Environmental Impact Assessment

CAEL Wind Farm, Great Valley Manchester

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Table of Contents

Tables

Figures

APPENDICES

Environmental Impact Assessment
CAEL Wind Farm
Great Valley, Manchester

1.0 Introduction

Clean Alternative Energy Limited (CAEL) is a Jamaican company incorporated under the Companies Act of Jamaica. The company's primary objective is to pursue all types of businesses, including pursuing and developing green energy solutions to provide low cost energy for the Jamaican population. CAEL is proposing to construct eight (8) 3MW wind turbines for the development of a wind farm in Great Valley Manchester. Twelve (12) sites are being explored from which eight (8) sites will be selected. The wind farm is part of CAEL's intent to develop a green energy facility in central Jamaica that produces electricity from wind to be supplied to the local grid for distribution.

This Environmental Impact Assessment (EIA) has been prepared to satisfy the information requirements of the National Environment and Planning Agency (NEPA). See Appendix 1 for the letter from NEPA indicating their requirements.

1.1 Background and Project Rationale

Wind energy is the fastest growing renewable energy source. The usage of wind energy currently spans all continents, with China having the highest installed wind capacity. According to the Global Energy Wind Council and World Wind Energy Association at the end of 2010 the total installed capacity world-wide was 197,647 MW; an increase of 22.5% over 2009 figures. At the end of 2011 global installed wind capacity was 238, 351 MW, a 20.6% increase over 2010 figures. Energy generated from wind turbines provides approximately 3% of electricity demands worldwide.

Jamaica is currently the leading producer of wind energy in the Caribbean and is ranked number 53 in the world. At the end of 2010 and 2011, Jamaica had a total installed wind capacity of 29.7 MW and 41.7MW respectively. The Petroleum Corporation of Jamaica (PCJ) and the Jamaica Public Service Company Limited (JPSCo) are currently the leading producers of commercial wind energy on the island, with the PCJ's Wigton Wind Farm being the single largest producer of wind energy on the island, with a totalled installed capacity of 38.7MW. The Wigton Wind Farm currently generates 3% of Jamaica's electricity[1] and in the 1st quarter of fiscal year 2011-2012, produced 46.32 million kWh of electricity, resulting in US$2.67 million (J$229 million) savings on oil imports.[2]

Jamaica, similar to other Small Island Developing States (SIDS) in the Caribbean, is heavily dependent on imported fuel as a primary energy source. Approximately 97% of Jamaica's

[1] Reynolds, J (2012). Sun Water, Wind and Garbage, Sunday Gleaner. Jamaica Gleaner (Sunday, April 1, 2012) http://jamaica-gleaner.com/gleaner/20120401/focus/focus7.html

[2] Jamaica Gleaner. In Five Months, Wigton Saves Jamaica $229 Million (Sunday, September 25, 2011) http://jamaica-gleaner.com/gleaner/20120401/focus/focus7.html

[2] Jamaica Gleaner. In Five Months, Wigton Saves Jamaica $229 Million (Sunday, September 25, 2011) http://jamaica-gleaner.com/gleaner/20110925/business/business1.html

energy usage comes from oil. In 2008, only an estimated 5% of Jamaica's energy supplies mix came from other sources – 4% from hydro and 1% from wind. According to the Statistical Institute of Jamaica in July 2011 Jamaica spent US$1.5 billion on oil imports.[3] Currently an estimated 13% of Gross Domestic Product (GDP) is spent on oil/energy imports. This high dependency renders Jamaica vulnerable to disruptions in energy supply as well as fluctuations in oil prices (most notably increases). The productive sector is estimated to spend US$0.31 kW/hour on energy.

In 2007, Jamaica imported about 25 million Barrels of Oil Equivalent (BOE) for approximately US$2.6 billion, which was accounted as follows: (i) 40% for the bauxite industry; (ii) 25% for electricity sector; (iii) 25% for transportation sector, and (iv) the remaining 10% for shipping, aviation and lighting industries combined.[4]

In 2008, Jamaica imported in excess of 28 million Barrels of Oil Equivalent (BOE). The oil import bill in 2008 also increased significantly over 2007 figures, a recorded increase of 49.6%. In 2008, three (3) areas, namely bauxite/alumina (34.6%), power/electricity generation (23.1%), and transport (21.5%) accounted for the largest share of petroleum consumption by volume or 79% of the oil consumption. In terms of cost, the transport sector is the single highest.[5]

The high level of energy imports significantly contributes to Jamaica's balance of payments deficits and places additional pressure on foreign exchange reserves and exchange rates in addition to exposing Jamaica to fluctuations in international oil prices. Jamaica's oil import cost in 2007 for the first time surpassed Jamaica's export earnings of US$771.3 million for the year.

The variation in Jamaica's energy import cost is directly linked to the variation in fuel prices. Changes on the world oil market contribute to the constant fluctuation in the overall monthly cost of imported fuel and by extension the cost of energy production. Figure 1 and Table 1 show the variation in crude oil prices for 2011based on the West Texas Intermediate Crude Oil Prices[6] to which Jamaica's fuel prices are linked. In April 2011, the price per barrel of oil peaked at US$110.04 and reached its lowest in September, costing US$85.62 per barrel of oil. The data shows an overall net increase in the price of oil by 9% between January and December 2011.

[3] Jamaica Observer. Fuel and Food Imports Must be Cut (Wednesday, December 7, 2011) (http://www.jamaicaobserver.com/business/-Food-and-fuel-imports-must-be-cut-_10335504

[4] Inter-American Development Bank (2011). Project Profile, Jamaica. http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=35839412

[5] Government of Jamaica (2009). Jamaica's National Energy Policy 2009-2030. Kingston, Jamaica

[6] http://www.indexmundi.com/commodities/?commodity=crude-oil-west-texas-intermediate&months=12

Box 1: Overview of Jamaica's Electricity Sector

Overview of Jamaica's Electricity Sector

The Electricity Sector in Jamaica is vital to the stability of the society and plays a critical role in the viability and modernization of the Jamaican economy. It is often considered as the main life blood for development and the improvement in the standard of living of the people.

The generation stock of over 818MW is largely oil based and is comprised of over 30% of its capacity that goes well beyond its economic life. 30% of total generation is supplied by Private Power Partners under the Independent Power Purchase Agreements.

The transmission system includes a network of more than 1200 km of 138 kV and 69 kV lines. The primary distribution system operates at voltages of 12 kV, 13.8 kV and 24 kV and altogether there are more than 12,000 km of distribution lines.

Over the past few years JPSCo has experienced an increase in system losses. This increase is attributed to an increase in technical losses due to load increases as well as an apparent increase in non technical losses, which are estimated to be approximately 12% of the energy supplied by JPSCo.

