	Parameter	Results (ppm)	TPH Standard
S_1 A and S_1 B	2	TPH	2.4 ± 0.1	50 ppm
S_1 Su A and S_1 Su B	2	TPH	0.8 ± 0.1	50 ppm
S_2 A and S_2 B	2	TPH	0.4 ± 0.1	50 ppm
S_2 Su A and S_2 Su B	2	TPH	0.2 ± 0.1	50 ppm
S_3 A and S_3 B	2	TPH	0.1 ± 0.1	50 ppm
S_3 Su A and S_3 Su B	2	TPH	0.1 ± 0.1	50 ppm
S_4 A and S_4 B	2	TPH	0.3 ± 0.1	50 ppm

The results on the eleven (11) parameters that were evaluated from the marine water samples collected on April 21 and April 26, 2017, are shown in Table 23 below.

Table 25: Comparison of results obtain from the SRC with NRCA's National Trade Effluent Standards & Draft Jamaica National Ambient Water Quality Standard (Marine, 2009)

Date Analysis	Parameter	S_1	S_2	S_3	S_4	S_1 Su	S_2 Su	S_3 Su	S_4 Su	Water Quality Standard [1]
21 & 27 April, 2017	BOD	2.0	1.5	1.4	1.4	0.7	0.9	1.3	0.9	0.0 – 1.16 ppm
21 & 26 April, 2017	FOG [2]	5.30 ± 0.59	4.00 ± 0.44	4.43 ± 0.55	4.63 ± 0.57	3.80 ± 0.42	2.60 ± 0.30	2.80 ± 0.31	3.82 ± 1.00	10 ppm
22 & 27 April, 2017	Faecal Coliform	130	170	1600	540	<1.8	<1.8	<1.8	<1.8	< 2 – 13 MPN/100mL
	Total Coliform	240	280	>1600	540	<1.8	<1.8	<1.8	<1.8	2 – 256 MPN/100mL
24 & 28 April, 2017	Phosphate	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	<0.05	0.11	0.001 – 0.003 ppm
	Nitrate	<0.9	<0.9	<0.9	<0.09	<0.9	<0.9	<0.9	<0.9	0.007 – 0.014 ppm
26 April, 2017	TSS [2]	112	188	162	161	120	96	139	116	< 150 ppm [3]
26 April 2017	Temperature	23	22	20	23	21	19	20	21	27.7°C (+ / - 2 °C average ambient temperature)[4]
	Salinity [5]	21	21	21	21	21	21	21	21	35 ppt
	pH	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.00 – 8.40
	Turbidity	17.3	17.5	18.3	18.5	19.2	22.8	21.3	20.2	

[1] = *Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009*
[2] = *NRCA's National Trade Effluent Standards, 1995*
[3] = *Yearly value*
[4] = *Average ambient temperature for Month of April, 2017, was 27.7 °C.* https://www.seatemperature.org/central-america/jamaica/rocky-point-april.htm*, June 12, 2017 (Readings are from daily satellite recordings provided by NOAA. Temperatures are surface temperature [SST])*
[5] = http://oceanservice.noaa.gov/facts/whysalty.html*, 'Why is the ocean salty?', June 12, 2017*

5.4.4.5.3. Discussion

It should be noted that when compared to NRCA's National Trade Effluent Standards and the Draft Jamaica's National Ambient Water Quality Standards for Marine Water, only a few parameters fell within the acceptable standards as shown in the Table 25cabove. It should also be noted that NEPA does not have any standards for marine water.

The results obtained for TPH when compared with the Interim Standards for Petroleum in Ground Water and Soil shows that all samples, surface and depth, fell well below the average standards of 50 ppm in ground water with a range of 0.1 ± 0.1 ppm to 2.4 ± 0.1 ppm.

The results for Total Coliform, Faecal Coliform, Phosphates, Nitrate, TSS, FOG and BOD when compared with the Draft Jamaica National Ambient Water Quality Standard (Marine) and NRCA's National Trade Effluent Standards show that only a few of the samples collected for each parameter fell within the acceptable standards.

The results for FOG in all samples came within acceptable national standards, with a range of 2.60 ± 0.30 ppm to 5.30 ± 0.59 ppm when compared to the NRCA's National Trade Effluent Standards of 10 ppm.

The results for TSS in samples S_2, S_3 and S_4 exceeded the national standards of < 150 ppm (yearly value) when compared with NRCA's National Trade Effluent Standards. The results for the samples S_2, S_3 and S_4 were greater by 25.3%, 8% and 7.3% respectively, while samples S_1, S_1 Su, S_2 Su, S_3 Su and S_4 Su fell within the national standards with 112 ppm, 120 ppm, 96 ppm, 139 ppm and 116 ppm respectively.

BOD results for samples S_1, S_2, S_3, S_4 and S_3Su fell out of the national standards of 0.0 ppm – 1.16 ppm. The results for samples S_1, S_2, S_3, S_4 and S_3 Su were greater by 72.4%, 29.3%, 20.7%, 20.7% and 12.1% respectively. Samples S_1Su, S_2Su and S_4Su fell within the national standards with 0.7ppm, 0.9 ppm and 0.9 ppm respectively. Most animals that live in the water need oxygen, except for air breathing animals such as whales and dolphins. Most use oxygen dissolved in the water. Natural processes and human pollution can cause serious reduction in dissolved oxygen. Both anoxia (no oxygen) and hypoxia (very low oxygen - ≤2 ppm) are harmful to fish, shellfish and other marine animals.

The value for Faecal Coliform and Total Coliform in one location, sample S_3, was considerably higher than the rest of samples. The sample location is in close proximity to Salt Island. When compared to the national standards for Faecal Coliform, the results for samples S_1, S_2, S_3 and S_4 was greater by 900%, 1207.7%, 12,207.7% and 4,053.8% respectively, while the value for Faecal Coliform in samples S_1 Su, S_2 Su, S_3 Su and S_4 Su fell below the national standards with < 1.8 MPN/100mL in all samples.

Total Coliform in sample S_1 fell within the national standards with 240 MPN/100mL. Samples S_2, S_3 and S_4, when compared to the national standards, were greater by 9.4%, 525% and 110.9% respectively. Samples S_1Su, S_2 Su, S_3Su and S_4 Su fell well below the national standards by 99.3%.

Phosphates exceeded the national standards of 0.001 ppm – 0.003 ppm in all samples. Samples S_1, S_2, S_3, S_4, S_1Su and S_3Su were greater by 1,566.7% when compared to the national standards. Sample S_2 Su was greater by 1,900% and sample S_4 Su was greater by 3566.7%.

Nitrates exceeded the national standards of 0.007 ppm – 0.014 ppm in seven samples. Samples S_1, S_2, S_3, S_1 Su, S_2Su, S_3Su and S_4 Su were greater by 6,328.6% compared to the national standards, while sample S_4 fell within the national standards with < 0.09 ppm.

The average surface marine water temperature (SST) tested around the Rocky Point, Clarendon area within the month of April 2017, was 27.7 ^{0}C. The temperatures recorded from all samples collected on April 21 and April 26, 2017, ranged from 19 ^{0}C to 23 ^{0}C. The temperatures in each sample fell below the average ambient temperature of marine water. Samples S_1 and S_4 recorded 4.7 ^{0}C (+/- 2) below the average temperature. Sample S_2 recorded 5.7 ^{0}C (+/- 2) below the average temperature. Sample S_3 and S_3 Su recorded 7.7 ^{0}C (+/-2) below the average temperature. Samples S_1 Su and S_4 Su recorded 6.7 ^{0}C (+/- 2) below the average temperature. Sample S_2 Su recorded 8.7 ^{0}C (+/- 2) below the average temperature.

Salinity is the measure of all salts dissolved in water. Salinity is measured in parts per thousand (ppt) and the average ocean salinity is 35 ppt. All samples showed that they fell within the Global standards of salinity provided by the National Oceanic and Atmospheric Authority (NOAA).

The normal pH of open ocean seawater is about 8.1 or slightly alkaline. The pH of seawater in typical estuaries and coastal waters routinely varies from pH 7.5 to 8.5 with occasional occurrences of pH greater than 9 or less than 7. The pH levels recorded for each sample is 8.3 which are in line with typical coastal waters.

Turbidity and TSS have similarities, however, turbidity is not a direct measurement of total suspended material in the water; but instead an indicator of water quality based on clarity and estimated TSS in water. Turbidity can also include coloured dissolved organic matter (CDOM), fluorescent dissolved organic matter (FDOM), other dyes and suspended sediments such as clay, silt, organic and inorganic matter. In some shallow areas, high winds regularly cause enough vertical mixing to re-suspend the bottom sediments. Sea grass beds normally decrease the turbidity measurements because they absorb light that could have been reflected from the seafloor.

5.4.4.5.4. Conclusion

The test conducted for the total value of TPH and compared with the Interim Standards for Petroleum in Ground Water (50 ppm) and Soil (1000 ppm) showed that all samples, S_1 - S_4, fell below the interim standards for petroleum in ground water with a range of 0.1 ± 0.1 ppm to 2.4 ± 0.1 ppm.

The results from the water quality analysis conducted, indicates that the water quality in the tested areas, S_1, S_2, S_3 and S_4 were above the Draft Jamaica National Ambient Water Quality Standards (Marine, 2009) and observed to be in poor condition for the following parameters:

- Phosphate
- Nitrate
- BOD
- Total Coliform
- Faecal Coliform

Samples S_1, S_2, S_3 and S_4 all fell within the national standards pH range.

The following parameters were analyzed for all samples and were observed above NRCA's National Effluent Trade Standards:

- Total Suspended Solids (TSS).

All samples fell within acceptable standards for Fats, Oil and Grease (FOG) when compared to the National Effluent Trade Standards.

The temperatures recorded in each sample fell below the acceptable standard.

This represents the baseline conditions and suggests there is some pollution loading arising from other activities within the region.

5.4.4.6. Sediment Characterization

Videography was carried out of the benthic sediments. The following assessment was made:

In general, at the nearshore, the benthic sediments appear to be coarse grained inorganic material that is a well sorted mixture of fine sand to medium gravel.

Sea current conditions imply that the finer particles are unlikely to be disturbed by normative sea conditions. If disturbed free settling is mostly controlled by the particle density and shape.

At deep sea, the benthic material appears to be inorganic and poorly sorted with an unconsolidated top layer of material consisting mostly of fine-grained sediments. Material appears to be easily entrained in, and dispersed by, a fluid medium with free settling mostly controlled by eddys rather than particle density and shape. Material may be indicative of high energy and/or high duration transport overland by surface water. Thickness of unconsolidated layer appears to increase closer to the Rocky Point Port.

5.4.4.7. Oceanography Character

As suggested by Webber, Webber and Williams (2003), there was evidence to suggest that the Portland Bight was influenced predominantly by wind forces. The Meteorological Service of Jamaica[29] has indicated that for most of the year, the daily Jamaican wind pattern is dominated by an east-southeasterly wind with an average speed of 18 knots while at night, the winds have a northerly component with an average speed of 7 knots. This speed varies during the year with the lowest speed components being experienced between December to March. Highest daytime speeds are typically achieved during the months of June to July, with wind speeds of up to 26 knots being experienced.

This would therefore suggest that daytime winds would induce daytime wave movements running towards the west-north west and night time movements running to the south. Figure 143 and Figure 144 below support this suggestion, illustrating wave/water movements that appear to be dominated by the direction of the prevailing wind. Figure 145 below appears to show a combination of land-breeze influenced water movement and river flow movements, as indicated by turbidity pattern movements shown on the Google Earth images used for the illustration. The water surface on the Google Earth image observed for Figure 145 below showed a northeasterly component when zoomed into, suggesting a land-wind influence at the time of the image capture.

The conclusion drawn here is that, over the alignment of the proposed NG pipeline, wind-induced water movement will prevail, with northwesterly movement water being experienced during the daytime and southerly movement being experienced in the night and into early morning. Thus, if the deployment of the pipeline results in the disturbance of the seafloor, then areas to the northwest of the alignment could be affected by turbidity during the daytime and areas south of the alignment could be affected at night or into early morning.

[29] http://www.metservice.gov.jm/wind.asp

Figure 143: Direction of Daytime Wind-induced Wave Action over the Proposed NG Pipeline Alignment (red line – wave crest alignment, yellow line – wave crest movement direction). Wind Generated out of the Southeast.

Figure 144: Land Breeze-Induced Current Movement Illustrated by Freshwater Movement on Seawater Surface (white arrows)

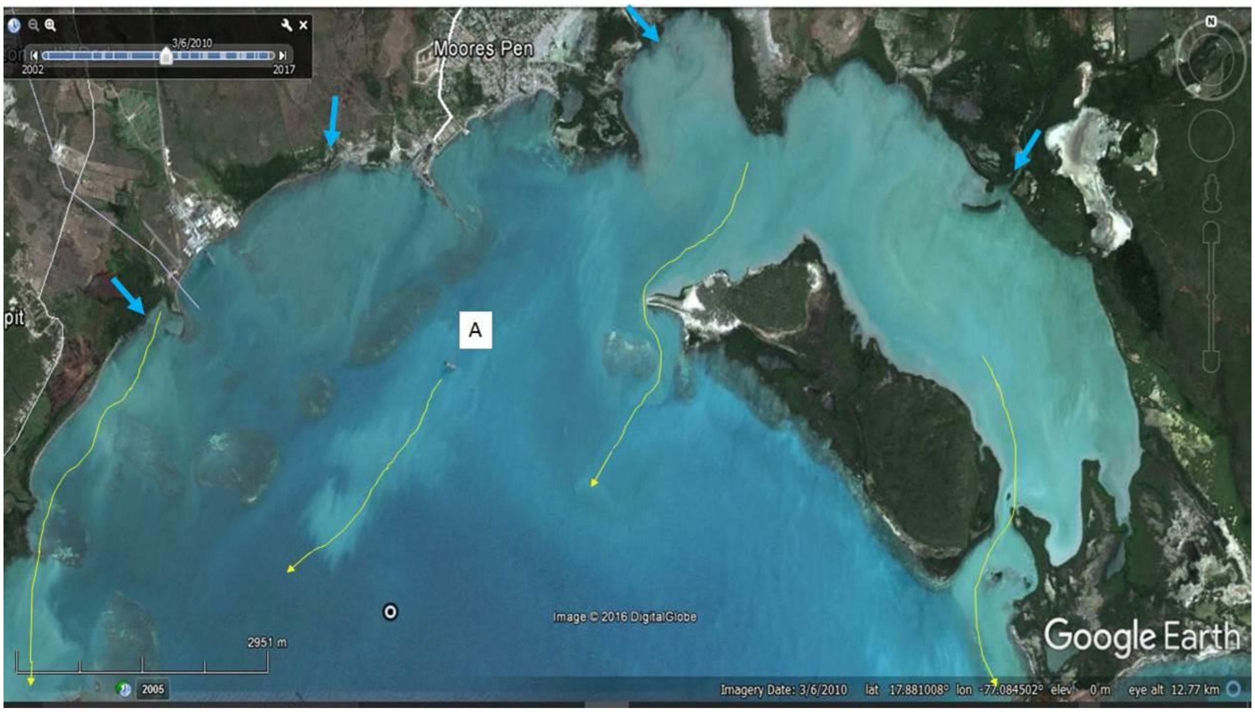


Figure 145: Land Breeze-Induced Current Movement Illustrated by Seafloor Turbidity Movement (yellow lines) A= Ship-Generated Turbidity Movement, Blue Arrows = River Sources.

5.4.5. Environmental/Socio Economic Risk Analysis:

5.4.5.1. Marine NG Pipeline Deployment

The following provides information on the NG pipeline:

1. The pipeline will be deployed primarily on muddy seafloor substrates devoid of any significant marine life.
2. The pipeline will be deployed in a trough excavated from the seafloor and then buried.
3. Directional drilling methods will be used, if necessary to traverse the shallow seafloor areas immediately adjoining the seafloor, resulting in the pipeline being deployed under sensitive seafloor resources (refer to alignment depicted on Figure 8B above) without excavating a trough through the resources.

It can therefore be concluded that there should be no significant impacts on seagrass and scattered coral head resources within the nearshore environment of the JAMALCO Marine Terminal area. However, since:

a. The pipeline will pass within 300 meters of coral reef resources at Salt Island
b. There will be excavation work to create a trough within which the pipeline will be buried
c. Daytime wind action generates water movement that will move across the pipeline path towards Salt Island;

It is reasonable to believe that turbidity generated by the burying of the pipeline could be transported to the Salt Island reef area (at-risk area depicted on Figure 147 below) and could have the following impacts:

1. Smothering of seafloor hard substrates supporting fish populations in the Salt Island reefs
2. The generation of potentially eutrophic conditions if the transported sediments are ladened with nutrients.

Duration of the activity will return to normal afterwards.

5.4.5.2. Land NG Pipeline Deployment:

Figure 148 applies the IPIECA environmental and socio-economic risk rankings to the proposed land-based NG pipeline route. The area indicated as red relates to areas where the pipeline will be built near to or within wetlands immediately adjoining a railway line route leading to the JAMALCO Halse Hall alumina refinery. Two species of mangroves, namely the Black and Red mangroves, were observed along the proposed pipeline route. Construction of the pipeline potentially pose negative impacts on these wetland resources.

On the other hand, red mangrove seedlings were observed to be regenerating along both the seaward wetland margins immediately north of the proposed NG pipeline alignment as well as along wetland margins south of the alignment (see example on Figure 146). This means therefore that the potential for regrowth in these areas is strong given the right conditions.

The impact on the avifauna is expected to be very minimal since any birds in the vicinity of the construction area will be expected to relocate during construction activities.

As it relates to the non-wetland sections of the proposed alignment, the assessment results show an area that could be classified as having a low plant diversity. Historically, the non-wetland sections of the study area was known for its sugarcane fields, which have now been overgrown with the Brazil Macca and the invasive Lead tree. These changes in the land cover have reduced the terrestrial ecological value of the area immediately adjoining the proposed NG pipeline alignment to the point where no environmental issues are foreseen where the implementation of the Land NG pipeline construction is concerned.

Figure 146: Plate X: Red Mangrove Seedlings Observed Growing on Northern Shoreline Areas Adjacent to the Proposed NG Pipeline Alignment.

5.4.5.3. Proposed ADO Truck Route – Salt River Route

Figure 149 applies the International Petroleum Industry Environmental Conservation Association (IPIECA) environmental and socio-economic risk rankings to the proposed ADO Salt River truck route. The area indicated as red relates to areas where the main road immediately adjoining marsh and mangrove wetland resources (as illustrated on Figure 146 above). An accident involving a tanker truck hauling ADO would result in immediate impact on the wetland resources. The nature of the wetlands adjoining the roadway would also potentially present an issue for containment and recovery work, which of itself could lead to further impacts on the wetlands.

5.4.5.4. Proposed ADO Truck Route – East-West Highway 2000 Toll Road Route

Figure 150 applies the IPIECA environmental and socio-economic risk rankings to the proposed ADO East/West Toll Road. No environmentally sensitive features of importance were determined to be along this route. It was determined that there was a moderate socio-economic risk along two sections of the route, owing to the fact that these routes traversed close to established residences at New Harbours One and Two housing developments near to Old Harbour, and residences and commercial facilities along the Halse Hall/Hayes main road leading to the JAMALCO processing plant.

5.4.5.5. Environmental Risk Analysis – Areas Adjoining the Marine Terminal, West Harbour and Rocky Point

Figure 151 to Figure 152 define environmental and socio-economic sensitivities for locations adjoining the proposed development area to the south. Owing to the nature of the construction and operation of the NG facilities, the properties of the Natural Gas to be transported by the facilities and the nature of the dominant currents in the area, it is not anticipated that the proposed development construction and operation will have any impact on these areas.

Figure 147: Area of Salt Island Reefs that may be Impacted by Turbidity Generated from the Deployment of the NG Pipeline

Figure 148: NG Pipeline Route on Land Emphasizing Area of High Risk Corresponding to Proximity to Wetlands and Moderate Risk Due to Proximity to Residences

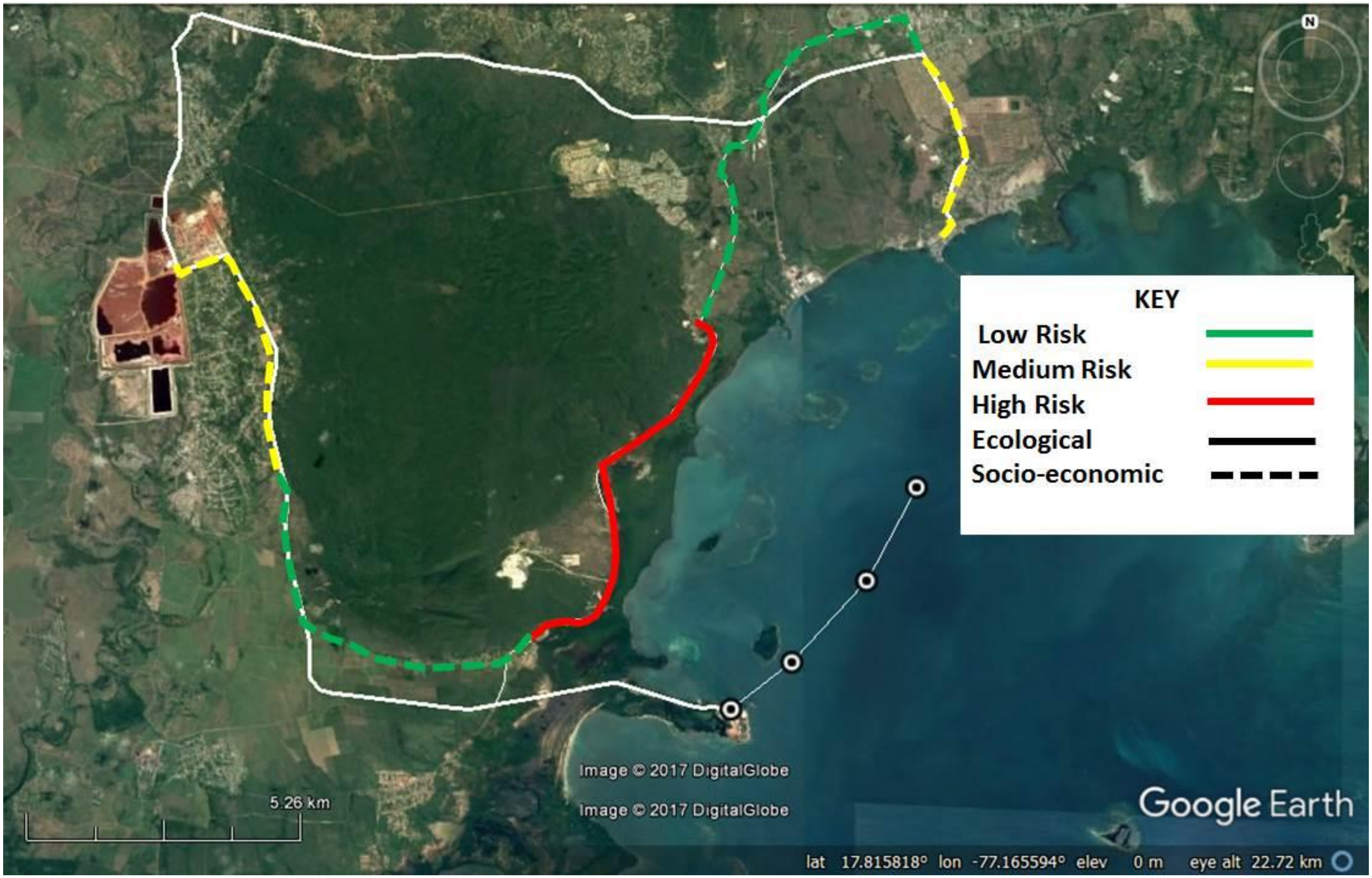


Figure 149: ADO Route on the Salt River Main Road Emphasizing Area of High Risk Corresponding to Proximity to Wetlands and Moderate Risk Due to Proximity to Residences.

Figure 150: ADO Route on the East West Highway 2000 Toll Road Emphasizing Area of Moderate Socio-economic Risk Due to Proximity to Residences

Figure 8: IPIECA-based Shoreline Environmental Sensitivity Index Map for the Study Area. Green: Index 1B – Exposed Solid Man-made structure, Yellow: Index 5 – Mixed Sand and Gravel Beach, Red: Index 10, Tidal Wetlands.

Figure 151: Extracted from Report Entitled Environmental Sensitivity Mapping – JAMALCO Alumina Terminal: Prepared by Conrad Douglas and Associates Limited, Oct 2014

Figure 152: Indication of Shoreline Environmental and Socio-Economic Sensitivities Extending South of the JAMALCO Marine Terminal and West to Rocky Point.

5.4.6. Conclusions

5.4.6.1. Marine NG Pipeline Deployment:

Potential impacts related to turbidity are foreseen for the reef areas adjoining the Salt Island during the deployment of the pipeline. The duration of any excavation, laying and covering operations to be done near to the island is approximately two weeks (1 week for laying pipeline and 1 week for tie-ins). It is known, however, that mitigations, such as the use of silt curtains, will be impractical either at the excavation site or near to the reef areas owing to the depths involved (14 meters and 5 meters respectively).

It is known, however, that the marine area typically experiences conditions of elevated turbidity, particularly during strong winds and heavy seas. It is therefore concluded that:

1. The reef environment is already adapted to elevated turbidity levels
2. The period of elevated turbidity due to construction will be short lived.

Thus, it is not anticipated that the pipeline construction works in the vicinity of the Salt Island area will result in long term environmental impacts.

Where the marine pipeline landfall is concerned, the use of directional drilling to bypass marine benthic resources near-shore will negate against any environmental issues occurring nearshore.

5.4.6.2. Land NG Pipeline Deployment:

Potential impacts related to construction of the NG pipeline on land are foreseen specifically adjoining the railway line leaving the JAMALCO Marine Terminal, and leading up to the Mitchell Town road intersection, owing to the presence of Mangrove wetlands along the proposed route. Consideration will have to be given to environmental compensation for any wetland growth lost through the replication or enhancement of wetland resources in areas immediately adjoining the construction site.

It is therefore recommended that a **Mangrove Growth Promotion Programme** be devised for implementation on the wetland margin immediately to the south of wetlands adjoining the proposed pipeline construction site to compensate for any mangrove loss during the pipeline construction. Note that such a programme may not necessarily have to contain re-planting components. If the following components are available within the target promotion areas:

1. Soil characteristics are or have been suitable for the natural growth of mangroves
2. Favourable hydrological conditions exist or can be promoted
3. Natural sources of mangrove recruitment exist
4. Suitable topography exists that can support both points 1, 2 and 3

then there will not be a need to actually harvest plants for replanting and natural recruitment could be facilitated. A condition similar to that created for the rehabilitation of mangroves adjoining the Hunts Bay side of the Portmore Causeway Toll Road could be created. In this instance, the creation of semi-submerged berms immediately seaward of the area at which rock revetments were deployed for shoreline protection facilitated the natural settling and growth of White Mangroves – the dominant mangrove vegetation type found along the periphery of the Hunts Bay. Since the completion of the toll road in 2005, natural mangrove growth has progressed as portrayed on Figure 153 to Figure 155 below.

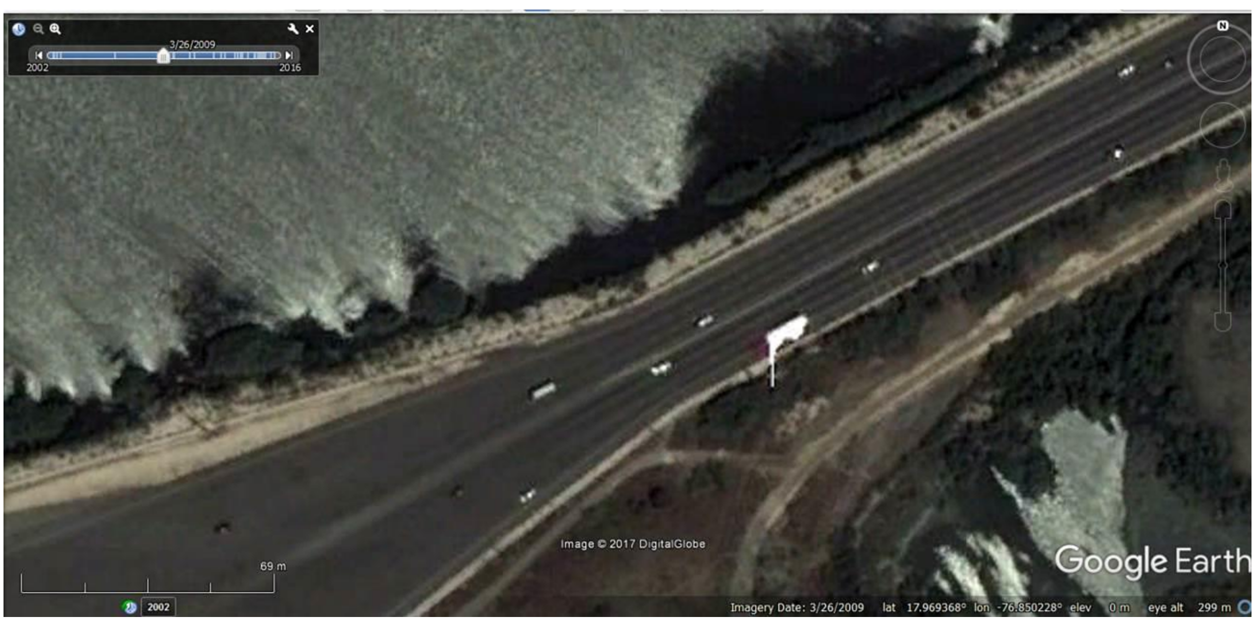


Figure 153: White Mangrove Growth Along the Portmore Causeway – 2009

Figure 154: White Mangrove Growth Along the Portmore Causeway – 2013

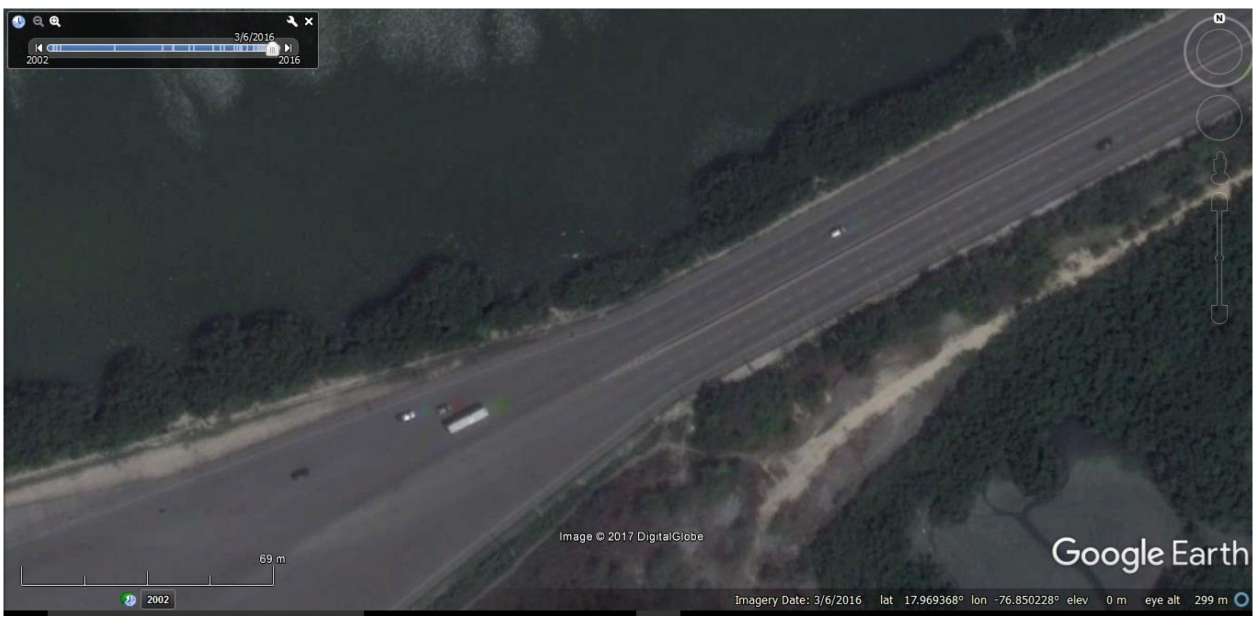


Figure 155: White Mangrove Growth Along the Portmore Causeway – 2016

It is pertinent that construction best management practices are implemented to prevent significant negative impacts on the water quality of the adjoining wetland and, by extension, the marine environment to the south of the proposed pipeline alignment. The presence of an elevated railway corridor to the north of the proposed pipeline presents an obstruction to the movement of any water quality issues to the northern side and, ultimately, to the Salt Harbour Special Fish Sanctuary.

The area within the study site zoned as wetland area had healthy stands of mangroves in some sections and mangrove die-off in others. However, any construction activity within this area may further result in the destruction or alteration of the site's hydrology, vegetation, biotic (living organisms) functions and hydric soils. Additionally, a loss of and/or reduction of the wetland species would cause erosion, decreased ability to store storm and flood waters, decreased ability to recharge groundwater, and reduced ability to filter and purify surface water.

Excavation along the conveyance routes for the installation of the pipeline is recommended to be conducted during the dryer season to avoid potential erosion and sedimentation flows into the marine environment. If this is not possible and construction occurs within the wet season then measures, such as the installation of silt fences or berms immediately south of the proposed construction area will be required.

Table 26 proposes the following mitigating measures to avoid, minimize, and or compensate for potential impacts within the wetland area:

Table 26: Potential environmental impacts as a result of the proposed development and its associated mitigations measures

Environmental Impacts	Mitigation
Vegetation Loss	Routes for the installation of the pipeline should be carefully selected to avoid sensitive wetland areas where possible. Limit vegetation clearing to what is necessary to construct the pipeline. Only trees and shrubs within the footprint of construction and tree limbs extending into the clearance area should be removed. No mangrove vegetation should be removed, if possible. Develop a wetland mitigation plans for those wetland areas that cannot be avoided during construction
Water Quality	Careful design, proper construction practices and maintenance of construction equipment Implementing an erosion and sediment control plan and following best management practices.
Increased sediment loading	Implement an erosion and sediment control plan and following best management practices Ensure proper disposal or storage for reuse, of excavated materials Install silt screens or berms Employ sediment control practices for stockpiles
Increase runoff	Limit vegetation clearing as this will aid in the absorption of storm water and runoff
Oil Spills	Implement the best management practices to avoid oil spills into the marine environment. These practices include proper storage, use, and cleanup of all construction-related chemicals.
Noise	Ensure that noise levels are in compliance with NEPA's day and night guidelines, noise level during working hours and 24 hours noise level standards in areas where work is close to residences.
Contamination of ground water from Construction Equipment oil spills	Install adequate technology for early detection of oil leakage

5.4.6.3. Proposed ADO Truck Route – Salt River Route:

Owing to the proximity of the roadway route to wetland resources, it is strongly recommended that this route not be used for the trucking of ADO for emergency fueling of the facilities to be built at the JAMALCO processing plant.

5.4.6.4. Proposed ADO Truck Route – East-West Toll Road Route:

It is recommended that this route be considered for the transport of ADO for emergency refueling of the proposed NG facilities to be developed at the JAMALCO processing plant.

5.5. Socio-Cultural and Economic Environment

5.5.1. Survey Population

In order to comprehensively analyze the potential impacts associated with any development, a Social Impact Assessment (SIA) is necessary to obtain data on the demographic and cultural characteristics of the communities and residents within the sphere of influence, and most importantly, their knowledge, views and concerns regarding the proposed development. New Fortress Energy Limited (NFE) is keen on gathering the opinions, attitudes and views of the communities in which it does business with the overarching objective of incorporating stakeholders' perspectives and concerns into their project. As such, within the context of the nature of the proposed development, communities, which are potential impact receptors were identified and surveyed. This report presents the demographic and social profile of the communities, which have the potential to be impacted by the project and the findings of a survey that was conducted in May 2017.

A systematic approach was undertaken to identify the areas that may be impacted by the proposed development. Areas within a five (5) kilometer radius of the site were immediately identified as the sphere of influence for the proposed housing development. This includes, but is not limited to, the communities of:

- Hayes,
- Halse Hall,
- Lionel Town,
- Salt River,
- Mitchell Town,
- Race Course,
- Mineral Heights and
- Palmer's Cross.

The survey population was derived from a 1% sample of the total population within the area according to the 2011 Population Census.

The draft socio-economic survey instrument was submitted to NEPA on April 21, 2017 and was reviewed by NEPA. CD&A adjusted the survey instrument according to the comments received from NEPA. The pre-testing of the survey instrument was completed among 8 communities in the sphere of influence administered among 57 households. The communities are listed below:

- Hayes
- Salt River/Mitchell Town
- Lionel Town
- Race Course/Kemps Hill
- New Bowens/Mineral Heights

Following review and finalization of the Socio-economic survey, a total of 381 surveys were conducted in the EDs as outlined by STATIN, which were within and on the periphery of a 5 kilometer radius of the project site (See Table 27). These statistics were obtained from the Population Census 2011 at the Statistical Institute of Jamaica.

The selection of the areas for interviewing was based on Enumeration Districts (ED) as defined by the Statistical Institute of Jamaica (STATIN). However, it must be noted that it is possible for some communities to cross ED boundaries. As a result, the communities as presented in this report were also defined in the field by the interviewer and the respondent.

Table 27: Enumeration Districts Surveyed

Clarendon Parish Enumeration District	ED Communities	Population	Sample Population
CLARENDON			1.00%
Southeast 43, 44, 45, 46, 47, 48, 49	Halse Hall	5,283	53
Southeast 70, 71, 72, 73, 74, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90	Hayes	10,916	109
Southeast 68, 69, 92, 93, 94, 95, 96	Salt River, Mitchell Town, Portland Cottage	2,681	27

Southeast 91, 97, 98, 99, 100, 101 Southwest 74, 75, 76, 77, 78, 79, 80, 81, 82, 83	Lionel Town, Water Lane, Alley	4,606	46
Southwest 42, 58, 59	Gimme-Me-Bit, Race Course	1,174	12
Southeast 20, 24, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 50 Central 76, 83, 84, 85	Mineral Heights, Palmer's Cross, Sandy Bay, Hazard	9,466	95
TOTAL		**34,126**	**341**

5.5.1.1. Demographic & Socio-economic Profile

The affected communities identified within the sphere of influence together have a total population in excess of 34,126 individuals. The age-sex pyramid depicted in Figure 156 below highlights the fact that the majority of the respondents (61%) are between the ages of 20 and 49 years while individuals under the age of 20 years accounted for the smallest (6%). The population structure of the survey population roughly reflects the demographic profile of Jamaica with a large economically active population (persons of working age), a contracting youthful population and an expanding ageing population). However, there are variations from the national profile for age-sex ratio since the males outnumber the females accounting for 55% and 45% respectively

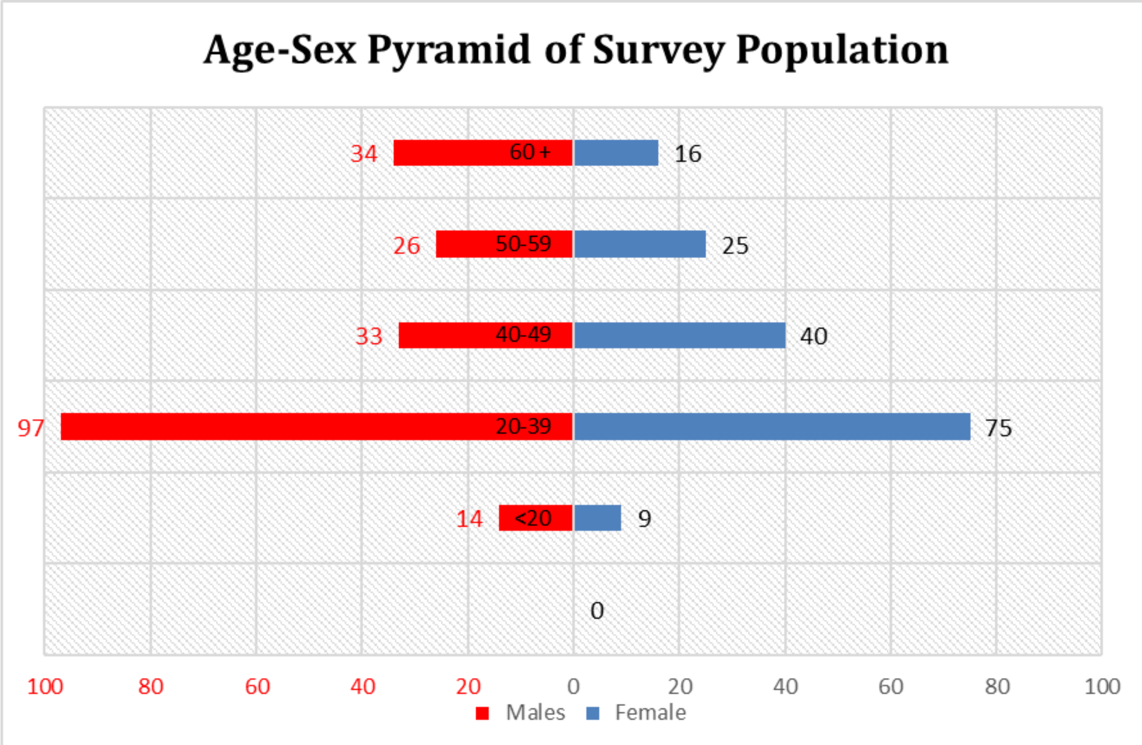


Figure 156: Age-Sex Pyramid of the Respondent Population

Most of the households (21%) surveyed are comprises four (4) persons, and are dominated by males. It must, however, be noted that households with sizes of three and five persons were also dominant in area accounting for 17.8 and 17.3% of the survey population respectively. The individuals found in the households of the surveyed population are mostly between the ages of 20 to 39 years with most households having two dependents.