Jamaica's National Energy Policy 2009-2030

Figure 1: Spot Oil Price: West Texas Intermediate January-December 2011

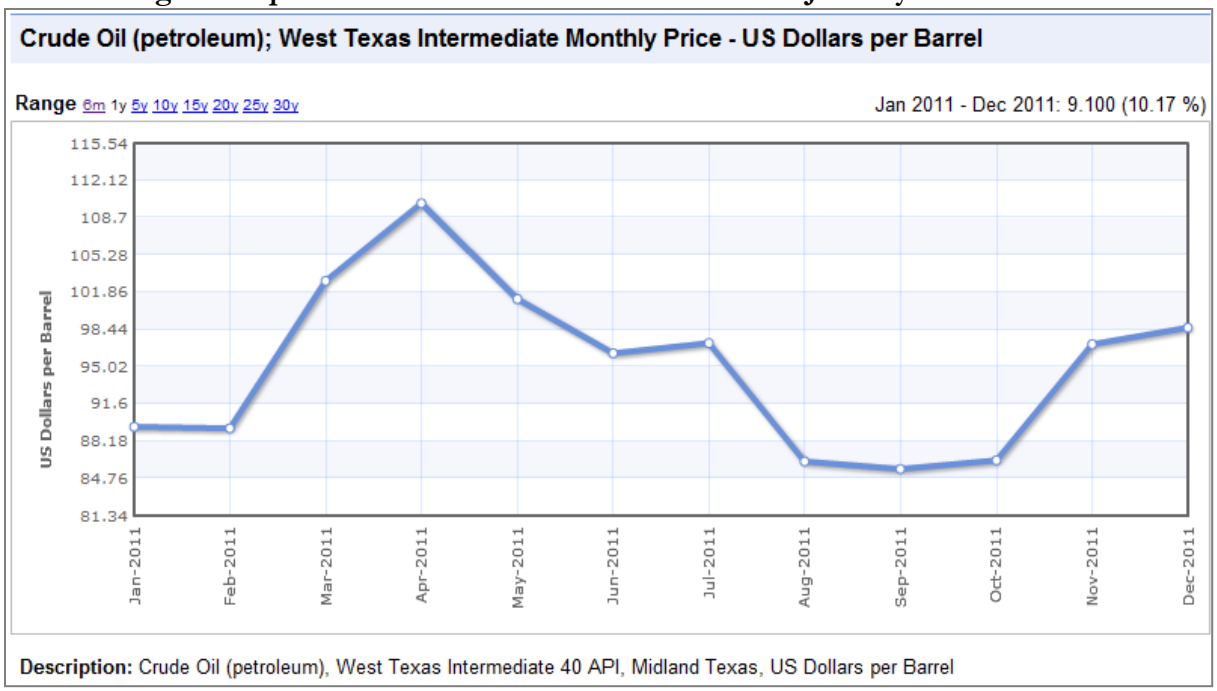


Table 1: Crude Oil West Texas Intermediate Price January – December 2011

Month	Price	Change
Jan 2011	89.51	-
Feb 2011	89.37	-0.16 %
Mar 2011	102.92	15.16 %
Apr 2011	110.04	6.92 %
May 2011	101.25	-7.99 %
Jun 2011	96.25	-4.94 %
Jul 2011	97.19	0.98 %
Aug 2011	86.33	-11.17 %
Sep 2011	85.62	-0.82 %
Oct 2011	86.41	0.92 %
Nov 2011	97.07	12.34 %
Dec 2011	98.61	1.59 %

In order to diversify Jamaica's energy sources by using more indigenous sources and to reduce the demand for foreign exchange, the Government in its Energy Policy 2009-2030 developed by the Ministry of Energy and Mining, has set a target for renewable sources to make up at least 20% of the energy production by 2030.

Proposed targets for renewable energy sources (Jamaica's Energy Policy 2009-2030):

- **11% by 2012**
- **12.5% by 2015 and**
- **20% by 2030**

CAEL in seeking to advance and contribute to the energy diversification agenda of the Government of Jamaica is seeking to promote and expand 'green energy' through the proposed wind farm development. The main objective of CAEL is to implement the first privately owned commercial wind farm to be connected to the grid. In undertaking this project CAEL is striving to achieve the following objectives:

- Increase temporary and permanent employment through the development of renewable energy projects
- Improve on the skills of locals by offering capacity training in the operation and maintenance of the wind turbines
- Continue transfer of technology to Jamaicans thereby developing a cadre of local experts with medium to large scale wind energy projects
- Improvement in energy security
- Diversification of the nation's energy mix
- Meeting the GOJ's energy targets for reduced reliance on fossil fuel sources to supply electricity needs

- Tangible and affirmative action from Jamaica as a signatory of the United Nation Framework Convention on Climate Change (UNFCCC), regarding the reduction of greenhouse gases (GHGs)

- Increase foreign exchange earnings from the trading of carbon credits

- Continued use of environmentally friendly idle/mining land

The use of wind turbines to generate electricity has tremendous benefits since wind is abundant, renewable, widely distributed, clean and reduces net greenhouse gas emissions on the island. Most importantly is the fact that there are no associated fuel costs with the operation of wind turbines. Jamaica's geographic position and climate are conducive to economically feasible wind energy production since the predominant trade winds guarantee a relatively good supply of wind throughout most of the year.

2.0 Project Description

2.1 Project Location

Clean Alternative Energy Limited (CAEL) plans to develop a wind farm on 124 hectares (312.091 acres) of land area in the parish of Manchester. The Great Valley Wind Farm is being designed to have an overall installed wind capacity of 24 MW to be supplied by eight (8) 3MW wind turbines.

The Great Valley Wind Farm site is located in the Great Valley Community in Cross Keys, Southern Manchester (Figure 2). The community is 17km south of Mandeville, the parish capital and 5km south of the town of Newport. Great Valley is an unpopulated area, comprising extensive Greenfield areas. The community is surrounded by other populated areas, including the communities of Broughton, Cross Keys, Cocoa Walk and Plowden Hill (Figure 3).

Figure 2: Map of Jamaica showing Location of Proposed Wind Farm

The proposed wind farm will be constructed on lands owned by the National Land Agency. The lands have been leased to CAEL for an agreement period of twenty-five (25) years. Sections of the property have also been leased to Alpart for bauxite mining. The company has in turn leased the land to local farmers, who have been using the land for more than ten (10) years. The eight (8) turbines will be strategically placed across the property. The siting pattern was chosen to ensure that turbines are not constructed on sections of the property containing bauxite and to minimise the displacement of farmers. This will allow the bauxite companies that have mining rights to conduct mining activities in the future without

obstruction or hindrance from the wind turbines. The property will be fenced to control access. Table 2 provides the geographical coordinates of each of the twelve (12) possible turbine locations from which eight (8) will be selected. The proposed Wind Farm layout is present on the map at Figure 4.

Figure 3: Proposed Great Valley Wind Farm Site and Surrounding Communities

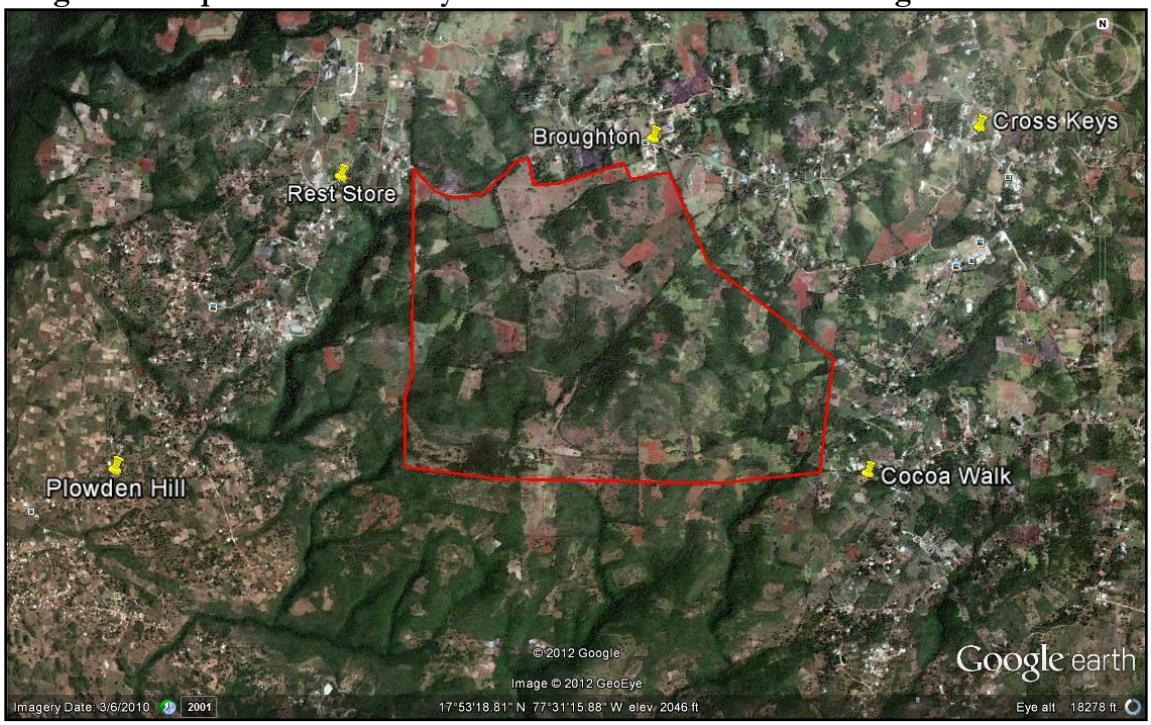
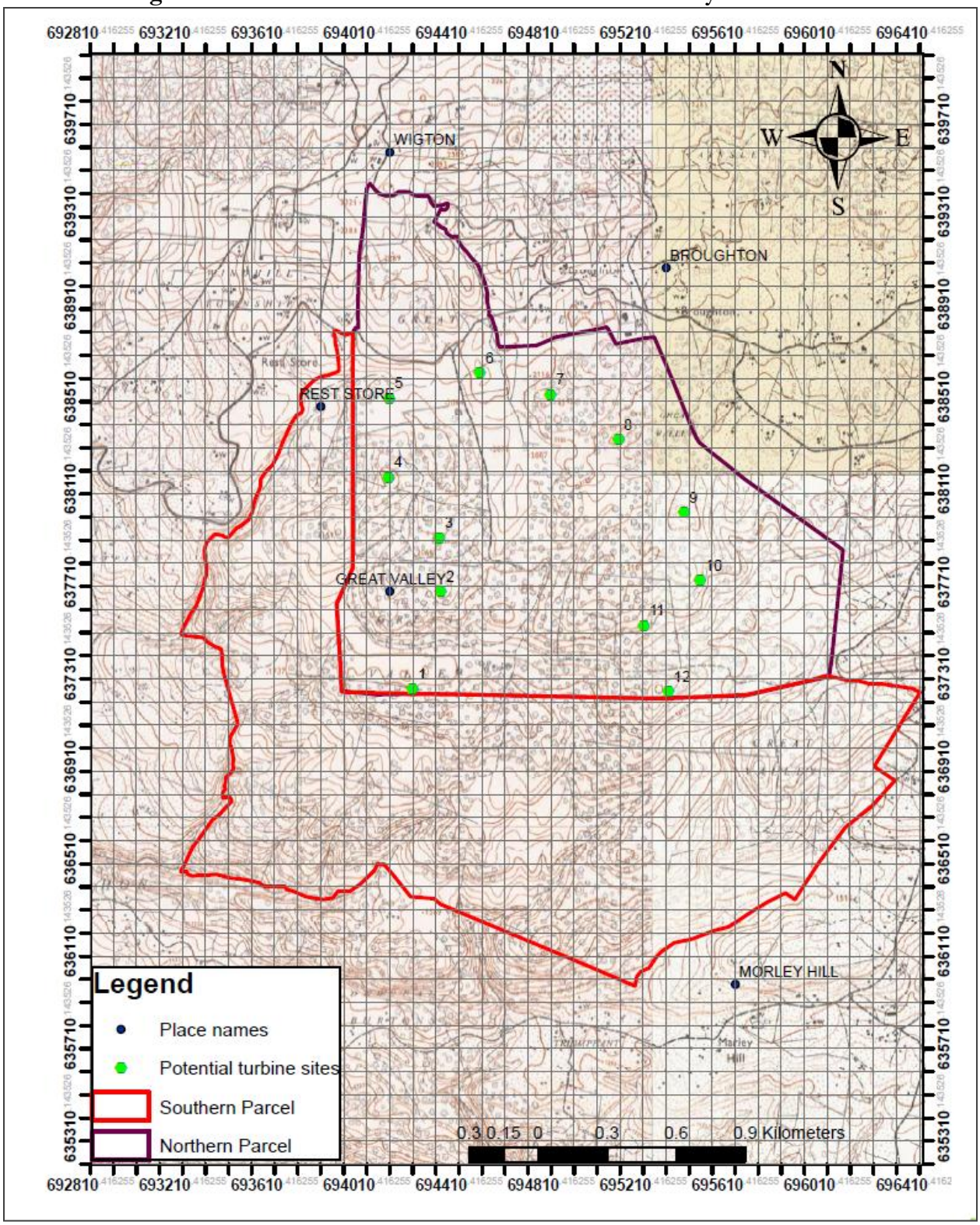


Table 2: Geographical Coordinates of possible Turbine Locations

Turbine	Geographical Coordinates (JAD 2001)	
	X	Y
1	694208.671	637166.931
2	694330.422	637590.015
3	694324.334	637821.342
4	694105.182	638083.107
5	694108.226	638424.009
6	694500.873	638533.585
7	694808.294	638442.272
8	695103.540	638247.470
9	695386.611	637930.918
10	695456.618	637635.672
11	695213.116	637440.870
12	695319.648	637154.756

Figure 4: Possible Wind Turbine Locations Great Valley Manchester



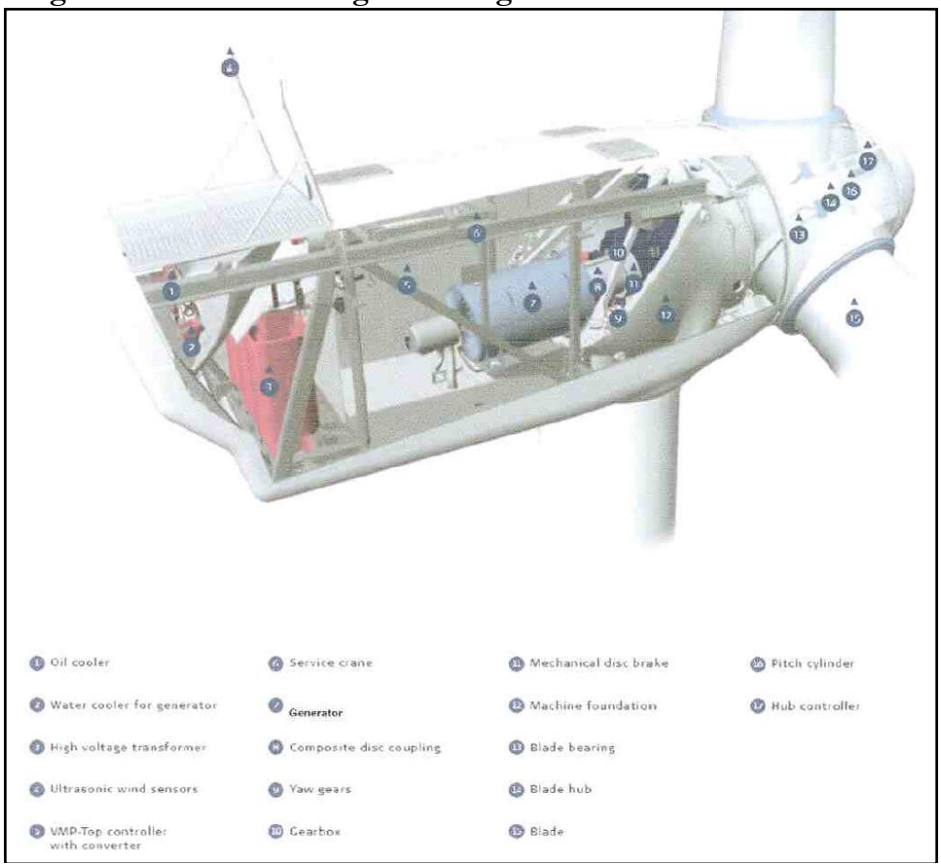
Source: Geo-Edge Limited, 2011

2.2 Project Design

Vestas Wind Systems has been selected by CAEL to design, supply and construct the wind turbines for the Great Valley Wind Farm. CAEL has selected the Vestas V90-3.0MW wind turbine to be installed at the proposed site. The Vestas V90-3.0 MW turbine is a pitch regulated upwind turbine with active yaw and a three-blade rotor. The turbine utilises a microprocessor pitch control system called OptiTip and the Vestas Converter Resistor System (VCRS). The turbine has been designed to operate the rotor at variable speed (rpm), helping to maintain output at or near rated power even in high wind speeds. The VCRS and OpiTip systems also help to minimise noise (sound) emission from the turbine. The turbine consists of the following components:

- Rotor
- Blades
- Blade Bearing
- Pitch System
- Hub
- Main Bearing
- Gear Box
- Generator Bearings
- Yaw System
- Crane
- Towers
- Wind Sensors
- Nacelle Cover
- Bedplate Cover
- Cooling Systems
- High voltage (HV) cables