Employment levels appear to be moderate in the area with approximately 67% (255) of the respondents indicating that they are currently in paid employment. Full time employment dominates with 26%, mainly comprising taxi operators, farmers, fishermen and construction workers, followed by persons who are self-employed either as business operators or the skill-based jobs such as carpentry, mason, cosmetologist, hair dresser or dressmaker accounting for 23% of the respondent population. In addition, secondary education is the most common education attained with 52% of the respondents (198 individuals) not achieving more than secondary education. Only eighty respondents (21%) have tertiary level education but outnumbered those with only primary education (10%)

or vocational or technical training (11%). According to Figure 157 below, income levels in the communities surveyed are generally low. Although the majority of the respondents did not indicate their annual income, of the 44% that did, 26% suggested that they earned less than JA$350,000.00 annually and approximately 1% earning more than JA$2 million dollars for the year.

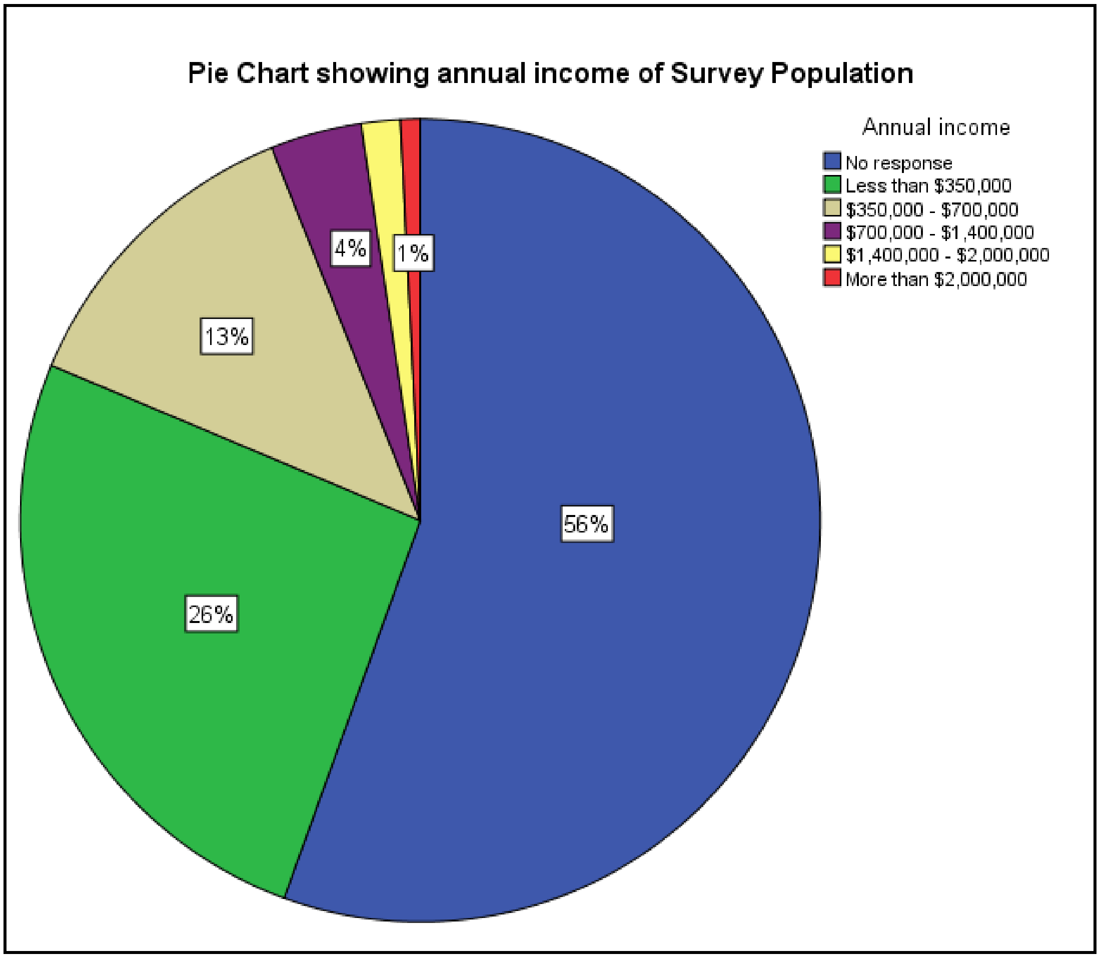


Figure 157: Annual income of Survey Population

The majority of the respondents have been live in the community for over a decade with 62% of the respondents residing there for over 20 years. A total of one hundred and fifty three (153) respondents (41%) have lived there for up to forty years. This correlates with the large proportion of the respondent population in age range 20-39 and reinforces the fact that the majority of the respondents have been living in these communities for all their lives. This will be critical for analysis of the community perception and attributes as it validates information gathered from them based on years of their experience and familiarity with the area.

5.5.1.2. Housing and Amenities Characteristics

Home ownership appears to be high in the area as the majority of respondents (72%) suggested that they owned the property while rental properties accounted for 19%. Most of the houses are serviced with electricity with 367 respondents (96%) indicating it as their source of lighting. Residents without electricity account for approximately 2% of the survey population with other sources including candles and kerosene lamps.

Similar to the access to electricity, the availability and provision of water in the area appears to be satisfactory with a total of 312 respondents (82%) indicating having water either by indoor tap or outdoor tap (see Figure 158 below). Of this total, two hundred and seventy persons, accounting for approximately 71% of the respondents, indicated having water from indoor tap and the other forty-two (11%) having outdoor tap as their water source. The use of public stand pipes and rainwater still exist in some communities, while the NWC provides water by truck in some areas. This is particularly the case in the Salt River community accounting for 50% of the respondents who receive water from these sources.

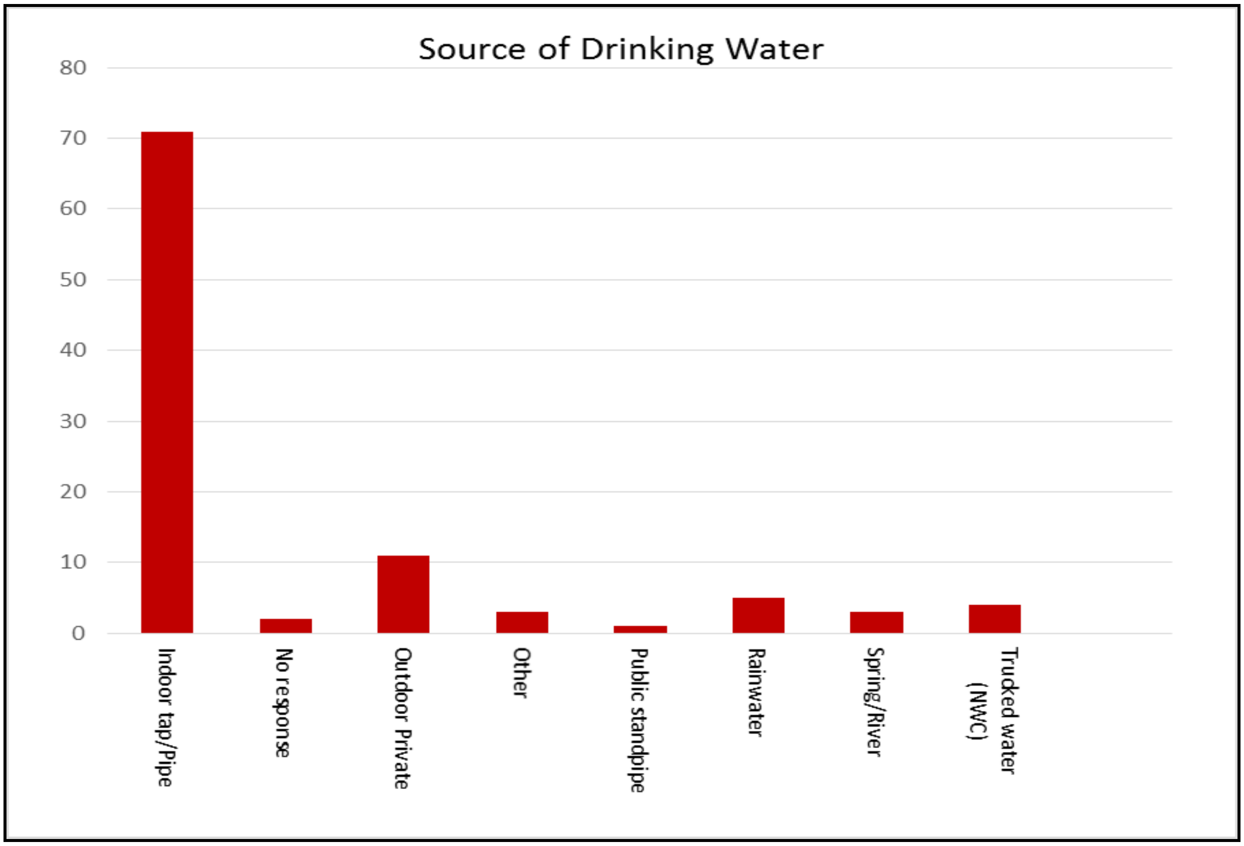


Figure 158: Bar Chart Showing Major Source of Water in the Area

Satisfaction also appears to be high among community members in the survey communities with the quality and reliability of the water provided as summarized in Table 28 below.

Table 28: Residents' Opinion on the Quality and Reliability of Water Supply

PARAMETERS		COMMUNITY NAME									Total
		Corn-Piece Settlement	Hayes	Lionel Town	Mineral Heights	Halse Hall/ New Bowens	Alley	Phase One	Race Course	Salt River	
Quality of water supply in community	Very Poor	0	15	2	4	23	0	0	12	2	58
	Poor	1	11	1	3	10	0	0	3	1	30
	Fair	3	23	14	9	11	0	0	4	7	71
	Good	2	18	34	21	6	2	1	2	7	93
	Excellent	7	46	8	24	8	1	2	8	9	113
	No Response	0	5	0	5	2	0	0	2	1	15
	Not applicable	0	1	0	0	0	0	0	0	0	1
Total		13	119	59	66	60	3	3	31	27	381
Reliability of water supply in community	Very Poor	1	11	0	4	37	0	0	4	3	60
	Poor	1	5	3	2	11	0	0	5	6	33
	Fair	1	11	8	6	5	1	0	5	4	41
	Good	1	21	39	16	0	1	0	5	4	87
	Excellent	9	64	9	32	4	1	3	10	9	141
	No Response	0	6	0	6	3	0	0	2	1	18
	Not Applicable	0	1	0	0	0	0	0	0	0	1
Total		13	119	59	66	60	3	3	31	27	381

The high availability of water and the prevalence of indoor tap as the water source could be the major determining factor in the high satisfaction rating given to the water quality and reliability in the area. A total number, two hundred and 6 respondents (54%), gave the water quality a rating of good or excellent while an even larger number accounting for 60% of the respondents (228), said the same of the reliability of water provision in the area. Displeasure with the quality of the water is greatest in the communities of Hayes and New Bowens/Halse Hall where fifty respondents, accounted for 60% of the persons who suggested that water quality was poor or very poor. Among the reasons listed for the poor quality, the most popular noted by the respondents were the salinity or chlorine content of water and contamination from unnamed sources. Ninety-three respondents (24%) indicated that the reliability of water supply in the communities were either poor or very poor. The majority of these person were residents of the Halse Hall/New Bowens communities accounting for more than half of the respondents who gave water reliability a low rating due to mainly to the inconsistency in supply to these areas.

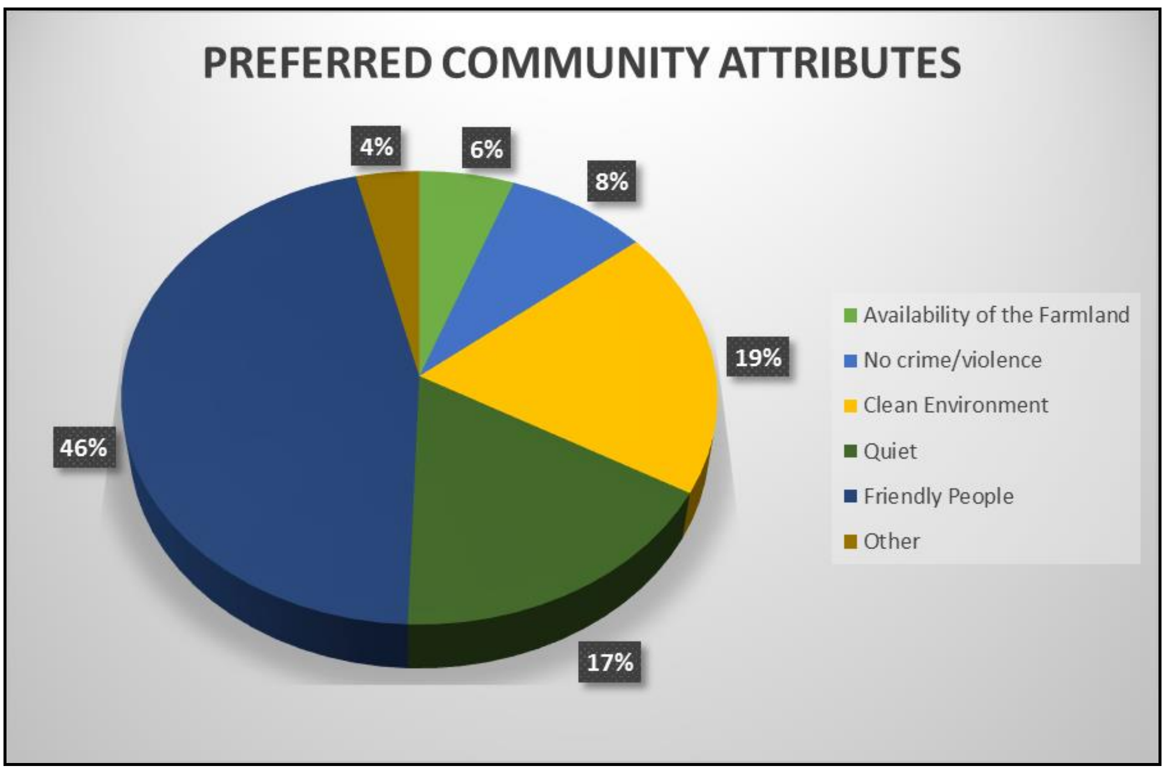


Figure 159: Pie Chart Showing the Preferred Community Attributes

5.5.1.3. Community Perceptions

Figure 160 below clearly outlines the community attributes preferred by the respondents. Friendly people, quiet, and clean environment are the most favored traits as accounting for 46%, 17% and 19% respectively. The availability of farmland and a lack of crime and violence were the least popular traits. The preference of the respondents can be considered a reflection of the perceived safety rating given to the area with 15% of the respondents surveyed indicating that was a concern (see Figure 5). Poor road and unemployment, however, are currently the most disliked attributes of the communities.

A distinctly clear majority of the respondents cite unemployment as a significant community trait needing urgent attention. Forty-three per cent (43%) of the respondents confirmed this sentiment while another 29% echoes sentiments about the condition of the roads. This was further re-iterated when respondents were asked about the improvements needed in the community. The majority of the respondents (79%) indicated that there was a great need for job opportunities and skills training and improvement to housing and infrastructure. Although these opinions straddled all communities, they were very popular in the more urban communities of Hayes, Lionel Town, Halse Hall/New Bowens and Mineral Heights.

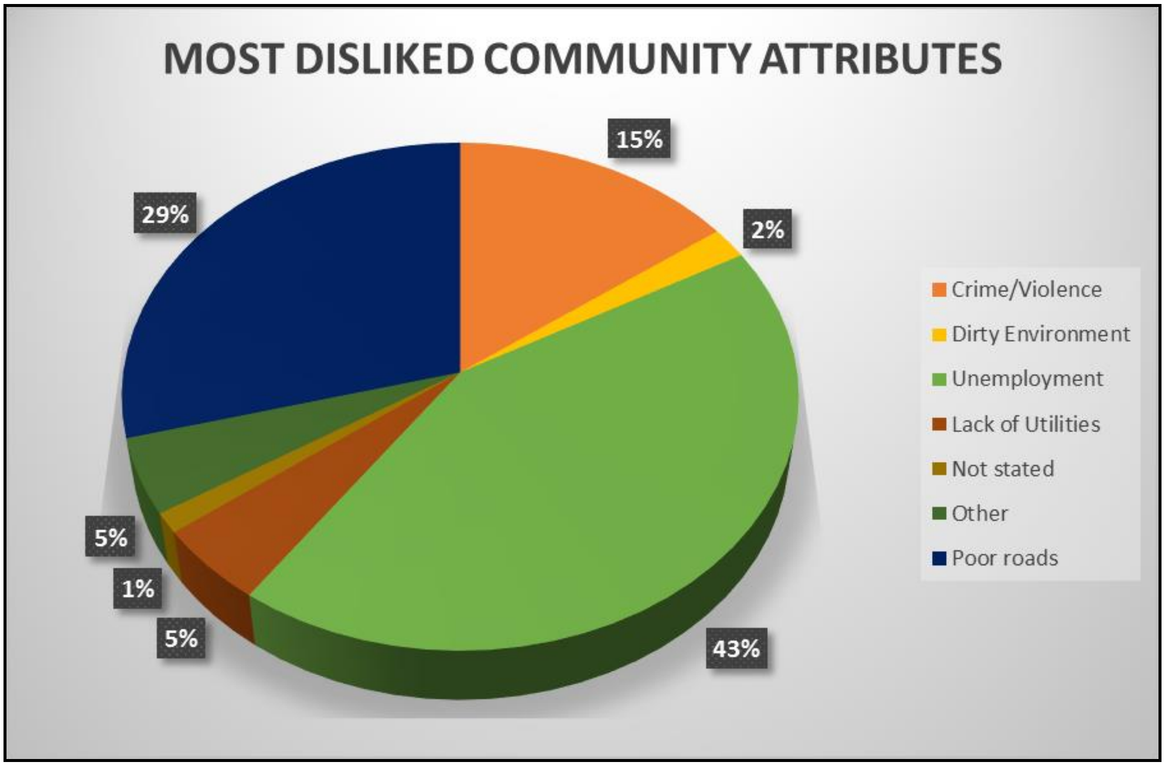


Figure 160: Most Disliked Community Attributes

Traffic appears to only be an issue in certain communities, according to the survey respondents. Cumulatively, the number of respondents that suggested that traffic was either heavy or very heavy in their communities (103) account for 27% of the survey population. This was most common in Hayes and Halse Hall/New Bowens area, which accounted for 58% of the total, followed by Race Course (16%) and Mineral Heights (9%). The communities in the project area are also exposed to a variety of natural hazards according to survey respondents who suggest that the area experiences its fair share of atmospheric/hydrological natural hazards. Droughts, flooding and hurricanes are the most frequently experienced natural hazards in the area. While hurricanes seem to affect all the communities, flooding and droughts are more frequently distributed in Hayes, Lionel Town and Salt River.

5.5.1.4. Knowledge, Attitudes and Perceptions related to Proposed Development

There were two hundred and seventy-one respondents who were made aware by the survey undertaken of the proposal to transport natural gas via a pipeline from the Rocky Point Port to the proposed Natural Gas – Fired Combined Heat & Power Station at JAMALCO. This directly correlates with the low level of knowledge and awareness of the proposed development, with approximately 71% of the respondent having no knowledge of the proposed development. Awareness of the power station at JAMALCO among the survey population was also low with only 30% of the respondents having previous knowledge of the proposed project.

Although awareness among the respondents are low, most of them are generally anticipating the project with positive expectations. A large majority of the survey population believe that the project will have a positive impact of job opportunities and the economic value of the community (see Figure 161 below). This is specific to the component of the proposal that involves the establishment of pipelines conveying natural gas from the Rocky Point Port to the power station at JAMALCO and electricity transmission lines to transfer energy into the national grid where 85% of the respondents acknowledged that they believe the project will have a positive impact on job opportunities and another 74% suggested the same for the income and economic value of the community. Similar sentiments were evident in the respondents' perception of the proposed power station at the JAMALCO premises with 80% indicating that they thought it would have a positive effect on job opportunities while 72% felt the effect on economic value of the area would also be positive. However, it must be noted that pollution and safety is a concern of the residents and suggested by 21% and 8% of the respondents respectively, who believe the proposed development will have negative ramifications. Of the total number of persons who have this opinion, the majority (77%) are residents of the Hayes, Halse Hall/New Bowens and Mineral Heights communities. It is also apparent that the resident populations need to be provided with more information on the project because a significant number of respondent indicated that they do not know the effects the project will have on the community. This is the case for the perceived effects on pollution and safety as suggested by 29% and 31% of the survey population, particularly from the communities of Hayes, Lionel Town, Mineral Heights and Salt River.

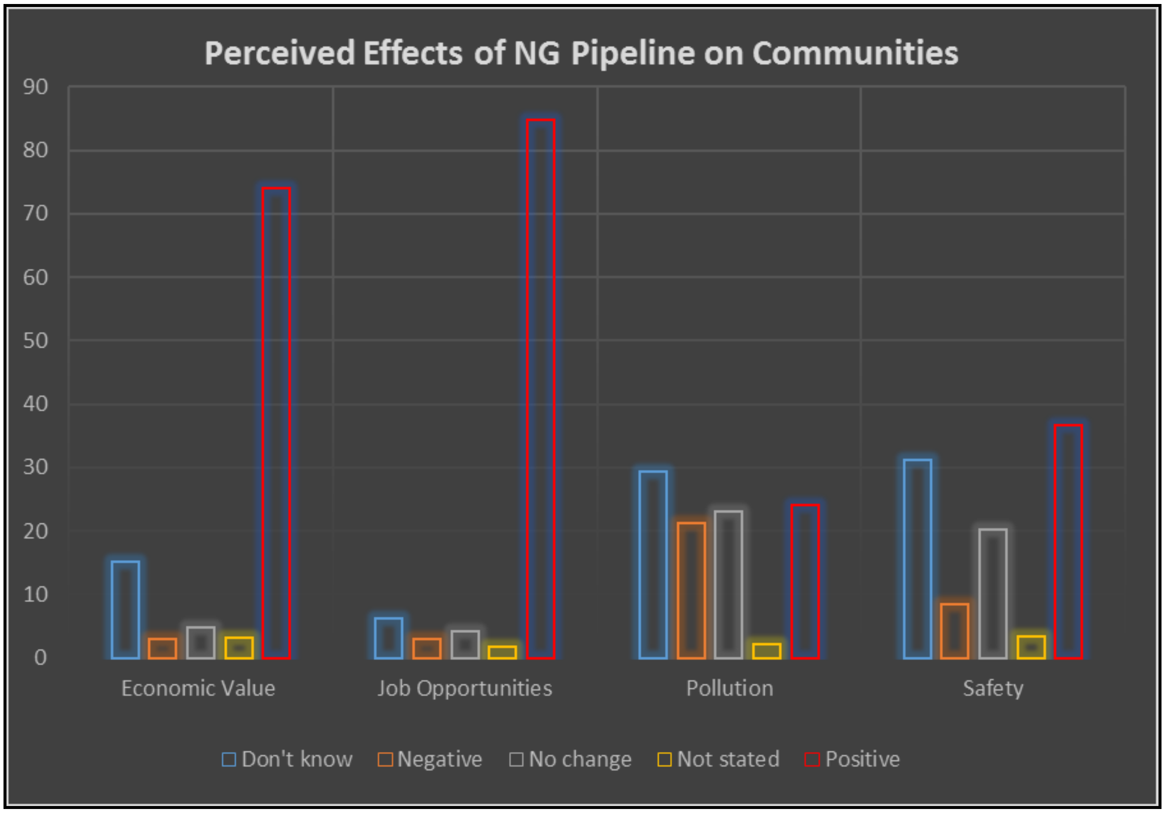


Figure 161: Attitude towards Proposed NG Pipeline Development

The issue of pollution is a common concern raised by the survey population, with air, noise and dust pollution among the most popular impacts expected by the respondents from the proposed development. As illustrated in Figure 162 below, dust pollution is the most popular negative impact which the residents associate with the project. A total of one hundred and sixty-seven respondents (167), which accounts for 44% of the survey population, identified dust pollution as a concern. This was followed by noise pollution as identified by 28% of the survey population. Although gas leaks was a common impact selected by respondents (27%), the risk of fire and explosion did not seem to be a major concern of the residents. Only twenty-seven individuals (7%) thought that fire and explosions would be an impact of the project. Other perceived negative impacts identified by the survey population, albeit the least popular, included water pollution (16%), reduced land value (12%) and damage to fishing grounds (5%).

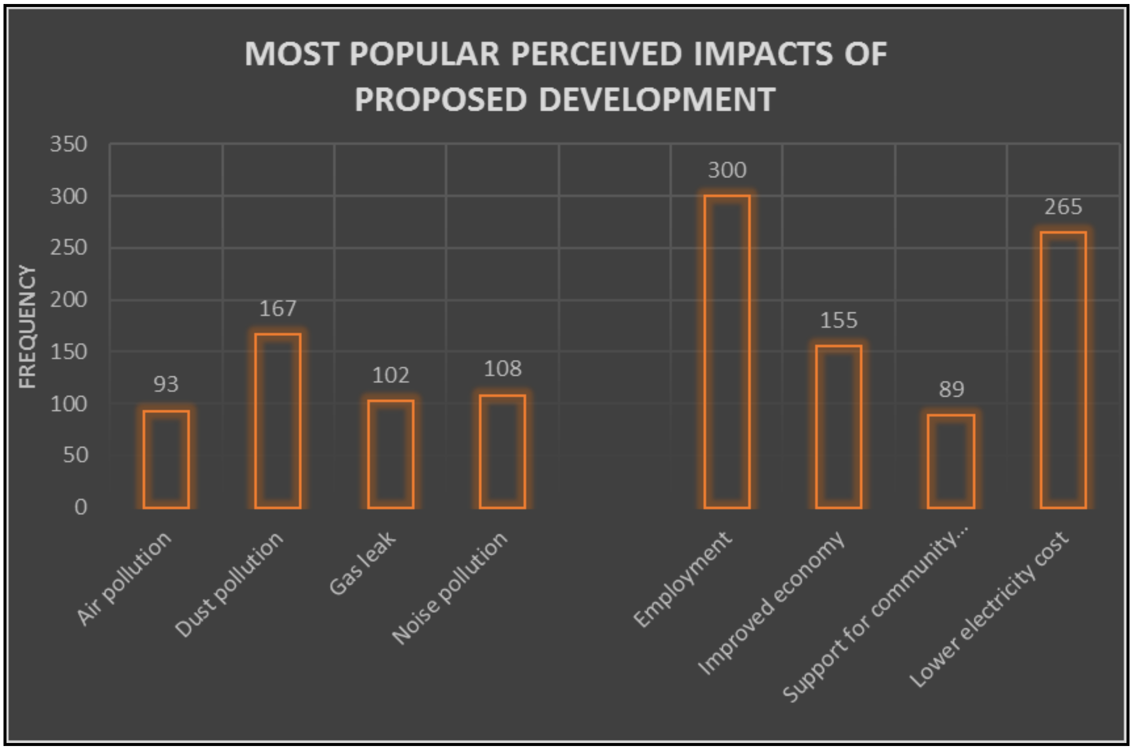


Figure 162: Perceived Impacts of Proposed Development

Figure 163 below also highlights the expected positive impacts associated with the proposed project according to the survey population. It is abundantly clear that the residents anticipate that the project will generate much needed employment opportunities in the area. This is the opinion of three hundred respondents, 79% of the survey population, and correlates with the perceived positive effect on job opportunities mentioned earlier. In addition, a significant portion of the respondents acknowledged that they associate a significant change in the cost for energy with the project and subsequently, lower electricity costs. These individuals accounted for 70% of the survey population and outnumbered those who indicated that other positive impacts such as improved economy (41%) and increased government revenue (23%). This suggest that respondents have a regional and national perspective when considering the impacts of the project. Its potential significance to national economic growth and prosperity is reflected in their responses. Its significance locally should not go unnoticed as the survey population made it local bias very clear. Eighty-nine individuals, accounting 23% of the survey population also associated support for community businesses with the proposed development while another 18% is expecting support and funding for community projects to be associated with the development.

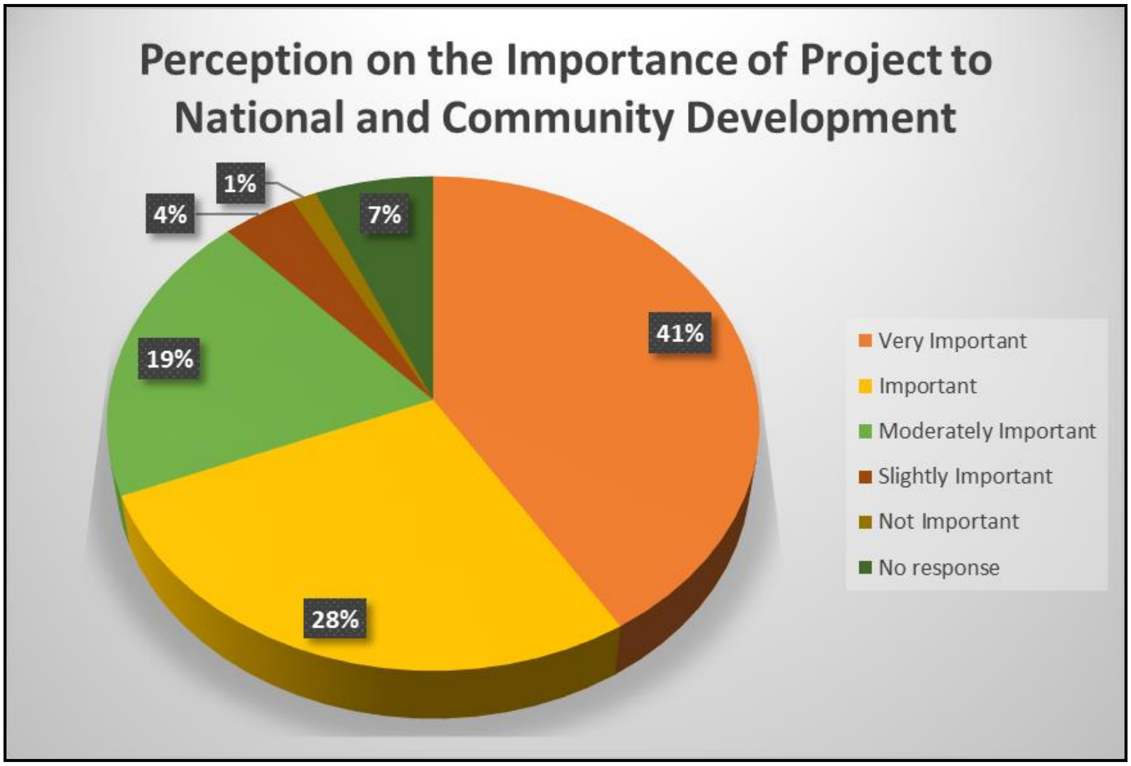


Figure 163: Perception of the Importance of Project to National and Community Development

<u>The survey population appears to have strong belief that the project is of monumental significance and value to their community and the country at large. Ninety-two per cent (92%) of the survey population believe that the project bears some importance to national and community development</u>. Only 1% of the respondents suggested that the proposed development had not local or national significance. As is evident from Figure 8, a majority 41% of the survey population scored the project's importance to local and national development at the highest grade (very important) and another 28% thought it to be important at the second highest grade.

5.5.1.5. Conclusions

The survey covered several communities and a total of three hundred and eighty-one (381) individuals, which account for 1% of the population in the area defined as the sphere of influence of the proposed development. Interviews were conducted with a mature population between the ages 20 years and 49 accounting for approximately 61% of the respondents, who have mostly been living in the area for over a decade. Their opinions and perception on current situations and prospective development are therefore considered critical and important in understanding the social ramifications that may be associated with the proposed infrastructure for the project, in particular the natural gas pipeline connecting the rocky point Port to a proposed gas fired power station at JAMALCO plant in Halse Hall.

Home and land ownership is high in the area (72%) and the provision of utilities in the area is very high with 96% of the households surveyed having electricity and 82% having access to water by either indoor tap or outdoor private tap. Water provision was identified as major problem only in select communities of Salt River, Mitchell Town and sections of Hayes. The condition of the roads and unemployment in the area is the major dislike of the residents as indicated by respectively approximately 29% and 43% of the residents surveyed. As such, there is a general consensus of anticipation and approval of the development amongst residents with the majority of the survey population expecting positive impacts especially in terms on job opportunities and increase economic value of community. Popular concerns raised by respondents was the level of dust, noise and air pollution that would be associated with the development. The proposed sites for the development (brownfield sites) appear to have very little impact on the livelihood of residents as is suggested by the fact that only three individuals (less than 0.1%) of the survey population cited a loss of income as negative impact associated with the development. This is further enforced by the fact that only 8% of the respondents indicated that they use areas adjacent to the proposed sites. Most respondent cited recreational purposes as their use of the area, while only 2% indicated that they use the area for fishing and another 1% use the area for farming and firewood.

Employment, increased support for local business and lower energy costs were the most cited by respondents as benefits to be attained by the community. As stated earlier, unemployment is a major problem in the area with 33% of the respondent not currently enjoying paid employment. The residents expect mostly positive impacts from the proposed development, although they expressed concerns about levels of air, noise and dust pollution.

5.5.2. Land-Use Analysis

5.5.2.1. Approach and Methodology

An accurate and thorough account of past and current land uses in the study area demanded a multi-faceted approach for collating land use information for the area. This included:

1. Aerial Photographs
2. Satellite Imagery of the area dating 2016 (Google Earth)
3. The use of field surveys to incorporate regional observations and documentation of existing land use, while providing verification of land use patterns depicted on the maps.

Land use was examined from regional perspective with analysis of the areas within 5 km of all areas of operation for the proposed project. As indicated on the Map 1, the areas of operation include:

- The Floating Storage and Regasification Terminal (off the coast of Salt River)
- The Rocky Point Port
- The pipelines transporting Natural Gas (NG)
- The site location of Power Station (on JAMALCO Bauxite Plant grounds)
- The site location for Electricity sub-station to tie into the National Grid
- The emergency route for transporting materials from the Jamaica Public Service (JPS) Power Plant in Old Harbour Bay via Highway 2000 (East-West corridor)

As such, an extensive area; including sections of Clarendon and to a lesser extent, St. Catherine, was established as the sphere of influence for the land use assessment. This will include a description of the general land use in the area as well as an analysis of potential land use conflicts which may arise during the construction and/or operational phases of the proposed development.

5.5.2.2. Historical and Existing Land Use Policy Overview

The parish of Clarendon is covered by a land use zoning under a Development Order (1982) and falls under the aegis of the Town and Country Planning Act. The Development Order has zoned specific areas of southern Clarendon for agricultural uses, forest, residential and conservation, which constitutes the major land uses in the region. An area which hosts the various land uses including the Portland Ridge, the Brazilletto Mountains, the extensive West Harbour mangals and several residential areas such as Mitchell Town, Salt River, Lionel Town, Hayes, Corn Piece and Rocky Point are zoned for conservation and is currently within the area designated as the Portland Bight Protected Area. The area was historically dominated by forest and brush vegetation which accounted for approximately 50% of the land cover at the time up to the 1980s, seconded by sugar cane cultivation accounting for approximately 21% of the total land cover. Over time, this has changed due to the growth of existing and unplanned settlements, the conversion and abandonment of sugar cane lands, the development of housing subdivisions and growing industrial activity especially since the establishment of Highway 2000.

Residential land use in the study area has expanded predominantly from small pockets of scattered settlements developed in linear pattern along major roadway to include large housing schemes.

Industrial activity gained momentum in the area with the development of port facilities at Port Esquivel (WINDALCO), JPS Co. Power Plant and Rocky Point (JAMALCO). An Industrial Estate/Park has also been established at Tarentum and accommodates a Coffee Factory and the Chemical Lime Quarry.

The sphere of influence also falls within St Catherine Coastal Development Order boundary of 1964, which makes provisions for land use such as open space, commercial, industry, urban development and approved subdivisions. The latter has been the most fast growing with the introduction of New Harbour and other subdivisions along Highway 2000 corridor. This is expected to continue given the proposed land use plan outlined in the Portmore to Clarendon Park Highway 2000 Corridor Development Plan which makes provisions for specific zones to be fully urbanized. This zone covers areas adjacent to existing residential/built-up areas that were previously under sugar cane cultivation of shrub/woodland vegetation. Heavy industry, light industry and varied agricultural land uses are also allocated (see Figure 164 below).

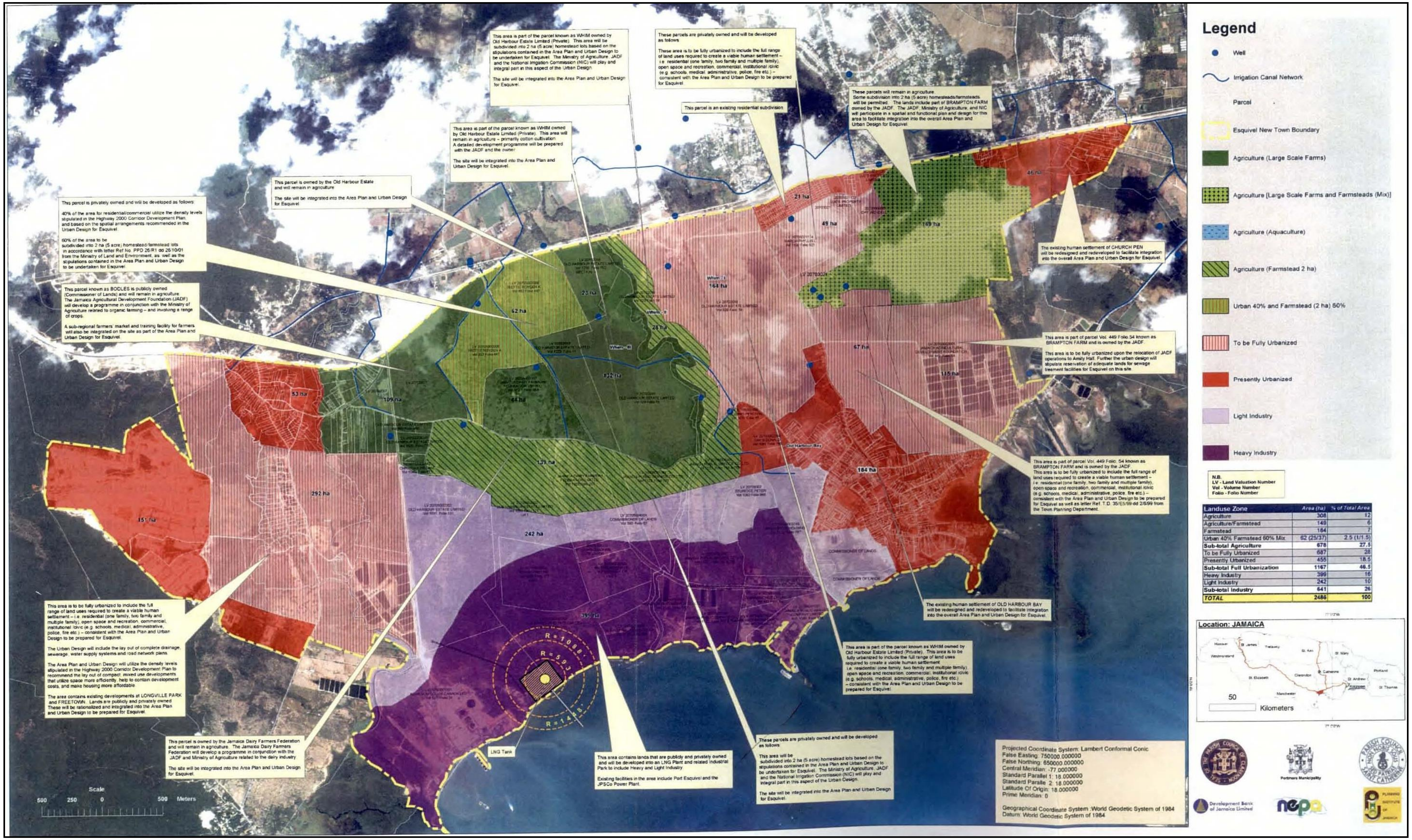


Figure 164: Proposed Land Use from the Highway 2000 Corridor Development Plan 2004-2025

5.5.2.3. Current Land Use

As illustrated in Figure 174 below, the general land use in the area can be classified as, but not limited to, the following:

- Sugar Cane Cultivation
- Built-Up/Industrial includes Rural Residential, Mixed Residential/Commercial
- Wetlands/Mangroves
- Forests
- Woodland/Shrub land

5.5.2.3.1. Built-Up/Industrial

This land use includes planned and unplanned residential, mixed residential/commercial and industrial areas and is currently experiencing the fastest growth rate in the study area. Currently, it constitutes 16% of the study area and is approximately 58 km^2 in size. The area comprises unplanned settlements developing in a linear pattern along major and minor roadways such as in Salt River, Gimme-me-Bit, Palmer's Cross and Freetown while mixed residential and commercial use entail the larger settlements in the study area designated as villages and sub-regional centres. It includes the major towns such as Hayes, Lionel Town, Old Harbour and Old Harbour Bay where residential activity is well developed to the point where commercial and institutional services have emerged to support the increase in size and population of these areas. There also large planned residential areas which is responsible for the rapid growth of the land use in the area. Mineral Heights, Clarendon Park (Longville Park) and New Harbour Village housing developments have rapidly increased the size of the population and residential land use within the study area.

The area is also made up of light and heavy industrial activities. The heavy industries that currently exist within the area include the JAMALCO Alumina Plant and its red mud ponds in Hayes, the JAMALCO Alumina Port at Rocky Point, WINDALCO Alumina Port at Port Esquivel and the JPS Power Plant in Old Harbour. Other lighter industrial activities occur at the Tarentum Industrial Estate which host a Coffee Processing Plant and a Limestone Quarry. An aerial photographic profile of the land use in the area is shown below.

Figure 165: Jamalco Alumina Refinery

Figure 166: A: Corn Piece Community adjacent Jamalco Railroad (B) | C: Jamalco Alumina Refinery located to the west

Figure 167: A part of Corn Piece Community located adjacent Jamalco Railroad (A)

Figure 168: A: Brazilleto Mountain in background | B: Salt River Springs and Communities in Foreground

Figure 169: Tarentum Industrial Estate, Salt River and dry limestone forest

Figure 170: A: Brazilletto Quarry and dry limestone forest shown in background

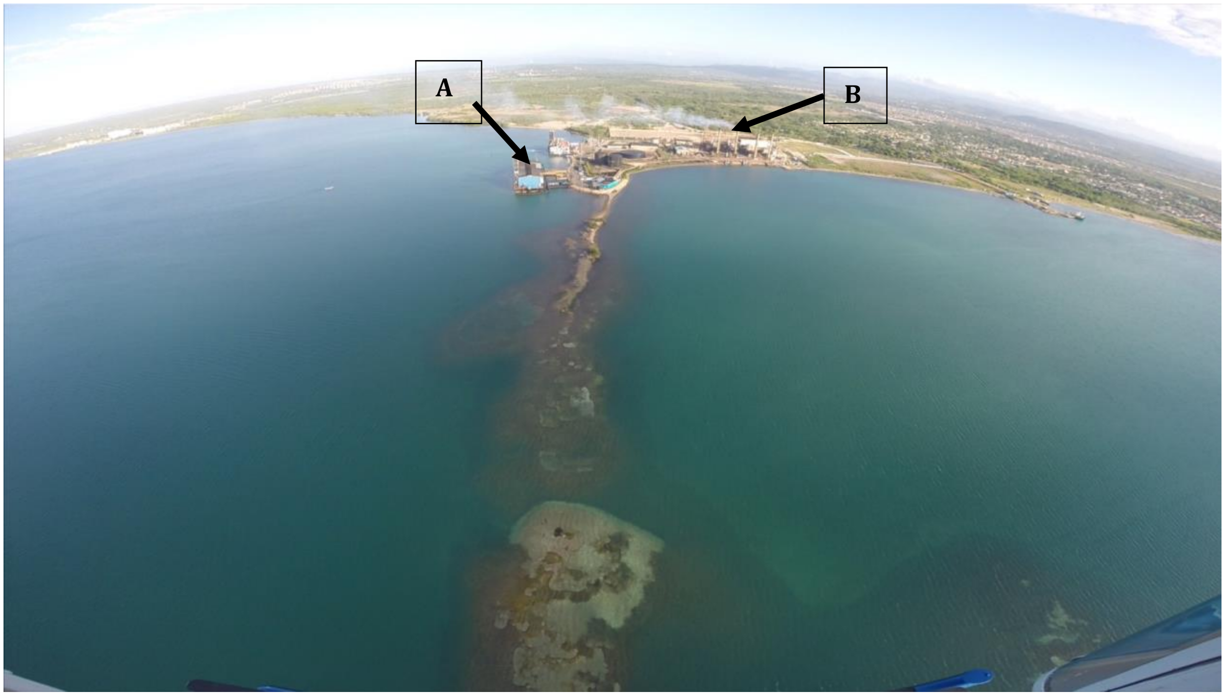


Figure 171: A: Jamaica Energy Partners Barge Facilities | B: JPSCo. Old Harbour Power Plant

Figure 172: New Harbour Village Community, Old Harbour, Clarendon

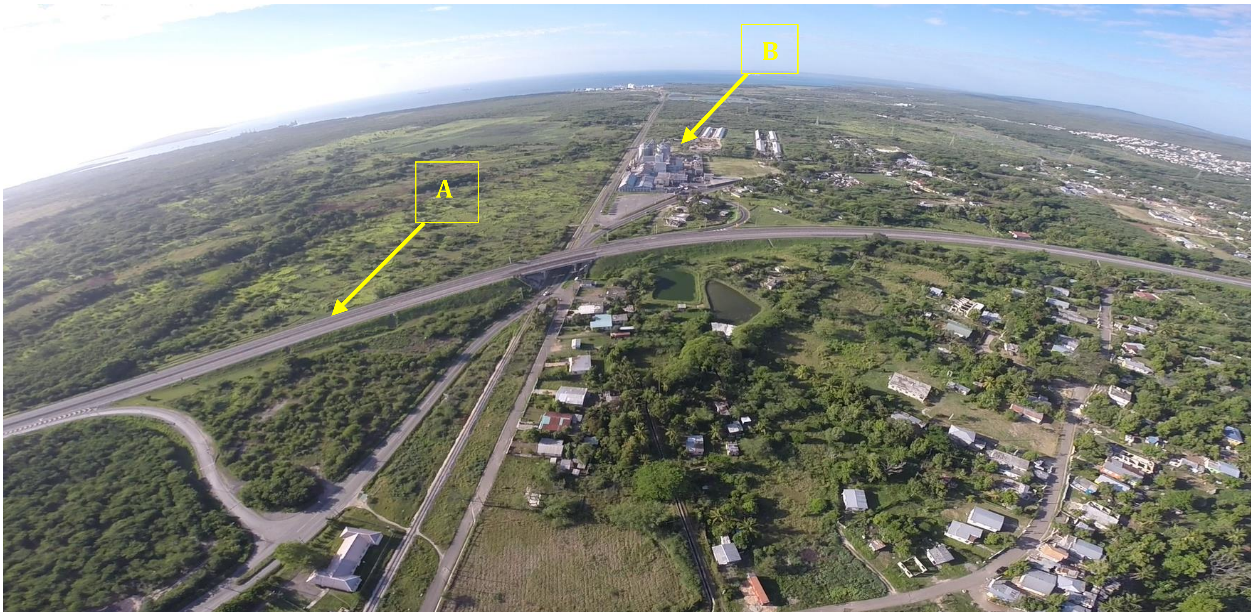


Figure 173: A: Highway 2000 east-west | B: Jamaica Broiler's Hi-Pro Feeds is shown in the background

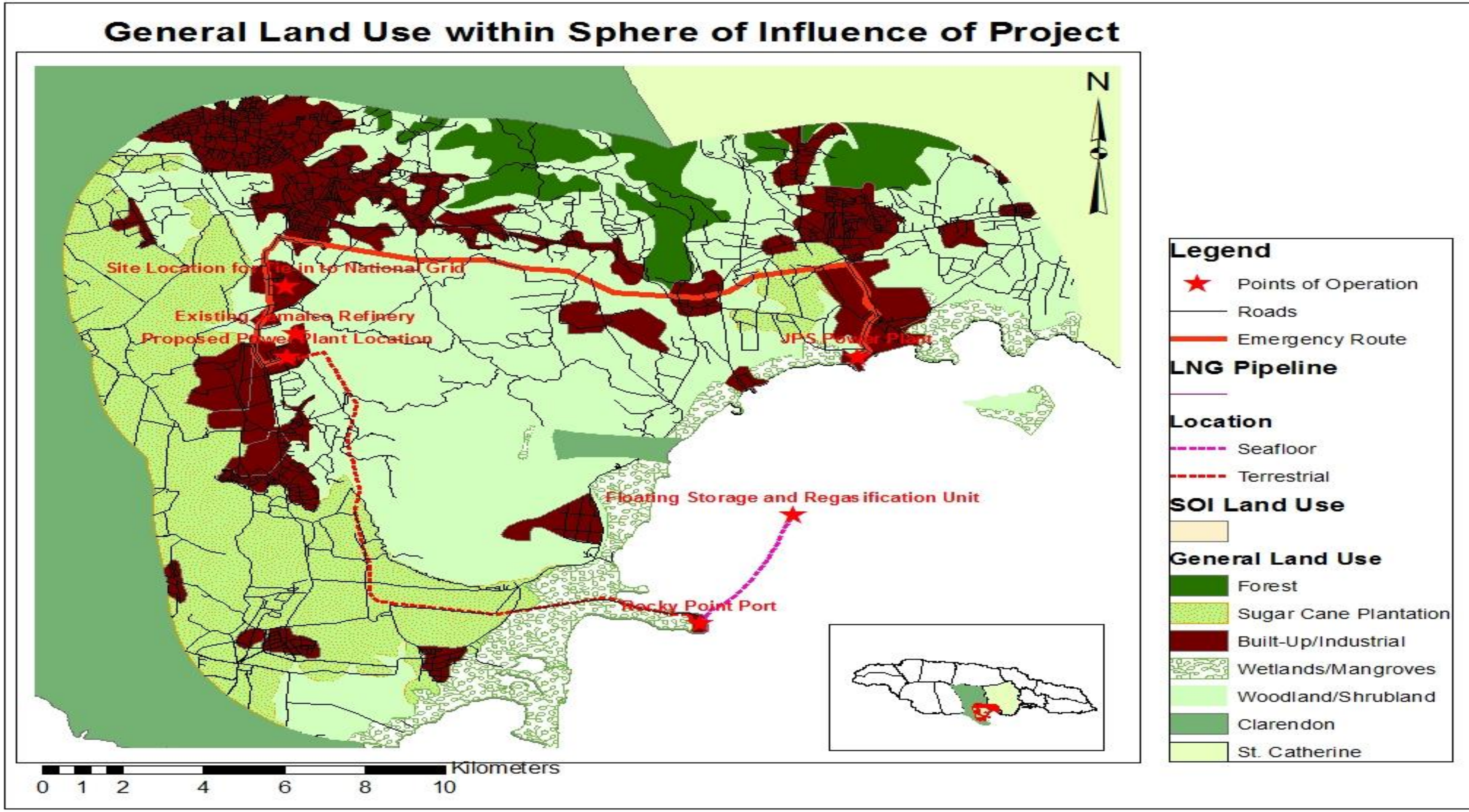


Figure 174: General Land Use within Sphere of Influence of Project

5.5.2.3.2. Sugar Cane

An extensive area within the sphere of influence (23%) is currently designated to sugar cane cultivation. These lands region are owned by the Pan-Caribbean Sugar Company once provided the bulk of the raw materials for the Monymusk Sugar Factory in Lionel Town. However, since the closure of operations at Monymusk in 2016, the area has serviced the nearby Bernard Lodge with sugar cane, similar to other sugar cane lands in St. Catherine.

5.5.2.3.3. Recreational

Recreational activities in the study area exist in several forms. The Gun, Rod and Tiller Club in the Salt River community provides bird shooting and fishing for its members while people from outside and within the community use the Salt River for swimming, bathing and fishing. Welcome Beach and Old Harbour Bay provide another major recreational use as major fishing and swimming beaches in the area. Other recreational uses in the area are evident in the presence of playing fields and sports ground in various communities. These areas are very few and small in size.

5.5.2.3.4. Wetlands

Both coastal and non-coastal wetlands are present within the study area. The coastal areas comprise mangal forest (red and black mangroves) and grassland swamps which experience either perennial or tidal flooding. These areas form a part of the Port Bight Wetlands and Cays Protected Areas which host the largest remaining stand of mangrove forest in the Caribbean earning its status as Wetland of International Importance (Ramsar Site). Other natural fresh water marshes that are not directly connected to the sea exist in the non-coastal areas.

5.5.2.3.5. Woodland/Shrub Vegetation

These areas include grassland/brush, shrub and woodland vegetation which dominates by comparison to other land uses in the area, accounting 48% of the total land area within the sphere of influence. The woodland areas cover the large expanse of the Brazilletto

Mountains where dry limestone woodland vegetation is the most dominant and provides a source of income for many residents in the area as the vegetation is used for charcoal production and lumber. Acacia, logwood and other hardwood species prevail in these dry and hilly areas. Grassland and brush areas exist on less steep slopes on the fringe of the Brazilletto Mountains where the land was cleared but is now covered with grass and brush. Brush cover is present mainly in the form of cashew and cacti. Similar type of vegetation is evident adjacent to built-up areas along the Highway in Sandy Bay, Old Harbour and Old Harbour Bay.

5.5.2.3.6. Forests

This land use area is made up of montane evergreen forest and lowland semi-deciduous forest whose 22km^2 account for 6% of the study area in close proximity to the communities of Old Harbour, Sandy Bay and Rosewell where conditions are not as dry and locals forage for livelihood and establish small scale subsistence farming.

5.5.2.4. Potential Land Use Conflicts

Potential conflicts were identified in relation to the activities involved in the construction and operation of the proposed development and their impact on land uses in the immediate area. They were assessed in the context of noting conflict of interests that are likely to result from the nature, location and scale of the proposed development and its interaction with the various land uses in the study area. The brown-field nature of the development limits most of the major conflicts to operational phases. The clearing of vegetation will only be required along a narrow corridor already being used by the railway connecting JAMALCO Plant to the Rocky Point Port. This will result in minor loss of vegetation to sugar cane land and brush vegetation. However, it must be noted that some mangroves may also be impacted by this activity. The site of the power station is at the JAMALCO Plant which means noise and dust nuisance may be an issue for the residents in that area during construction. Fishers and recreational users of the bay where the pipeline will be laid beneath the ocean floor are likely to be impacted during the excavation for laying of the pipeline while emissions from the stack at the power station may present a conflict for residents close by if not compliant with the emissions standards for criteria pollutants. The greatest potential negative impact (however unlikely) may be the safety concerns arising from potential fire and explosion along the pipeline or transport routes. However, with the use of state of the art technology and the highest international standard for construction, operation and safety standards, including routine maintenance, these potential risks are expected to be avoided or minimized. The type and nature of potential land use conflicts arising are summarized in Table below.

Table 29: Type and Nature of Potential Land-Use Conflicts

Phases of Operations	Affected Land Use/Area		Nature of Potential Impacts
Land/ Vegetation Clearance	Wetland/Mangrove	Salt River/Rocky Point Port	Loss of narrow zone of disturbed mangroves adjacent to the rail line at Rocky Point Port
	Sugar Cane Plantation	Hayes, Salt River	Clearance of sugar cane and other vegetation from sugar cane lands
	Woodland/ Shrub Vegetation	Hayes	Loss of woodland/shrub cover
Construction	Residential	Hayes, Halse Hall, Mineral Heights,	Noise and dust nuisance for heavy trucks movement and other machinery
	Recreational/ Fisheries	Salt River, Mitchell Town	The excavating of the seafloor for the laying of the pipeline bears the potential for a short term negative impact on local fishers and recreational users of the Salt River Bay. Poses a threat to other coastal resources in the area (sea grass, coral reefs, marine life)
Operation	Residential	Hayes, Halse Hall, Gimme-Me-Bit, Mineral Heights,	Noise at the Power Station Location Air quality impacts due to the stack emissions if not compliant with emission criteria standards (implications for respiratory illnesses)
	Recreational/ Fisheries	Salt River, Mitchell Town	Maintenance dredging can result in displacement and threats similar to that in the construction phase
	All Land Uses	All Communities (dependent of incident location)	The safety risks and concerns in the event of a leakage or explosion along pipeline or emergency/alternate transportation route.

5.5.3. Synopsis of Voluntary Public Consultation Meetings

Two Voluntary Public Consultation Meetings were held at the following locations:

- Hayes All Age School
- Jamalco Refinery Community Council

The preparation for the meetings were done in keeping with NEPA' guidelines.

There was congruence with the issues raised by the representatives of the population with the findings of the contact socio-economic survey carried out.

The Voluntary Public Consultation Meeting Report is located in Volume II: Extended Appendix 9.

6.0. Environmental Risk Analysis

6.1. Introduction

The CHP is proposed to involve the following:

1. The construction of a 200 MW natural gas fired Combined Heat and Power cogeneration plant (CHP)
2. Installation of 22.4 km of pipeline (5.6km buried beneath the seafloor and 16.8 km buried beneath the land) for the delivery of natural gas to the CHP
3. Installation of a pipeline to deliver steam to Jamalco
4. Installation of an electricity transmission network to deliver electricity to the national grid
5. Storage of ADO for use under emergency conditions
6. Transportation of ADO under emergency conditions

The layout of the infrastructure is shown in Figure 175 below

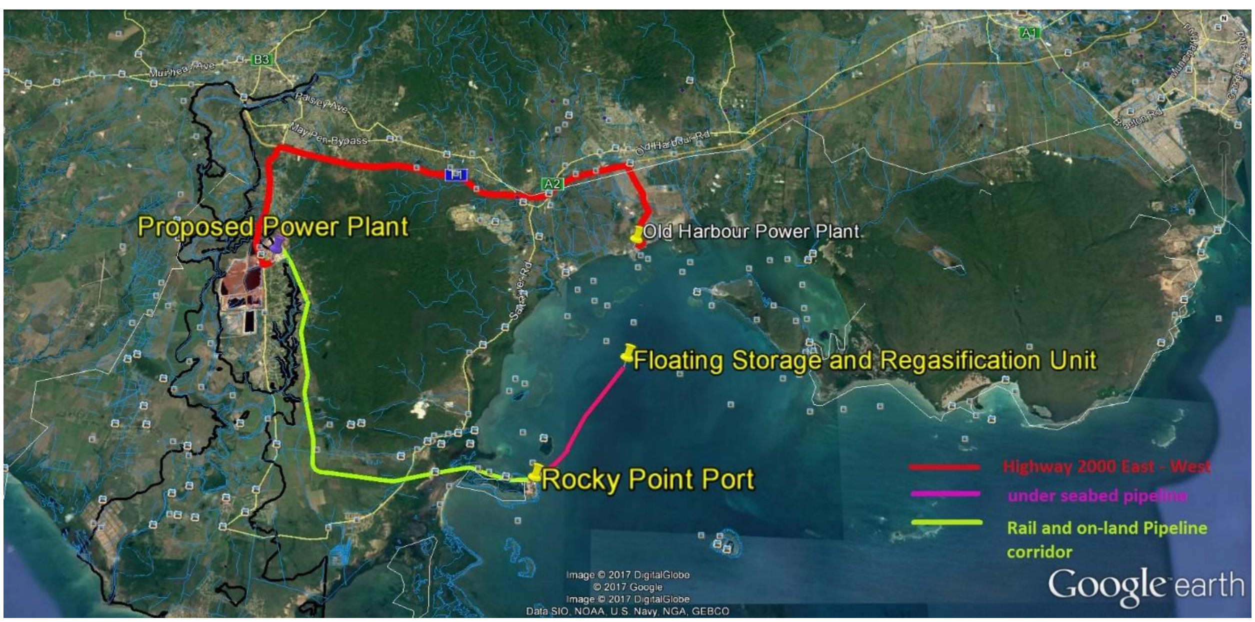


Figure 175: Infrastructure layout for the CHP

The supporting infrastructure will extend over a distance of approximately 26 km (gas pipeline, steam pipeline (within the battery limits of Jamalco's alumina refinery) and electricity transmission line. This spans the marine environment (underwater pipelaying and port connection), wetland environment (port interconnections and pipelaying on land), terrestrial environment (pipelaying, plant construction and transmission network installation).

The Portland Bight Protected Area (PBPA) is a biodiversity hot spot. The footprint of the CHP is very narrow and its infrastructure located in brownfield site locations at the port, along the railway alignment, and the alumina refinery which have been in operation since 1963 and 1970 respectively.

The construction and operation of the infrastructure associated with the development of this technological state of the art system is being done in an environment, which is zoned for various types of activities such as agricultural, residential, commercial and industrial. For this reason, there are existing risks, which may result from these activities.

LNG will be loaded to the FSRT by supply ships in the Portland Bight in Old Harbour Bay. The NG will be pumped through a 16-inch carbon steel metal pipeline to the power station (CHP), 22.4 km away emerging from the seafloor at the Rocky Point Port and buried underground up to the plant. The natural gas will be combusted in a Combustion Turbine Generator (CTG) to produce electricity which will be supplied to the national grid. The waste hot gases from the combustion and electricity generation turbines will be re-used to heat water to produce steam. The steam will be supplied to Jamalco's steam generators to provide process steam and generate electricity.

The CHP proposed is dual fired, and can be operated with NG as well as Automotive Diesel Oil (ADO). In case of emergency situations when NG is unavailable, or during maintenance operations of the system, ADO will be used as backup fuel. ADO is required to meet these planned and unplanned situations.

There will be several inputs to the operations of the project and two main outputs. These include:

- ✓ Natural Gas – for primary electricity and steam generation. The combustion of the NG will also generate air pollutants such as SO_2, NO_2, CO_2 and particulate matter.
- ✓ Automotive Diesel Oil – for electricity and steam generation during maintenance and emergency situations. This will be stored in tanks in three (3) areas for the security of supply and distribution. The combustion of the ADO will also generate air pollutants such as SO_2, NO_2, CO_2 and particulate matter.
- ✓ Demineralized water will be produced by Reverse Osmosis and stored on the CHP site.
- ✓ Steam – for electricity generation and processing of bauxite at Jamalco's alumina refinery. The water used for steam generation will be recycled to reduce waste generation as a conservation measure.
- ✓ Electricity – will be transmitted to the national grid.

The LNG transportation, delivery and storage industry has made over 100,000 voyages over the last 55 years without major accidents, safety problems, hazardous incidents or public fatalities and injuries, both in port and at sea[30]. The ships are built to ensure safety. All facilities associated with this project will be built to international standards consistent with modern industry best practices for environmental safety and health protection. The safety record of the industry is maintained by strict industry regulations, standards and controlled mitigation and preventative measures. The activities constituting the highest potential levels of threat to the environment, health and safety for the CHP project operations are:

1. The storage and transportation of ADO
   a. Especially in close proximity to sensitive areas such as wetlands, the marine environment and communities
2. The combustion of ADO in the plant
3. The emissions from the combustion process
4. The delivery of steam to Jamalco and

[30] Environmental Impact Assessment for the New Fortress Energy Marine Terminal and Pipeline Project, Old Harbour, St. Catherine

5. The delivery of electricity to the national grid

The construction of the project will have activities in sensitive areas and hence there are risks for impacting negatively on the environment human health and safety. The risks associated with these activities are effectively managed by health and safety management plans that are highly developed, internationally accepted and in use at Jamalco. These risks will therefore not be analyzed here. This section seeks to analyze the risks from new activities associated with the CHP project, and the management of these risks.

The consequences of hazards associated with the operational activities of concern are described below:

6.2. Storage of Natural Gas and ADO

The project proposes four (4) major storage facilities as described below:

1. FSRT – storage of up to175,000 m^3 of natural gas at -160 ˚C and 5 mbar (already permitted by NEPA),
2. Storage tanks for 132,000 (2 x 66,000) barrels of ADO at the Rocky Point Port for use under emergency conditions.
3. Storage tank for 15,000 barrels of ADO at the Jamalco alumina refinery for use during maintenance and under emergency conditions.
4. Storage tank for 100,000 barrels (2 x 50,000) of ADO at Old Harbour Bay for use under emergency conditions (already permitted by NEPA).

The potential hazards associated with these facilities is manifested when spillages occur, resulting in negative impacts on the natural environment.

Figure 176: Fuel Storage Sites and their Railroad Linkages

6.2.1. NG Supply

LNG is vaporized from storage at the FSRT and is pumped under low pressure (650 psig) to the undersea pipe for supply to the CHP.

The pipeline for transmission of NG to the plant has a length of 23 km and traverses the marine, wetland and terrestrial environment in PBPA. Any rupture of this supply line will lead to loss of electricity and steam generating capacity for the plant.

The potential for natural gas spills in this activity can occur in:

1. <u>The marine environment from a rupture of the submerged pipeline:</u>
    a. The probability of accidental rupture is low because the pipeline will be buried and its location made available and approved by the Harbor Master for chart updating. The information will be made available for navigation and channel maintenance purposes. The risk associated with this event is low.

   b. The consequence of spills in this area is from the possible build-up of NG which has the potential to cause fire and explosion which may result in the loss of natural resources and fixed assets in the built environment.
   c. The low pipeline rupture possibility and the low chance of ignition on the open sea make this a low risk activity.
2. <u>The wetland environment owing to ruptures of the buried pipeline:</u>
   a. The pipelines will be buried in this area thus reducing the risk of ruptures.
   b. The consequences of the rupture is increased concentration of NG in the wetland and the possibility of fires and explosions. The buildup of marsh gas (NG) in the environment is a natural phenomenon and swamp fires occur in these environments. This may result in the loss of plant and animal life.
   c. The low possibility of pipeline rupture and a concomitant low risk of fires caused by the possibility of NG escaping from the pipeline.
3. <u>The terrestrial environment owing to ruptures of the buried pipeline</u>:
   a. The pipeline will be buried on land along the alignment of the railways in areas which are used for sugar cane production and other farming activities and housing.
   b. The consequences of rupture is an increase in NG concentration with the possibility of fires and explosions. There could be damage to various types of property for example infrastructure, buildings and farmland. The most significant consequence would be loss of life.
   c. The low possibility of ruptures from the burial of the pipeline, fencing and monitoring of the pipeline corridor results in a low risk for this to occur.

6.2.2. Transfer of ADO from Tanker to on land Storage facility (Rocky Point and Old Harbour)

It is proposed to ship ADO to the port for loading to the storage facilities. Infrastructure exists at Rocky Point Port for offloading of HFO. The management of the transfer of fuel oils will not be a new activity at the site. There is a permitted storage facility existing at the location.

The consequences of a spill at this location are increased ADO concentration in the marine and wetland environment and the possibility of fires and explosions. Increased ADO concentration and fires in the marine environment could cause loss of human life, biodiversity and fixed assets.

The activities at this location will fall under Jamalco's existing management framework. The risk management for these activities are incorporated in the SOPs for these activities. These activities area therefore of low risk for environmental adverse impacts. A similar situation is anticipated for the Old Harbour storage facility

6.2.3. ADO Transfer – Storage Tank to Tank Railcar

The transfer of ADO to rail cars will be done at the Rocky Point Port. This will occur only during cases of emergency conditions.

The consequences of a spill at this location are increased ADO concentration in the marine and wetland environment and the possibility of fires and explosions. Increased ADO concentration and fires in the marine environment could cause loss of human life, biodiversity and fixed assets.

The risk of spills during transport by rail to the power station are fires and explosions. This could occur in the wetlands, along the farmlands or in the community. There could also be contamination of the wetland and degradation of water quality.

The activities at this location will fall under Jamalco's existing management framework. The risk management for these activities are incorporated in the Standard Operating Procedures (SOPs) for these activities. These activities are therefore of low risk for impacting adversely on the environment.

6.2.4. Storage tank to Trucks

It is proposed to unload ADO from storage tanks to trucks at the Old Harbour Storage site and Rocky Point Port under emergency conditions.

The consequence of spillages at this location is pollution of the marine and wetland environment as well as the possibility of fires and explosions, which may result in the damage to infrastructure and loss of life.

The activities at this location will fall under Jamalco's existing management framework. The risk management for these activities are incorporated in the SOPs for these activities. These activities are therefore of low risk for impacting adversely on the environment.

6.2.5. Trucks to Storage Tank

This transfer of ADO will only take place at the storage facility at the Jamalco alumina refinery.

The consequences of spills at this location are increased ADO concentration and soil contamination, fires and explosions, damage to infrastructure and possible loss of life.

The activities at this location will fall under Jamalco's existing management framework. The risk management for these activities are incorporated in the SOPs for these activities. These activities are therefore of low risk for impacting adversely on the environment.

6.3. Port to Plant Linkages

6.3.1. Description Railroad and Pipeline route

The satellite imagery (Figure 177) shows the corridor linking the Port to the Refinery by railway and pipeline. The roadway stops were there is a near 90^{o} inflexion of the corridor, while the railway continues into the refinery. Figure 178- Figure 181 are aerial photographs that show the pathway traversed by the railway and the pipeline from the Port to the Refinery. Potential spill impact receptors of both the natural and built environment are shown along the railway route.

Figure 177: Satellite Imagery showing the Alignment of the Marine Terminal to Refinery Railway Line.

Figure 178: Alignment of Railway Track Leading from the JAMALCO Marine Terminal (alignment in ***RED***).

Figure 179: Alignment of Railway Track Leading Westwards from the JAMALCO Marine Terminal through Wetland Area (alignment in ***RED***).

Figure 180: Alignment of Railway Track Leading from the JAMALCO Marine Terminal Northwards through the Community of Corn Piece (alignment in ***RED***).

Figure 181: Termination of Railway Track at JAMALCO Refinery. Note Community of Corn Piece Immediately Adjoining to the South (right of image) (alignment in ***RED***).

6.4. Combustion of Fuels in the Station Plant

Combustion of fuels will occur at Jamalco alumina refinery property. There will be either 4 of 5 combustion turbines operating at the location and will be fed with 58 m^3/hr of natural gas or 9,000 gallons/hr of ADO. High pressure gas and high temperature.

The consequences of a rupture or malfunction in the facility could be catastrophic for the surrounding areas. There could be explosions and fires resulting in loss of life and damage to refinery and associated infrastructure.

Such occurrences are rare and the measures for quality assurance and facility management reduces the risks for such outcomes significantly.

This is therefore a low risk activity for the project.

6.5. Transmission of Steam and Electricity

The products of the power station will be delivered to the clients via a steam conduit pipeline and a transmission network. The steam conduit will be fully within the battery limits of the Jamalco alumina refinery while a network for electricity transmission will leave the property and run adjacent to the main road. These are both in environments that are already exposed to the activities being proposed.

The consequences of a rupture in the delivery networks are:

1. For the steam, there could be health and safety consequence resulting in death of onsite personnel from burns associated with steam and shrapnel from explosions
2. For the electricity, there could be electrocutions resulting in deaths of passersby and workers.

The implementation of Jamalco's existing policies have effectively reduced the occurrence of these possibilities when transferring steam.

This activity is therefore a low risk activity for this project.

6.6. Hazard Identification

This environmental risk analysis seeks to predict the likely impacts of the construction and operation of the CHP and its infrastructure on the natural and built environment in relation to the consequences, which could occur in the event of a hazardous spill through impacts on the following receptors:

- ✓ human settlements,
- ✓ mangroves,
- ✓ marine environment (seagrass beds, and corals.

The hazards addressed in this report are associated with the accidental release of

1. Natural Gas,
2. Automotive Diesel Oil,
3. Air pollutant from combustion

Hazards in this report are identified in relation to the hazardous materials mentioned above. The occurrence of at least one of these events is referred to as an incident, and the likelihood of an event that can directly cause a spill is referred to as a potential incident.

The following four (4) hazardous inputs and outputs of the CHP project are considered to be environmental hazards:

- Automotive Diesel Oil
- Natural Gas
- Steam
- Electricity

6.7. Automotive Diesel Oil

Automotive Diesel Oil has the following hazardous characteristics:

- Flammable
- Explosive
- May cause illness if inhaled or if contact is made with the skin or eyes or if smoke from flames is inhaled
- May be toxic to marine life

- ADO is a liquid and has a lower density than water. ADO is immiscible in water. Consequently, if spilled in seawater, it will float and may be dispersed by wind, current and wave action
- ADO has the potential to impact negatively on human health and various natural resources

6.8. Natural Gas

Natural Gas has the following hazardous characteristics:

- Flammable
- Explosive

The physico-chemical characteristics of ADO and Natural Gas are provided in the table below.

Table 30: Physcio-chemical characteristics of ADO and Natural Gas

Physico-chemical Characteristic	Automotive Diesel Oil	Natural Gas
Chemical Name	Petroleum	Methane
Structural Formula	Hydrocarbons consisting of paraffins, cycloparaffins, aromatic and olefinic hydrocarbons with carbon numbers predominantly in the C_9 to C_{25} range	CH_4
Molecular Weight	Variable because it consists of a wide range of substances of different molecular weight	16.04 g mol^{-1}
Aspect	Sticky, black liquid similar in appearance and smell to asphalt sealing compounds	Colourless, odorless gas A relatively stable inorganic material
Solubility in water	6.26 mg/L at 22°C	Insoluble in water
Concentration (%)	May have a composition of: • 88% wt Carbon • 10% wt Hydrogen • 1% wt Sulphur • 0.5% wt Water	N/A

	• 0.1% wt ash	
Density	820-860 kg/m^3	0.65 kg/m^3

6.9. Determination of Risk to the Environment:

The risk of negative environmental impact resulting from accidental spillage of a hazardous material is pronounced where:

1. the accidental spillage occurs or result in consequences beyond the boundaries of the facility, and;
2. environmental factors, such as wind, water currents or ground infiltration, facilitate transport to resources or populations that are vulnerable.

The natural resources which could be affected by an incident at the marine terminal are:

- mangrove wetlands,
- coral, and;
- seagrass beds.

ADO is less dense than water and will float on the surface of the water column Without containment spilled oil will be dispersed in the wetlands and marine environment. This could cause clean-up issues. This depends on the vulnerability of the shoreline environment that becomes contaminated.

Figure 183 shows locations along the rail corridor where hazardous materials could be spilled outside of both the marine terminal and the refinery. The resources which may be impacted by an incident along the railroad are listed below:

- Mangrove wetlands within 50 meters south of the rail line
- Human settlements within 50 meters east and west of the rail line
- Sugar cane lands and open fields adjacent to the rail line

Figure 184 illustrates areas of sensitivity within 50 meters to the left and right of the rail corridor linking the marine terminal to the refinery. The area from the refinery to the near 90^{o} inflexion is considered least vulnerable due to the absence of mangroves, settlements or agricultural lands in close proximity to the rail line. The area from the near 90^{o} inflexion to the community of Hayes is considered moderately vulnerable due to the presence of agricultural lands or settlements within 100 to 300 meters from the rail line. The area traversing the communities and up to the refinery is considered most vulnerable due to the presence of mangroves or residences in close proximity to the rail line.

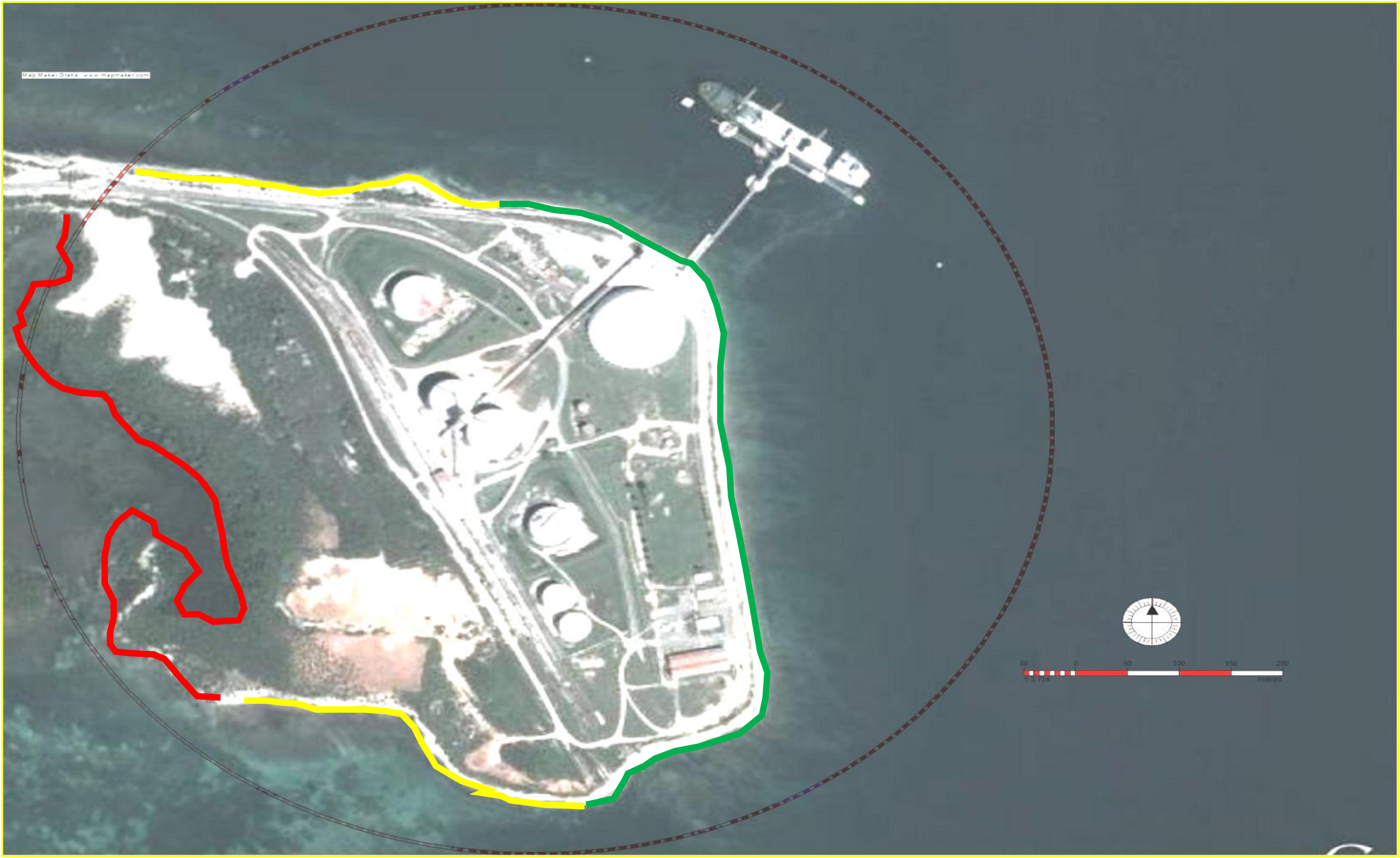


Figure 182: International Petroleum Industry Environmental Conservation Association (IPIECA)-based shoreline environmental sensitivity index map for the study area. **Green**: Index 1B – Exposed solid man-made structure, **Yellow**: Index 5 – Mixed sand and gravel beach, **Red**: Index 10, Tidal wetlands.