Figure 5: Structural Design Showing Side View of V90-3.0MW Turbine



Source: Vestas Wind Systems

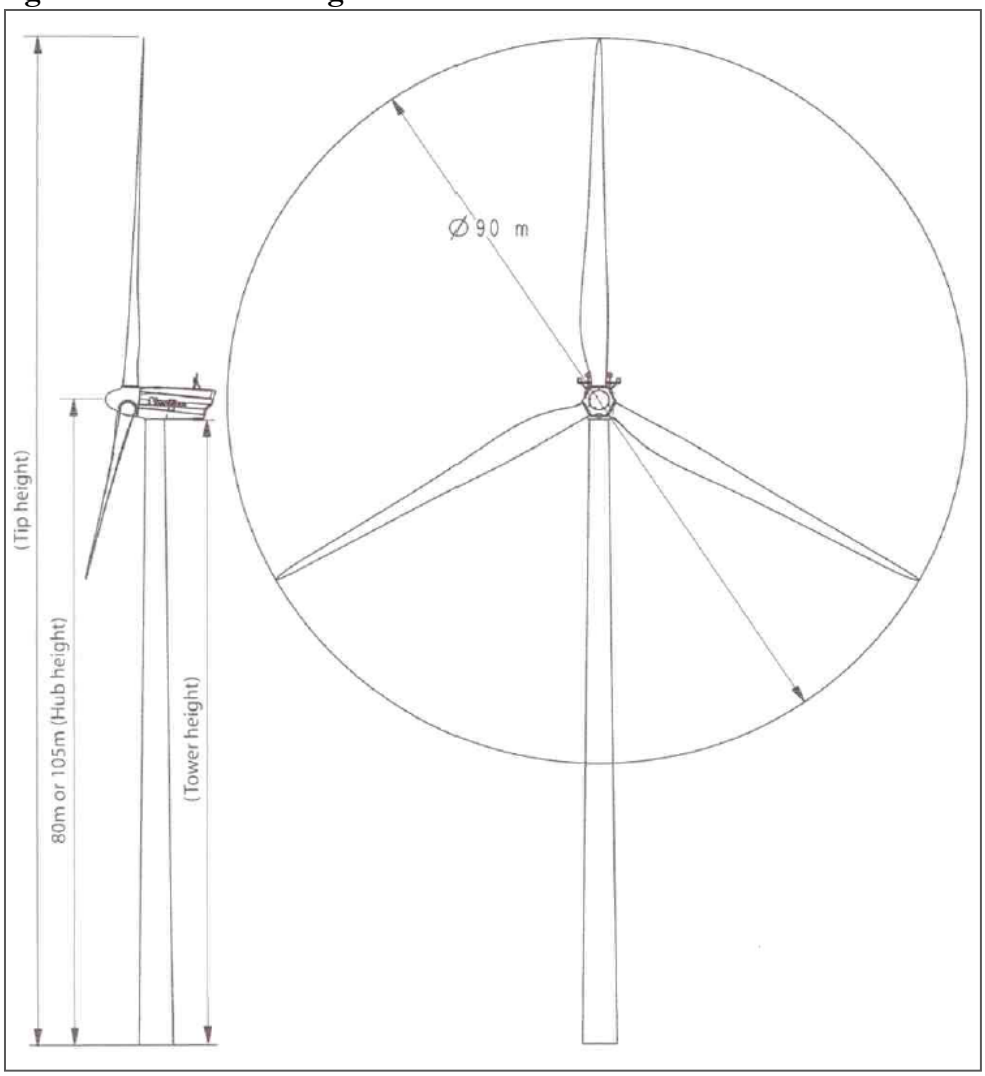
Table 3: Technical Specifications of Wind Turbines

Technical Specifications	
Manufacturer and Supplier	Vestas Wind System
Type	Pitch Regulated, Upwind Turbine
Nominal output rating	3.0 MW (Model: Vestas V90)
Rotor diameter	90 m
Rotor swept area	6,362 m^2
Hub height	80 m
Blade Length	44m
Design class	IEC IA
Rotational Speed Static, Rotor	16.1rpm
Rotation speed	8.6-18.4 rpm
Pitch system	Hydraulic
Bearings (type)	4-point ball bearing
Generator type	Double-fed asynchronous with wound rotor, slip rings and VCRS/ 4-pole asynchronous with variable speed
Drive train	Direct drive system (gearless)
Operating range	
• Cut in speed	3.5 m/s
• Rated speed	15 m/s
• Cut out speed	25 m/s
• Re-cut in	20 m/s
Power control	Pitch regulation
Power converter type :	AC/DC/Ac Inverter
Controller	Vestas Multi-processor Controller (microprocessor based control units)
SCADA	Web based
Lightning protection	One (1) receptor, internal ground conductor
Tower Type	Conical Tubular
Top diameter of towers	2.3m
Bottom diameter of towers	3.98m
Blade material	Fibre glass reinforced epoxy and carbon fibres
Hub material	Cast Iron
Hub weight (approx.)	8850kg
NB: hub heights listed includes 0.55 m distance from the foundation section to the ground level and 2.0 m distance from the tower top flange to the hub center.	

Table 4: Proposed Turbine Siting and Specific Design Information

Site ID	Latitude	Longitude	Gnd Height (m)
Turbine 1	17°53'0.01"N	77°31'35.26"W	576.92
Turbine 2	17°53'13.78"N	77°31'31.16"W	646.15
Turbine 3	17°53'21.31"N	77°31'31.39"W	646.15
Turbine 4	17°53'29.80"N	77°31'38.86"W	653.85
Turbine 5	17°53'40.89"N	77°31'38.79"W	646.15
Turbine 6	17°53'44.49"N	77°31'25.46"W	659.38
Turbine 7	17°53'41.55"N	77°31'15.01"W	669.23
Turbine 8	17°53'35.24"N	77°31'4.96"W	653.85
Turbine 9	17°53'24.97"N	77°30'55.31"W	661.54
Turbine 10	17°53'15.37"N	77°30'52.91"W	646.15
Turbine 11	17°53'9.01"N	77°31'1.16"W	600.00
Turbine 12	17°52'59.72"N	77°30'57.51"W	607.69
General Information			
Site Location: Great Valley **Parish**: Manchester **Nearest Aerodrome**: Norman Manley International Airport		**Nearest Town**: Rest Store **Tower Height**: 80m	

Figure 6: Structural Design of the Outer Dimensions of V90 3.0MW Turbines



Source: Vestas Wind Systems

General Ambient Design

Temperature

The wind turbine is designed for operation in ambient temperatures ranging from -20°C to +40°C. All components including liquids, oil etc., are designed for temperatures as low as -40°C. Special precautions must be taken outside these temperatures. If the temperature inside the nacelle exceeds 50°C, the turbine is paused.

Wind Conditions

Table 5 lists the design conditions assumed for the operating environment for the Vestas V90-3.0 MW, 50 Hz wind turbine.

Table 5: Operating Environment Design Criteria

Design Conditions	
Standard IEC IA	Turbulence I15*) 18%
Average wind speed 8.5 m/s	Max average wind **) 42.5 m/s
C-parameter 2	Max wind gust ***) 59.5 m/s

Notes: wind speed and turbulence refer to hub height

*) The turbulence is wind dependent and varies from 34.1 – 16.1% at wind speeds between 4 - 25 m/s.
At 15 m/s the turbulence is 18%
**) 10 min., 50 years' mean wind speed
***) 3 sec., 50 years' gust wind speed

Source: General Specifications V90-3.0 MW 60Z, Vestas Wind Systems A/S

The wind conditions listed are design parameters as is the cut out wind speed. Other parameters can also influence the turbine lifetime and the following values should not be exceeded.

- Max wind gust acceleration 10 m/s^2
- Cut out Wind Speed 25 m/s
- Restart Wind Speed 20 m/s

Project Components and Design Elements for the 3 MW Wind Turbine

1. Blades

There are three (3) blades on each rotor. Each blade measures 44 m in length. The blades are made of fibre glass reinforced epoxy and carbon fibres. Each blade consists of an inner beam encircled by two shells. The blades are designed for optimised output and minimised noise and light reflection. The V90 blade design minimizes the mechanical loads applied to the turbine. The blade bearing is a double raced 4-point ball bearing bolted to the blade hub.

Each blade has a lightning protection system consisting of lightning receptors on the blade tip and a copper wire conductor inside the blade.

2. Nacelle

The nacelle cover is made of fibreglass. The roof section of the nacelle is equipped with skylights, which can be opened to access the roof and the wind sensors. Wind sensors are mounted on the nacelle roof and aviation lights, if any, are also placed on top of the nacelle. The specifications of the nacelle are described in Table 6.

Table 6: Nacelle Specifications

Nacelle Specifications			
Including hub and nose cone		*Without hub and nose cone*	
Length	13.25 m	Length	9.65 m
Width	3.65 m	Width	3.65 m
Height	4.05 m	Height	4.05 m
Weight approx.	88,000 kg +/- 3,000 kg	Weight approx.	68,000 kg +/- 2000 kg

Source: General Specifications V90-3.0 MW 60Z, Vestas Wind Systems A/S

3. Bedplate

The front of the nacelle bedplate is the foundation for the drive train that transmits forces and torque from the rotor to the tower, through the yaw system. The front of the nacelle bedplate is made of cast steel. The nacelle cover is mounted on the nacelle bedplate. The nacelle bedplate is in two parts and consists of a cast iron part and a girder structure. The cast iron part serves as the foundation of the main gear and the generator.

4. Gearbox

The main gear transmits the torque from the rotor to the generator. The gear unit is a combination of a 2-stage planetary gear and a 1-stage helical gear. The gear housing is bolted to the bedplate. The low speed input shaft is bolted directly to the hub without the use of a traditional main shaft. The gearbox lubrication system is a forced feed system without the use of an integrated oil sump. The technical specification of the gearbox is:

- Length: 2,100 mm
- Diameter: 2,600 mm
- Weight max.: 23,000 kg

5. Yaw System

The yaw bearing system is a plain bearing system with built-in friction. The system enables the nacelle to rotate on top of the tower. The system transmits the forces from the turbine-rotor/nacelle to the tower. Four electrical yaw gears with motor brakes rotate the nacelle.

6. The Brake System

The turbine brakes by full-feathering of the rotor blades. The individual pitch cylinders ensure triple braking safety. Furthermore, a hydraulic system supplies pressure to a disc brake located on the main gear high-speed shaft. The disc brake system consists of three (3) hydraulic brake callipers. The disc brake is considered as the parking brake.

7. Generator

The generator is an asynchronous 4-pole generator with a wound rotor. Variable speed allows varying the rotor speed within a wide speed range. The variable speed system optimises the power production of the turbine, particularly at low wind speeds. The generator is water-cooled. The technical specification for the generator is:

- Length max.: 2,800 mm
- Diameter max.: 1,100 mm
- Weight max: 8,500 kg

8. Transformer

The step up transformer is located in a separate compartment to the rear of the nacelle. The transformer is a three phase dry-type cast resin transformer specially designed for wind turbine applications. The transformer room is equipped with arc detection sensors. The technical specification for the transformer is:

- Length: 2,340 mm
- Width: 1,090 mm
- Height: 2,150 mm
- Weight max.: 8,000 kg

9. Hydraulics

A hydraulic system produces hydraulic pressure for the pitch systems in the hub. In case of grid failure or leakage, a backup accumulator system provides sufficient pressure to pitch the blades and stop the turbine. A collector system prevents oil leaks, if any, from spreading outside the hub.

10. Controller

All functions of the wind turbine are monitored and controlled by microprocessor based control units called VMP (Vestas Multi Processor). The VMP controller consists of several individual sub controller systems. Each system has separate operation tasks and communicates via an optical-based network (ArcNet).

The VMP controller serves the following functions:

- Monitoring and supervision of the operation.
- Synchronising the generator to the grid during the connection sequence, in order to limit the in rush current.
- Operating of the turbine during various fault situations.
- Automatic yawing of the nacelle in accordance with the wind direction.
- Controlling the blade pitch.
- Reactive power control and variable speed.
- Noise emission control.
- Monitoring of ambient conditions (wind, temperature, etc.).

- Monitoring of the grid.

11. Sensor Features

a. Ultrasonic Wind Sensors

The nacelle is equipped with two redundant ultrasonic wind sensors in order to increase the reliability and accuracy of the wind measurements. The wind sensors measure the wind direction and wind speed. The sensor is self-testing and if the sensor signal is defective the turbine will be brought to a safe condition.

The sensors are located on top of the nacelle and are protected against lightning strikes.

b. Smoke Detectors

The tower and nacelle are equipped with optical smoke sensors. If smoke is detected an alarm is sent via the RCS (Remote Control System) and the main switcher is activated. The detectors are self-controlling. If a detector becomes defective, a warning is sent via the RCS.

c. Lightning Detectors

Lightning detectors are mounted on all three rotor blades. The lightning protection system on the turbine protects the entire turbine from the tip of the blades to the foundation. The system enables the lightning current to by-pass all vital components within the blade, nacelle and tower without causing damage. As an extra safety precaution, the control units and processors in the nacelle are protected by an efficient shielding system.

Data from the detectors are logged and enable the operator to identify the blade that was hit, the exact time of the stroke, and how powerful the lightning was.

These data are very useful for making a remote estimate of possible damage to the turbine and the need for inspection.

d. Accelerometers

Accelerometers register the movements of the tower top. The registrations are intelligent controlled by the VMP and used to remove unfavourable movements and vibrations.

e. GPS (Real Time Clock)

The GPS is primarily used to synchronise the turbine clock. The GPS accuracy is within 1 second. Via this system it is possible to compare the various log observations with other turbines within the same area/site e.g. fluctuations in the power, grid or lightning activity.

f. Arc Protection

The transformer and the low voltage switchboards are protected by an arc protection system. In case of an electrical arc, the system will instantly open the main breaker downstream from the turbine.

Wind Design Considerations

Data derived from the following sources were used to generate information on wind to be inputted in the final design considerations for the Great Valley Wind Farm.

1. Wind data was collected between 2008 and 2009 at Great Valley site at 50m met-mast. Wind data was collected on a 10 minute interval as well as date and timestamp, average, standard deviation, maximum, minimum, wind speeds.

2. Wind data collected at meteorological tower located at Wigton Wind Farm (Wigton 1) at 50m (met-mast) and reflected date and timestamp, average, standard deviation, maximum, minimum, wind speeds.

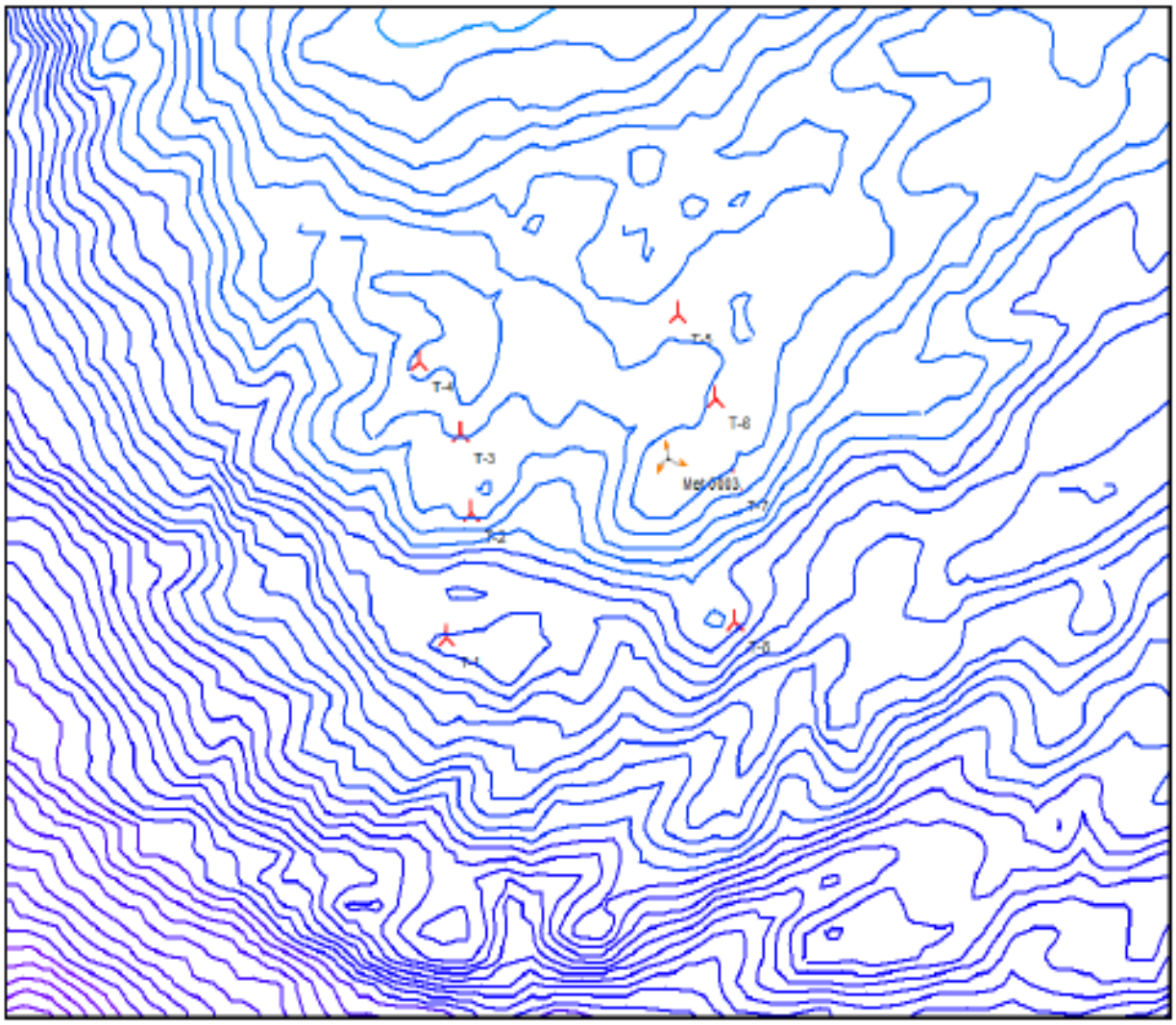
3. Wind data collected from Norman Manley International Airport and Sangster International Airport between 1997 and 2009. The wind data is captured via wind sensors located at 10m and recorded at 2 minute intervals. This was used to predict long term viability of wind speed, etc.