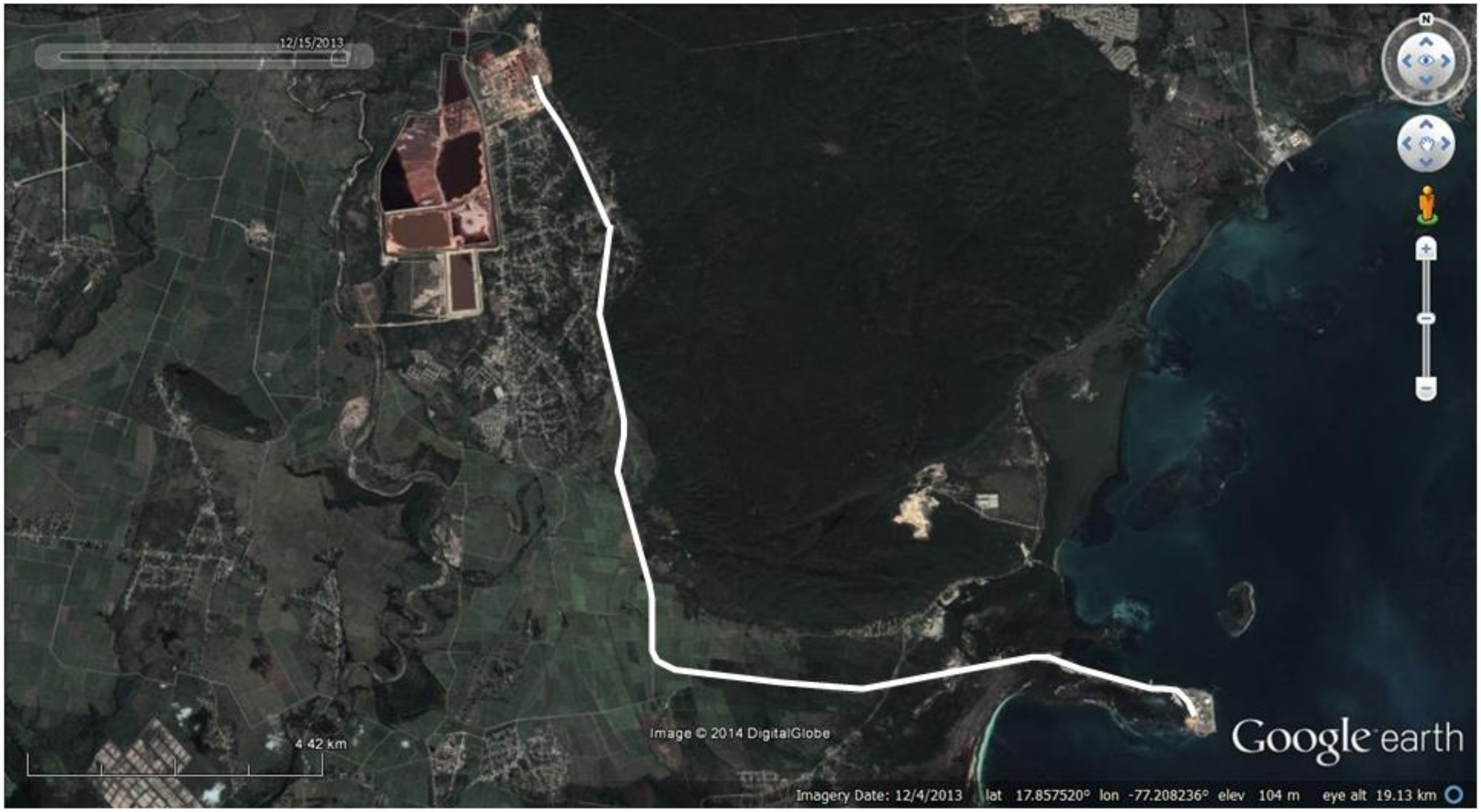


Figure 183: Locations along rail corridor where derailment could cause hazardous materials to escape outside of the marine terminal periphery

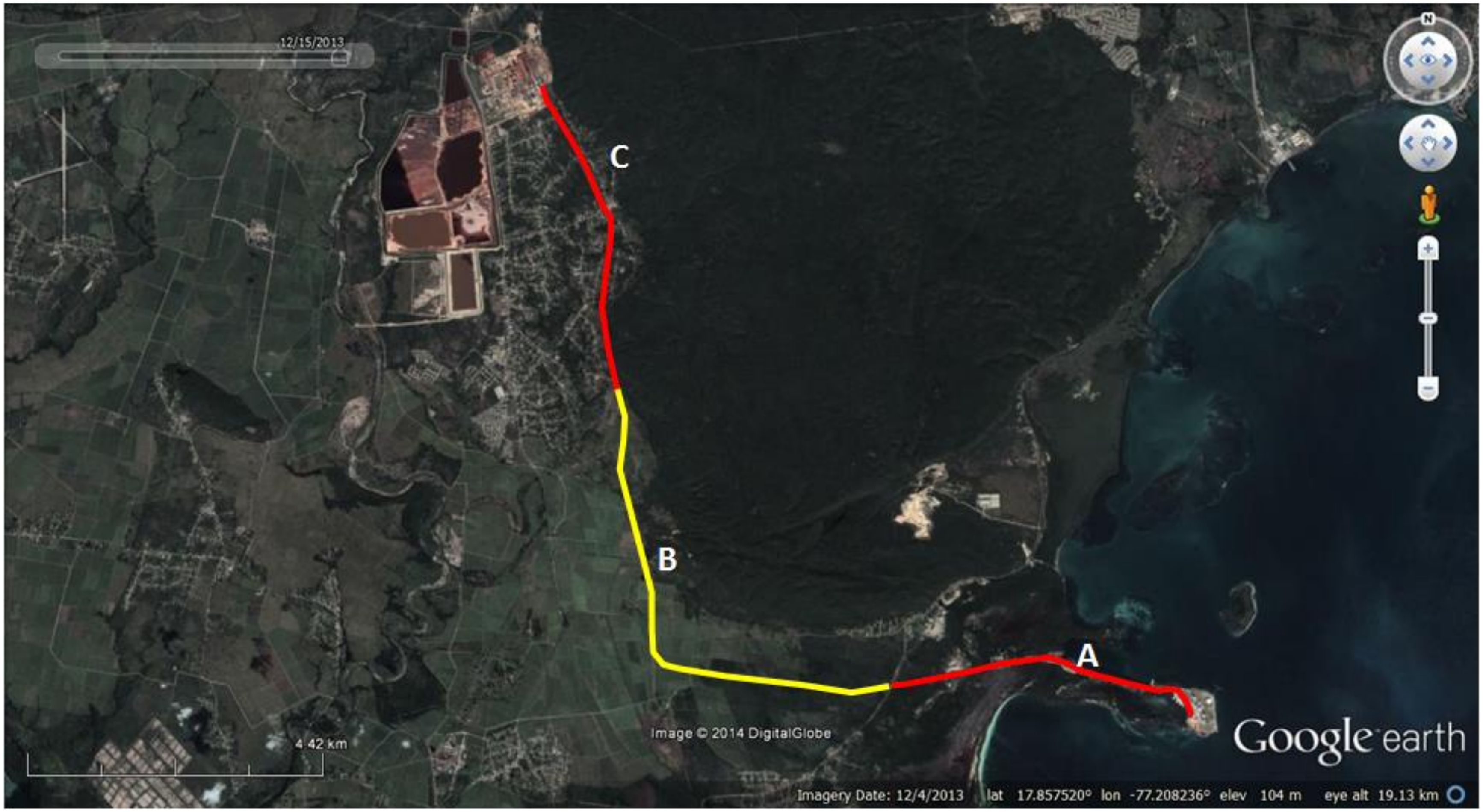


Figure 184: Adaptation of IPIECA environmental sensitivity index map for the rail corridor leading from marine terminal. **Red**-A: Index 3, Mangrove wetlands within 50 meters south of rail line, **Red**-C: Index 3, Settlements within 50 meters east and west of rail line. Yellow B: Index 2, Sugar cane lands and open fields surrounding rail line.

6.10. Impact Identification

The potential direct, indirect and cumulative impacts as a result of the CHP facility operations to the marine, terrestrial and socio-cultural environments were assessed and described below.

The indirect or secondary impacts are changes that are usually less obvious, occurring later in time or further away from the impact source.

Cumulative effects, typically, result from the incremental impact of an action when combined with impacts from projects and actions that have been undertaken recently or will be carried out in the near or foreseeable future. These impacts may be individually minor but collectively significant because of their spatial concentration or frequency in time. Cumulative effects can accumulate either incrementally (or additively) or interactively (synergistically), such that the overall effect is larger than the sum of the parts. In conducting the cumulative assessment it has been noted that the surrounding economic zone comprises:

- Windalco's Port Esquivel - *exporters of alumina, importers of caustic soda and oil*
- energy generation facilities – *importers of oil*
- commercial boatyards,
- piers,
- various land-based commercial shops, and a
- recreational shooting range (game fishing and hunting facility).

If spilled continuously, ADO has the potential for accumulation. However, ADO is eventually assimilated by the marine environment. It is also immiscible in seawater and floats on seawater because of its lower density. The impact of an ADO spill on the coastal and marine environment vary as a function of volume of ADO spilled, the duration of the spill and weather and marine conditions and the impact receptors in the areas. Oil spill can directly impact marine wildlife through ingestion, absorption or inhalation.

In the event of a spill, Jamalco's spill prevention plan involves initiating the immediate steps necessary to contain or divert releases away from surface water bodies and other sensitive receptors. If the spill enters the sea, absorbent material and/or skimming equipment may be used to remove the oil.

The indirect impacts of spillage of oil are the loss of habitat, loss of feeding ground, disruptions in natural life cycles, loss of the fisheries resources on which the fishers in the area are dependent and the loss of recreational spaces such as beaches.

6.11. Risk Analysis

The major consequence to the natural and built environment in respect ADO is identified on the basis of the minimum quantities of the substances that in the event that a spill should occur, require reporting to NEPA. In that regard, the risk evaluation reflects how any aspect of their operation may be assessed in relation to having to make a report to NEPA in the event of a spill. By extension, it also represents NEPA's a major safe guard to ensure compliance with NEPA's standards for the operation in relation to the potential of a spill.

Table 31: Derived Hazard List Risk Analysis

	Hazard Identification			Consequences
Hazardous compound	**Hazard**	**Environmental Receptor**	**Activity**	
Automotive Diesel Oil	Fire and Explosion	Humans	• Spillage of oil during off-loading activities • Spillage of oil during its storage • Spillage of oil during its transport via railroad • Spillage of oil during its transport via road during emergency conditions • Accidental or Intentional malfunction at CHP	✓ Health impartment – 1. air pollution, plume from fire dispersed to settlements in the air shed. 2. Skin damage due to contact with ADO on water and land ✓ Fish kill ✓ Aquatic flora and fauna smothered – death to organisms ✓ Damage to houses and property from fires and explosion ✓ Loss of life in fires and explosion ✓ Loss of livelihood
		Marine		
		Terrestrial –Flora and Fauna		
	Environmental Damage	Marine	• Spillage of oil during off-loading activities • Spillage of oil during its storage • Spillage of oil during its transport via railroad • Spillage of oil during its transport via road during emergency conditions	
		Built Environment		
		Terrestrial – Flora and Fauna		
	Health impairment	Humans	• Spillage of oil during off-loading activities • Spillage of oil during its storage • Spillage of oil during its transport via railroad • Spillage of oil during its transport via road during emergency conditions	

Methane	Fire and Explosion	Marine environment	• Spillage of methane gas during off-loading and storage activities • Spillage of methane during conveyance	✓ Aquatic flora and fauna smothered – death to organisms ✓ Damage to houses and property from fires and explosion ✓ Loss of life in fires and explosion ✓ Loss of livelihood
		Humans/Built Environment	• Spillage of methane during conveyance • Accidental or Intentional malfunction at CHP	
		Terrestrial – Flora and Fauna	• Spillage of methane during conveyance	
Steam	Hot	Humans	• Spillage during CHP operation	✓ Loss of life
Electricity	Electrocution	Human	• Transformer operation and Transmission to national grid	✓ Health impairment – death, severe burns, property damage, system block outs

6.12. Risk Prevention, Avoidance and Mitigation

Jamalco's Rocky Point Port operations are guided by a Spill Prevention, Control and Countermeasure (SPCC) Plan, which was prepared in accordance with applicable ALCOA and local government regulations regarding spill prevention and control and in accordance with ISO 14001:2004 requirements for emergency preparedness and response.

This plan is designed to provide the controls and procedures necessary to **avoid** or **minimize** the releases of hazardous substances to the air, soil, surface waters, and groundwater. In the event of an incident, the SPCC plan contains Jamalco's Emergency Response Action Plan (ERAP), which guides Jamalco's action in stopping the source of a spill, notifying the appropriate people, and initiating procedures to prevent or minimize risks to human health and the environment.

The philosophy which in part guides Jamalco's Spill Prevention, Control and Countermeasure (SPCC) relies on inspections and testing as the primary operational means of avoiding releases, which should be done often enough to identify problems in time to before they develop into an incident.

It should be noted that Jamalco employs routine inspection and periodic structural integrity testing of pipelines and storage tanks and earthen dikes as their primary operational means of avoiding releases from the tanks and impoundment at the port.

Jamalco has an inspection schedule that identifies:

- Areas and equipment to be inspected
- Types of problems to look for during inspection
- Relevant department delegated with responsibility for inspection
- Inspection frequency

Inspection frequencies at the Port are variable, and are based on the design specifications of the equipment being used and the probability of an environmental or human health incident should the expected deterioration or malfunction or operator error goes undetected between inspections. Therefore, if an incident occurs between scheduled inspections, then the frequency of the inspection period is re-examined in light of the incident and its cause.

6.13. Risk Management and Monitoring Plan

This report was based on a detailed analysis of Jamalco's ISO 14001:2004 certified, world class port and railroad operations, which use best practices. The company operates in compliance with the regulatory framework of Jamaica. In respect of environmental monitoring, it operates in compliance with the requirements of Section 17 of the NRCA Act, 1991.

All the requirements for the efficient and effective management and monitoring of Jamalco's operations are already in place and being actively practiced.

The scope of the monitoring and management carried out by Jamalco is listed below:

- Spill Prevention, Control and Countermeasure (SPCC) Plan
- Emergency Response Procedures and Plans, Spill Prevention Plans which informs each person on the plant site of potential emergency situations and educates them as to what to do if such an event occurs.

In general, the following types of risk scenarios are covered by the plans:

- Storage unit leaks and/or ruptures of hazardous materials
- Leaks/spills of hazardous materials and petroleum products during loading/unloading operations
- Pipeline failures
- Tanks and vessels overflows
- Releases of hazardous materials due to railroad accidents
- Training
- Reporting

These activities take place on a schedule basis, encompass the environmental monitoring and evaluation of all the operations at the port and are documented and reported internally and externally to regulatory authorities in compliance with the requirements of the regulatory framework.

7.0. Impact Identification & Mitigation

7.1. Introduction

The project may be considered in its entirety as mitigation action for air quality management of the airshed in which it is planned. If implemented the proposed development has the potential to create a number of impacts. These potential impacts can be either positive or negative depending on the receptors involved and other parameters such as the magnitude, duration, and level of project management and monitoring. Since this section of the report is geared primarily towards identification of environmental impacts those will be presented in greater detail.

In assessing the significance of potential impacts, various measures are used. These include the use of checklists/matrices, expert knowledge and a keen assessment of the project plans and details. Each parameter is evaluated according to the following:

- Potential impact - any potential change to the environment, whether adverse or beneficial, wholly or partially resulting from the proposed activities, products or services
- Activity –action taking place during a phase of the development
- Environmental receptor - sensitive component of the ecosystem that reacts to or is influenced by environmental stressors
- Magnitude - A measure of how adverse or beneficial an impact may be
- Duration - the length of time needed to complete an activity
- Significance - A measure of importance of an effect
- Mitigation - Measures taken to reduce adverse impacts on the environment

Outlined below are the impacts on the various phases of the proposed development as they relate to key aspects of the project. Namely:

- Physical environment
- Biological environment
- Socio-economic environment

- Cumulative impact assessment

Mitigation measures are provided, where necessary, at the end of each subsection.

7.2. Impact Identification & Mitigation Method

7.2.1. Impact Identification

This section forecasts the characteristics of the main potential impacts and can be broken down into three overlapping categories:

- *identification* — to specify the impacts associated with each phase of the project and the activities undertaken;
- *prediction* — to forecast the nature, magnitude, extent and duration of the main impacts; and
- *evaluation* — to determine the significance of residual impacts i.e. after taking into account how mitigation will reduce a predicted impact

Impact identification and prediction are undertaken against an environmental baseline, such as:

- human health and safety;
- flora, fauna, ecosystems and biological diversity;
- soil, water, air, climate and landscape;
- use of land, natural resources and raw materials;
- protected areas and designated sites of scientific, historical and cultural significance;
- heritage, recreation and amenity assets; and
- livelihood, lifestyle and wellbeing of those that may be affected by the proposed project

These requirements were identified in the Terms of Reference. The parameters to be taken into account in impact prediction and decision-making include:

- likelihood (probability, uncertainty or confidence in the prediction);
- nature (positive, negative, direct, indirect, cumulative);
- magnitude (severe, moderate, low);
- extent/location (area/volume covered, distribution);
- duration (short term, long term, intermittent, continuous);
- reversibility/irreversibility; and
- significance (local, regional, global)

7.2.1.1. Nature

The most obvious impacts are those that are directly related to the proposed project, and can be connected (in space and time) to the action that caused them. Typical examples of direct impacts as it relates to this project are: potential loss of habitat caused by land clearance; any perceived changes/increases and air particulate emissions (temporary/permanent)[31].

Indirect or secondary impacts are changes that are usually less obvious, occurring later in time or further away from the impact source. Typical examples of indirect impacts as it relates to this project are: stress and community disruption associated with increased traffic volumes and noise caused by urban development.

Cumulative effects, typically, result from the incremental impact of an action when combined with impacts from projects and actions that have been undertaken recently or will be carried out in the near or foreseeable future. These impacts may be individually minor but collectively significant because of their spatial concentration or frequency in time. Cumulative effects can accumulate either incrementally (or additively) or

[31] Biodiversity loss in this context is mainly represented as a decrease in populations. The reduction in population has the potential impact of making a species more vulnerable to extinction, while the genomes may still exist, particularly if conditions favorable to the reproduction, growth and development of the species are not favourable or available

interactively (synergistically), such that the overall effect is larger than the sum of the parts.

7.2.1.2. Magnitude (Intensity)

Magnitude of the impact has been expressed in this document in terms of relative severity, such as major, moderate or low. Severity, takes into account other aspects of impact magnitude, notably whether or not an impact is reversible.

- **Low**: negligible effect occurs when a component is slightly altered. For human population, the effect is negligible when it slightly affects a component or its use or valuation by the community.
- **Moderate**: moderate effect occurs when a component is altered to a lesser extent but doesn't compromise its presence in the new environment. For human population, the effect is less intense when it partially limits the use of the component or its valuation by the community.
- **Major**: major effect occurs when a component is completely destroyed or is altered significantly. For human population, the effect is when it compromises or alters significantly the component or its use or valuation by the community.

7.2.1.3. Duration

Some impacts may be short-term, such as the noise arising from the operation of equipment during construction. Others may be long-term, such as increase in traffic on existing roads. Certain impacts may be intermittent, whereas others may be continuous.

- **Short-term impacts**: when component will be affected for a limited period such as the pre-construction phase of the project, i.e., pre-construction and construction.
- **Intermittent impacts**: when component will have difficulty to adjust at first to the new environmental conditions but will eventually return to pre-project levels and the population will be able to use it eventually as before or even better.

- **Long-term impacts**: when component will be affected for the lifetime of the project enough to compromise the survival of a local species or use of a component by the population.

Impact magnitude and duration classifications will be cross-referenced; as necessary, for example, major but short term (less than one year).

7.2.1.4. Extent/Location

The spatial extent or zone of impact influence can be predicted for site-specific versus regional occurrences. Depending on the type of impact, where necessary, the variation in magnitude will be estimated.

- **Limited**: When impact occurs in relatively restricted areas such as the construction site facilities
- **Local**: Limited area when component is well represented in region (<1 km radius)
- **Regional**: When an impact exceeds local boundary and has the potential to affect a wide radius of communities such as a nearby town (1-10 km radius)
- **National**: When an impact has the potential to affect the entire island
- **International**: Impacts that may be considered as affecting the global population such as contributions to global warming

7.2.1.5. Significance

The evaluation of significance at this stage of EIA will depend on the characteristics of the predicted impact and its potential importance for decision-making. An impact may be categorized as negative if it adversely affects an environmental component and positive if it favourably affects an environmental component. For the purposes of this project:

- **Minor**: An impact of low significance is one that is short term and will have no long term cumulative effect on the environment and/or will affect a negligible portion of an environmental component.

- **Moderate**: An impact may be considered to be of moderate significance when the change is medium to long term and/or will result in changes that affect a considerable portion of the environmental component.
- **Major**: An impact of high significance will cause long term changes and/or will result in changes that affect a major percentage of the environmental component.

Significance may also be attributed in terms of an existing standard or criteria of permissible change, for example as specified in the Noise Pollution Rules, 2001.

7.2.1.6. Impact Mitigation

The elimination of adverse environmental impacts, or their reduction to an acceptable level is at the heart of the EIA process. By definition all EIA projects are likely to have significant environmental effects. In this case, the potential for mitigation will be considered at every stage of the proposed project. In determining the level of effectiveness of mitigation measures, the following will be taken into account:

A. **Prevent** - The most effective approach will be to prevent the creation of adverse environmental effects at source rather than trying to counteract their effects through specific mitigation measures. At source solutions may include:
    - specification of operational equipment- for example the use of an inherently quieter machine
B. **Reduce** - If the adverse effects cannot be prevented steps will be taken to reduce them. Methods to reduce adverse effects include: minimization at source
    - use of low noise or vibration construction equipment
    - operating the site to minimize the production of leachate
    - abatement on site
        i. colour of buildings
        ii. screen planting and landscaping
        iii. noise attenuation measures
        iv. reduced hours of construction
    - abatement at receptor

i. noise insulation for houses
ii. relocating rare species

Quantification of impacts is a difficult technical aspect of an EIA. For some impacts the theoretical basis for computing the magnitude does not exist. Such impacts may have to be addressed in a qualitative way.

7.2.1.7. Summary of Impact Matrices

Summary matrices are included and give an overall picture of the potential pre-mitigation impacts and residual impacts.

7.2.2. Residual Impacts

Any potential residual impacts, ranked as moderate or major will be discussed in more detail in the subsequent text in the section addressed. The residual environmental impacts refer to the net environmental impacts after mitigation, taking into account the background environmental conditions and the impacts from existing, committed and planned projects.

The following table outlines the criteria used to assess environmental impacts in terms of minor, moderate, or major impact subsequent to mitigation measures being incorporated.

Table 32: Level of Impact after Mitigation Measures

	Ecological Effects	Socio-economic Effects	Stakeholders	Consequence for Proponent
Major	Degradation to the quality or availability of habitats and/or fauna with recovery taking more than 2 years	Change to commercial activity leading to a loss of income or opportunity beyond normal business variability/risk Potential short-term effect upon public health / well-being, real risk of injury	Concern leading to active campaigning locally or wider a field	Introduce measures to avoid these impacts wherever possible, closely monitor and control areas of residual impact
Moderate	Change in habitats or species beyond natural variability	Change to commercial activity leading to a loss of income or	Widespread concern, some press coverage,	Actively work to minimize scale of impacts

	Ecological Effects	Socio-economic Effects	Stakeholders	Consequence for Proponent
	with recovery potential within 2 years	opportunity within normal business variability/risk Possible but unlikely effect upon public health/well-being. Remote risk of injury	no campaigning	
Minor	Change in habitats or species which can be seen and measured but is at same scale as natural variability	Possible nuisance to other activities and some minor influence on income or opportunity. Nuisance but no harm to public	Specific concern within a limited group	Be aware of potential impacts, manage operations to minimize interactions
Negligible	Change in habitats or species within scope of existing variability and difficult to measure or observe	Noticed by but not a nuisance to other commercial activities. Noticed by but no effects upon the health and well-being of the public	An awareness but no concerns	No positive intervention needed but ensure they do not escalate in importance
Positive	An enhancement of ecosystem or popular parameter	Benefits to local community	Benefits to stakeholder issues and interests	Actively work to maximize specific benefits

7.3. Impact Identification & Mitigation

This project will provide employment opportunities during all phases of the project (pre-construction, construction and operation). Additionally, NFE will utilize a pool of national engineering professionals and contractors. NFE will also employ other residents from the surrounding communities owing to their proximity to the project site, and their knowledge of the area and local operations.

Foreign Exchange Earnings/Benefit to Economy – The proposed development represents an investment of US$265 million. Jamalco will benefit through a reduction in its dependence on HFO for process steam and for generating electrical energy for processing of alumina. Jamalco may also become more competitive on the world alumina market.

Jamalco will see an increased profitability. This is a significant positive, both direct and indirect, long-term impact on the economy of the communities and the country.

The following tables provide a clear indication of potential environmental impacts associated with this project, and provide information on potential receptors, duration, magnitude, and mitigation measures. Since these are potential impacts, there is no certainty that they will materialize; however, the developers will be prepared to deal with any adverse impacts should they arise during any phase of this project.

Mitigation costs associated with this project have been factored into the overall project cost.

7.3.1. Impacts from the Natural Gas Fired Combined Heat & Power (CHP) Station

7.3.1.1. Impacts to Physical Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Aesthetics							
Site Clearance, short-term construction and operation	Humans	***Item A1*** – The site is already clear and there is no need for removal of vegetation. The site for the CHP at the refinery is presently a throw down storage area for scrap metal. All activities on the site will be carefully examined to ensure as little impact on the surrounding community as possible.	Low & Short-term	Limited & insignificant	High & Direct	Proper upkeep and maintenance of the site will be done. Measures include: minimizing height of temporary structures, replanting of disturbed vegetation, and the re-use of topsoil stripped during site clearance Landscaping to increase greenery	Positive
Geological and Geotechnical							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item GG1*** – The inclusion of existing drainage features (which will be upgraded, where necessary) into the project's overall drainage design will allow for better control and management of stormwater which will reduce or eliminate erosion.	Moderate & Long- term	Local & Minor	Low & Direct	A properly designed drainage system will be a feature of the proposed development. Once implemented along with other protective measures such as silt screens, as necessary, will provide adequate protection for land stabilization. All effort will be made to ensure that this aspect of the project is implemented. Vegetated areas outside the design footprint must be maintained to reduce the risk of erosion. Stockpile material near drainage corridors must be bermed.	Positive
Water Quality, Surface Water Hydrology and Groundwater							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item WQ1*** – Gullies in vicinity of plant.	Low & Long - term	Local & Minor	Low & Indirect	Jamalco's existing system of runoff management will handle runoff during construction Stockpiles will be kept away from the drains and be properly bermed. Temporary sewage and waste water management systems will be implemented during this period. All drainage features to be designed must meet a minimum 1:25 year return period.	Minor
Air Quality							
Pre-Construction, Construction,	Humans, Flora and Fauna	***Item AQ1*** – During site clearance and construction activities, there is a possibility	Moderate & Short -term	Local & Minor	Low & Indirect	All stockpiles of construction material should be kept onsite for a minimum amount of time. This will limit the	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Operation		that stockpiles of various materials associated with the proposed project may have to be maintained in the project area. These stockpiles, without proper management and monitoring can dry out and result in fugitive dust formation which can be dispersed by the wind affecting air quality. This is a short term, reversible and mitigable impact.				potential for stockpiles drying out and becoming airborne. If unavoidable, the stockpiles should be wetted or in the worst case covered to limit dispersion of dust. Stockpile material that may generate fugitive dust should be totally covered during transportation. Proper personal protection equipment (PPE) devices such as face mask should be provided to workers where necessary.	
		Item AQ2 – Various mechanical equipment and vehicles are expected to be used at the project site. The heavy duty vehicles are expected to be primarily diesel fuel vehicles. When properly maintained heavy duty vehicles can operate without causing a significant decrease in air quality. However, if maintenance is poor, excessive fugitive emissions may result.	Low & Short-term	Local & Minor	Low & Indirect	Heavy duty equipment and vehicles using diesel fuel must be properly maintained and inspected at regular intervals. As much as possible, all vehicular maintenance should be done at an approved off-site maintenance location such as a garage. Vehicles causing excessive fugitive emissions should be removed from service.	Minor
		Item AQ3 – The removal of vegetation from the site during site clearance activities may increase the potential for particulate matter to get into the atmosphere. This is as a result of exposed soil that may dry out.	Low & Short-term	Local & Minor	Low & Indirect	During site clearance activities, the area must be monitored and dust suppression techniques put in place as needed.	Minor
Noise							
Pre-Construction, Construction, Operation	Humans and Fauna	***Item N1*** –Vehicles and site activities, and various mechanical equipment, can generate noise that may exceed acceptable levels.	Low & Long-term	Local & Minor	High & Direct	Silencers or mufflers on construction equipment should be properly fitted and maintained. If site activities are known to be noisy, they should be scheduled at times least likely to impact those in hearing distance.	Minor
		Item N2 – Operation of the plant will generate continuous noise	Low & Long-term	Local & Major	High & Direct	Housings and enclosures for turbines and generators are designed and installed to industry best practice and standards. Foundation design to meet vibration control requirements	Minor
		Item N3 – Explosion at plant during operations from generation facility, Oil storage facility	High & Short-term	Regional & Major	Low & Direct	SOPs developed and adhered to. Staff trained in SOPs and Audited	Minor

7.3.1.2. Impacts to Biological Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Marine Resources							
Pre-Construction, Construction, Operation	Marine Fauna	***Item MR1*** – Ship delivering parts could damage corals	Moderate & Long-term	Local & Major	High & Direct	Established shipping routes will be utilized	Minor
	Mangrove	***Item MR1*** – The mangrove could be impacted mainly during the pre-construction and construction phases owing to accidents that may occur during transportation of parts from the port by rail or road. This potential impact is particularly in the form of a loss of biodiversity.	Moderate & Short-term	Local & Minor	Low & Direct	All SOPs for transportation must be adhered to.	Moderate
		Item MR1 – Fire and explosion during operations have the potential to cause biodiversity loss	High & Intermittent	Local & Major	Low & Direct	Implement fire prevention system SOPs developed and implemented Community engagement and pipeline monitoring	Major
Terrestrial Wildlife Resources							
Pre-Construction, Construction, Operation	Fauna	***Item WR1*** – Transport of parts by rail could affect wildlife if accidents occur.	negligible & short-term	Limited & Minor	Low & Direct	The use of Jamalco' SOPs	Negligible
		Item WR2 – Fire and explosion during operations have the potential to cause biodiversity loss	High & Intermittent	Local & Major	Low & Direct	Implement fire prevention system SOPs developed and implemented Community engagement and pipeline monitoring	Major
Terrestrial Vegetative Resources							
Pre-Construction, Construction, Operation	Flora	***Item VR1*** – In order to construct this development some aspects of the existing vegetation will be removed.	Negligible & Long term	Limited & Minor	High & Direct	The removal of vegetation and ecological habitats is unavoidable and is the main trade-off to be made against the benefits to be derived from project implementation. Vegetation should only be removed within the design footprints. Any landscaping measures to be put in place must incorporate plants that are growing in the area only.	Positive
		Item VR2 – Fire and explosion during operations of the pipeline have the potential to cause biodiversity loss	High & Intermittent	Local & Major	Low & Direct	Implement fire prevention system SOPs developed and implemented Community engagement and pipeline monitoring	Major

7.3.1.3. Impacts on Socio-Economic and Socio-Cultural Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Employment & Worker Health & Safety							
Pre-Construction, Construction, Operation	Humans	***Item E&HS1*** – This project will provide employment opportunities during all phases of project implementation, which will include residents of the surrounding communities resulting from their proximity to the project site, and their knowledge of the area and operations there.	Major & Long-term	Regional, National & Major Positive	High & Direct	No mitigation required, though re-training may be essential for certain class of operations	Positive
		Item E&HS2 – There are risks associated with any working condition. This is primarily important where workers interact with moving and heavy equipment.	Moderate & Long-term	Local & Major Negative	Low & Indirect	Proper PPE should be issued to workers depending on the area they work in. This should include boots, ear muffs, goggles, gloves and hard hats at a minimum. Management should institute a standard annual health and safety retraining exercise for all categories of workers. Compliance audits and accident/injury records must be done on a periodic basis.	Positive
Relocation/Compensation							
Pre-Construction, Construction, Operation	Humans	***Item H1*** – Existing facilities will be relocated	Minor & Long-term	Local & Minor	High & Direct	No mitigation required.	Positive
Recreation & Heritage Sites							
Operation	Human	***Item CH1*** – The Halse Hall Great House is 4 km away	Minor & Long-term	Regional & Minor	Negligible & Indirect	No mitigation needed.	Positive
Traffic							
Pre-Construction, Construction, Operation	Humans	***Item T1*** – The existing main roads will not be used to deliver and remove materials, and equipment to and from the proposed site location. Construction traffic is minimal. Increased traffic congestion and accidents during operation	Minor & Long-term	Regional & Minor	Minor & Direct	At a minimum, proper ingress and egress must be designed into the development plans to accommodate the smooth flow of traffic in and out of the development through all phases of the project. Heavy duty vehicles such as trucks should be scheduled to deliver and/or remove construction waste during off-peak times.	Minor
Solid Waste							
Pre-Construction, Construction, Operation	Humans	***Item SW1*** – Site clearance activities during the pre-construction phase and other waste from packaging and materials in the other phases will generate solid waste. If these waste streams are not properly managed then the potential exists for a negative impact. A	Low & Short-term	Limited & Minor Negative	Low & Indirect	All solid waste generated during all phases will be collected, handled and disposed of appropriately. Following the guidelines of the Jamalco waste management system. A comprehensive on-site waste management plan will	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
		properly implemented and executed solid waste management plan can remove this negative potential.				be prepared for the construction period. Such a management plan will incorporate site specific factors, such as the designated areas for the temporary storage of solid waste.	
Sewage Waste							
Pre-Construction, Construction, Operation	Humans and Fauna	***Item SeW1*** – The potential for sewage waste pollution during site clearance and construction activities exist though remote.	Low & Short-term	Limited & Minor Negative	Low & Indirect	The use of regularly serviced portable chemical toilets will negate this potential negative impact. Sewage handling and disposal will be effectively and carefully managed as part of the project management and monitoring plans. Tertiary treated zero discharge operation system	Minor
Storm Water Management							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item SWM1*** – The potential for storm water inundation/damage during site clearance and construction activities exist during adverse weather conditions such as hurricanes and tropical storms.	Low & Long-term	Regional & Major Negative	Low & Direct	Site elevation is above the 100-year flood level for the Rio Minho The site drainage is incorporated into Jamalco's water management system	Minor
Oil Spill Contingency							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item OSC1*** – Heavy duty vehicles onsite has the potential for oil leaks and spills	Low & Long-term	Local & Minor	High & Direct	Maintenance of vehicles will be scheduled and monitored using maintenance preventative systems.	Minor
		Item OSC2 – The potential for oil spills during the transport of ADO exists along all the delivery routes and the storage areas: • Marine environment • Terrestrial • Built up areas	High & Short term	Regional & Major	Low & Direct	Industry best practices and standard for, transmission, storage and transportation. Jamalco SOPs implemented and monitored for all ADO handling components.	Major
Community and Surrounding Infrastructure							
Pre-Construction, Construction, Operation	Humans, built environment.	***Item CSI1*** – Dust, noise, vibration from construction can soil buildings, cause nuisance to the occupants and damage to buildings and surrounding infrastructure.	High & Short-term	Regional & Medium	High & Direct	Wetting of work site Using silencers, constructing doing noisy hours Industry best practice for vibration control Pre-construction survey of infrastructure	Minor
		Item CSI2 – Vibration from operation of power station can cause damage and nuisance to nearby communities.	High & Long term	Regional & High	High & Direct	Design foundation to industry best practice and standard Establish baseline	Minor
		Item CSI3 – Explosion at power station during operation can cause damage to buildings (refinery, communities, mud lakes) by fire and vibration.	High & Short-term	Local & High	Low & Direct	Develop SOPs Train staff in SOPs. Audits regularly Develop and practice emergency management plans.	Positive

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
						Community consultations	

7.3.2. Impacts from the Pipeline

7.3.2.1. Impacts to Physical Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Aesthetics							
Site Clearance, short-term construction and operation	Humans	***Item A1*** – The clearance and removal of vegetation from various areas will result in a visually negative impact as it represents a change from what is customary. All activities on the site will be carefully examined to ensure as little impact on the surrounding community as possible.	Low & Short-term	Limited & Minor Negative	High & Direct	Proper upkeep and maintenance of the site will be done. Measures include: landscaping access along the pipeline Re-use of topsoil stripped during site clearance	Minor
		Item A2 – The minimal clearance and removal of mangrove from various areas will result in a visually and ecologically negative impact as it represents a change from what is customary. All activities on the site will be carefully examined to ensure as little impact on the surrounding community as possible	Moderate & Long-term	Regional & Major Negative	High & Direct (Cumulative)	Mangrove replanting will be done on a scale not exceeding 3:1, and be monitored externally by NEPA and any other required agency. On completion of the proposed project, the mangrove parallel the proposed pipeline will be protected and monitored regularly to ensure it continues to perform a key role in the development of the region.	Positive
Geological and Geotechnical							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item GG1*** – Excavation of trenches for pipelaying can lead to erosion of the area.	Moderate & Long- term	Regional & Major	Medium & direct	Construction planning and monitoring should ensure that all agreed stabilization designs are properly implemented. Excavated material management plant to be developed.	Minor
		Item GG2 – The inclusion of existing drainage features, which impact the pipeline alignment, in the project's overall drainage design will allow for better control and management of storm water which will reduce or eliminate erosion and limit associated impacts of silting and sedimentation on water bodies.	Moderate & Short- term	Regional & Major	Medium & Direct	A properly designed drainage system will be a feature of the proposed development. Once implemented along with other protective measures such as silt screens, as necessary, will provide adequate protection for land stabilization. All effort will be made to ensure that this aspect of the project is implemented. Vegetated areas outside the design footprint must be maintained to reduce the risk of erosion. Stockpile material near drainage corridors must be bermed.	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Water Quality, Surface Water Hydrology and Groundwater							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item WQ1*** – The impact on water quality is confined to sediment runoff into wetlands and the marine environment. The coastal waters may be impacted if significant erosion takes place primarily during the pre-construction and construction phase. The coastal area may be impacted negatively by siltation and sedimentation if a problem with soil erosion is realized. Spills from equipment laying pipe in close proximity to wetlands and marine environs	Low & Long - term	Local & Minor	Low & direct	Heavy equipment will be operated on hard surfaces. Stockpiles of excavated and engineered fill should be kept at least 25m from the coastal waters edge and be properly bermed. It is recommended that portable chemical toilets be made available for site workers during construction	Minor
Air Quality							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item AQ1*** – During site clearance and construction activities, there is a possibility that stockpiles of various materials associated with the proposed project may have to be maintained in the project area. These stockpiles, without proper management and monitoring can dry out and result in fugitive dust formation which can be dispersed in the wind affecting air quality. This is a short term, reversible and mitigable impact.	Moderate & Short -term	Local & Minor Negative	Low & Indirect	All stockpiles of construction material should be kept onsite for a minimum amount of time. This will limit the potential for stockpiles drying out and becoming airborne. If unavoidable, the stockpiles should be wetted or in the worst case covered to limit dispersion of dust. Stockpile material that may generate fugitive dust should be totally covered during transportation. Proper personal protection equipment (PPE) devices such as face mask should be provided to workers where necessary.	Minor
		Item AQ2 – Various mechanical equipment and vehicles are expected to be used at the project site. The heavy duty vehicles are expected to be primarily diesel fuel vehicles. When properly maintained heavy duty vehicles can operate without causing a significant decrease in air quality. However, if maintenance is poor, excessive fugitive emissions may result.	Low & Short-term	Local & Minor Negative	Low & Indirect	Heavy duty equipment and vehicles using diesel fuel must be properly maintained and inspected at regular intervals. As much as possible, all vehicular maintenance should be done at an approved off-site maintenance location such as a garage. Vehicles causing excessive fugitive emissions should be removed from service.	Minor
		Item AQ3 – The removal of vegetation from the site during site clearance activities may increase the potential for particulate matter to get into the atmosphere. This is as a result of exposed soil that may dry out.	Low & Short-term	Local & Minor Negative	Low & Indirect	During site clearance activities, the area must be monitored and dust suppression techniques put in place as needed.	Minor
Noise							
Pre-Construction, Construction, Operation	Humans and Fauna	***Item N1*** –Vehicles and site activities, and various mechanical equipment, can generate noise that may exceed acceptable levels.	Low & Short-term	Local & Minor Negative	Medium & Direct	Silencers or mufflers on construction equipment should be properly fitted and maintained. If site activities are known to be noisy, they should be scheduled at times least likely to impact those in hearing distance.	Minor
		Item N2 – noise from leaks on the pipe	Low & Long-term	Local & Minor	Low & Direct	Leak detection system	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
						Effective pipe material in design Pipe maintenance and monitoring plan implemented	

7.3.2.2. Impacts to Biological Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Marine Resources							
Pre-Construction, Construction, Operation	Marine Fauna	***Item MR1*** – The marine community may be affected mainly during the pre-construction and construction phases due to the possibility for increases in turbidity through increased sedimentation and/or siltation within the dredging/drilling corridor. This potential impact is particularly in the form of a loss of biodiversity.	Moderate & Long-term	Local & Major Negative	High & Direct	The use of industry best practice strategies for pipelaying on the seafloor. Directional drilling	Moderate
	Marine Flora	***Item MR1*** – Seagrasses could be affected mainly during the pre-construction and construction phases due to the proposed dredging. This potential impact is particularly in the form of a loss of biodiversity.	Moderate & Long-term	Local & Major Negative	Low & Direct	Directional drilling to be used in sensitive areas	Moderate
	Mangrove	***Item MR1*** – The mangrove will be affected mainly during the pre-construction and construction phases due to the installation of footprints for the pipeline corridor. This potential impact is particularly in the form of a loss of biodiversity.	Moderate & Short-term	Local & Minor Negative	High & Direct	A comprehensive mangrove transplanting exercise must be conducted preferably within the immediate region where mangrove loss has been experienced. A monitoring plan should be formulated.	Positive
Terrestrial Wildlife Resources							
Pre-Construction, Construction, Operation	Fauna	***Item WR1*** – There exists a potential loss of wildlife resources within the immediate area during construction. This loss is temporary since any resident wildlife will temporarily relocate to surrounding areas that are not affected. No region-specific wildlife resource occupies the area that may be impacted should this project go ahead. The proposed protection of the mangrove will maintain the conditions for the existing wildlife resources, particularly the avifauna.	Low & Short-term	Limited & Minor	High & Direct	The potential impact on wildlife resources and their ecological habitats is unavoidable notwithstanding the fact that the area is disturbed through the various activities in the area along the route. Wildlife is mobile in nature and will more than likely relocate to other areas in the vicinity where they are less likely to be impacted. Those deemed important will be tagged, relocated or otherwise placed in a nursery during site clearance and construction to be rehabilitated in the immediate vicinity. Special effort must be made to protect wildlife such as crocodiles, manatees and sea turtles that may be in the area, as well as worker safety. Sightings should be recorded in a` log book specifically designed for that purpose. NEPA should be contacted immediately to handle any necessary relocation should crocodiles venture onto the property and pose a problem.	Minor
Terrestrial Vegetative Resources							
Pre-Construction, Construction, Operation	Flora	***Item VR1*** – In order to construct this pipeline some removal of the existing vegetation unavoidable. This presents a loss of	Moderate & Long term	Regional & Minor	High & Direct	The removal of vegetation and ecological habitats is unavoidable and is the main temporary loss to be made against the benefits to be derived from project	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
		biodiversity within the immediate area. Established ecosystems will be lost. No region-specific endemic plant species were found in the area.				implementation. Vegetation should only be removed within the design footprints. Any landscaping measures to be put in place must incorporate plants that are growing in the area only.	