4. Monthly climatological data for period 1992 to 2010 was received for both airport locations.

Based on the wind design considerations and environmental concerns during the Operation Phase outlined in Section 6.1.2 (1 – Operational Noise and 5 – Shadow Flicker) Vestas, the supplier of the wind turbines determined the optimum layout for eight (8) turbines as shown in Figure 7 and Table 7, to eliminate the potential adverse environmental impacts while optimizing energy yield.

The energy yield from the wind turbines of 68.3 GWh/year determined by Vestas is presented in Table 8. This energy yield is based on an average design wind speed of 8.1 m/s.

Figure 7: Topography Map with Meteorological Towers and positions of Wind Turbines



Source: Vestas Wind Systems

Table 7: Wind Turbine Coordinates

WTG ID	Easting UTM WGS 84, Zone 18	Northing UTM WGS 84, Zone 18	M.A.S.L.[7]
T-1	232296	1979032	580
T-2	232294	1979472	622
T-3	232362	1979750	630
T-4	232202	1980009	640
T-5	233203	1980163	648
T-6	233343	1979866	640
T-7	233410	1979570	635
T-8	233408	1979068	595

Source: Vestas Wind Systems

[7] Measurement above sea level

Table 8: Summary of Energy Yield from Wind Turbines

WTG ID	Energy Result (GWh/Year)	Capacity Factor (%)	Wake Efficiency (%)	Wind Speed (m/s)
1	8.553	32.50	91.7	8.27
2	8.503		92.0	8.24
3	8.440		93.3	8.16
4	8.696		95.6	8.17
5	8.106		99.2	7.81
6	8.315		99.1	7.90
7	8.776		98.6	8.10
8	8.899		98.9	8.14
Total/Averages	68.288	32.5	96.05	8.10

Source: Vestas Wind Systems

Civil Works

The other works to be executed include civil works (site preparation and access roads), electrical works, transportation and erection of the wind turbines and construction of the wind farm substation (Refer to Table 9). Some blasting may be necessary for the excavation of the foundations for the base of the turbines. Vestas Wind Systems will also provide training to CAEL personnel, test and commission the turbines, and maintain them for five (5) years. The following services will be provided for all activities over the stipulated period:

- Project Management,
- Quality Control and Assurance (QC/QA) and
- Environment, Health and Safety Management.

Vestas Wind System has given special consideration to the following issues in the design and construction of the wind turbines:

- Minimisation of adverse environmental impacts
- Disasters such as hurricanes, earthquakes and lightning strikes
- Protection of public infrastructure (roads, electrical grid, electrical poles)
- Optimisation and control of construction management
- Compliance with local legislation, permits and licences

Table 9: Description of Civil Works

A.	Civil works
	• Site measurement
	• Site preparation
	• Access road construction
	• Crane pad construction
	• Excavation
	• Re bar fabrication
	• Concrete pouring
	• Backfilling
	• Drainage
	• Fence work
	• Restoration work
	• Waste management
B.	Electrical work
	• Earthing work
	• Cabling work (power cable, communication cable)
	• Installation of switchboards at wind farm substation
	• Grid connection to JPS distribution
C.	Transportation (crane and wind turbine components)
	• Sea transportation
	• In-land transportation (port to jobsite)
D.	Erection work
	• Main crane (250T crawler type)
	• Tail crane (50T mobile)
E.	Civil works for wind farm substation
F.	Testing and Commissioning work
G.	Operation and maintenance (five years)
H.	Training of CAEL personnel

2.3 Transportation and Road Widening

Heavy duty equipment such as cranes will be imported by the contractor to construct the wind turbines. Special arrangements will be made at Port Esquivel, St. Catherine to offload the cranes and large components of the wind turbines.

The cranes and wind turbine components will be transported using low-boy trucks piloted by police outriders during the early morning hours (between 1:00 and 4:00 a.m.) to the site at Great Valley, Manchester.

The transportation route for the wind turbines will extend from the main road leading from Port Esquivel to the Highway (A2) connecting the parishes of Clarendon and Manchester.

The turbines will be transported through two major roundabouts in the parish of Manchester, before turning unto the Alpart Haul road in the Spur Tree community. The haul road extends from the Highway via Newport to the community of Rose Hill (which is a few kilometres north of Wigton), a distance of approximately 13km. The vehicles transporting the turbines will exit unto the main road leading to Rest Store. The final travel route will be on the main road linking the communities of Rest Store and Cross Keys.

The Alpart Haul road will require rehabilitation works. These works are likely to include:

- Clearing of vegetation and heavy grass verge,
- Levelling of road surface
- Erection of road safety signs

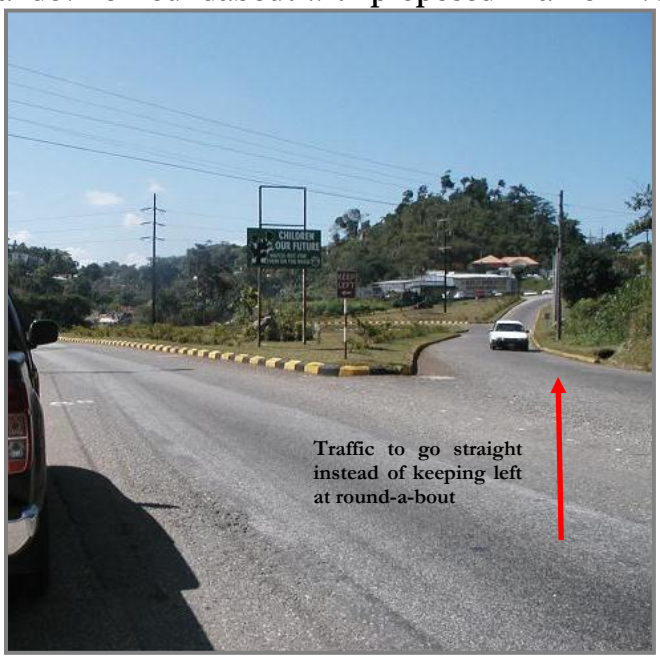
Permission will be required from Alpart for the use of the haul road.

A number of route diversions will be required in order to facilitate the transportation as follows:

a. At the Mandeville roundabout; rather than keeping left at the roundabout, the trucks will have to keep right to avoid the deep curve of the roundabout.

b. During the transportation of the equipment through Porous, the route will need to be temporarily converted to one way. CAEL will coordinate with the local police to ensure that appropriate traffic diversions are in place.

Figure 8: Mandeville Roundabout with proposed Traffic Divergent Route



Source: Environmental and Engineering Managers Limited, 2010

CAEL may require the services of JPSCo. to provide support along the route to lift overhead power lines where required.

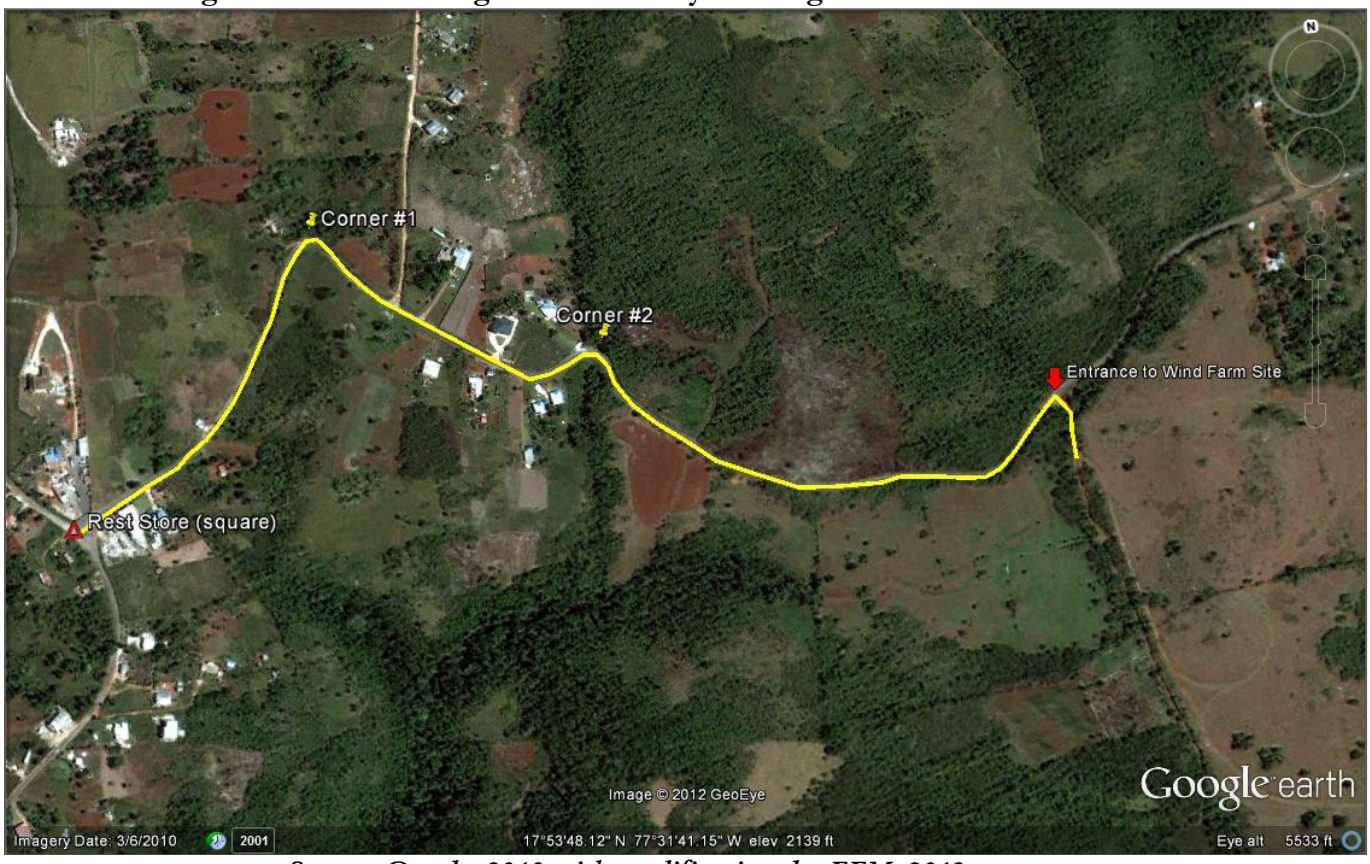
In addition to traffic changes, two corners along the roadway between Rest Store and the entrance to the wind farm at Great Valley will require minor widening and/or clearance of the heavy grass verge (Figure 9). The travel route from Wigton Wind Farm to the Great Valley site is considered the only 'new' travel route, as equipment and heavy vehicles would have previously utilised the proposed travel route during the construction of the turbines at the Wigton Wind Farm. The corners are located 0.33km and 0.5km from the Rest Store crossing (Figure 10 and Figure 11). The changes will be as follows:

- Corner #1 has a deep narrow radius of curvature and will require the road to be widened by approximately 1.0-1.5m

- Corner #2 has small radius of curvature and will require the road to be widened by approximately 1.2- 1.8 m.

The Manchester Parish Council has approved the widening of the corners as indicated in a letter to CAEL dated July 10, 2012 (Appendix 2). All proposed changes to the roadway, including final designs will be submitted to the agency for approval prior to the beginning of road works.

Figure 9: Corners along Main Roadway Leading to Wind Farm Site



Source: Google, 2010 with modifications by EEM, 2012

Figure 10: View of Corner #1 to and from the Proposed Wind Farm Site

Source: EEM, 2012

Figure 11: View of Corner #2 to and from the Proposed Wind Farm Site

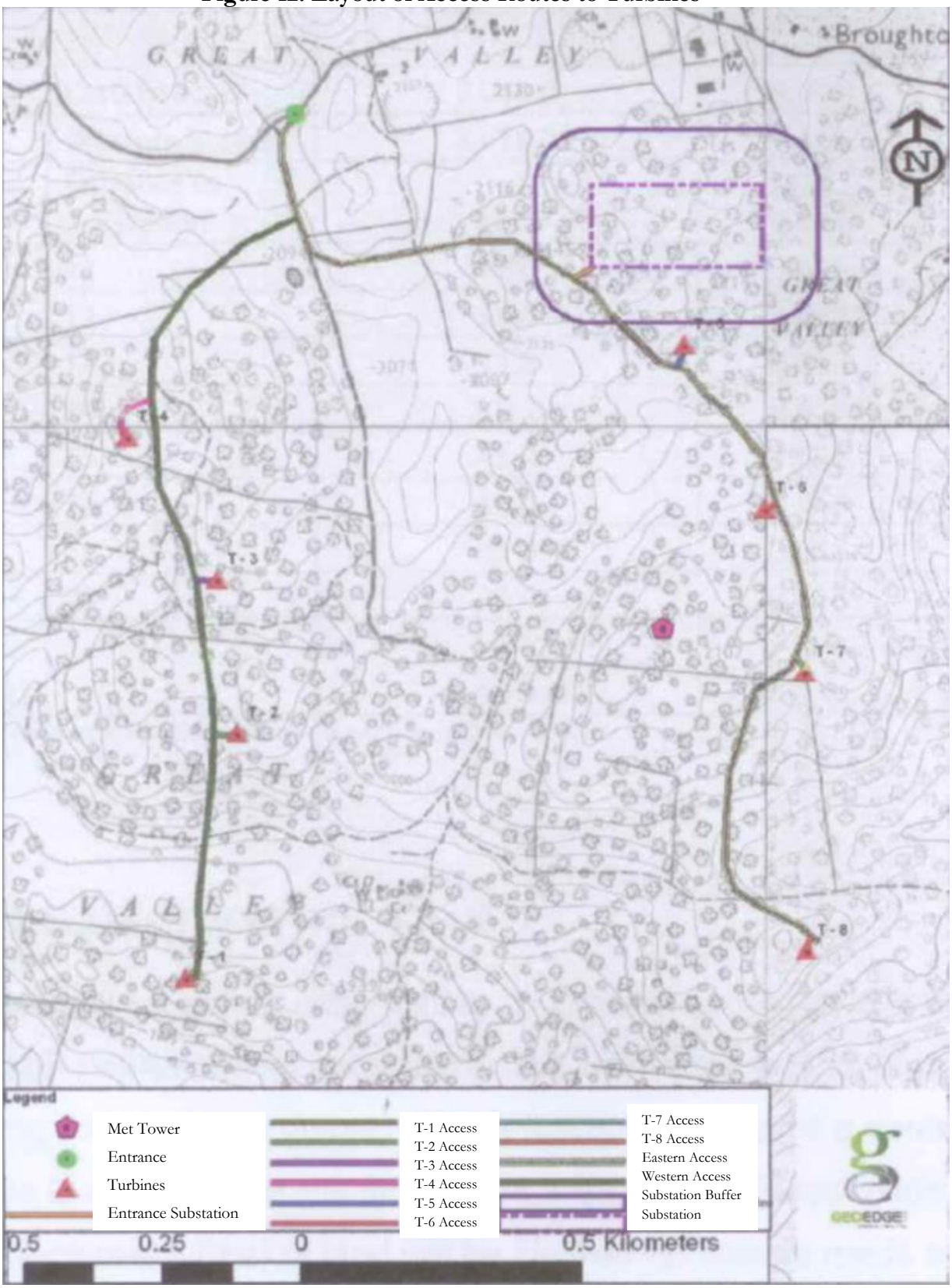
Source: EEM, 2012

2.4 Access Road Design

The proposed road design to access the wind turbine site totals approximately 4.12 km. The main arterial road measures 3.8 km and the total length of the 8 spurs/secondary access roads (to the turbines) is 0.32 km. The main access road has an average width of 9 m and the spurs have an average width of 3.6 m. Approximately 3.6 ha will be cleared for access roads to the project sites. The road will be designed and the relevant approvals obtained from the National Works Agency (NWA) and/or the Manchester Parish Council.

The access to the site from the Rest Store-Cross Keys main road will require temporary widening to facilitate the entrance of the large equipment and wind turbines parts. Once the equipment has been transported to the site the entrance will be reinstated. Again the relevant designs will be prepared and approval obtained from the Manchester Parish Council.

Figure 12: Layout of Access Routes to Turbines



2.5 Project Schedule and Project Management Team

The construction phase of the project will last for 9 to 12 months and will commence in November of 2012. Construction activities will be done in phases and are detailed in the Gantt Chart at Appendix 3.

2.6 Decommissioning

The lifespan of the wind turbines is 20 years. At the end of their useful life, they will be decommissioned and taken out of service along with the substation.

Skilled contractors will be used to dismantle the wind turbines and the substation and every effort will be made to reuse useful parts. Where components can be sold or given away as scrap, this will be done. The remaining parts will be disposed of at an approved disposal site.

3.0 Regulatory Framework

This section on the regulatory framework highlights the policies and legislation that are applicable to wind power projects.

3.1 Applicable Policies

The national policies applicable to this project are the National Energy Policy and the National Renewable Energy Policy. The National Energy Policy was approved by Cabinet in October 2009. The National Renewable Energy Policy is still awaiting Cabinet approval.