7.3.2.3. Impacts on Socio-Economic and Socio-Cultural Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Employment & Worker Health & Safety							
Pre-Construction, Construction, Operation	Humans	***Item E&HS1*** – This project will provide employment opportunities during all phases of project implementation, which will include residents of the surrounding communities owing to their proximity to the project site, and their knowledge of the area and operations there.	Major & Long-term	Regional & Major Positive	High & Direct	No mitigation required, though re-training may be essential for certain class of operations	Positive
		Item E&HS2 – There are risks associated with any working condition. This is primarily important where workers interact with moving and heavy equipment.	Moderate & Long-term	Local & Major Negative	Low & Indirect	Proper PPE should be issued to workers depending on the area they work in. This should include boots, ear muffs, goggles, gloves and hard hats at a minimum. Management should institute a standard annual health and safety retraining exercise for all categories of workers. Compliance audits and accident/injury records must be done on a periodic basis.	Minor
Relocation/Compensation							
Pre-Construction, Construction, Operation	Humans	***Item H1*** – depending on the routing of the pipeline corridor, the potential exist for consideration of relocation	Minor & Short-term	Local & Minor Negative	Low & Indirect	No mitigation required. The preferred design alternative should not impact on any existing houses. No relocation and/or compensation required.	Moderate
Recreation & Heritage Sites							
Construction Operation	Humans	***Item CH1*** – The Salt River area is known to have areas that can be considered heritage sites and recreation areas. This route will not be used for transporting ADO. The transport of ADO during emergency conditions will pass the Halse Hall Great House	Major & Short-term	Local & Minor Positive	Minor & Indirect	No "heritage sites" will be affected by this development. No recreational facility will be affected by this development. Industry best practices for fuel transport will be implemented for this project. The JNHT and the Police should be contacted immediately and all work stop should human remains be found anywhere within the project boundaries. A similar protocol is recommended for the unearthing of historical artefacts.	Minor
Traffic							
Pre-Construction, Construction, Operation	Humans	***Item T1*** – The existing main roads will be used to deliver and remove any materials, and equipment to and from the proposed site location. The added vehicles and the frequency of their movement have the potential to add to the existing volume on the	Moderate & Short-term	Regional & Minor	Low & Direct	At a minimum, proper ingress and egress must be designed into the development plans to accommodate the smooth flow of traffic in and out of the development through all phases of the project. Heavy duty vehicles such as trucks should be scheduled to deliver and/or remove construction waste during off-peak	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
		roads during peak usage periods. During emergency situation Automotive Diesel Oil may be transported by road increasing traffic load .				times. Additional management features will be instituted during emergency operation of the plant when ADO is being transported by road. During operation there will be limited impact on the existing traffic in the area. The project does not propose to add to the existing traffic volumes.	
Solid Waste							
Pre-Construction, Construction, Operation	Humans/Marine	***Item SW1*** – Site clearance activities during the pre-construction phase and other waste from packaging and materials in the other phases will generate solid waste. If these waste streams are not properly managed then the potential exists for a negative impact. A properly implemented and executed solid waste management plan can remove this negative potential.	Low & Short-term	Limited & Minor	Low & Indirect	All solid waste generated during all phases will be collected, handled and disposed of appropriately. Centralized storage areas (dumpsters, compactors, etc.) will be located within the development for proper solid waste handling and storage. Solid waste removal will be facilitated by using approved licensed haulage contractors. A comprehensive on-site waste management plan will be prepared for the construction period. Such a management plan will incorporate site specific factors, such as the designated areas for the temporary and permanent storage of solid waste.	Minor
Sewage Waste							
Pre-Construction, Construction, Operation	Humans and Fauna	***Item SeW1*** – The potential for sewage waste pollution during site clearance and construction activities exist though remote.	Low & Short-term	Limited & Minor Negative	Low & Indirect	The use of regularly serviced portable chemical toilets will be used to avoid this potential negative impact. Sewage handling and disposal will be effectively and carefully managed as part of the project management and monitoring plans.	Minor
Storm Water Management							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item SWM1*** – The potential for storm surge inundation/damage during site clearance and construction activities exist during adverse weather conditions such as hurricanes and tropical storms. Erosion of pipeline corridor is a potential impact for lack of proper stormwater management	Moderate & Long-term	Regional & Major	Medium & Direct	Construction in areas sensitive to storm surges should be executed outside of hurricane season Incorporate all existing drainage features (natural and manmade in the plan for the pipelaying route.	Minor
Oil Spill Contingency							

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item OSC1*** – The potential for oil spill damage during site clearance and construction activities exist especially when heavy equipment operates close to the mangroves and coastline	Low & short-term	Local & Major	Low & Direct	An oil spill contingency plan should be drafted if the project is advanced. This should be designed with the assistance of NEPA, ODPEM, Marine Police and in conjunction with JAMALCO.	Minor
Community and Surrounding Infrastructure							
Pre-Construction, Construction, Operation	Humans, built environment.	***Item CSI1*** – Dust, noise, vibration from construction can cause nuisance to the occupants and damage to buildings and surrounding infrastructure.	Low & Short-term	Local & Minor	High & Direct	Wetting of work site Using silencers, constructing doing noisy hours Industry best practice for vibration control Pre-construction survey of infrastructure	Minor
		Item CSI3 – Fire along pipeline during operation has the potential to cause damage to surrounding infrastructure (communities, railroad, port facilities) due to fire and vibration	Major & Short-term	Local & Major	Low & Direct	Develop SOPs Train staff in SOPs. Audits regularly Develop and practice emergency management plans. Community consultations Lay pipeline underground Establish setback as close to Possible Impact radius	Minor

7.3.3. Impacts from the Electricity Transmission Network

7.3.3.1. Impacts to Physical Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Aesthetics							
Site Clearance, short-term construction and operation	Humans	***Item A1*** – The clearance and removal of vegetation from various areas will result in a visually negative impact as it represents a change from what is customary. All activities on the site will be carefully examined to ensure as little impact on the surrounding community as possible.	Low & Short-term	Limited & Minor Negative	High & Direct	Proper upkeep and maintenance of the site will be done. Measures include: replanting of disturbed vegetation, and the re-use of topsoil stripped during site clearance	Minor
Geological and Geotechnical							
Pre-Construction, Construction, Operation	Flora and Fauna	***Item GG2*** – The inclusion of existing drainage features (which will be upgraded, where necessary) into the project's overall drainage design will allow for better control and management of storm water which will reduce or eliminate erosion and limit associated impacts of silting and sedimentation on coastal waters.	Moderate & Long- term	Local & Minor Negative	Low & Direct	A properly designed drainage system will be a feature of the proposed development. Once implemented along with other protective measures such as silt screens, as necessary, will provide adequate protection for land stabilization. All effort will be made to ensure that this aspect of the project is implemented. Vegetated areas outside the design footprint must be maintained to reduce the risk of erosion. Stockpiled material near drainage corridors must be bermed.	Minor
Water Quality, Surface Water Hydrology and Groundwater							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item WQ1*** – Siltation to surrounding gullies	Low & Long - term	Local & Minor Negative	Low & Indirect	Stockpiles should be kept from gully banks and be properly bermed. All drainage features to be designed must meet a minimum 1:25 year return period.	Minor
Air Quality							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item AQ1*** – During site clearance and construction activities, there is a possibility that stockpiles of various materials associated with the proposed project may have to be maintained in the project area. These stockpiles, without proper management and monitoring can dry out and result in fugitive dust formation which can be dispersed in the wind affecting air quality. This is a short term, reversible and mitigable impact.	Moderate & Short -term	Local & Minor Negative	Low & Indirect	All stockpiles of construction material should be kept onsite for a minimum amount of time. This will limit the potential for stockpiles drying out and becoming airborne. If unavoidable, the stockpiles should be wetted or in the worst case covered to limit dispersion of dust. Stockpile material that may generate fugitive dust should be totally covered during transportation. Proper personal protection equipment (PPE) devices such as masks should be provided to workers where necessary.	Minor
		Item AQ2 – Various mechanical equipment and vehicles are expected to be used at the project site. The heavy duty vehicles are expected to be primarily diesel fuel vehicles. When properly maintained heavy duty vehicles can operate	Low & Short-term	Local & Minor Negative	Low & Indirect	Heavy duty equipment and vehicles using diesel fuel must be properly maintained and inspected at regular intervals. As much as possible, all vehicular maintenance should be done at an approved off-site maintenance location such as a garage. Vehicles causing excessive fugitive emissions should be removed from	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
		without causing a significant decrease in air quality. However, if maintenance is poor, excessive fugitive emissions may result.				service.	
		Item AQ3 – The removal of vegetation from the site during site clearance activities may increase the potential for particulate matter to get into the atmosphere. This is as a result of exposed soil that may dry out.	Low & Short-term	Local & Minor	Low & Indirect	During site clearance activities, the area must be monitored and dust suppression techniques put in place as needed.	Minor
		Item AQ4 – EMF increased	Moderate & Long-term	Local & Minor	High & Direct	Industry best practices to be implemented for pole heights and conductor insulation.	Minor
Noise							
Pre-Construction, Construction, Operation	Humans and Fauna	***Item N1*** –Vehicles and site activities, and various mechanical equipment, can generate noise that may exceed acceptable levels.	low & Long-term	Local & Minor	Medium & Direct	Silencers or mufflers on construction equipment should be properly fitted and maintained. If site activities are known to be noisy, they should be scheduled at times least likely to impact those in hearing distance.	Minor
		Item N2 – The powerlines to be installed may result in a characteristic noise being generated.	Low & Long-term	Local & Minor	High & Direct	Industry standard for height and lengths of sections to be implemented	Minor

7.3.3.2. Impacts to Biological Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Terrestrial Wildlife Resources							
Pre-Construction, Construction, Operation	Fauna	***Item WR1*** – There exists a potential loss of wildlife resources within the immediate area. This loss is temporary since any resident wildlife will temporarily relocate to surrounding areas that are not affected. No region-specific wildlife resource occupies the area that will be critically endangered should this project go ahead. Birds are especially vulnerable to high tension wires	Low & Long-term	Limited & Minor	High & Direct	This development is along the existing main road. Special effort must be made to protect wildlife such as crocodiles.	Minor
Terrestrial Vegetative Resources							
Pre-Construction, Construction, Operation	Flora	***Item VR1*** – In order to construct this transmission line some aspects of the existing vegetation will be removed. This presents a loss of biodiversity within the immediate area. Established ecosystems will be lost. No region-specific endemic plant species were found in the area.	Minor & Long term	Limited & Minor	High & Direct	The removal of vegetation and ecological habitats is unavoidable and is the main trade-off to be made against the benefits to be derived from project implementation. Vegetation should only be removed within the design footprints. Any landscaping measures to be put in place must incorporate plants that are growing in the area only.	Minor

7.3.3.3. Impacts on Socio-Economic and Socio-Cultural Resources

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Employment & Worker Health & Safety							
Pre-Construction, Construction, Operation	Humans	***Item E&HS1*** – This project will provide employment opportunities during all phases of project implementation, which will include residents of the surrounding communities due to their proximity to the project site, and their knowledge of the area and operations there.	Major & Long-term	Regional & Major Positive	High & Direct	No mitigation required, though re-training may be essential for certain class of operations	Positive
		Item E&HS2 – There are risks associated with any working condition. This is primarily important where workers interact with moving and heavy equipment.	Moderate & Long-term	Local & Major Negative	Low & Indirect	Proper PPE should be issued to workers depending on the area they work in. This should include boots, ear muffs, goggles, gloves and hard hats at a minimum. Management should institute a standard annual health and safety retraining exercise for all categories of workers. Compliance audits and accident/injury records must be done on a periodic basis.	Minor
		Item E&HS – broken powerlines in operation can cause electrocution of passersby on plant site and road corridor**.**	Low & Short-term	Local & Major	Low & Direct	Establish Buffer zone around high voltage components. Signs illustrating danger Training of workers and Community and road users.	Minor
Relocation/Compensation							
Pre-Construction, Construction, Operation	Humans	***Item H1*** – depending on the routing of the transmission network, the potential exist for consideration of relocation	Minor & Short-term	Local & Minor Negative	Low & Indirect	No mitigation required. The preferred design alternative does not impact on any existing houses. No relocation and/or compensation required	Minor
Recreation & Heritage Sites							
Operation	Human	***Item CH1*** – Damage to heritage sites, obstruction to access	Minor & Long-term	Local & Minor	Low & Indirect	No heritage sites in corridor. The JNHT and the Police should be contacted immediately and all work stop should human remains be found anywhere within the project boundaries. A similar protocol is recommended for the unearthing of historical artefacts.	Minor
Traffic							
Pre-Construction, Construction, Operation	Humans	***Item T1*** – Road blockages due to heavy equipment operations during construction. Traffic impact due to material delivery to site Road Blockage for installation of wires	Moderate & Short-term	Local & Minor Negative	High & Direct	Activities to be carried out outside of road corridor. Request for road closures and adequate signs.	Minor
Solid Waste							
Pre-Construction,	Humans/Marine	***Item SW1*** – Site clearance activities during the	Low & Short-term	Limited & Minor Negative	Low & Indirect	All solid waste generated during all phases will be collected,	Minor

Activity	Environmental Receptor	Potential Impact	Magnitude & Duration	Extent/Location & Significance Level	Likelihood & Nature	Mitigation	Residual
Construction, Operation		pre-construction phase and other waste from packaging and materials in the other phases will generate solid waste. If these waste streams are not properly managed then the potential exists for a negative impact. A properly implemented and executed solid waste management plan can remove this negative potential.				handled and disposed of appropriately. Centralized storage areas (dumpsters, compactors, etc.) will be located within the development for proper solid waste handling and storage. Solid waste removal will be facilitated by using approved licensed haulage contractors. A comprehensive on-site waste management plan will be prepared for the construction period. Such a management plan will incorporate site specific factors, such as the designated areas for the temporary storage of solid waste.	
Sewage Waste							
Pre-Construction, Construction, Operation	Humans and Fauna	***Item SeW1*** – The potential for sewage waste pollution during site clearance and construction activities exist though remote.	Low & Short-term	Limited & Minor Negative	Low & Indirect	The use of regularly serviced portable chemical toilets will negate this potential negative impact. Sewage handling and disposal will be effectively and carefully managed as part of the project management and monitoring plans.	Minor
Storm Water Management							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item SWM1*** – Contamination by stockpiled material.	Low & Short-term	Local & Minor	High & Direct	Implement proper waste management plan Remove stockpiles asap.	Minor
Oil Spill Contingency							
Pre-Construction, Construction, Operation	Humans, Flora and Fauna	***Item OSC1*** – The potential for oil spill during site clearance and construction activities exist.	Low & Short-term	Local & Minor	High & Direct	Vehicle maintenance plan implemented	Minor

7.4. Cumulative Impact Assessment

The potential cumulative impacts as a result of this development are as follows:

- Impacts to Biological Resources
- Impacts to Physical Resources
- Impacts on Socio-Economic and Socio-Cultural Resources

7.4.1. Impacts to Physical Resources

The surrounding economic activities comprises; bauxite-alumina ports, energy generation facilities, sugar production, commercial boatyards, piers and various land-based commercial shops.

7.4.1.1. Water

Water demand for the proposed development has been considered in conjunction with present usage patterns and known capacities. In terms of potable water demand, the proponents will not be considering commissioning groundwater well development to adequately supply the proposed project as they plan to tie in to Jamalco's water supply system. The cumulative impact of water supply to the development would not be to the detriment of other users presently being supplied by well water in the area. Jamalco will operate within the limits of its abstraction licences.

7.4.1.2. Sewerage

Sewerage demands for the proposed development have been considered in conjunction with present usage patterns and known capacities. There exists no centralised sewage network in the area. As a result, NFE will be tie into Jamalco's sewage treatment plant to process all sewage and drainage waters that will be generated from the operational stage of the development. Additionally, the treated effluent will be regularly analysed to ensure it meets NEPA's existing standards. With this system implemented, the development will not add any new stresses on the existing environment. It should be highlighted that the option exists for use of commercial chemical toilets during the construction of the pipeline. These will be disposed of outside of the watershed.

7.4.1.3. Air Quality

In addition to the CHP Project, air emissions from nine other nearby facilities were included in a cumulative modelling for the region. The maximum impacts from the cumulative modelling are dominated by contributions from other nearby facilities. The cumulative modelling results indicate that the CO_x impacts are below the JAAQS. All other pollutant and averaging periods breach the JAAQS. The modelled annual PM10 is below the standard, but when added to the ambient background concentration the total PM10 concentration is above the standard. The cumulative scenario was modelled with the latest stack emissions data from the sources. No consideration was given to the improvement in air quality anticipated with the installation of the CHP.

Although the cumulative impacts are exceeding the JAAQS, the CHP Project is not contributing significantly to any exceedances. The cumulative modelling provides a baseline for the conditions now, showing that improvement is needed. This highlights the need to mitigate the air quality impacts by switching fuel from HFO to NG, a significantly cleaner burning fuel. Clean projects like the proposed CHP Project are needed to achieve the emissions reductions while providing the steam and electricity that is crucial for Jamaica.

7.4.1.4. Natural Hazards

The proposed project area is not prone to land-slippage though coastal erosion is known to occur during periods of significant storm surge and hurricane activity. It is not to the benefit of NFE to construct this development in a manner that will result in erosion or land slippage; in fact any area(s) deemed to be susceptible to impacts should be reinforced. The proposed development is not expected to affect the stability of soils in the area. No measurable cumulative impact.

7.4.2. Impacts to Biological Resources

Biological resources of the area are being impacted at present from farming, industrial activity. The aquatic and/or marine environment is already potentially impacted by the existing JAMALCO port (heavy metals, oily waste, residual chemicals) and other commercial ventures along the waterfront ranging from energy generators, fishing beach to Bauxite-alumina port.

The development will not discharge waste to the environment. Incorporation with Jamalco's management system will reduce its contribution to the environment. It is not anticipated that the development, if implemented, will significantly add to any existing impacts resulting in worsening of the cumulative impact. To the contrary, the reduction of squatting, illegal solid waste disposal and illegal removal of mangrove for charcoal and the associated chemicals may result in an improvement in the quality of runoff and drainage into Colon Bay.

The loss of vegetated land is not a major impact (since the corridor for the development is in an already degraded (brownfield corridors). This development will not add significantly to any cumulative impact.

Impacts to groundwater should not be manifested from this development. There is no real source of groundwater contamination associated with this development. The other sources of potential groundwater impact such as chemicals associated with agriculture, the sugar waste and boatyards (tributyltin [TBT]), improperly treated sewage from residential areas (Faecal Coliform), and others need to be investigated and monitored to improve water quality. The marine water quality is also in a degraded state.

7.4.2.1. Potentially Impacted Coastal Mangroves & Seagrass Beds

- Loss of mangroves and other marine habitats
- The mangrove communities that will be disturbed are a part of the largest intact mangrove forest along Jamaica's coastline.

The possible loss of wetland character on the edge of the rail line reservation is unlikely to have a significant ecological impact on the mangrove system distributed throughout the surrounding area.

Loss of seagrass beds is not anticipated for this project as the use of directional drilling has been effective in bypassing these sensitive ecosystems.

While NFE is committed to implementing the best available environmental practices in this project, there is the potential for other indirect impacts unless appropriate mitigation measures are implemented, particularly during any near-shore works. Such mitigation measures mainly relate to controlling the potential for impacts to water quality. As with all other projects occurring at the land-water interface, the control of erosion, sedimentation and other water quality impacts is a key issue. Given the existing level of disturbance in the vicinity of the proposed project area and the fact that any activities associated with the dredging works would incorporate implementation of appropriate environmental management and impact mitigation measures, the potential impacts are unlikely to be substantial or significant with regard to the marine and aquatic communities.

7.4.2.1.1. Recommended Mitigation Measures - Mangroves

If required, mangroves can be replanted through seedlings. In order to overcome the deficiencies in existing replanting techniques, encased replanting is suggested as the mitigation method. The method focuses on isolating the seedling in a controlled environment at the actual replanting site. The encasement artificially creates an environment favourable to the seedling's initial development while protecting the plant long enough for it to become well established. The isolation physically separates the seedling from surrounding conditions that are unfavourable to early development of the tree. If necessary, seedlings of each affected type of mangrove to be replanted will be harvested as much as possible from the affected site or sourced through various ENGO's involved in replanting of mangroves across the island.

Areas in which 5 percent or more of the mangrove trees have been trimmed below 4 feet in height, destroyed, defoliated, or removed as a result of this project will be rehabilitated or mitigated. Rehabilitation will be accomplished by replanting mangroves, in the same geographical sphere and of the same species as each mangrove destroyed, defoliated, removed, or trimmed, to achieve within 5 years a canopy area equivalent to the area affected on a mitigation ratio of 3:1.

This replanting exercise could be located in areas that have experienced significant stress during recent hurricanes to assist in the re-establishment of mangroves in those areas.

7.4.2.1.2. Recommended Mitigation Measures – Seagrass

Dredge and fill activities have been widely recognized as a major anthropogenic disturbance contributing to the destruction of seagrass meadows. The direct and immediate effect of dredging on seagrass communities is mortality due to removal and/or burial. In addition, there may be indirect losses resulting from the disturbance of sediments during dredging operations. Sediment disturbance results in increased turbidity, and decreased light availability. Seagrasses have high light requirements and the decreased light availability associated with sediment resuspension has been closely associated with seagrass loss (Texas Parks and Wildlife, 1999).[32]

The Project proposes to use directional drilling to bypass seagrass beds.

7.4.3. Impacts on Socio-Economic and Socio-Cultural Resources

The region of the development is an existing commercial and industrial zone. The introduction of the NG fired CHP will have a positive impact on the socio-economics of the area. Residents will have new job solutions in closer proximity to their place of living. From a cumulative perspective, this project would be a benefit since work solutions are in high demand in the area.

The further development of area could be catalyzed by this development as Jamalco's stalled upgrade becomes possible with the use of a cleaner fuel to generate steam and power. The stability of supply of NG based on its available reserves makes the prospect for

[32] http://www.epa.gov/gmpo/habitat/seagrassmanagementplan.pdf

long-term energy supply very attractive. The upgrade of Jamalco would see more professionals in the parish, more traffic and more need for housing solutions.

7.5. Impact Matrices

Table 33: Impact Identification of the Proposed Development

	EIA Activities																	
	Site Preparation				Construction								Operation					
	Site Surveying	Site Clearance	Site Access	Solid Waste Disposal	Materials Sourcing	Materials Transport	Materials Storage	Construction Works	Solid Waste Disposal	Sewage Treatment	Surfacing/Paving	Landscaping	Traffic	Solid Waste Disposal	Water Supply	Electricity Generation	Increased Marine Traffic	ADO Transport
Physical Parameters																		
TOPOGRAPHY																		
GEOLOGY & GEOTECHNICAL																		
AMBIENT NOISE & VIBRATION																		
WINDS																		
RAINFALL																		
NOISE AND DUST																		
DRAINAGE																		
WATER QUALITY																		
TEMPERATURE																		
NATURAL HAZARD VULNERABILITY																		
Ecological Parameters:-																		
TERRESTRIAL ECOSYSTEMS																		
TERRESTRIAL VEGETATION																		
AVIFAUNA																		
OTHER FAUNA																		
MARINE ECOSYSTEMS																		
MARINE VEGETATION																		
MARINE FAUNA																		
SENSITIVE HABITATS																		
Socio-Economic Parameters:-																		
AESTHETICS																		
LAND USE COMPATIBILITY																		
EMPLOYMENT																		

	EIA Activities																	
	Site Preparation				Construction								Operation					
	Site Surveying	Site Clearance	Site Access	Solid Waste Disposal	Materials Sourcing	Materials Transport	Materials Storage	Construction Works	Solid Waste Disposal	Sewage Treatment	Surfacing/Paving	Landscaping	Traffic	Solid Waste Disposal	Water Supply	Electricity Generation	Increased Marine Traffic	ADO Transport
STRUCTURES/ROADS	No Impact	Minor Negative	Minor Negative	Minor Negative	No Impact	No Impact	Minor Negative	No Impact	Minor Negative	No Impact	Major Positive	No Impact	Minor Negative	Minor Negative	No Impact	No Impact	No Impact	No Impact
WASTE MANAGEMENT	No Impact	No Impact	No Impact	Minor Positive	No Impact	No Impact	No Impact	No Impact	Minor Positive	No Impact	No Impact	No Impact	No Impact	Minor Positive	No Impact	No Impact	No Impact	No Impact
TRAFFIC	No Impact	Minor Negative	Minor Negative	Minor Negative	No Impact	Minor Negative	Minor Negative	Minor Negative	Minor Negative	No Impact	No Impact	No Impact	Minor Negative	Minor Negative	No Impact	No Impact	No Impact	No Impact
INCREASED CRIME POTENTIAL	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	Minor Negative	Minor Negative
HAZARD VULNERABILITY	No Impact	Minor Negative	No Impact	No Impact	No Impact	Minor Negative	No Impact	Minor Negative	No Impact	No Impact	No Impact	Minor Positive	Minor Negative	No Impact	No Impact	No Impact	Minor Negative	Minor Negative
SEWAGE DISPOSAL	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	Major Positive	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact
OCCUPATIONAL HEALTH & SAFETY	No Impact	Minor Negative	No Impact	No Impact	Minor Negative	Minor Negative	No Impact	Minor Negative	Minor Negative	Minor Negative	No Impact	Major Positive	No Impact	No Impact	No Impact	No Impact	No Impact	No Impact

KEY

No Impact

Minor Negative

Major Negative

Minor Positive

Major Positive

Table 34: Impact Mitigation Matrix – Residual Effect (Pre-Construction Phase)

	Proposed Mitigation Measures													
	Detailed Topographic Surveys	Effective Site Management	Scheduling of Construction Activities	Waste Management Plan	Regular Solid waste collection	Placing of Solid waste Receptacles	Road Paving and Surfacing	Dust Management Techniques	Proper Vehicle Maintenance	Installation of Sediment Traps	Security & Fencing	Positive Impact No Mitigation	Community Relations	Flora & Fauna Relocation
Impacts – Pre-construction Phase														
Clearing of Site Vegetation														
Levelling of Site														
Transportation of Construction Material														
Increase in Noise														
Increase in Dust														
Disturbance of flora and fauna														
Aesthetics														
Increased Traffic														
Increased Employment														
Road Wear														
Increased Sedimentation of Coastal Waters														
Change in the Natural Drainage Patterns														
Solid Waste Generation														
Disturbance of Sensitive Habitats														
Increased Earning Potential for Community														
Trespassers into Conservation Area														
Traffic Inconveniences														
Seagrass Relocation & Monitoring														
Mangrove Replanting & Monitoring														

Table 35: Impact Mitigation Matrix – Residual Effect (Construction Phase)

	Proposed Mitigation Measures																	
	Detailed Topographic Surveys	Phasing of Building Plans	Scheduling of Construction Activities	Waste Management Plan	Regular Solid waste collection	Placing of Solid waste Receptacles	Road Paving and Surfacing	Dust Management Techniques	Proper Vehicle Maintenance	Landscaping Measures	Effective Site Management	Security & Fencing	Installation of Sediment Traps	Scheduling of Heavy Vehicles	Positive Impact No Mitigation	Community Relations
Impacts - Construction Phase																
Increased Employment																
Preparation of Site																
Transportation of Construction Material																
Increase in Noise																
Increase in Dust																
Occupational Health & Safety Concerns																
Aesthetics																
Increased Earning Potential for Community																
Increased Traffic																
Road Wear																
Increased Sedimentation of Coastal Waters																
Change in the Natural Drainage Patterns																
Solid Waste Generation																
Sewage Disposal																
Trespassers into Conservation Area																
Disturbance of Wetland Communities																

Table 36: Impact Mitigation Matrix – Residual Effect (Operational Phase)

	Proposed Mitigation Measures							
	Community Wide Plan	Operation & Maintenance Plan	Regulatory Monitoring	Waste Management Plan	Regular Solid waste collection	Placing of Solid Waste Receptacles	Security & Fencing	Landscaping Measures
Impacts - Operational Phase								
Increased Employment opportunities	Positive			Negligible				
Sewage Treatment System Management		Negligible	Negligible	Negligible				
Drainage Patterns	Negligible		Negligible	Negligible		Negligible		Positive
Solid Waste Management		Negligible	Negligible	Negligible	Positive	Positive		
Water Conservation		Negligible		Negligible				
Energy Conservation		Negligible						
Aesthetics		Negligible		Negligible	Positive	Negligible	Negligible	Positive
Regulatory Compliance			Positive	Negligible		Negligible		
Trespassers in Conservation Area	Positive	Negligible					Positive	
Fugitive Dust	Negligible		Negligible	Negligible				Positive
Increased Earning Potential for Community	Negligible	Negligible						
Seagrass Relocation & Monitoring	Negligible	Negligible	Major					
Mangrove Replanting & Monitoring	Negligible	Negligible	Major					

KEY

Major

Moderate

Minor

Negligible

Positive

8.0. Environmental Management Plan

8.1. Introduction

NFE will conform with Jamalco's Environmental Health & Safety, Security Planning, Construction Management, and Emergency Response Policies and Procedures in constructing and operating all major infrastructure for:

- conveying natural gas from an FSRT to onshore facilities
- establishing a CHP which provides process steam to Jamalco and electricity to the national grid.

The primary objective of the EMP is to ensure that the project complies with the terms and conditions of NEPA and other applicable and relevant authorities as they have been outlined in the Environmental Permit. The plan provides guidance in the following areas:

1. Training of managers and staff
2. Solid waste handling and disposal
3. Hazardous material storage and disposal
4. Sewage treatment and disposal
5. Hazard Management

As required or as necessary, environmental monitoring will be undertaken for areas that are potentially impacted by project activities. This will be done during all phases of the project through the reporting of quantitative parametric data that describes the physical state of the environment in accordance with permit conditions. Areas of concern are:

- Water quality
- Air quality
- Loud noise

8.2. Emergencies: Response, Preventative Measures & Contingency Plans

8.2.1. Safety

NFE will adopt, and operate under, Jamalco's Environmental, Health & Safety (EHS) Policy.

The Jamalco Operations Safety and Health Rules Book contains general safety rules, department safety rules, craft safety rules and general procedures related to specific subjects.

The intent of the Jamalco Operations Safety and Health Rules Book is to provide a listing of the general safety rules for Jamalco Locations. It is recognized that for most job assignments the general information contained in the book must be supplemented and reinforced by more specific information and instruction. This is accomplished through the departments' following procedures:

- JSAs (Job Safety Analysis),
- Equipment Safety Analysis (ESAs), and
- Tool and Equipment Safety Procedures.

In addition, staff are regularly trained and educated on environment, health & safety practices.

8.2.2. Security

NFE will adopt Jamalco's security plan. The plan involves procedures and policies that will conform to the vision, mission and values of the company. Each element of the plan is consistently assessed ensure: the following:

- the security of all assets,
- productivity remain as high as practicable,
- accountability is promoted at all levels, and that
- efficiencies are enhanced.

The Plan is reviewed by the Chief Security Officer (CSO), who has the responsibility for its implementation and maintenance.

8.2.3. Railroad Security

Jamalco has developed and adheres to requirements for safe operation of railroad mobile equipment and associated activities at Jamalco, in order to prevent accidents and injuries associated with railroad operations. NFE will adopt Jamalco's Railroad Safety Programme.

8.2.4. Fire Prevention and Control Program

Jamalco has developed and follows procedures for:

- handling flammable/combustibles materials,
- maintenance and inspection of fire prevention equipment,
- training in, and carrying out drills for and emergency response.

Jamalco's goal is to prevent all incidents associated with fires and explosions. This goal and its program will be adopted by NFE.

8.2.5. Waste Management Programme

NFE will adopt Jamalco's detailed Waste Management Program which includes an inventory of waste streams, their classification and final disposal method.

Solid waste from the CHP will also be managed according to Jamalco's Waste Management Programme and integrated into Jamalco's solid waste stream.

Jamalco's waste inventory is inclusive of all phases of matter (solid, liquid, gas) and accounts for the waste generated from its facilities in the island, namely:

- Clarendon Alumina Works,
- Williams Field Lands Office,
- Rocky Point Port, and

- all Mining Areas.

Operating procedures and guidelines have been developed and implemented for the handling and disposal of all waste streams identified. Currently, there are five (5) method of waste disposal that is practiced at Jamalco. These are:

1. Landfill,
2. Recycle/reuse (internal and external)
3. Storage – Impoundments (permanent) and
4. Shipment overseas (hazardous waste)
5. Sanitary Sewage Treatment Plant

These methods will be applied to NFE's CHP operations which will be integrated into Jamalco's Waste Management programme.

8.2.6. Hazardous Material Control Programme

NFE will adopt Jamalco's Hazardous Material Control Programe for its operation of the CHP. Jamalco's hazard identification, control and communication program includes provision for:

- managing, controlling and communicating potential hazards to impacted employees, and
- safe and healthy working procedures including engineering, administrative control and personal protective equipment (PPE).

The program applies to any chemical that is known to be present on site (i.e Jamalco Operations, Shipment Port, and Mining) in such a manner that employees may be exposed under normal conditions of use or in a foreseeable emergency or unforeseeable emergency.

8.2.7. Wastewater Management Programme

NFE will adopt Jamalco's Water/Wastewater Management Programme and integrate the wastewater from its CHP facility into Jamalco's waste water system for treatment and reuse by the refinery. Wastewater generated at Jamalco operations can be classified into three (3) broad headings:

- Storm water,
- treated sewage effluent, and
- process related wastewater.

Under normal operating conditions the discharge of wastewater from Jamalco facilities is prohibited. All wastewater generated under normal conditions at Jamalco facilities are collected, treated and appropriately recycled or reused.

8.2.8. Air Emission Control Management Programme

NFE will adopt Jamalco's Air Emission Control Management Programme for its CHP.

Jamalco has developed and maintained an Air Emission Control Management Programme to provide guidelines and procedures to ensure compliance with applicable local air quality regulations and the ISO 1400:2004 standard.

8.2.9. Natural Hazard Management

It is necessary to develop a hazard response plan to offset the worst effects of hurricanes on the project area. This plan will be prepared as a separate document on the advice from the Office of Disaster Preparedness and Emergency Management (ODPEM).

Losses due to hurricanes can be reduced through an effective response plan. The principal features of such a plan are:

- Comprehensive risk assessment based on historical precedent and vulnerability of the site.

- Distribution of occurrences, frequencies of wind strengths and direction, and frequencies of storm surges.
- Appropriate preventative design and engineering (e.g. structures built to withstand hurricane force winds etc.)
- Public awareness and staff training in disaster response
- An effective national warning system

8.2.10. Emergency Preparedness and Response

8.2.10.1. Natural Gas (NG) Pipeline

8.2.10.1.1. Pressure Monitoring & Response

Flow rate and pressure in the subsea pipeline will be continuously monitored and recorded at the onshore pipeline facility and at the offshore platform. The natural gas pipeline will have a leak detection system which will detect a break or leak in the subsea pipeline. The system will send a signal to the automated block valves to close and a signal will be sent to the platform to stop delivering natural gas into the pipeline. Coordination with JPS will take place immediately as well.

8.2.10.1.2. Block Valves

An automated block valve will be located at the launcher and receiver and will be used for isolation and emergency shutdown purposes. The launcher block valve will be located on the platform and the receiver valve will be onshore in the proximity of the beach Automated block valves will be located at the inlet of the meter skid and at the inlet to each regulator skid.

In the event of a pipeline leak, the automated block valves will close to stop transportation of natural gas to the power station and isolate the pipeline. The location of the leak will be determined by utilizing an active acoustic wave analysis monitoring system.

In the event of a fire at the power station, the automated block valves will close and a signal will be sent to the platform to stop delivering natural gas into the pipeline.

8.2.10.1.3. Subsea Block Valve

The need for an automated subsea block valve will be evaluated during the detailed design process.

If needed, the automated subsea block valve will be located on the subsea pipeline approximately 60 to 150 meters (200 to 500 feet) away from the offshore platform and will be used for isolation and emergency shutdown purposes. The subsea valve will prevent a fire on the offshore platform from being fed by the natural gas in the subsea pipeline.

During construction, the subsea pipeline will include a pipe spool piece of exactly the same length as the valve skid. After the subsea pipeline is installed, the pipe spool will be replaced with the valve skid.

8.2.10.1.4. Hurricanes and Tropical Storms

The pipeline operation will follow the operation of the offshore platform in the event of a storm.

8.2.10.2. ADO Storage

The ADO tanks will be located inside containment sufficient to hold 120% of the volume of one tank. Each tank will have instrumentation to automatically shut down to prevent overfilling.

Jamalco has procedures in place to contain and manage the spillage of HFO which is a heavier and more recalcitrant hydrocarbon. These procedures will be adopted by NFE in the management of ADO at the Port, the alumina refinery and port-plant conveyor linkages.

8.2.10.3. ADO Transportation

ADO will be transported by railroad and by trucks from the Rocky Point Port, in the unlikely event of temporary disruption in NG supply to the CHP. Under emergency conditions ADO will be transported from Old Harbour. The transportation of ADO by truck introduces the potential for the following hazards:

- spillage into and short-term contamination of the marine and terrestrial environment
- fire and explosion

NFE will adopt Jamalco's procedures for mobilizing personnel and local emergency services, including equipment and material for emergency response to hazardous material spillages into the terrestrial and marine environment from rail cars and trucks.

In addition, NFE will determine an estimate for the impact radius for the hazards cited based on the characteristics of the ADO. This will be used along with internationally accepted best practices in managing the risk to impact receptors from material spillage, projectiles, or heating effects. To this end NFE will work with NEPA and local NGOs.

9.0. Environmental Monitoring Plan

9.1. Introduction

The Monitoring Plan to be devised for the development will be implemented during the pre-construction and construction phases of the project.

The plan will be developed with a view to observe, review and assess onsite activities to ensure adherence to regulatory standards and the recommendations made to reduce negative impacts. The Plan will be comprehensive and address relevant issues, with a reporting component that will be made available to the regulatory agencies based on a mutually agreed frequency. It is recommended that a minimum monthly monitoring report be prepared and submitted to NEPA, if required.

The monitoring report will include at a minimum:

- Raw data collected
- Tables/graphs (where appropriate)
- Discussion of results with respect to the development in progress, highlighting parameters which exceed standards
- Recommendations
- Appendices with photos/data, etc.

At a minimum, the following basic activities will be monitored during specified phases of the project:

9.2. Pre-Construction Phase Monitoring

- During site preparation activities, any flora that should be saved and incorporated into the development must be identified and protected.

  The proposed pipeline will convey NG through brown field sites contiguous with farm and sugar cane lands. Therefore, it is unlikely that this cataloguing exercise will need to be carried out. It is noted however; that since the pipeline is proposed for installation in a protected (with dense mangrove population), the contractor should be particularly mindful of this fact when installing the pipeline.

- The plants to be retained should be flagged, and if necessary fenced. This It is suggested that the developers assess a monetary value to be placed on each plant, for which the contractor will be made liable. Should the contractor damage or remove a flagged tree, the penalty should be assessed. An inventory and map (if applicable) of all trees to be retained must be developed. (Weekly Monitoring)
- Where identified, endemic and rare species should be preserved in place or collected for transplanting (As Observed)
- Stockpiles of soil and vegetative debris generated during site clearing activities should be monitored and maintained to eliminate generation of fugitive dust. (Daily Monitoring)
- Noise levels along the perimeters of the project area should be monitored and recorded to ensure that activities at the site are not exceeding standards. (Daily Monitoring).

These baseline measurements are especially important for the proposed CHP. In addition to boundary measurements, baseline noise measurements should also be carried out just beyond the Jamalco's southern property at the nearest residential impact receptor.

9.3. Construction Phase Monitoring

- Sewage - Ensure that temporary portable chemical toilets are available for construction personnel and that the contents are disposed by an approved waste hauler in an appropriate waste disposal facility. (Weekly Monitoring)
- Sand/Marl/Aggregate Supply - Routinely monitor sourcing of quarry materials to ensure supplier is obtaining supplies from licensed operations. (Monthly Monitoring)

- Solid Waste Management - Ensure that workers are made aware of the solid waste management plan to ensure that no solid waste material is scattered around the site. Monitor availability and location of skips/dumpsters. (Weekly Monitoring)
- Monitor the disposal of refuse to ensure that skips/dumpsters are not overfilled. (Weekly Monitoring)
- Routine collection of solid waste for disposal must be implemented, and disposal monitored to ensure use of approved disposal facilities. (Weekly Monitoring)
- Exposed soil areas must be monitored to determine potential for erosion, silting and sedimentation particularly during storm events. (Weekly Monitoring)
- If erosion, silting or sedimentation is a potential or occurs, immediate steps must be taken to negate the impact on the coastal waters and other receptors where applicable. (As Needed)
- Equipment staging and parking areas must be monitored for releases and potential impacts. (Weekly Monitoring)
- If any cultural heritage resources are unearthed during construction, activities should be stopped and the Archaeological Retrieval Plan included in this report implemented. (As Needed)
- If any unexploded ordinance or other military materials are unearthed, work should be stopped immediately, the site vacated and professionals brought in to determine how to proceed.
- Noise levels along the perimeters of the project area should be monitored and recorded to ensure that activities at the site are not exceeding standards. (Daily Monitoring)

9.4. Operation Phase Monitoring

- Sewage - Monitor effluent quality periodically to determine compliance with regulatory standards and appropriateness for use as irrigation water. (Monthly Monitoring or as determined by regulatory standards)
- Solid Waste - Monitor solid waste skips or dumpsters and removal contractor to ensure proper waste handling and disposal. (Weekly Monitoring)

- Drainage - Regular inspections of drainage systems should be performed to ensure that the drains remain clear of blockages to safeguard against flooding or damage to wetland. (Monthly Monitoring).

9.5. Detailed Environmental Monitoring Plan

The development of appropriate environmental management and monitoring programmes and methodologies are a vital part of the environmental management and monitoring control of the Project. This section outlines the main environmental parameters to be monitored, timing of the monitoring work and the recommended frequency of monitoring. A more detailed scope of work will be provided by NFE once a contractor for the construction of the proposed development has been selected, and will be subjected to NEPA's approval prior to the commencement of any pre-construction/construction work.

The main objectives of the proposed management and monitoring protocol are:

1. to clarify and identify sources of pollution, impact and nuisance arising from the proposed works;
2. to confirm compliance with legal and contract specifications;
3. to provide an early warning system for impact prevention;
4. to provide a database of environmental parameters against which to determine any short term or long term environmental impacts;
5. to propose timely, cost-effective and viable solutions to actual or potential environmental issues;
6. to monitor performance of the mitigation measures;
7. to verify the EIA predicted impacts;
8. to collate information and evidence for use in public, NEPA, and any other required regulatory consultation; and
9. to audit environmental performance.

The proposed environmental monitoring will take the form of site inspection and supervision. The two main phases of the project for which the proposed monitoring will cover are the pre-construction (baseline) and construction phases

Environmental monitoring for dust and noise during the construction phase is recommended in order to ensure all proposed mitigation measures are implemented and effective.

Obtaining a suitable and representative baseline data set will be critical to the whole monitoring and audit process because it forms the standard against which environmental impacts are assessed. Thus, baseline monitoring for dust and noise will be required prior to the start of construction.

Mitigation to avoid the pollution of any water courses in the study area have also been recommended by the EIA, as have waste management procedures and thus, monitoring in the form of regular site inspections is also required to ensure mitigation measures are being implemented and are effective.

In addition, monitoring of mitigation measures to avoid impacts on landscape and visual resources will be required during the construction period. Maintenance and monitoring will be the responsibility of the management put in place after this period.

The details of monitoring are discussed in the following sections and summarised in Table 37 below.

Table 37: Framework for Environmental Monitoring Plan

Monitoring	Period	Parameters	Monitoring Frequency
Noise	Baseline (1 occasion)	Leq (30 mins) GPS location	One set of measurements at selected locations (within and surrounding project site)
	Construction Phase	Leq (30 mins) GPS location	One set of measurements between 0700-1900 hours on normal weekdays once per week.
Air Quality	Baseline (1 occasion)	Total Suspended Particulates, wind speed/ direction GPS location	One set of measurements (24 hour sampling) at selected locations.
	Construction Phase	Total Suspended Particulates, wind speed/ direction GPS location	One set of measurements (1 hour sampling) between 0700-1900 hours on normal weekdays once per week.
Water	Baseline	Survey of coastal waters, stream and tributaries in the study area BOD, Total & Faecal Coliform, DO, Nitrates, Phosphates, Turbidity, pH, Oil & Grease	One set of measurements
	Impact (during construction)	Visual Survey of watercourses in area of active construction works and other areas with stockpiled materials on exposed ground surface BOD, Total & Faecal Coliform, DO, Nitrates, Phosphates, Turbidity, pH, Oil & Grease	Once per week in areas undergoing construction Once bi- monthly during construction.
Waste	Baseline	Visual Survey of area around proposed sites	Once
	Construction Phase	Routine supervision of construction works	As per site inspection schedule
Landscape/ Visual Resources	Baseline	Tree survey and vegetation mapping	Once immediately prior to construction

Monitoring	Period	Parameters	Monitoring Frequency
	Construction Phase	Survey of protection measures for trees and landscaping GPS location	Twice a month during construction works
	Operational Phase	Survey of establishment of planting	Once every two months for a one year period after completion of the works.
Chemical Waste & Control of Spills	Construction	Materials and chemicals that will be used during construction	Once per week during construction works
Construction Camps	Construction	Establishment and operation	Once per week

Note (1): Should the construction schedule require works in restricted hours, monitoring in the form of 3 consecutive $L_{eq\ (5mins)}$ readings should be taken.

9.6. Action and Limit Levels

Monitoring stations will be set up at representative sensitive receivers and the results will be used to ensure compliance with determined performance criteria, based upon specific action and limit levels. The definitions of these are as follows:

- the Action Level represents a level at which some appropriate action will be required to prevent conditions deteriorating to the extent that statutory or guide criteria are breached; and
- the Limit Level represents the upper limit permitted and is generally equivalent to the statutory levels specified in legislation

Action plans will be developed for use in the event of exceedances and will be included in Contractor's Operating Manual.

Action plans are not relevant to the water quality, waste, and landscape and visual criteria. However, the supervision methodology is highlighted below.

9.6.1. Noise

To minimise the amount of noise generated at the construction site, a Noise Control Plan will be prepared.

The construction noise level will be measured in terms of the A-weighted equivalent continuous sound pressure level (L_{eq}). L_{eq} measurements will be taken during 30 minutes of typical construction activity during unrestricted periods. No work during restricted periods is anticipated at this stage; however, three consecutive $L_{eq\ (5mins)}$ readings will be taken to monitor the noise during these periods if required.

Sound level metres in compliance with NEPA specifications will be used for carrying out the noise monitoring, in accordance with any Specific Conditions issued under the Environmental Permit. The noise measurements should be carried out 10m from the worst affected external receptors and not be made in the presence of fog, rain or excessive steady or gusty wind.

The proposed construction phase sampling frequency will be once per week and action and limit levels for work during the unrestricted period, and restricted periods for reference, are shown in the table below.

Table 38: Action and Limit Levels for Construction Noise

Time Period	Action Level	Limit Level
Unrestricted Period Normal work days (0700 -1900)	When one documented complaint is received	75 dB(A)
Restricted Period 1 All days during the evening (19.00-23.00) and general holidays (including Sundays) during the daytime and evening (07.00-23.00)	When one documented complaint is received	65 dB(A)
Restricted Period 2 All days during the night-time (23.00-07.00)	When one documented complaint is received	45 dB(A)

9.6.2. Air Quality

NFE will carry-out all construction activities in accordance with Jamalco's Construction Management Plan which is careful to minimize the emissions from vehicles and equipment used for construction activities, and minimize fugitive dust from construction areas and unpaved roads within construction areas.

Monitoring of the Total Suspended Particulates (TSP) levels shall be carried out to detect any deterioration in air quality and so enable early action to be taken for impact prevention or amelioration. 1-hour TSP levels only shall be measured to indicate the impacts of construction dust on air quality using direct reading methods. Other relevant data that will need to be recorded will include the prevailing weather conditions, namely wind speed and direction and rainfall. Also, any other point sources with photographic evidence.

The sampling frequency will be once per week. Action and limit levels are shown in the following table.

Table 39: Action and Limit Levels for Air Quality

Parameters	Action	Limit
24 Hour TSP Level (μg/m³)	For baseline level ≤150 μg/m³, action level = average of baseline level plus 30% and limit level For baseline level >150 μg/m³, action level = limit level	150 μg/m³

9.6.3. Water Quality

The monitoring program will include monitoring for both point and non-point sources to assess the effects of surface water runoff and wastewater discharges from areas disturbed by all construction related activities on water quality.

Surveys are to be undertaken for watercourses which are within the influence of construction works at least once per week. The surveys should include a description of the stream course, influencing factors, photographs of the watercourse and a map showing areas of project construction works.

Any noticeable change to water quality should be recorded in the watercourse survey reports and should be investigated and remedial actions shall be undertaken to reduce impacts.

Particular attention shall be paid to the Contractor's incorporation of mitigation measures.

9.6.4. Waste

Supervision of the construction works should be undertaken during site inspections to ensure that waste material is being properly stockpiled and handled. Any malpractice should be reported and remedial measure recommended.

Table 40 below lists the manner in which each type of waste will be managed.

Table 40: Waste material management during pre-construction and construction phases

Type of Waste	Description	Fate or Deposition
Plant material and cuttings	All plant material, including invasive plant removal, shrubs and trees removed from project site	Chip and compost small material, recycle tree logs as needed or disposal in an approved landfill
Construction debris	Large pieces of non-toxic waste from packing material, concrete, wire and lumber	Lumber recycled in landscaping where possible, Unusable material compacted and disposed of at an approved landfill
Recycled material	Glass, tin, paper, and plastic	Any material that can be recycled should be recycled
Sewage and wastewater treatment	High organic content, potential public health hazards	Tertiary treatment facility , Composting and/or chemical toilets

9.6.5. Landscape and Visual

NFE will minimize vegetation clearing for construction activities and control erosion and sedimentation from disturbed in accordance with Jamalco's Construction Management Plan. This will include specifications for the removal of vegetation from the construction areas and the management of runoff from disturbed areas, and will utilize site vegetation surveys and construction plans to mark out areas to be cleared.

The landscape and visual mitigation proposals comprise a combination of preventive measures to protect the existing landscape resources which includes careful alignment of temporary roads to avoid any important flora identified for saving, as well as sensitive building design. To ensure these impact mitigation measures are carried out satisfactorily, monitoring during the construction and operational phases are proposed.

Baseline monitoring for the landscape will comprise a vegetation survey of the entire selected route option undertaken on an 'area' basis, as work progresses. An assessment of landscape character will be made against which future change can be monitored. The landscape resources and elements of particular concern are to be noted. Reference to the terrestrial findings included in the EIA shall be made.

9.6.6. Soil Conservation

Soil erosion rates, slope stability, effectiveness of soil conservation measures should be monitored at frequent intervals during construction, at least once per month.

9.6.7. Chemical Waste & Control of Spills

The objective to minimise the potential for impacts associated with handling, storage, use and disposal of any chemicals on site during construction. A Chemical Waste & Spillage Management Plan will be prepared, which will include implementation and monitoring of the use of chemicals and chemical wastes to cover materials such as fuel and oils, paints, solvents, and concrete additives.

9.6.8. Traffic and Access

To implement measures to manage traffic and access on the construction site during construction works a Traffic and Access Management Plan will be prepared and monitored by the Police.

9.6.9. Environmental Management & Monitoring Responsibilities

The noise and dust baseline and impact environmental monitoring, water quality and waste supervision should be carried out by an independent Environmental Specialist (ES), who will be employed by NFE but remains an independent company. The responsibilities of the ES will include field measurements, sampling, analysis of monitoring results, and reporting. The ES will be required to be approved by NEPA. The ES shall be competent and have relevant environmental monitoring experience.

Due to the specialist nature of some of the monitoring works required for this project, the Environmental Team (ET) should comprise professionals proficient to undertake the tasks involved. Thus, the ET should include personnel experienced in noise, dust and supervision of water quality and waste management. The table below outlines the proposed management approach for this project.

Table 41: Proposed Management Protocol

Task	Implementation	Coordination	Site Monitoring	Oversight	Funding
Compliance with environmental construction obligations					
Construction site management ♦	Construction and/or Project Management Contractors	NFE	Contractors	NFE & NEPA	Contractor
Adaptive Ecological Management*					
Rivers/ Stream impacts	Construction Contractors & Environmental Consultants	NFE	Environmental Consultant	NEPA	NFE and/or Contractors
Terrestrial animals in site area	Construction Contractors & Environmental	NFE	Environmental Consultant	NEPA	NFE and/or Contractors

Task	Implementation	Coordination	Site Monitoring	Oversight	Funding
	Consultants				
Wetland formation and restoration	Environmental Consultants	NFE	Environmental Consultant	NEPA	NFE and/or Contractors

- ♦ includes; traffic, noise, air quality etc management
- *a structured, iterative process of optimal decision-making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.

9.6.10. Reporting

Deliverables in the form of the baseline survey report and regular and summary Environmental Monitoring Reports should be prepared in accordance with any requirements issued by NEPA as part of the Environmental Permit.

It is recommended that Reports are issued monthly during the construction phase and bi-monthly during the operational phase in respect of the tree planting monitoring. Further details on the contents of these reports should be provided in the Contractors Operating Manual.

10.0. References

International Maritime Organization (IMO) and IPIECA (the global oil and gas industry association for environmental and social issues). (2012). *Sensitivity Mapping for Oil Spill Response.* London: International Association of Oil & Gas Producers.

Atlantic and Gulf Rapid Reef Assessment. (2014). Retrieved from www.agrra.org

Atlantic and Gulf Rapid Reef Assessment. (2017). Retrieved from http://www.agrra.org/training-tools/fish-training/

CaMPAM Network and Forum. (2010). Retrieved from http://campam.gcfi.org/campam.php

Canadian Transport Emergency Centre. (2012). *2012 Emergency Response Guidebook.* Canada: Transport Canada.

Caribbean Coastal Area Management Foundation. (2017). Retrieved from https://www.facebook.com/pg/Caribbean-Coastal-Area-Management-Foundation-266327140059377/about/?ref=page_internal

Caribbean Coastal Area Management Foundation. (2017). Retrieved from https://www.facebook.com/Caribbean-Coastal-Area-Management-Foundation-266327140059377/

Caribbean Coastal Area Management Foundation. (2017). Retrieved from https://www.facebook.com/Caribbean-Coastal-Area-Management-Foundation-266327140059377/

Carvajal, A. R. (2006, February 2). *Ramsar Convention on Wetlands*. Retrieved from World Wetlands Day 2006 in Jamaica: http://archive.ramsar.org/cda/en/ramsar-activities-wwds-jamaica-names-new-ramsar/main/ramsar/1-63-78%5E17519_4000_0__

Climate Studies Group, Mona. (2016). *Jamaica: Future Climate Changes.* Kingston.

Conrad Douglas & Associates Limited. (2004). *Environmental Impact Assessment for 2.8 Million Metric Tonne Per Year Efficiency Upgrade at Jamalco.* Retrieved from http://nepa.gov.jm/eias/clarendon/jamalco/JAMALCO_EFFICIENCY_UPGRADE.pdf

Conrad Douglas & Associates Limited. (2004). *Environmental Impact Assessment for 2.8 Million Metric Tonne Per Year Efficiency Upgrade at Jamalco.* Kingston: CD&A.

Conrad Douglas & Associates Limited. (2007, January). *Environmental Impact Assessment for the Construction and Operation of a Temporary Barge Unloading Facility.* Kingston: CD&A.

Conrad Douglas & Associates Limited. (2007, January). *Environmental Impact Assessment; For The Construction and Operation of a Temporary Barge Unloading Facility.* Kingston: CD&A. Retrieved from http://nepa.gov.jm/eias/Clarendon/Rocky_Point/Jamalco-Barge/Jamalco-Temporary-Barge.pdf

Conrad Douglas & Associates Limited. (2008, May). *Environmental Impact Assessment; For The Construction of a Port, Stockpile Area and Transportation Corridor.* Retrieved from http://nepa.gov.jm/new/services_products/applications/eias/docs/Clarendon/Rocky_Point/Stock-pile/eia_for_port_&_transportation_corridor_-_volume_i.pdf

Conrad Douglas & Associates Limited. (2008, May). *Environmental Impact Assessment; For The Construction of a Port, Stockpile Area and Transportation Corridor.* Kingston: CD&A.

Conrad Douglas & Associates Limited. (2009). *Environmental Impact Assessment for the Construction of a Port and Conveyor Corridor.* Kingston: CD&A.

Conrad Douglas & Associates Limited. (2013, October 16). *Environmental Management Scoping of the Portland Bight Area, Inclusive of the Goat Islands Final Report.* Kingston: CD&A.

Conrad Douglas & Associates Limited. (2014). *Environmental Sensitivity Mapping-JAMALCO Alumina Terminal.* Kingston.

Conrad Douglas & Associates Limited. (2014). *Environmental Sensitivity Mapping-JAMALCO Alumina Terminal.* Kingston: CD&A.

Conrad Douglas & Associates Limited. (n.d.). *Description of the Environment.* Retrieved from http://nepa.gov.jm/eias/Clarendon/Jamalco%20RDA5/JAMALCO%20RDA%205%20EIA_part2.3.pdf

Convention on Biological Diversity. (1992). Retrieved from https://www.cbd.int/doc/legal/cbd-en.pdf

Convention on Wetlands of International Importance especially as Waterfowl Habitat. (1971, February 2). Retrieved from http://www.ramsar.org/sites/default/files/documents/library/current_convention_text_e.pdf

Dlugokencky, E. J., Steele, L. P., Lang, P. M., & Masarie, K. A. (1994). The growth rate and distribution of atmospheric methane. *Journal of Geophysical Research, 99*, 17. doi:10.1029/94JD01245

Dlugokencky, E., Steele, L., Lang, P., & Masade, K. (1994). The growth rate and distribution of atmospheric methane. *Journal of Geophysical Research* , 17.

Draft Jamaica National Ambient Water Quality Standard-Marine Water. (2009). Retrieved from http://nepa.gov.jm/standards/water_quality_standard_marine.pdf

Earth System Research Laboratory. (n.d.). Retrieved from NOAA In Situ Methane (CH4) Measurements: https://www.esrl.noaa.gov/gmd/obop/mlo/programs/esrl/methane/methane.html

Earthquake Unit, The University of West Indies at Mona. (2007, July 27). Retrieved from https://www.mona.uwi.edu/earthquake/

ESRL Global Monitoring Division. (n.d.). Retrieved from https://www.esrl.noaa.gov/gmd/obop/mlo/programs/esrl/methane/methane.html

Fincham, A. (1997). *Jamaica underground: the caves, sinkholes and underground rivers of the island.* Kingston: University of The West Indies Press.

Geomatrix Jamaica Limited. (1995). Retrieved from http://nepa.gov.jm/eias/Clarendon/Jamalco%20RDA5/JAMALCO%20RDA%205%20EIA_part3.pdf

Global Sea Temperature. (2017, April). Retrieved from Rocky Point Average Sea Temperature: https://www.seatemperature.org/central-america/jamaica/rocky-point-april.htm

Government of Jamaica. (2011). *The Second National Communication Of Jamaica To The United Nations Framework Convention On Climate Change.* Kingston: GOJ.

Healthy Reefs for Healthy People. (2017). Retrieved from www.healthyreefs.org

Healthy Reefs for Healthy People. (2017). Retrieved from http://www.healthyreefs.org/cms/healthy-reef-indicators/

IDOM Ingeneria y Consultoria and Conrad Douglas & Associates Limited. (2015). *Gas Pipe Lines & Regulating.* Kingston: World Bank / National Environment & Planning Agency.

IDOM Ingeneria y Consultoria and Conrad Douglas & Associates Limited. (2015). *Gas Sector Regulatory Framework.* Kingston: World Bank / National Environment & Planning Agency.

IDOM Ingeneria y Consultoria and Conrad Douglas & Associates Limited. (2015). *LNG Satellite Plant.* Kingston: World Bank / National Environment & Planning Agency.

IDOM Ingeneria y Consultoria and Conrad Douglas & Associates Limited. (2015). *Planning Construction & Maintenance of Shoreline.* Kingston: World Bank / National Environment & Planning Agency.

IDOM Ingeneria y Consultoria and Conrad Douglas & Associates Limited. (2015). *Regassification Terminals.* Kingston: World Bank / National Environment & Planning Agency.

IPIECA. (2016). Retrieved from http://www.ipieca.org/

IPIECA. (2016). Retrieved from http://www.ipieca.org/about-us/

Kohler, K., & Gill, S. (2006). Nova Southeastern University. *Computers and Geosciences, Vol.32, No.9*, 1259-1269. doi:10.1016/j.cageo.2005.11.009.

Link, C. (2012, December 18). *Carbon Link*. Retrieved from CPL Carbon Link: http://www.activated-carbon.com/

Map Maker. (1996). Retrieved from http://www.mapmaker.com/v4/Map%20maker%204.Pro.htm

Maritime Safety Authority. (2004). *Guidelines for Port & Harbour Risk Assessment and Safety Management Systems in New Zealand.* Wellington, New Zealand: Maritime Safety Authority.

Meteorological Service Jamaica. (2017). Retrieved from Climate-Wind: http://www.metservice.gov.jm/wind.asp

Mild, K. H. (n.d.). *Guide Electromagnetic fields in working life A guide to risk assessment .*

Mild, K. H., & Sandström, M. (2015). *Guide Electromagnetic fields in working life A guide to risk assessment.* Belgium: Umeå University.

Ministry of Agriculture. (2017, April 25). Retrieved from Special Fisheries Conservation Areas : http://www.moa.gov.jm/Fisheries/fish_sanctuary.php

Ministry of Local Government and the Environment and Disaster Unit, Jamaica. (2011). *The Second National Communication of Jamaica to the United Nations Framework Convention on Climate Change.* Kingston: Meteorological Service of Jamaica.

Ministry of Science Energy and Technology. (n.d.). Retrieved from An Overview of Jamaica's Electricity Sector: http://mstem.gov.jm/overview-jamaicas-electricity-sector

Mora, C., Frazier, A., Tong, E., Longman, R., Kaiser, L., Dacks, R., . . . Giambelluca, T. (2013). The projected timing of climate departure from recent variability. *Nature 502*, 183-187.

National Ocean Service. (2017, June 12). Retrieved from Why is the Ocean Salty?: http://oceanservice.noaa.gov/facts/whysalty.html

NEPA. (1999). *Jamaica National Noise Standards.* Retrieved from http://nepa.gov.jm/standards/national_noise_standards.pdf

Nova Southeastern University. (2017). Retrieved from http://cnso.nova.edu/cpce/index.html

Raffaele, H. (1998). *A Guide to the Birds of the West Indies.* Princeton University Press.

Ramsar. (1971). Retrieved from http://www.ramsar.org

Ramsar. (2006, February 10). Retrieved from Ramsar Convention on Wetlands: http://www.ramsar.org/profile/profiles_jamaica.htm

Ramsar. (2014). Retrieved from About the Ramsar Convention: http://www.ramsar.org/about-the-ramsar-convention

Safuan, M., Boo, W., Siang, H., Chark, L., & &Bachok, Z. (2015). Optimization of Coral Video Transect Technique for Coral Reef Survey. *Open Journal of Marine Science*, 379-397.

StormCarib-Caribbean Hurricane Network. (2011). Retrieved from http://stormcarib.com/climatology/

StormCarib-Caribbean Hurricane Network. (2011). Retrieved from http://stormcarib.com/climatology/MKJP_dec_isl.htm

StormCarib-Caribbean Hurricane Network. (2011). Retrieved from http://stormcarib.com/climatology/MKJP_all_isl.htm

Sutton, A., & Downer, A. (1990). *Birds of Jamaica: A Photographic Field Guide.* Cambridge Press.

Texas Parks and Wildlife. (1999). *Seagrass Conservation Plan for Texas.* Austin, Texas: Texas Parks & Wildlife.

The Noise Pollution Control Rules. (2001). Retrieved from http://www.ema.co.tt/new/images/pdf/noise_pollution_control_rules_2001.pdf

Water Resources Authority. (2015). *Water Resources of Jamaica; Scarcity or Availability.* Kingston: Water Resources Authority.

Webber, D., Webber, M., & Williams, D. (2003). The relative importance of meteorological events, tidal activity and bathymetry to circulation and mixing in Kingston Harbour, Jamaica. *Bulletin of Marine Science*, 273-290.

Wunderle Jr, J. M. (1994). *Census Methods for Caribbean Land Birds.* New Orleans,Louisiana: US Department of Agriculture,Forest Service Southern Forest Experiment Station.

APPENDIX

Appendix 1: Approved Terms of Reference

Terms of Reference

for proposed

Combined Heat and Power Facility

consisting of

(1) CHP POWER PLANT,
(2) NATURAL GAS DISTRIBUTION PIPELINE
and
(3) ELECTRICITY TRANSMISSION

NFE South Power Holdings
Pimento Way
Freeport
Montego Bay
St. James
Jamaica, W.I.

Conrad Douglas & Associates Limited
14 Carvalho Drive
Kingston 10
Telephone: (876)-929-0023/0025/8824
Fax: (876)-960-2014
Email: info@cdaestech.com,
cdaestech@hotmail.com
Website: www.cdaestech.com

TERMS OF REFERENCE

for proposed

Combined Heat and Power Facility

consisting of

(1) CHP POWER PLANT,
(2) NATURAL GAS DISTRIBUTION PIPELINE
and
(3) ELECTRICITY TRANSMISSION

Prepared for:

NFE South Power Holdings
Pimento Way
Freeport
Montego Bay
St. James
Jamaica, W.I.

Prepared by:

Conrad Douglas & Associates Limited
14 Carvalho Drive
Kingston 10
Telephone: (876)-929-0023/0025/8824
Fax: (876)-960-2014
Email: info@cdaestech.com, cdaestech@hotmail.com
Website: www.cdaestech.com

Submitted on:
April 21, 2017

Terms of Reference

Table of Contents

Terms of Reference

1.0. Introduction

New Fortress Energy is the proponent for the establishment of a natural gas fired combined heat and power (CHP) project in area location suited for switching from heavy fuel oil to natural gas. This is in keeping with Government of Jamaica (GOJ) Energy Policy which involves a mix of non-renewable and renewable energy. The GOJ energy mix policy consists of coal, oil, natural gas, hydroelectricity, solar, wind and biofuels. This project involves the use of natural gas and will achieve a major milestone with numerous environmental, economic and social benefits

The proposed NFE project which is concerned with the use of natural gas and will consist of:

1. Installing a pipeline under the seabed to deliver Natural Gas from a permitted Floating Storage and Re-gasification Unit (FRSU) in the Portland Bight (Old Harbour Bay) to the existing and operational Rocky Point Port which is presently owned and operated by Jamalco.
2. Installation of a pipeline from the Rocky Point Port to deliver Natural Gas to the new power plant at Jamalco Refinery at Halse Hall.
3. Construction of a new 200 MW natural gas fired Combined Heat and Power (CHP) power plant at Jamalco alumina refinery at Halse Hall, Clarendon
4. Installation of a pipe network to deliver steam from the CHP power plant to Jamalco boiler steam headers.
5. Construction of a 138 kV substation
6. Construction of an electricity distribution network to deliver power to the National Grid.
7. Storage and distribution of Automotive Diesel Oil (ADO)

New Fortress Energy (NFE) is working in collaboration with Jamalco and the JPSCo to develop the proposed Combined Heat and Power (CHP) system. The JPSCO component at Old Harbour Bay has already been permitted as well as the FSRU from which it will receive natural gas. The FSRU will also be built out to supply natural gas through pipeline beneath the ocean floor

Conrad Douglas & Associates Limited 4 CD*PRJ 1279/17 and beneath land to the CHP at the Jamalco refinery site.

Jamaica's bauxite alumina industry has been adversely affected as a result of high oil prices for more than 40 years. This has resulted in this major sector of the Jamaican economy ether under-performing by performing below capacity and in some instances experiencing closures. The country's economic growth development and job creation has been negatively impacted. In addition to supply of low cost environmentally friendlier electricity to the national grid the project will also result significantly improving the production cost of Jamalco's alumina and hence its competiveness. This has the potential to propel the Jamalco refinery once more to be among the world's first quintile of alumina producers.

Jamalco and JPSCo are therefore the two primary recipients of the major direct products of the CPH with the Jamaican economy in general benefitting significantly from this development. Jamalco is cooperating further by providing access to lands and property for the development of the infrastructure associated with project.

Conrad Douglas & Associates Limited (CD&A) will work closely with our clients, New Fortress Energy by providing environmental consultancy services to NFE and their partners, CD&A will work closely with the regulators for the permitting of the project. This will among others involve the preparation of a high quality EIA report that addresses all environmental, engineering and project development issues that may be associated with the development of a new CHP facility at Jamalco's brown site alumina refinery at Halse Hall Clarendon. The project also includes the development of the necessary infrastructure to deliver natural gas to the plant, deliver steam from the power plant to Jamalco's refinery and deliver electricity to the national grid. These inputs and outputs of the power plant will require the laying of approximately 25 km of pipeline of varying sizes and composition and 3 km of transmission lines.

The CHP will supply steam to Jamalco to drive its electricity generators which will significantly reduce its use of heavy fuel oil (HFO) for process steam and electricity generation. This reduction in the use of HFO will carry significant positive benefits for the environment, climate change, cost competiveness for alumina production and several other micro and macro-economic benefits.

All electricity generated by the CHP will be transmitted to the JPSCo for distribution on the national grid. Several industrial, agricultural commercial and residential benefits that could arise from lower cost clean electricity generation to the national economy.

NEPA has already provided permits to New Fortress for the establishment and operation of a Floating Storage and Regasification Unit (FSRU) in the Portland Bight area of Old Harbour Bay in order to supply natural gas for power generation to the new JPSCo gas fired power plant which is now under construction. Figure 1 to Figure 3 show the general layout of the project with pipeline and transmission routes identified along with the CHP location.

In keeping with the NRCA Act of 1991, NFE is required to conduct an EIA on the proposed project development and its operations. This includes plant construction, conveyance pipeline laying, transmission lines establishment, interconnections between Jamalco's existing facilities and the new CHP facility. The backup fuel will be ADO, which will be used during maintenance and emergency conditions. An ADO storage and distribution system will be established for this purpose. Establishment of an ADO distribution system will be done in compliance with the regulatory framework of the Petroleum Industry. Conversely, the permitted ADO storage facility at the Old Harbour Bay JPSCo power plant could be used for this purpose. The EIA will be submitted to the National Environment and Planning Agency (NEPA), for review and permitting in order to obtain approval for project implementation.

A detailed description of all elements of the project during the pre-construction, construction and operational phases will be prepared. The elements which will be analyzed and assessed include the CHP and its associated infrastructure in both the terrestrial and marine environment and air quality. These will be assessed in relation to the biophysical and socio-economic baseline and setting, the regulatory framework, impact identification and risks, impact assessment for the built and natural environment, impact mitigation, and environmental monitoring requirements.

Figure 1: Proposed Power Plant Location and pipeline routes and transmission line route

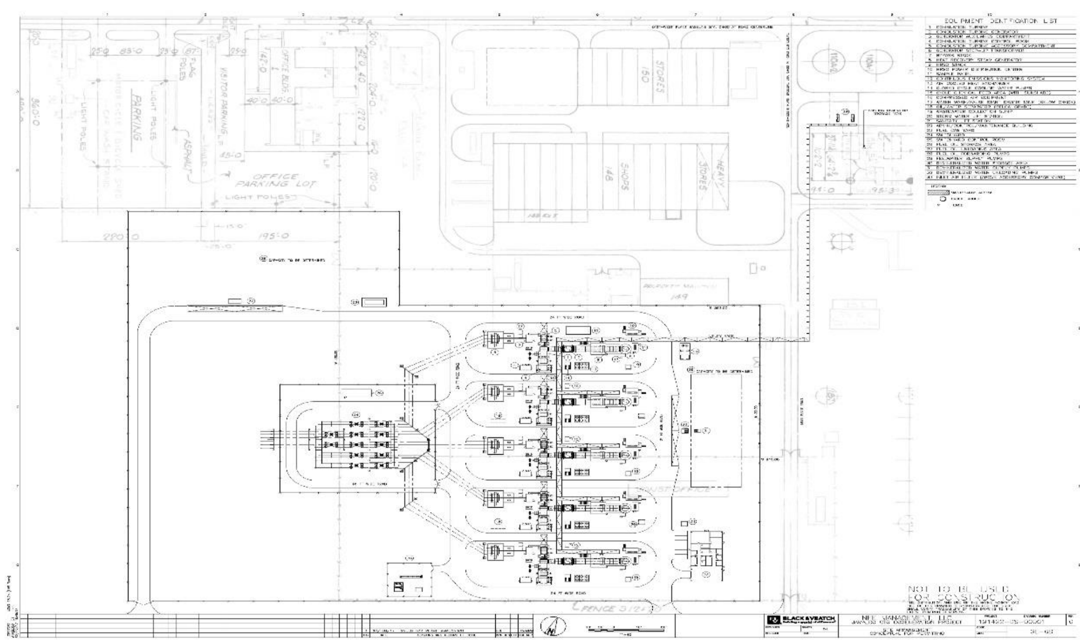


Figure 2: Proposed Power Plant Layout

Figure 3: Overview of new power plant relative to Jamalco's Infrastructure

2.0. Terms of Reference

The Environmental Impact Assessment will:

1. Provide a complete description of the existing site proposed for:

    a. the power plant facility
    b. The laying of pipelines (terrestrial and marine), and
    c. The erection of transmission lines
    d. Infrastructure associated with a – c above will also be assessed

2. Detail the elements of the project, highlighting areas to be reserved for construction and the areas which are to be preserved in their existing state.
3. Identify the environmental issues of concern through the presentation of baseline data which will include social and cultural considerations. Assess public perception of the proposed development.
4. Outline the international (Conventions, Treaties, Protocols and Agreements to which Jamaica is signatory) and national Policies, Legislation, Regulations and Standards relevant to the project.
5. Predict the likely impacts of the project on the environment, including direct, indirect and cumulative impacts, their magnitude, intensity and duration and indicate their relative importance to the design and function of the facilities.
6. Identify mitigation actions to be taken to minimize adverse impacts and quantify associated costs.
7. Outline a Monitoring Plan which will ensure that the mitigation plan is adhered to.
8. Analyse and assess the alternatives to the project.

To ensure that a thorough Environmental Impact Assessment is carried out, the following tasks will be undertaken:

Task 1: Description of the Project

CD&A will provide a comprehensive description of the project explaining details of the works and infrastructure proposed for the plant and the input and output distribution networks, noting areas reserved for construction. Areas to be reserved for construction, areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impacts (negative or positive) on the environment will be noted. This will involve the use of maps, site plans, aerial photographs and other graphic aids and images, as appropriate, and include information on location, general layout and size, as well as pre-construction, construction, and post-construction plans. A description of raw material inputs, technology and processes to be used as well as products and by-products generated, will be provided.

Sewage treatment system including treated effluent disposal will be clearly outlined as well as solid waste disposal options. In addition, plans for storm water collection and disposal as well as plans for providing utilities and other services will be clearly stated. This will involve the use of maps at appropriate scales, site plans, aerial photographs and other graphic aids and images with the use of GIS, as appropriate.

In terms of beach modification, the proposed works on the foreshore and the floor of the sea will be clearly described and assessed including but not limited to any seagrass bed, corals or mangrove removal and replanting.

A storm surge analysis and impact mitigation structures/measures will be conducted from secondary data.

The World Bank, NEPA, GOJ guidelines for the establishment of LNG projects in Jamaica will be used as necessary during the development of the project, for all its components.

Task 2: Description of the Environment

For this EIA Report, CD&A will generate baseline data which will be used to describe the study area (marine and terrestrial) in terms of:

i) physical environment
ii) biological environment
iii) socio-economic and cultural environment.

The approaches and methodologies which will be employed to obtain baseline and other data will be clearly stated. Baseline data will include:

(A) Physical

i) A detailed description of the existing **geology** and **hydrology.** Emphasis will be placed on storm water run-off, drainage patterns, impact on groundwater and coastal waters. Any slope stability issues that could arise will be thoroughly explored.

ii) **Water quality** of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of the project. A complete water chemistry report will be detailed; Quality Indicators will include but not necessarily be limited to oil and grease, nitrates, phosphates, total and faecal coliform, and total suspended solids, Total petroleum hydrocarbon (TPH).
   - **Assessments in both marine and terrestrial environment**
     - Sediment analysis in Marine environment - Sediment sampling will be done to determine the quality of the dredged material

iii) Weather and climatic conditions in the area of influence including wind speed and direction, precipitation, relative humidity and ambient temperatures,

iv) Air quality assessment will be done. Air dispersion modelling for all sources within the air shed. Measurement of existing concentrations of NO_2, SO_2, CO_2, CO, PM will be conducted for baseline data.

v) Noise levels of the undeveloped site and the ambient noise in the radius of influence.

vi) Electromagnetic Force measurement for baseline establishment in the vicinity of the distribution network.

vii) Obvious sources of pollution existing and extent of contamination.

viii) Availability of solid waste management facilities and procedures.

(B) Biological

CD&A will present a description of the flora and fauna of the area, with special emphasis on rare, endemic, protected or endangered species. Migratory species will also be considered. Generally, species dependence, niche specificity, community structure and diversity will be considered. This will include an assessment of the marine environment, including but not limited to:

- Potential impacts of excavation and construction
- Loss of natural features, habitats, and species by construction and pipe laying
- Impact on coastal, surface and ground waters
- Impact of dredging and spoil disposal
- Qualitative risk assessment
- Loss and replanting of mangroves if applicable
- Potential ADO spills and their clean-up
- Solid waste management
- Hazard vulnerability
- General Risk Assessment
- Carrying capacity of the environment will be assessed and discussed.

(C) Socio-economic & cultural

Present and projected population; present and proposed land use; planned development activities; issues relating to squatting and relocation; (housing demand and supply) community structure; economic base /employment; distribution of income; goods and services; utilities; recreation; public health and safety; cultural peculiarities, aspirations and attitudes will be explored. The historical importance (heritage, archaeological sites and feature) and other material assets of the area will also be examined. While this analysis is being conducted, an assessment of public perception of the proposed development will be conducted, and will take the form of consultation meetings with the public and key institutions.

Task 3: Legislative and Regulatory Considerations

The EIA will outline the relevant regulations and standards governing environmental quality, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The examination of the legislation will include at a minimum, legislation such as the NRCA Act, policies and regulations from the Water Resources Authority, the Watershed Protection Act, The Clean Air Act, Public Health Act, Beach Control Act, Harbour Act, relevant regulations applying to the petroleum storage and handling, Building Codes and Standards, Development Orders and Plans and any appropriate international convention, protocol, treaty and agreements where applicable.

Additionally, consideration will be taken into account for the Protected Area status and RAMSAR designation of the Portland Bight Protected Area. The site was given RAMSAR designation on 2nd February, 2006, as Portland Bight Wetland and Cays (RAMSAR Site No. 1597). Consideration will also be given to industrial zoning and other land, riverine and marine uses in the area.

Task 4: Identification of Potential Impacts

CD&A will identify the major environmental issues of concern and indicate their relative importance to the design of the facility. Identify potential impacts as they relate to (but are not restricted by) the following:

- change in drainage pattern
- flooding potential
- excavation and construction
- loss of natural features, habitats and species by construction and operation
- pollution of surface and ground water
- air pollution
- noise
- EMF and radiation
- Traffic impact assessment for routes to be traversed under emergency conditions to transport Automotive Diesel Oil (ADO) –
    - JPSCo Old Harbour Permitted ADO Storage System via Highway 2000

- Rocky Point, Jamalco via Halse Hall Main Road
- Under normal conditions, transportation is done by railcars from Rocky Point to Jamalco, Halse Hall

- capacity and design parameters of proposed sewage handling/treatment facility
- socio-economic and cultural impacts
- risk assessment
- noise
- leaching of substances or chemicals into ground water supply
- Community fragmentation

The EIA Report will:

1. **Identify** - the interaction between different impacts and impacts of other projects. In addition, the impacts that have occurred and those impacts which could still occur as a consequence of the clearing works at the site will also be identified and analysed.
2. **Distinguish** - between significant positive and negative impacts, reversible or irreversible direct and indirect, long term and immediate impacts as well as avoidable and irreversible impacts.
3. **Characterize** - the extent and quality of the available data, explaining significant information deficiencies, assumptions and any uncertainties associated with the predictions of impacts. Project activities and impacts will be represented in matrix form with separate matrices for pre and post mitigation scenarios

Task 5: Mitigation

We will prepare guidelines for avoiding, as far as possible, any adverse impacts due to the proposed project and utilizing of existing environmental attributes for optimum development. For those impacts which are unavoidable, mitigative measures will be proposed.

Task 6: Drainage Assessment

An assessment of Storm Water Drainage will be conducted. The EIA Report will cover, but not be limited to:

i. Drainage for the site during construction, to include mitigation for sedimentation to the marine and riverine environments and also to the built environment.
ii. Drainage for the site during operation, to include mitigation for sedimentation to the marine and riverine environments and also to the built environment

Task 7: Environmental Management & Monitoring

CD&A will design a preliminary plan to monitor implementation of mitigatory or compensatory measures and project impacts before, during and post construction. An Environmental Management Plan and Historic Preservation Plan (if necessary) for the long term operations of the site will also be prepared.

An outline of the monitoring programme will be included in the EIA, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the proposed development. At a minimum the monitoring programme and report will include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit license(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored. These may in instances, be pre-determined by the local authority and will incorporate a control site where no impact from the development is expected.

Frequency of reporting to NEPA

The Monitoring report will also include, at a minimum:

- Raw data collected.
- Tables and graphs, where appropriate

- Discussion of results with respect to the progress of work, highlighting any parameter(s) which exceed the expected standard(s)
- Recommendations
- Appendices of data and photographs.

Task 8: Project Alternatives

The EIA process will include the examination of alternatives to the project including the no-action alternative. This examination of project alternatives will incorporate the history of the overall area in which the site is located and previous and potential future uses of the site itself.

Task 9: Public Participation / Consultation Programme

Public participation consultation will take two forms:

1. Voluntary public consultation in keeping with Agenda 21 to sensitise the public to the project and take their knowledge and views into account while preparing the EIA
2. The mandatory pubic meeting, after the EIA has been submitted to NEPA. This will be done in keeping with NEPA's guidelines for conducting public meetings.

The mandatory public presentation on the findings of the EIA to inform, solicit and discuss comments from the public on the proposed development will be conducted. As a part of this process, the following will be done:

- Document the public participation programme for the project.
- Describe the public participation methods, timing, type of information to be provided to the public, and stakeholder target groups.
- Summarise the issues identified during the public participation process
- Discuss public input that has been incorporated into the proposed project design; and environmental management systems

All Findings will be presented in the **EIA Report** and will reflect the headings in the body of the TOR, as well as references. Eight hard copies and an electronic copy of the report will be submitted to NEPA for distribution to stakeholders and review. The report will include an appendix with items such as maps, site plans, the study team, photographs, and other relevant information.

Appendix 2: Study Team

The project team that carried out this Environmental Impact Assessment are as follows:

- **Dr. Conrad G.C. Douglas**, C.D., B.Sc., Ph.D. (Applied Chemistry & Process Engineering), MJIM, MJIE, *Project Director, Environmental Management and Climate Change*
- **Mr. Basil Fernandez,** C.D., BSc. (Geology & Hydrology) **-** *Team Leader, Hydrogeology and Hydrology*
- **Dr. Mark Richards, B.Sc., PhD –** Environmental Management, Atmospheric Pollution Modeling and Climate Change Specialist
- **Ms. Elizabeth Hendrick, Tetra Tech,** *Atmospheric Pollution Modelling*
- **Mr. Vance Johnson**, B.Sc. (Pure & Applied Chemistry), M.Sc., (Environmental Engineering), Snr. Environmental Engineer – *Noise Modeling, Geographic Information System (GIS), Risk Assessment, Air Quality, Water Quality and Noise Quality Assessment*
- **Mr. Doran Beckford,** B. Eng. (Chemical Engineering), MBA, Dip. Bus. Admin., MJIEP, Snr. Process & Environmental Engineer – *Air Quality, Water Quality and Noise Quality Assessment, Economics*
- **Mr. Peter Wilson-Kelly,** BSc. (Hons), MPhil., (Marine Sciences) - *Team Leader, Marine & Terrestrial Environment*
- **Mr. Delford Morgan**, BSc. MSc. (Physical Planning) – *Team Leader, Socio-Economic Baseline and Land Use Survey*
- **Ms. Melissa Douglas**, B.A. (UWI), LL.B. (Lond.), A.K.C. (Lond.), L.E.C. - *Policy and Regulatory Framework*
- **Environmental Technicians, Socio-economic interviewers, scientific laboratories**

Appendix 3: Jamalco's No Objection Letter

Jamalco

Jamalco
1st Floor Citi Building
19 Hillcrest Avenue
Kingston 6, Jamaica, WI
PO Box 241
Kingston 6, Jamaica, WI
Tel: 1 876 926 3390-5
Fax: 1 876 926 8901

4 April, 2017

Mr. Peter Knight J.P
Chief Executive Officer/Government Town Planner
National Environment and Planning Agency
10-11 Caledonia Avenue
Kingston 5

Dear Sirs:

Re: Application by NFE South Power Holdings Limited for Environmental Permits in connection with the Combined Heat & Power Facility Project

General Alumina Jamaica LLC (formerly known as Alcoa Minerals of Jamaica, LLC) and Clarendon Alumina Production Limited, the joint owners of JAMALCO, being the legal and beneficial owners of the lands registered at Volume 986 Folio 135, Volume 1030 Folio 512, and Volume 1167 Folio 557 of the Register Book of Titles; and Lessor of parts of the lands registered at Volume 1270 Folio 430, Volume 1270 Folio 432, Volume 591 Folio 43, Volume 1424 Folio 13, Volume 1456 Folio 156, and Volume 1270 Folio 546 of the Register Book of Titles (the "said land"), hereby advise that we have entered into a Joint Development Agreement with NFE South Power Holdings Limited ("NFE"), which provides for the establishment of:

1) a gas-fired steam and electric generation facility (the "Combined Heat & Power Facility" or "CHP") located at Clarendon Alumina Works, Halse Hall, Clarendon, (the "Jamalco Refinery");
2) a pipeline to carry natural gas ("Pipeline") from a liquefied natural gas ("LNG") storage and re-gasification facility ("LNG Terminal") being developed by NFE at Old Harbour Bay to the Jamalco Refinery and CHP;
3) electricity transmission lines to connect the CHP to Jamaica Public Service Company's ("JPS") transmission system ("Transmission Lines");

and that the parties are also negotiating for NFE to establish on the said land:

4) an automotive diesel oil ("ADO") terminal and storage facility ("ADO Storage Terminal") at Rocky Point to supply the CHP;
(the CHP, Pipeline, LNG Terminal, ADO Storage Terminal, and Transmission Lines together hereinafter referred to as the "Project").

Subject to further negotiations and the entry into binding legal written agreements for the non-exclusive use by NFE of portions of the said land for the Project, *inter alia*, we hereby confirm we have no objection to NFE applying to the Natural Resources Conservation Authority for environmental permits to construct the Project on part of said lands in accordance with the terms and conditions of such anticipated binding legal written agreements.

We reserve the right to withdraw this letter at any time, without any notice to NFE, in the event that the aforementioned negotiations with NFE are terminated and/or binding legal agreements are not entered into by JAMALCO and NFE in connection with the proposed construction and operation of the Project on the said lands within a time period acceptable to JAMALCO. For the avoidance of doubt, we reserve the right to apply to NEPA, or to give permission to any third party to so apply, at any time for an environmental permit to construct the Project not in collaboration with NFE on the said land.

CHRISTOPHE URTEL
PRESIDENT
GENERAL ALUMINA JAMAICA LLC

WINSTON HAYDEN
MANAGING DIRECTOR
CLARENDON ALUMINA
PRODUCTION LIMITED

Witnessed by:

NORMAN C. DAVIS
Justice of the Peace
Kingston, Jamaica
B000741

Justice of the Peace

Appendix 4: NFE and Jamalco's Agreement for NFE to Conform to Jamalco's Environment, Health & Safety, Security Planning, Construction Management and Emergency Response Policies and Procedures

Jamalco

Jamalco
1st Floor Citi Building
19 Hillcrest Avenue
Kingston 6, Jamaica, WI
PO Box 241
Kingston 6, Jamaica, WI
Tel: 1 876 926 3390-5
Fax: 1 876 926 6901

12 June, 2017

Mr. Peter Knight J.P
Chief Executive Officer/Government Town Planner
National Environment and Planning Agency
10-11 Caledonia Avenue
Kingston 5

Dear Sirs:

Re: Application by NFE South Power Holdings Limited for Environmental Permits in connection with the Combined Heat & Power Facility Project

Reference is made to No Objection letter dated 4 April 2017.

General Alumina Jamaica LLC (formerly known as Alcoa Minerals of Jamaica, LLC) and Clarendon Alumina Production Limited, the joint owners of JAMALCO, wish to advise that, subject to further negotiations and the entry into binding legal written agreements with NFE South Power Holdings Limited ("NFE"), JAMALCO and NFE will agree that NFE may dispose of the effluent and waste generated by its gas-fired steam and electric generation facility (the "Combined Heat & Power Facility" or "CHP") located at Clarendon Alumina Works, Halse Hall, Clarendon (the "Jamalco Refinery"), through connections to JAMALCO's existing effluent and waste generation systems, in accordance with the terms and conditions of such agreements.

By acknowledging and agreeing to the contents of this letter, NFE confirms that it will conform with Jamalco's Environmental Health & Safety, Security Planning, Construction Management, and Emergency Response Policies and Procedures in constructing and operating the Project (as defined in the 4 April 2017 letter) including the CHP.

General Alumina Jamaica LLC and Clarendon Alumina Production Limited reserve the right to withdraw this letter at any time, without any notice to NFE, in the event that the aforementioned negotiations with NFE are terminated and/or binding legal agreements are not entered into by JAMALCO and NFE in connection with the proposed construction and operation of the Project within a time period acceptable to JAMALCO. For the avoidance of doubt, we reserve the right to apply to NEPA, or to give permission to any third party to so apply, at any time for an environmental permit to construct the Project not in collaboration with NFE.

CHRISTOPHE URTEL
PRESIDENT
GENERAL ALUMINA JAMAICA LLC

WINSTON HAYDEN
MANAGING DIRECTOR
CLARENDON ALUMINA
PRODUCTION LIMITED

Witnessed by:

NORMAN C. DAVIS
Justice of the Peace
Kingston, Jamaica
B000741
NORMAN DAVIS

Justice of the Peace

Acknowledged and Agreed this 12th day of June 2017

Name: BRANNEN McELMURRAY
Position: MANAGING DIRECTOR
NFE SOUTH POWER HOLDINGS LIMITED

Witnessed by:

~~Justice of the Peace~~ Notary Public

DIANA MURRAY
Notary Public, State of New York
Registration No. 01MU6160602
Qualified in Rockland County
Filed in New York County
Commission Exp. Feb. 12, 2019

Appendix 5: SCJ Holdings Limited No Objection Letter

Head Office: Lot #12, Innswood, Old Harbour Road
Spanish Town P.O., St. Catherine, Jamaica W.I.
Telephone: (876) 618-5890, 618-5863
E-mail: sugarscjh@gmail.com

April 3, 2017

Mr. Peter Knight
Chief Executive Officer
National Environment and Planning Agency
Caledonia Avenue
Kingston 5

Dear Mr. Knight,

Re: Letter of No-Objection
Jamalco/SCJ Holdings Limited
New Fortress Energy (NFE) Cogen Project

Reference is made to the captioned matter.

SCJ Holdings Limited (hereinafter referred to as "SCJH") has been formally advised by Jamalco, our lessee that they have entered into legal agreements with New Fortress Energy (NFE) for the installation of Pipelines under parts of lands located in Hayes, Clarendon which we have leased to them, for the supply of Natural Gas to their Cogen Plant.

Please be advised that we have no objection to New Fortress Energy (NFE) applying to the Natural Resources Conservation Authority for the environmental permit for the construction of pipelines under these lands for the provision of a long term energy solution. The nature and scope of the project has received our support.

This consent, is however subject to the completion of the legal agreements between the parties and the satisfaction of the due diligence exercise required for such project.

We ask that you extend your usual courtesies to accommodate this process.

Sincerely,

John E. Gayle
Chief Executive Officer

copy: Mr. Donnovan Buckley, Operations Manager, SCJH
Mrs. Debbie Ann Kerr-Scott, Legal Manager, SCJH
Ms. Sonia Mitchell, General Counsel, Jamalco

Appendix 6: Socio-Economic Survey

New Fortress ENERGY

SURVEY INSTRUMENT

for
ENVIRONMENTAL IMPACT ASSESSMENT
conducted on behalf of
NEW FORTRESS ENERGY
for a proposed
COMBINED HEAT AND POWER (CHP) PROJECT
at
Portland Bight, Clarendon to Jamalco, Halse Hall, Clarendon
administered by
CONRAD DOUGLAS AND ASSOCIATES LIMITED

Community Name ______________________ Community Code ☐☐☐☐☐

Social Impact Assessment

SECTION 1

PERSONAL CHARACTERISTICS

1) Sex: **Male** ☐ **Female** ☐

2) Age Range: **Under 20** ☐ **20-39** ☐ **40-49** ☐ **50-59** ☐
60 & over ☐ Not Stated ☐

3) How many years have you been living in the community?
Under 20 ☐ **20-39** ☐ **40-49** ☐ **50-59** ☐ **60 & over** ☐

4) What is your level of educational attainment (at what level did you finish school)?
Primary ☐ **Secondary/Junior High** ☐ **Vocational/Skills** ☐
Tertiary ☐ **None** ☐

5) What is your current occupation? ______________________________

SECTION 2

COMMUNITY PROFILE AND PERCEPTIONS

6) What do you like most about the community? ***(ASK & WAIT FOR RESPONSE)***
Friendly People ☐ Clean Environment ☐ Availability of Farmland ☐
Quiet ☐ No crime/Violence ☐ Other ☐ ______________

Conrad Douglas & Associates Limited 1 CDA*PRJ 1279/17

7) What don't you like about the community? *(ASK & WAIT FOR RESPONSE)*
Poor Roads ☐ Lack of Utilities ☐ Crime/Violence ☐ Unemployment ☐
Dirty Environment ☐ Other ☐ ________________ Not stated ☐

8) On a scale of 1-5, how would you describe the traffic on the roads in your community? __
(1 meaning low as in little to no traffic and 5 the highest as in very heavy vehicular traffic)

9) When is traffic the heaviest? Morning ☐ Afternoon ☐ Night ☐

10) What type of improvements are needed in your community?

____

11) What are the types of natural hazards that affect your community?
Hurricane ☐ Earthquake ☐ Fire ☐ Drought ☐ Flooding ☐

SECTION 3

KNOWLEDGE AND VIEWS ON PIPELINES CONVEYING NATURAL GAS, NATURAL GAS FIRED POWER PLANT AND ELECTRICTY TRANSMISSION LINES

12) Are you aware that there is a proposal to transport NG from the Portland Bight Area onto lands at Rocky Point Port via a pipeline to a proposed NG fired Cogeneration Plant at Jamalco, Halse Hall? Yes ☐ No ☐

13) How did you hear about it?
Community Representation ☐ Poster/Flyer/Fact Sheet ☐ Word of mouth ☐
NFE Representative ☐ Consultant ☐ This Survey ☐

14) What effect do you think the pipeline and the power plant in or near your area will have on the following: (Answer in terms of positive, negative, no change, doesn't know. ASK AND WAIT)

i. Income/Economic value of the community
Positive ☐ Negative ☐ No Change ☐ Don't Know ☐ Not Stated ☐

ii. Job Opportunities
Positive ☐ Negative ☐ No Change ☐ Don't Know ☐ Not Stated ☐

iii. Pollution
Positive ☐ Negative ☐ No Change ☐ Don't Know ☐ Not Stated ☐

iv. Safety
Positive ☐ Negative ☐ No Change ☐ Don't Know ☐ Not Stated ☐

15) Are you aware that there is a proposal to install a natural gas combined heat and power (CHP) plant within the limits of Jamalco Refinery? Yes ☐ No ☐

16) How did you hear about it?
Community Representation ☐ Poster/Flyer/Fact Sheet ☐ Word of mouth ☐
NFE Representative ☐ Consultant ☐ This Survey ☐

17) What effect do you think the proposed installation of a natural gas CHP plant within the limits of Jamalco Refinery will have on the following: (Answer in terms of positive, negative, no change, doesn't know. ASK AND WAIT)

i. Income/Economic value of the community
Positive ☐ Negative ☐ No Change ☐ Don't Know ☐ Not Stated ☐

ii. Job Opportunities
Positive ☐ Negative ☐ No Change ☐ Don't Know ☐ Not Stated ☐

iii. Pollution
Positive ☐ Negative ☐ No Change ☐ Don't Know ☐ Not Stated ☐

iv. Safety
Positive ☐ Negative ☐ No Change ☐ Don't Know ☐ Not Stated ☐

18) Which of the following negative impacts do you associate with the proposed natural gas pipeline and CHP plant project?
Dust Pollution ☐ Noise Pollution ☐ Water Pollution ☐ Loss of Income ☐
Reduced Land Value☐ Loss of Land Resources ☐ Destruction of Farms ☐
Damage to Fishing Grounds ☐ Damage landscape/aesthetics ☐ Gas Leak ☐
Air Pollution ☐ Fire & Explosion Other ☐________

19) Which of the following positive impacts do you associate with the proposed natural gas pipeline and power plant project?
Employment ☐ Lower Electricity Cost ☐ Improved Economy ☐ Climate Change☐ Increased Land Value ☐ Support for Community Businesses ☐
Increased Government Revenue ☐ Funding for Community Projects ☐
Other ☐________

20) On a scale of 1-5 (1 being not important and 5 being very important), how important do you think this project is to national and community development? ________

21) Explain your answer

____

____

____

SECTION 4

HOUSING & ECONOMIC ATTRIBUTES

22) How many persons make up your household (including yourself)? _______________

23) What is your current employment status?
Full-Time ☐ Part-Time ☐ Self-Employed ☐ Other☐

24) What is your annual income?
Less than $350,000 ☐ $350,000 - $700,000 ☐ $700,000 - $1,400,000☐
$1,400,000 - $2,000,000 ☐ More than $2,000,000 ☐ No Response ☐

25) What is your main source of drinking water?
Indoor tap/pipe☐ Outdoor private tap/pipe☐ Public standpipe☐
Spring, river ☐ Rainwater (tank/drum) ☐ Trucked water (NWC) ☐
Other ☐ (specify)_______________

26) On a scale of 1-5 (1 being not important and 5 being very important), how would you rate the water supply in your community in terms of:
1. Quality __________ Give reason for rating ________________________
2. Reliability __________ Give reason for rating ________________________

27) What is the main source of lighting for your home?
Electricity ☐ Candles ☐ Kerosene Lamp ☐ Other ☐ ______________________

28) Do you currently Own☐ Lease☐ Rent☐ the property on which you live?

29) Do you rely on the areas close to the refinery, railway, port or sea for your livelihood?
Yes ☐ No ☐

30) If yes, explain how, when and where?

____

____

____

31) Have you or any member of your household ever worked for the Jamalco Refinery or in the bauxite mining industry? Yes ☐ No☐ Not Sure☐

32) Are you aware of any programs or activities initiated by the Jamalco in your community?

Yes ☐ No☐ Not Sure☐

END OF QUESTIONNAIRE

Name of interviewer:

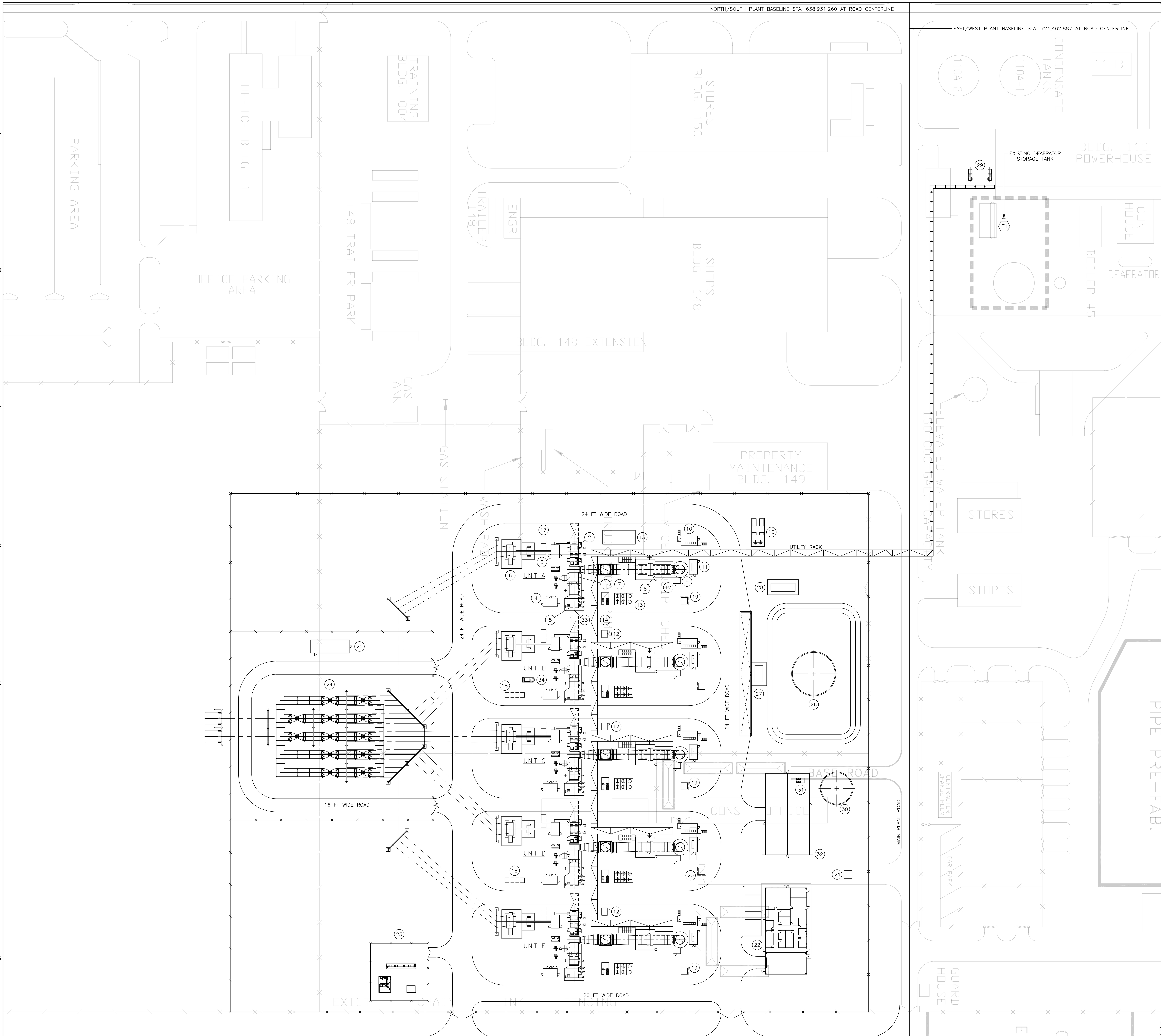
____

Signature of interviewer:

____

Date of interview: _________________________________

Appendix 7: Conceptual Drawings – Site Arrangements for GE



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	GENERATOR AUXILIARIES COMPARTMENT
4	COMBUSTION TURBINE CONTROL ROOM
5	COMBUSTION TURBINE ACCESSORY COMPARTMENT
6	GENERATOR STEP-UP TRANSFORMER
7	BYPASS STACK (SIMPLE CYCLE)
8	HEAT RECOVERY STEAM GENERATOR
9	HRSG STACK
10	HRSG POWER DISTRIBUTION CENTER
11	SAMPLE PANEL
12	CONTINUOUS EMISSIONS MONITORING SYSTEM
13	AIR COOLED HEAT EXCHANGER
14	CLOSED CYCLE COOLING WATER PUMPS
15	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
16	COMPRESSED AIR EQUIPMENT
17	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
18	OIL/WATER SEPARATOR (BELOW GRADE)
19	PROCESS WATER COLLECTION SUMP
20	STORM WATER LIFT STATION
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDNIG
33	INLET AIR FILTER (ABOVE ACCESSORY COMPARTMENT)
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS

CAGED LADDER

FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH
Building a world of difference®

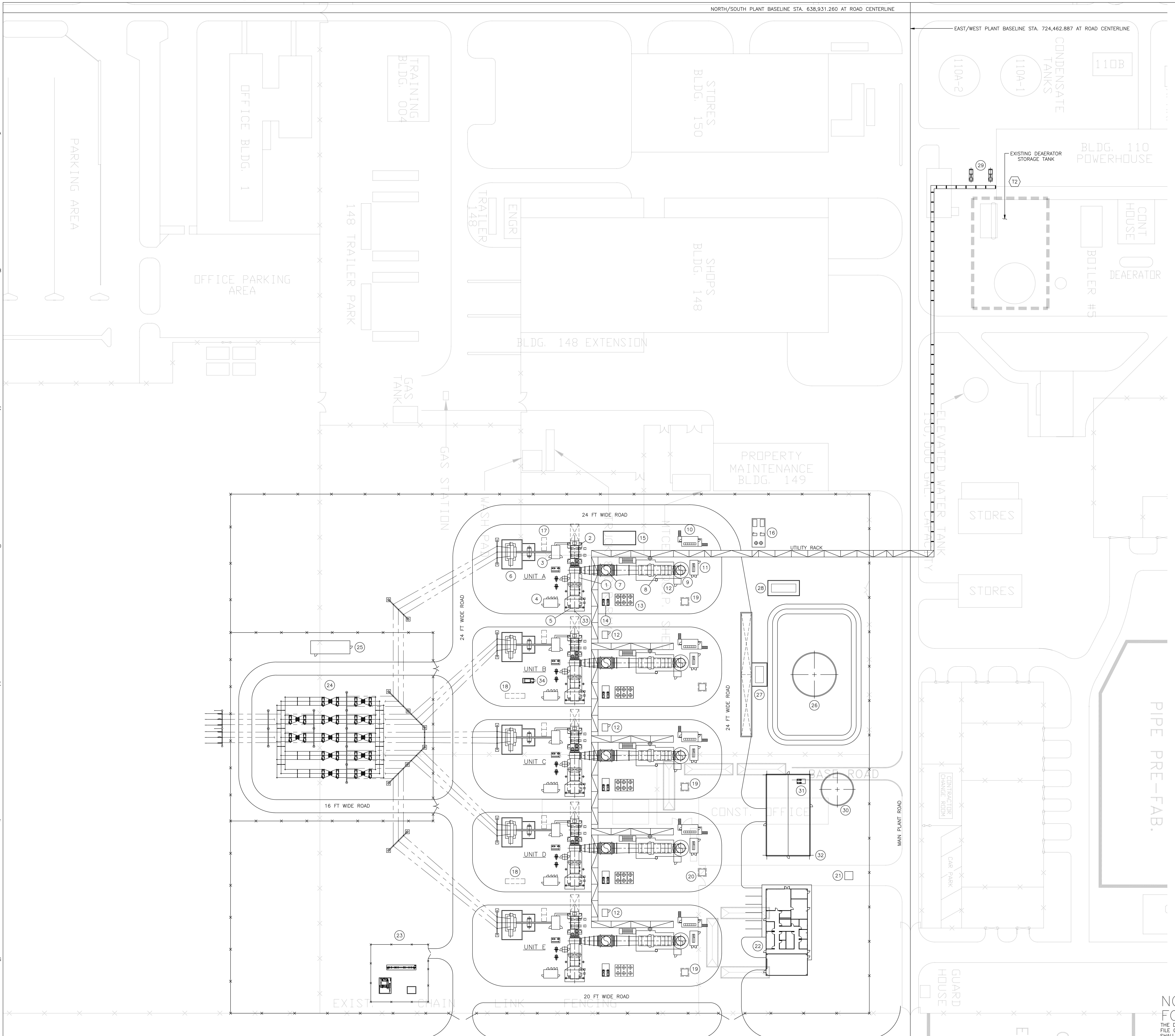
NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – CONDENSATE

DESIGNER	DRAWN DJL
CHECKED	DATE

PROJECT / DRAWING NUMBER: 191422–DS–00001A
REV: 1
CODE
AREA
GE–6B

LOP07762 E1 ACAD 18.2s (LMS Tech)
A1ASL030 1=1
06/20/17 07:26:15



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	GENERATOR AUXILIARIES COMPARTMENT
4	COMBUSTION TURBINE CONTROL ROOM
5	COMBUSTION TURBINE ACCESSORY COMPARTMENT
6	GENERATOR STEP-UP TRANSFORMER
7	BYPASS STACK (SIMPLE CYCLE)
8	HEAT RECOVERY STEAM GENERATOR
9	HRSG STACK
10	HRSG POWER DISTRIBUTION CENTER
11	SAMPLE PANEL
12	CONTINUOUS EMISSIONS MONITORING SYSTEM
13	AIR COOLED HEAT EXCHANGER
14	CLOSED CYCLE COOLING WATER PUMPS
15	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
16	COMPRESSED AIR EQUIPMENT
17	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
18	OIL/WATER SEPARATOR (BELOW GRADE)
19	PROCESS WATER COLLECTION SUMP
20	STORM WATER LIFT STATION
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDNIG
33	INLET AIR FILTER (ABOVE ACCESSORY COMPARTMENT)
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH Building a world of difference®

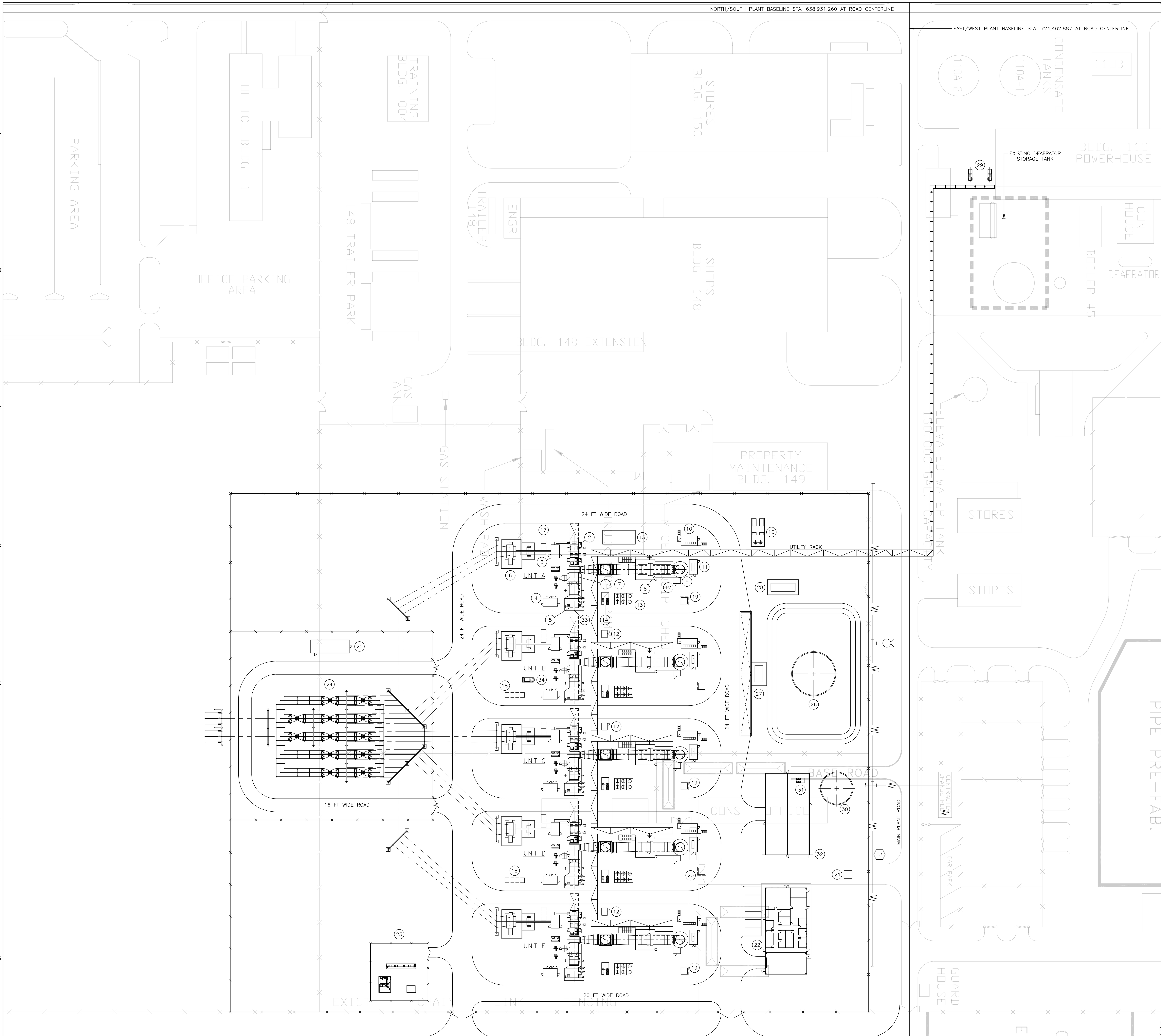
DESIGNER | DRAWN DJL | CHECKED | DATE

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – STEAM

PROJECT / DRAWING NUMBER: 191422–DS–00001B
REV: 1
CODE / AREA: GE–6B

LOP07762 ATA6L030 06/20/17 07:26:58 ACAD 18.2s (LMS Tech) E1 1=1



EQUIPMENT IDENTIFICATION LIST	
1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	GENERATOR AUXILIARIES COMPARTMENT
4	COMBUSTION TURBINE CONTROL ROOM
5	COMBUSTION TURBINE ACCESSORY COMPARTMENT
6	GENERATOR STEP-UP TRANSFORMER
7	BYPASS STACK (SIMPLE CYCLE)
8	HEAT RECOVERY STEAM GENERATOR
9	HRSG STACK
10	HRSG POWER DISTRIBUTION CENTER
11	SAMPLE PANEL
12	CONTINUOUS EMISSIONS MONITORING SYSTEM
13	AIR COOLED HEAT EXCHANGER
14	CLOSED CYCLE COOLING WATER PUMPS
15	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
16	COMPRESSED AIR EQUIPMENT
17	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
18	OIL/WATER SEPARATOR (BELOW GRADE)
19	PROCESS WATER COLLECTION SUMP
20	STORM WATER LIFT STATION
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDNIG
33	INLET AIR FILTER (ABOVE ACCESSORY COMPARTMENT)
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH Building a world of difference®

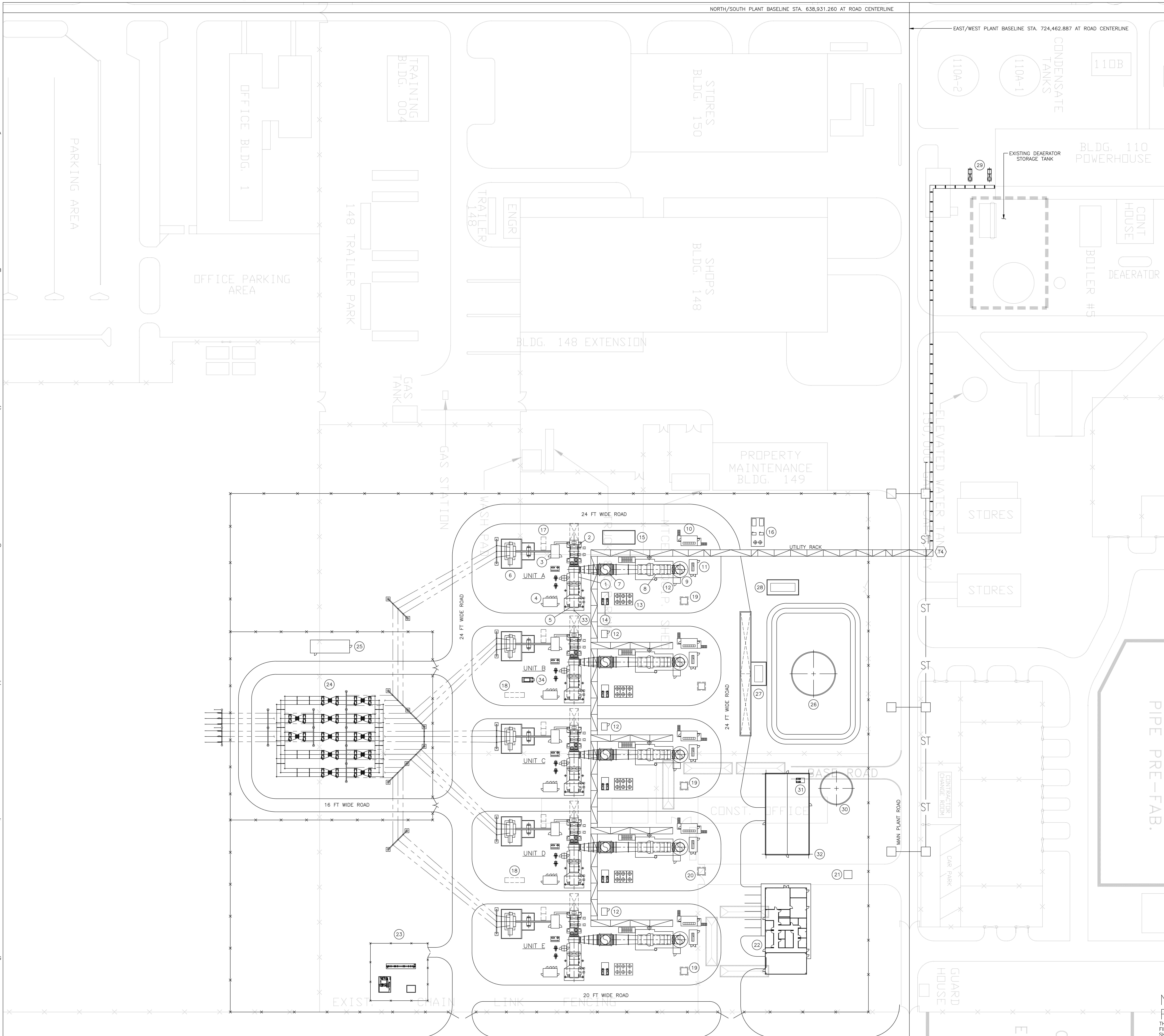
DESIGNER | DRAWN DJL
CHECKED | DATE

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – WATER

PROJECT 191422-DS-00001C | DRAWING NUMBER | REV 1
CODE | AREA | GE-6B

LOP07762 A1ASL030 06/20/17 07:27:22 ACAD 18.2s (LMS Tech) E1 1=1



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	GENERATOR AUXILIARIES COMPARTMENT
4	COMBUSTION TURBINE CONTROL ROOM
5	COMBUSTION TURBINE ACCESSORY COMPARTMENT
6	GENERATOR STEP-UP TRANSFORMER
7	BYPASS STACK (SIMPLE CYCLE)
8	HEAT RECOVERY STEAM GENERATOR
9	HRSG STACK
10	HRSG POWER DISTRIBUTION CENTER
11	SAMPLE PANEL
12	CONTINUOUS EMISSIONS MONITORING SYSTEM
13	AIR COOLED HEAT EXCHANGER
14	CLOSED CYCLE COOLING WATER PUMPS
15	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
16	COMPRESSED AIR EQUIPMENT
17	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
18	OIL/WATER SEPARATOR (BELOW GRADE)
19	PROCESS WATER COLLECTION SUMP
20	STORM WATER LIFT STATION
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDNIG
33	INLET AIR FILTER (ABOVE ACCESSORY COMPARTMENT)
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH
Building a world of difference®

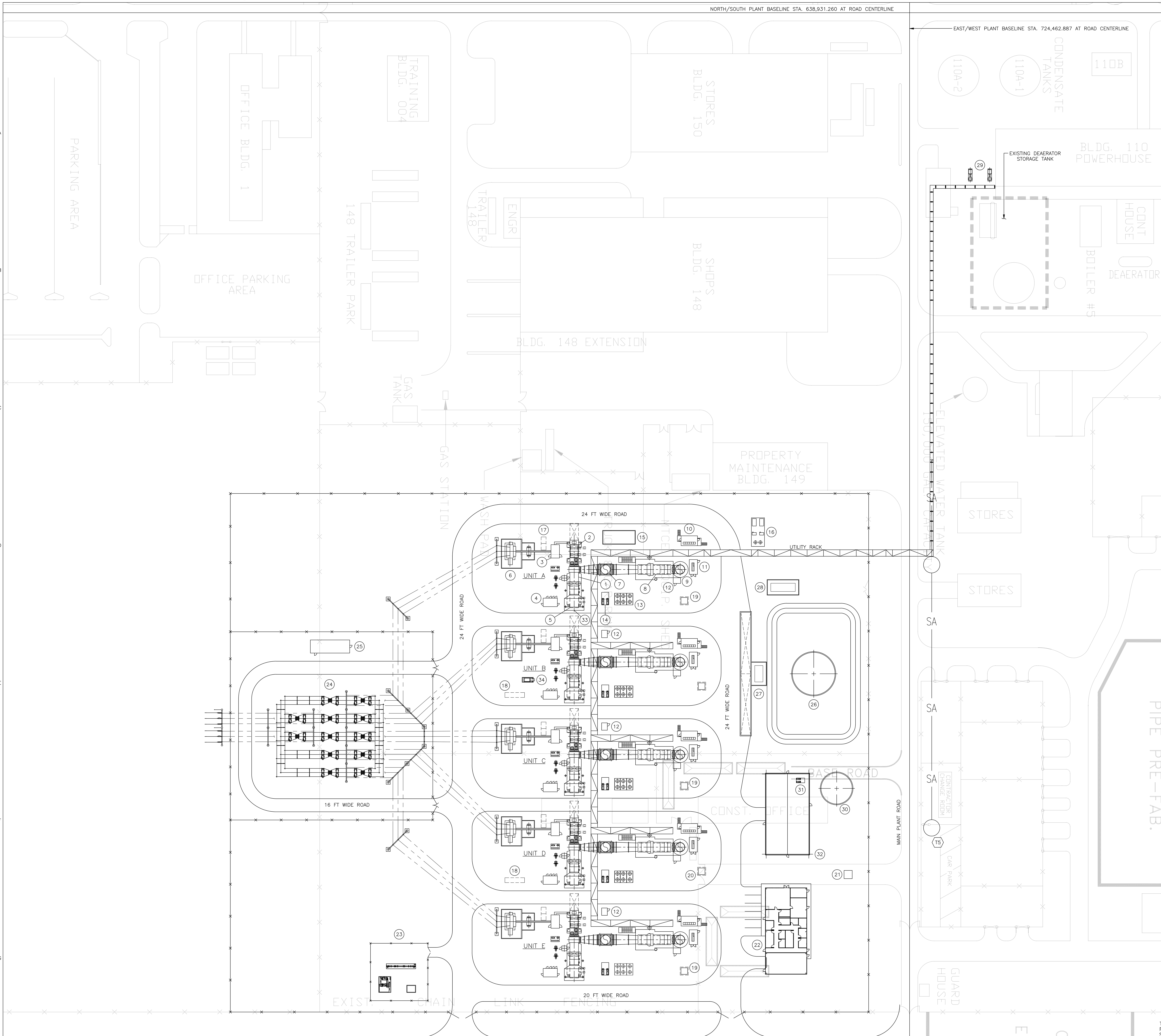
DESIGNER
DRAWN DJL
CHECKED
DATE

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – STORM WATER

PROJECT / DRAWING NUMBER: 191422–DS–00001D
REV: 1
CODE
AREA
GE–6B

LOP07762 A1ASL030 06/20/17
E1 07:27:55
ACAD 18.2s (LMS Tech) 1=1



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	GENERATOR AUXILIARIES COMPARTMENT
4	COMBUSTION TURBINE CONTROL ROOM
5	COMBUSTION TURBINE ACCESSORY COMPARTMENT
6	GENERATOR STEP-UP TRANSFORMER
7	BYPASS STACK (SIMPLE CYCLE)
8	HEAT RECOVERY STEAM GENERATOR
9	HRSG STACK
10	HRSG POWER DISTRIBUTION CENTER
11	SAMPLE PANEL
12	CONTINUOUS EMISSIONS MONITORING SYSTEM
13	AIR COOLED HEAT EXCHANGER
14	CLOSED CYCLE COOLING WATER PUMPS
15	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
16	COMPRESSED AIR EQUIPMENT
17	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
18	OIL/WATER SEPARATOR (BELOW GRADE)
19	PROCESS WATER COLLECTION SUMP
20	STORM WATER LIFT STATION
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDNIG
33	INLET AIR FILTER (ABOVE ACCESSORY COMPARTMENT)
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

1"=40'

BLACK & VEATCH Building a world of difference.

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

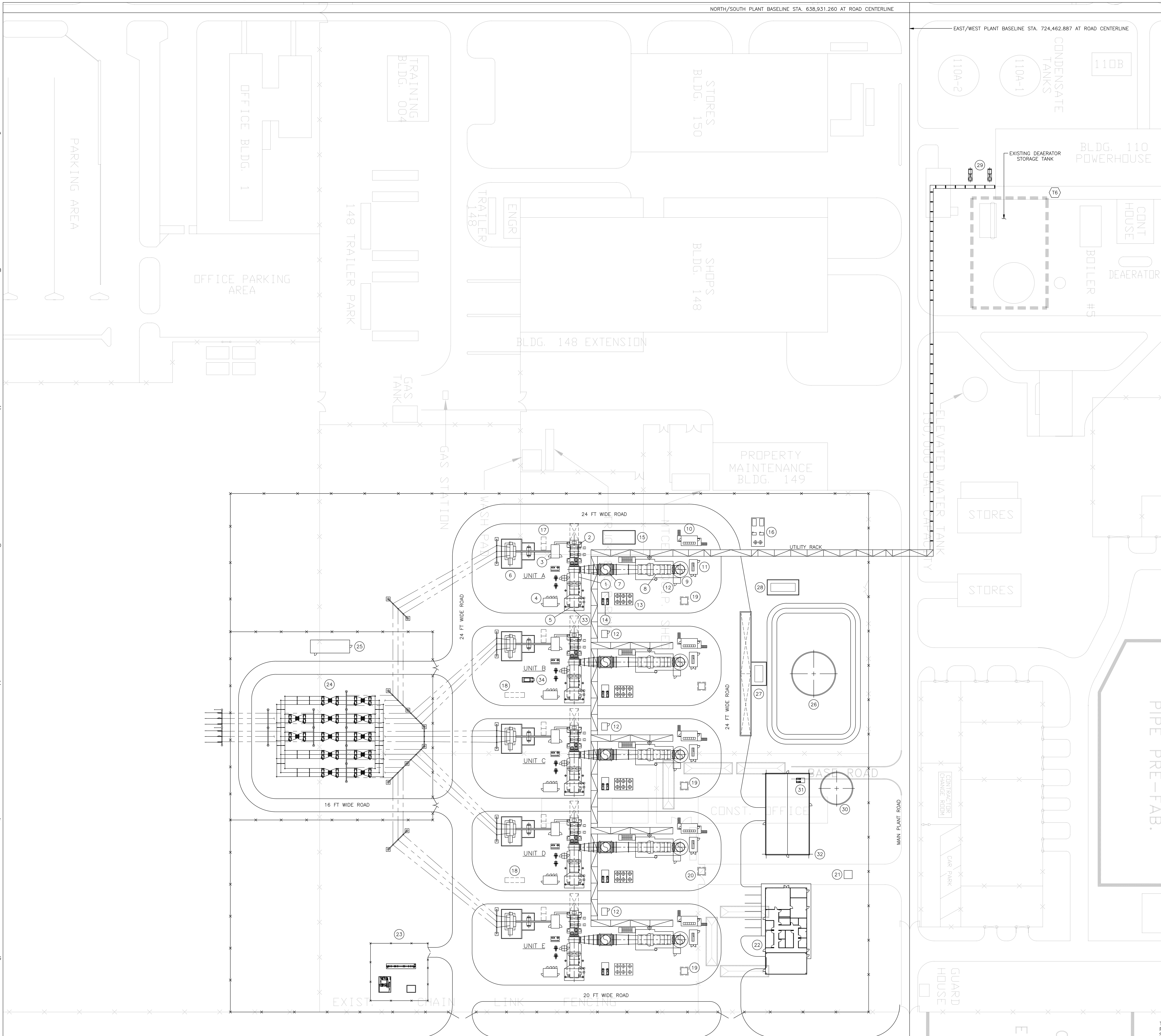
SITE ARRANGEMENT
TERMINAL POINT LOCATION – SANITARY SEWER

DESIGNER | DRAWN DJL | CHECKED | DATE

PROJECT 191422 | DRAWING NUMBER DS-00001E | REV 1

CODE GE-6B | AREA

LOP07762 ACAD 18.2s (LMS Tech)
A1ASL030 E1 1=1
06/20/17 07:28:22



	EQUIPMENT IDENTIFICATION LIST
1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	GENERATOR AUXILIARIES COMPARTMENT
4	COMBUSTION TURBINE CONTROL ROOM
5	COMBUSTION TURBINE ACCESSORY COMPARTMENT
6	GENERATOR STEP-UP TRANSFORMER
7	BYPASS STACK (SIMPLE CYCLE)
8	HEAT RECOVERY STEAM GENERATOR
9	HRSG STACK
10	HRSG POWER DISTRIBUTION CENTER
11	SAMPLE PANEL
12	CONTINUOUS EMISSIONS MONITORING SYSTEM
13	AIR COOLED HEAT EXCHANGER
14	CLOSED CYCLE COOLING WATER PUMPS
15	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
16	COMPRESSED AIR EQUIPMENT
17	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
18	OIL/WATER SEPARATOR (BELOW GRADE)
19	PROCESS WATER COLLECTION SUMP
20	STORM WATER LIFT STATION
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDNIG
33	INLET AIR FILTER (ABOVE ACCESSORY COMPARTMENT)
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED
FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
0	19/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH Building a world of difference®

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

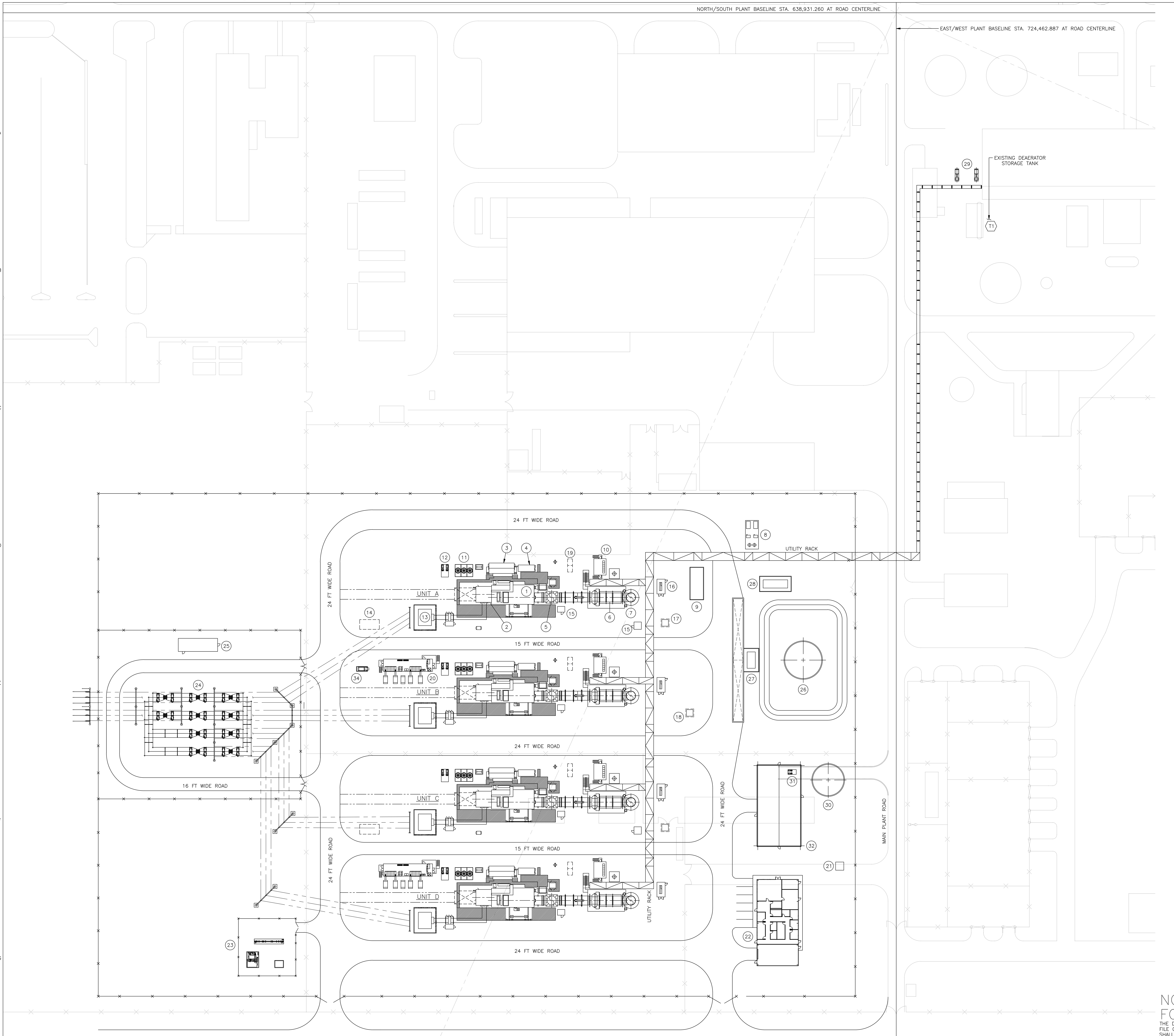
DESIGNER | DRAWN DJL
CHECKED | DATE

SITE ARRANGEMENT
TERMINAL POINT LOCATION – PROCESS WATER

PROJECT | DRAWING NUMBER 191422-DS-00001F | REV 0
CODE | AREA | GE-6B

LOP07762 ATASL030 06/20/17 07:28:43 ACAD 18.2s (LMS Tech) E1 1=1

Appendix 8: Conceptual Drawings – Site Arrangements for Siemens



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	COMBUSTION TURBINE CONTROL ROOM
4	COMBUSTION TURBINE BATTERY ROOM
5	BYPASS STACK (SIMPLE CYCLE)
6	HEAT RECOVERY STEAM GENERATOR
7	HRSG STACK
8	COMPRESSED AIR EQUIPMENT
9	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
10	HRSG POWER DISTRIBUTION CENTER
11	AIR COOLED HEAT EXCHANGER
12	CLOSED CYCLE COOLING WATER PUMPS
13	GENERATOR STEP-UP TRANSFORMER
14	OIL/WATER SEPARATOR (BELOW GRADE)
15	CONTINUOUS EMISSIONS MONITORING SYSTEM
16	SAMPLE PANEL
17	PROCESS WATER COLLECTION SUMP
18	STORM WATER LIFT STATION
19	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
20	MAIN ELECTRICAL POWER DISTRIBUTION CENTER
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDING
33	NOT USED
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH
Building a world of difference®

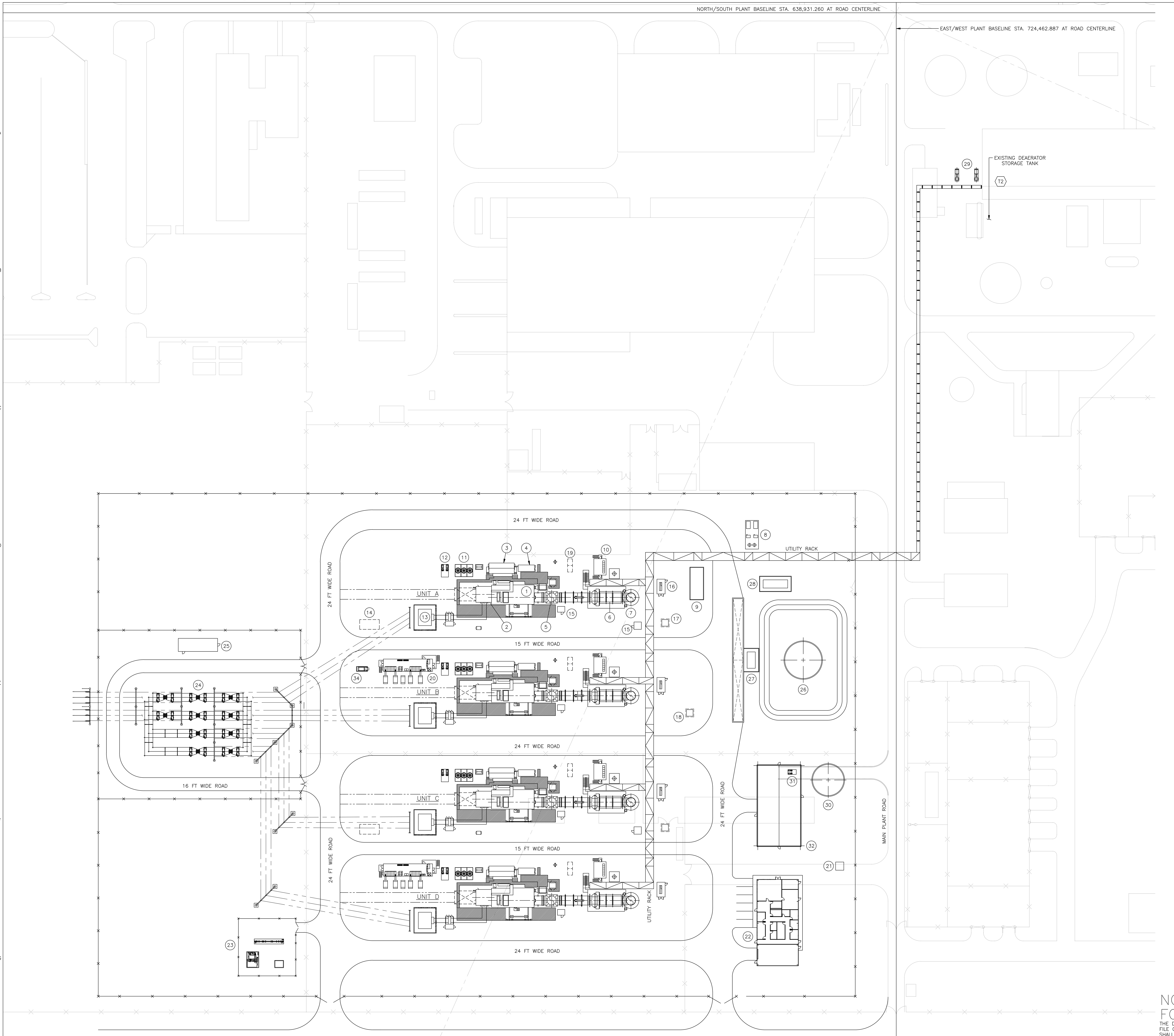
DESIGNER
DRAWN DJL
CHECKED
DATE

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – CONDENSATE

PROJECT 191422–DS–00002A
DRAWING NUMBER
REV 1
CODE SGT–800
AREA

LOP07762 ACAD 18.2s (LMS Tech)
A1ASLD30 1=1
06/20/17 07:33:08



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	COMBUSTION TURBINE CONTROL ROOM
4	COMBUSTION TURBINE BATTERY ROOM
5	BYPASS STACK (SIMPLE CYCLE)
6	HEAT RECOVERY STEAM GENERATOR
7	HRSG STACK
8	COMPRESSED AIR EQUIPMENT
9	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
10	HRSG POWER DISTRIBUTION CENTER
11	AIR COOLED HEAT EXCHANGER
12	CLOSED CYCLE COOLING WATER PUMPS
13	GENERATOR STEP-UP TRANSFORMER
14	OIL/WATER SEPARATOR (BELOW GRADE)
15	CONTINUOUS EMISSIONS MONITORING SYSTEM
16	SAMPLE PANEL
17	PROCESS WATER COLLECTION SUMP
18	STORM WATER LIFT STATION
19	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
20	MAIN ELECTRICAL POWER DISTRIBUTION CENTER
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDING
33	NOT USED
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

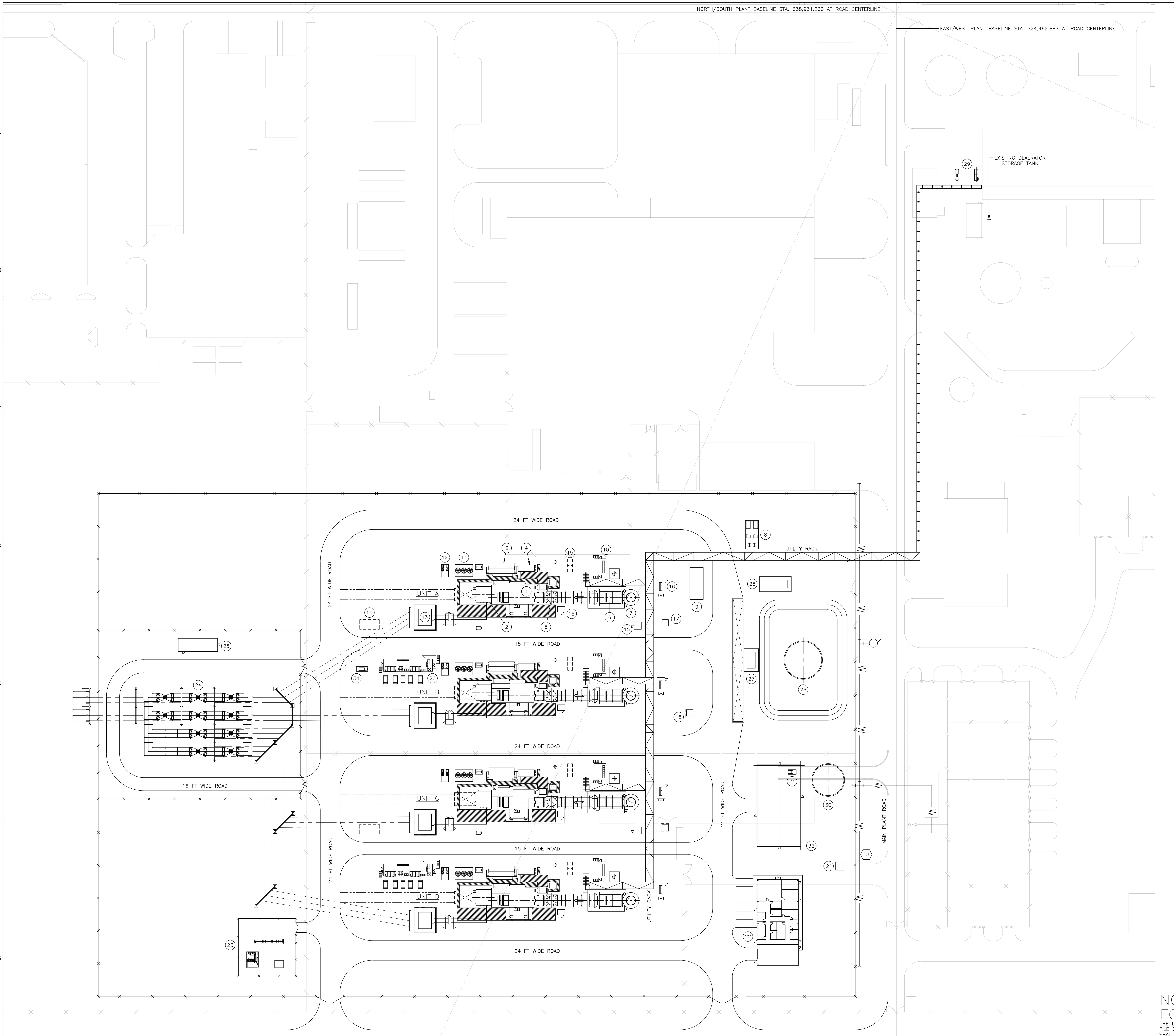
NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

BLACK & VEATCH
Building a world of difference®

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – STEAM

DESIGNER	
DRAWN	DJL
CHECKED	
DATE	
PROJECT / DRAWING NUMBER	191422-DS-00002B
REV	1
CODE	
AREA	
	SGT-800



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	COMBUSTION TURBINE CONTROL ROOM
4	COMBUSTION TURBINE BATTERY ROOM
5	BYPASS STACK (SIMPLE CYCLE)
6	HEAT RECOVERY STEAM GENERATOR
7	HRSG STACK
8	COMPRESSED AIR EQUIPMENT
9	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
10	HRSG POWER DISTRIBUTION CENTER
11	AIR COOLED HEAT EXCHANGER
12	CLOSED CYCLE COOLING WATER PUMPS
13	GENERATOR STEP-UP TRANSFORMER
14	OIL/WATER SEPARATOR (BELOW GRADE)
15	CONTINUOUS EMISSIONS MONITORING SYSTEM
16	SAMPLE PANEL
17	PROCESS WATER COLLECTION SUMP
18	STORM WATER LIFT STATION
19	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
20	MAIN ELECTRICAL POWER DISTRIBUTION CENTER
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDING
33	NOT USED
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH
Building a world of difference®

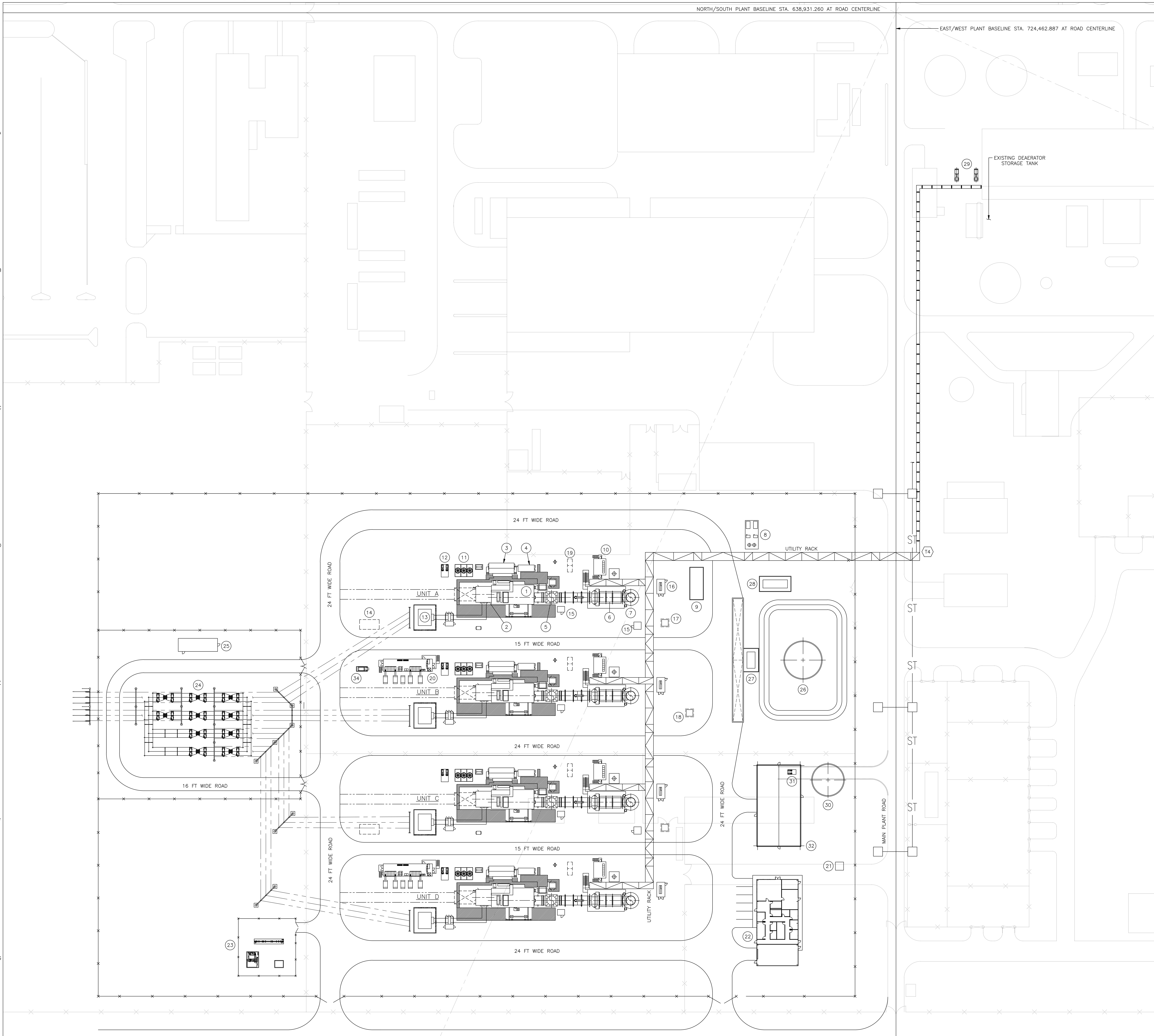
NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – WATER

DESIGNER
DRAWN DJL
CHECKED
DATE

PROJECT / DRAWING NUMBER: 191422–DS–00002C
REV: 1
CODE
AREA
SGT–800

LOP07762 E1 ACAD 18.2s (LMS Tech)
A1ASL030 1=1
06/20/17 07:33:58



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	COMBUSTION TURBINE CONTROL ROOM
4	COMBUSTION TURBINE BATTERY ROOM
5	BYPASS STACK (SIMPLE CYCLE)
6	HEAT RECOVERY STEAM GENERATOR
7	HRSG STACK
8	COMPRESSED AIR EQUIPMENT
9	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
10	HRSG POWER DISTRIBUTION CENTER
11	AIR COOLED HEAT EXCHANGER
12	CLOSED CYCLE COOLING WATER PUMPS
13	GENERATOR STEP-UP TRANSFORMER
14	OIL/WATER SEPARATOR (BELOW GRADE)
15	CONTINUOUS EMISSIONS MONITORING SYSTEM
16	SAMPLE PANEL
17	PROCESS WATER COLLECTION SUMP
18	STORM WATER LIFT STATION
19	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
20	MAIN ELECTRICAL POWER DISTRIBUTION CENTER
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDING
33	NOT USED
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS

CAGED LADDER

FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

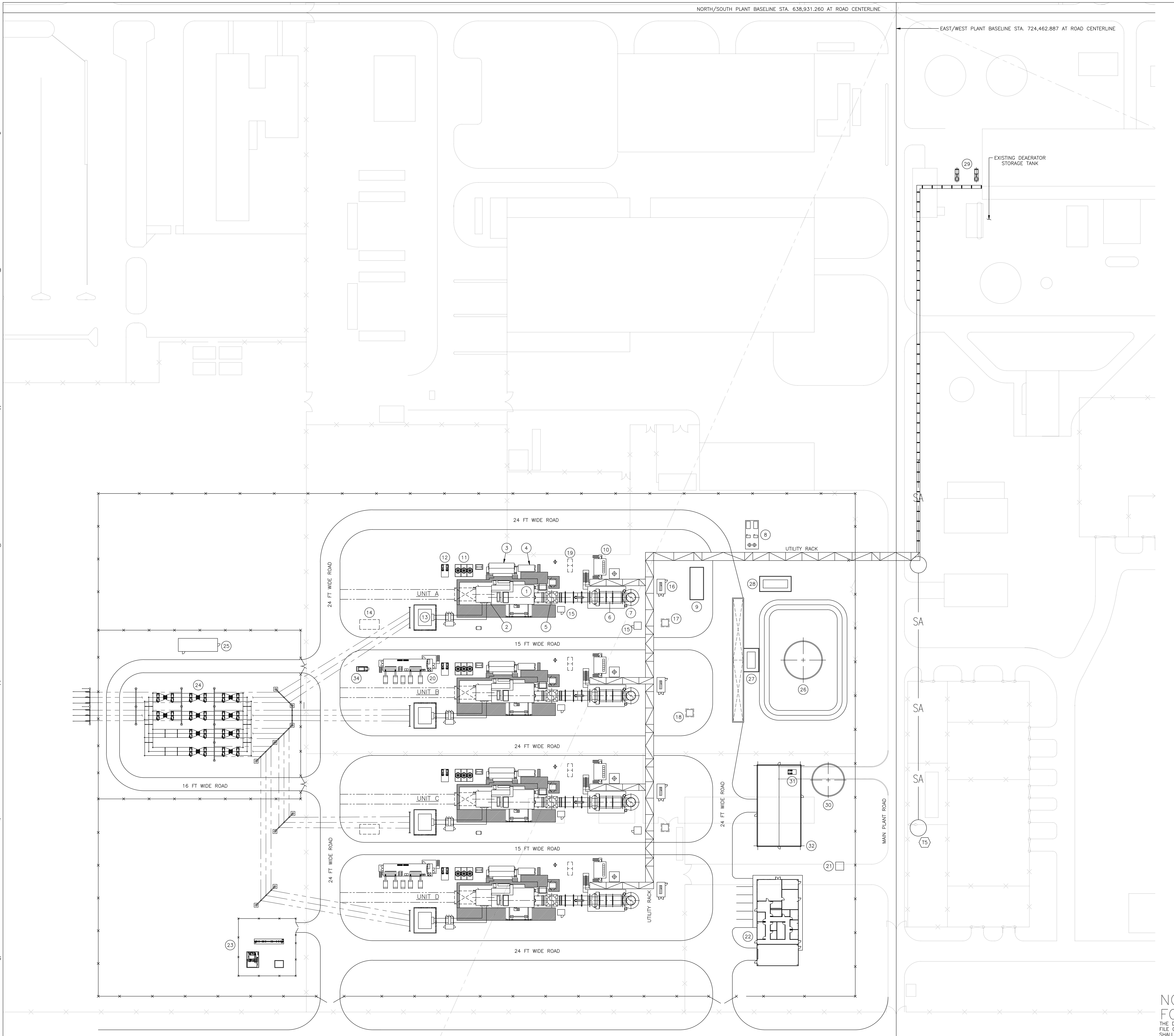
BLACK & VEATCH
Building a world of difference®

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – STORM WATER

DESIGNER	DRAWN DJL
CHECKED	DATE
PROJECT DRAWING NUMBER	191422–DS–00002D
REV	1
CODE / AREA	SGT–800

LOP07762 E1 ACAD 18.2s (LMS Tech)
A1ASL030 1=1
06/20/17 07:34:27



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	COMBUSTION TURBINE CONTROL ROOM
4	COMBUSTION TURBINE BATTERY ROOM
5	BYPASS STACK (SIMPLE CYCLE)
6	HEAT RECOVERY STEAM GENERATOR
7	HRSG STACK
8	COMPRESSED AIR EQUIPMENT
9	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
10	HRSG POWER DISTRIBUTION CENTER
11	AIR COOLED HEAT EXCHANGER
12	CLOSED CYCLE COOLING WATER PUMPS
13	GENERATOR STEP-UP TRANSFORMER
14	OIL/WATER SEPARATOR (BELOW GRADE)
15	CONTINUOUS EMISSIONS MONITORING SYSTEM
16	SAMPLE PANEL
17	PROCESS WATER COLLECTION SUMP
18	STORM WATER LIFT STATION
19	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
20	MAIN ELECTRICAL POWER DISTRIBUTION CENTER
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDING
33	NOT USED
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS

CAGED LADDER

FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	19/JUN/17	GENERAL REVISIONS	DJL			JAW	MRB
0	14/JUN/17	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH
Building a world of difference®

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

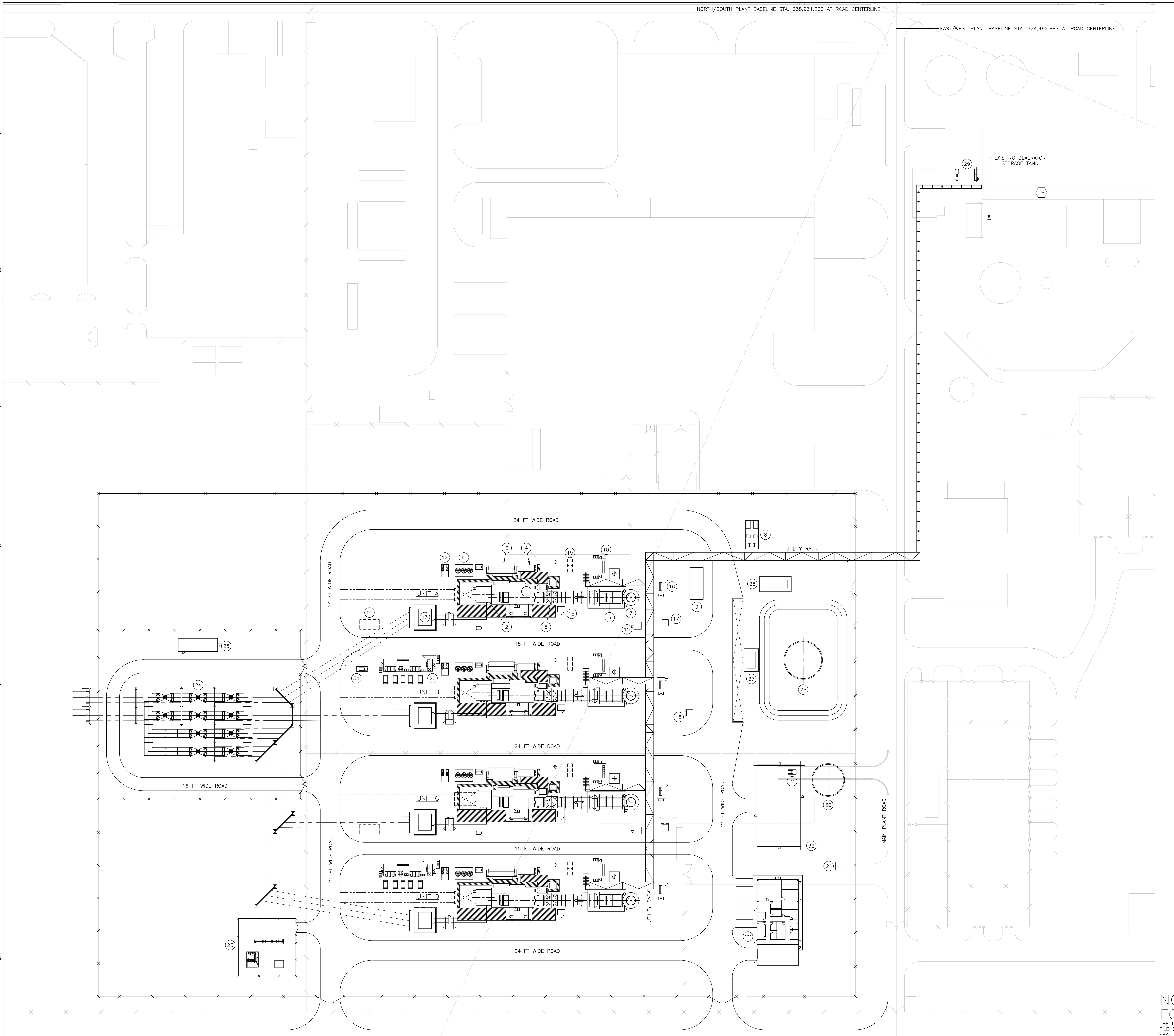
SITE ARRANGEMENT
TERMINAL POINT LOCATION – SANITARY SEWER

DESIGNER | DRAWN DJL | CHECKED | DATE

PROJECT: 191422 – DRAWING NUMBER: DS–00002E – REV 1

CODE | AREA | SGT–800

LOP07762 E1 ACAD 18.2s (LMS Tech)
A1ASL030 1=1
06/20/17 07:34:50



EQUIPMENT IDENTIFICATION LIST

1	COMBUSTION TURBINE
2	COMBUSTION TURBINE GENERATOR
3	COMBUSTION TURBINE CONTROL ROOM
4	COMBUSTION TURBINE BATTERY ROOM
5	BYPASS STACK (SIMPLE CYCLE)
6	HEAT RECOVERY STEAM GENERATOR
7	HRSG STACK
8	COMPRESSED AIR EQUIPMENT
9	CYCLE CHEMICAL FEED AREA (WITH SUNSHADE)
10	HRSG POWER DISTRIBUTION CENTER
11	AIR COOLED HEAT EXCHANGER
12	CLOSED CYCLE COOLING WATER PUMPS
13	GENERATOR STEP-UP TRANSFORMER
14	OIL/WATER SEPARATOR (BELOW GRADE)
15	CONTINUOUS EMISSIONS MONITORING SYSTEM
16	SAMPLE PANEL
17	PROCESS WATER COLLECTION SUMP
18	STORM WATER LIFT STATION
19	WATER WASH/FALSE START DRAINS TANK (BELOW GRADE)
20	MAIN ELECTRICAL POWER DISTRIBUTION CENTER
21	SANITARY LIFT STATION
22	ADMIN/CONTROL/MAINTENANCE BUILDING
23	FUEL GAS YARD
24	SWITCHYARD
25	SWITCHYARD CONTROL ROOM
26	FUEL OIL STORAGE TANK
27	FUEL OIL UNLOADING AREA
28	FUEL OIL FORWARDING PUMPS
29	FEEDWATER SUPPLY PUMPS
30	DEMINERALIZED WATER STORAGE TANK
31	DEMINERALIZED WATER SUPPLY PUMPS
32	WATER TREATMENT BUILDING
33	NOT USED
34	BLACK START DIESEL GENERATOR

LEGEND:

MAINTENANCE ACCESS
CAGED LADDER
FENCE

TERMINAL POINTS

T1 CONDENSATE
T2 STEAM
T3 WATER
T4 STORM WATER (ST)
T5 SANITARY SEWER (SA)
T6 PROCESS WATER

NOT TO BE USED
FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
0	19/JUN/2017	ISSUED AS SUPPORT TO PERMIT APPLICATION	DJL			JAW	MRB

40' 20' 0 40' 80'
1"=40'

BLACK & VEATCH
Building a world of difference®

DESIGNER | DRAWN DJL
CHECKED | DATE

NFE MANAGEMENT, LLC
JAMALCO CTG COGENERATION PROJECT

SITE ARRANGEMENT
TERMINAL POINT LOCATION – PROCESS WATER

PROJECT / DRAWING NUMBER: 191422–DS–00002F
REV: 0
CODE
AREA
SGT–800

LOP07762 A1ASL030 06/20/17 E1 07:35:16 ACAD 1=1 18.2s (LMS Tech)