The National Energy Policy (2009-2030)

Jamaica has an Energy Policy because of the country's:

- Heavy oil dependence
- High demand for foreign exchange
- Underdeveloped indigenous energy sources
- Inefficient use of energy
- Increasing pollution contributing to climate change

The policy seeks to, among other things:

- Manage the energy supply,
- Diversify the energy base,
- Encourage conservation and efficiency in energy production and use,
- Make electricity available and affordable to customers
- Establish the regulatory framework to protect consumers and investors and minimise environmental effects and pollution.

The National Energy Policy 2009-2030 contains seven (7) goals one of which relates specifically to the use of renewable energy as follows:

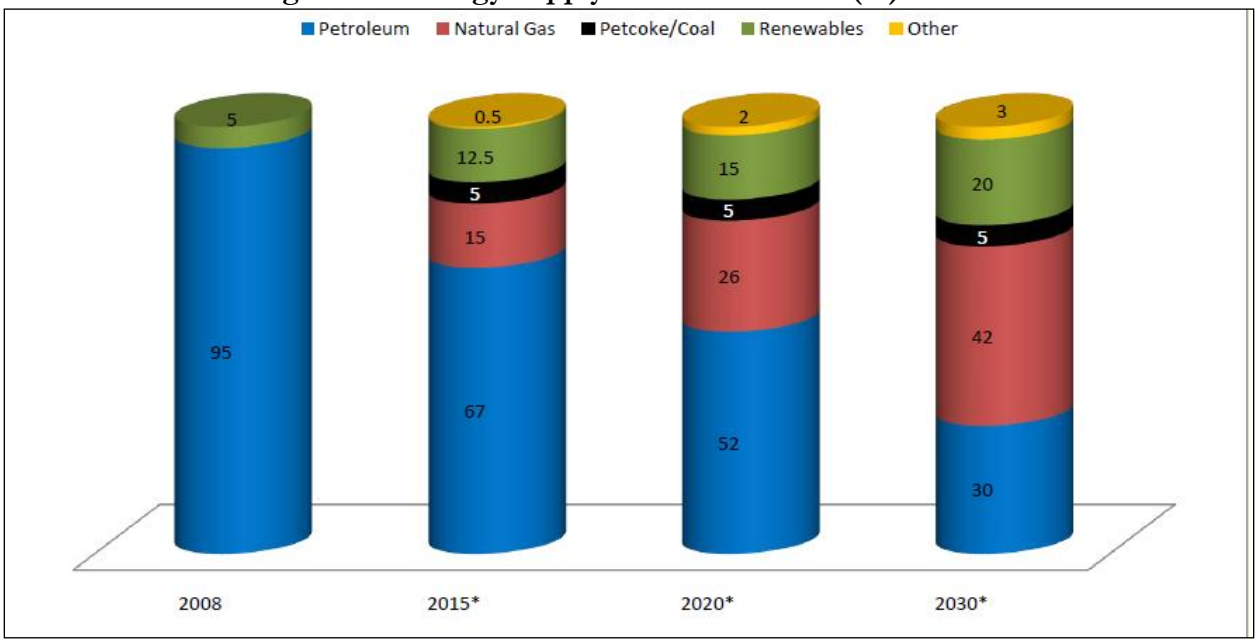
Goal 3:
Jamaica realizes its energy resource potential through the development of renewable energy sources and enhances its international competitiveness, energy security whilst reducing its carbon footprint

Opportunities for further development of indigenous renewable energy resources such as solar, hydro, wind and biofuels will be explored with the goal of increasing the percentage of renewable sources in the energy supply mix to 20% by 2030. This will reduce the country's dependence on imported oil. Increased use of renewable sources will also result in lowering the level of air pollution, a smaller carbon footprint for Jamaica and better enable compliance with international conventions on climate change.

The projected targets for increasing the percentage of renewable sources in the energy supply mix are as follows:

- 11% by 2012,
- 12.5% by 2015 and
- 20% by 2030

Figure 13 - Energy Supply Matrix 2008-2030 (%)



Excerpt from National Energy Policy 2009-2030, Ministry of Energy and Mining, 2009

Another goal of the National Energy Policy relevant to the proposed project is Goal 4, which is outlined below.

Goal 4: Jamaica's energy supply is secure and sufficient to support long-term economic and social development and environmental sustainability".

Under this goal, Jamaica will seek to reduce the percentage of petroleum in the country's energy supply mix from the current 95% in order to protect the country from disruptions in oil supply and price volatility. The National Renewable Energy Policy will effectively contribute to fuel diversification to achieve this goal.

This policy is applicable to this project since it proposes to generate electricity from a renewable source, in this case wind.

The National Renewable Energy Policy (2009-2030)

The policy seeks to provide affordable and accessible energy supplies with long-term energy security. The primary focus is the deployment of wind, the emerging potential and deployment of biomass and biofuels, the development of energy-from-waste initiatives, exploratory work on ocean energy and the deployment of other technologies such as solar and hydro-technologies.

There are five (5) goals of the National Renewable Energy Policy and these are as follows:

Goal 1: Support the economic, infrastructural and planning conditions conducive to the sustainable development of all of Jamaica's renewable energy resources

Goal 2: Create an enabling environment that facilitates the introduction of key policy instruments (financial and fiscal) for the promotion of renewable energy (by re-directing national resources and investments to Renewable Energy Technologies (RET)

Goal 3: Develop a dynamic legislative and regulatory environment, responsive to growth and development in the renewable energy sector

Goal 4: Enhance technical capacity and public awareness of renewable energy through effective support of training programmes, information dissemination strategies and ongoing government communication

Goal 5: Sustained Research and Development (R&D) and innovation in existing and emerging RETs

The 2009-2030 National Renewable Energy Policy primary objective is the achievement of Goal 3 of the National Energy Policy 2009-2030 which will be used to guide the development and introduction of specific measures to achieve the targets outlined for renewable energy (generation capacity) in the National Energy Policy (Table 10).

Table 10: Renewable Energy Targets

Indicator	2009	2012	2015	2030
Percentage of renewables in energy mix	9%	11%	12.5%	20%
Percentage of diversification of energy supply	9%	11%	33%	70%

3.2 Applicable Legislation

The legislation applicable to this project include:

- Electric Lighting Act, 1890
- The Office of Utilities Regulation Act, 1995
- The Natural Resources Conservation Act, 2001
- The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996
- The Natural Resources Conservation (Permits and Licences) Regulations, 1996
- The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004
- The Natural Resources Conservation, (Ambient Air Quality Standards) Regulations, 1996
- National Solid Waste Management Act 2001

- Town and Country Planning Act, 1957
- The Parish Council Building Act, 1901
- Main Roads Act, 1932
- The Wildlife Act, 1945

The Electric Lighting Act, 1890

This Act gives the Minister the power to licence entities to provide electricity for public or private use with limits and conditions.

The Office of Utilities Regulation Act, 1995

This Act indicates that the functions of the Office of Utilities Regulation (OUR) include:

a. Regulating the provision of prescribed utility services by licensees or specified organisations;
b. Receiving and processing applications for a licence to provide a prescribed utility service and make such recommendations to the Minister in relation to the application as the Office considers necessary or desirable;
c. Conducting such research as it thinks necessary or desirable for the purposes of the performance of its functions under this Act;
d. Advising the responsible Minister on such matters relating to the prescribed utility service as it thinks fit or as may be requested by that Minister; and
e. Carrying out, on its own initiative or at the request of any person, such investigations in relation to the provision of prescribed utility services as will enable it to determine whether the interests of consumers are adequately protected.

Clean Alternative Energy Limited (CAEL) will have to apply to the OUR for a licence to operate the wind turbines with generating capacity of 24 MW that they propose to construct at Great Valley, Manchester, Jamaica.

The Natural Resources Conservation Act, 1991

This Act gives the Natural Resources Conservation Authority [NRCA](now embodied within the National Environment and Planning Agency [NEPA]) the power to take the necessary steps for the effective management of the physical environment of Jamaica so as to ensure the conservation, protection and proper use of its natural resources among other things. In performing its functions it may among other things, formulate standards and codes of practice to be observed for the improvement and maintenance of the quality of the environment generally, including the release of substances into the environment in connection with any works, activity or undertaking. Based on the powers and functions of the NRCA, this proposed project falls within their jurisdiction.

The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996

This regulation requires that effective January 1, 1997, a permit be obtained for the construction and operation of certain types of projects.

The Natural Resources Conservation (Permits and Licences) Regulations, 1996
The Natural Resources Conservation (Permits and Licences) (Amendment) Regulations, 2004

A Permit Application and a Project Information Form are to be submitted to NEPA in accordance with this regulation for the construction and operation of prescribed activities. An Environmental Impact Assessment may also be requested by NEPA as well.

Power generation plants, including hydroelectric plants and installation for the harnessing of wind power for energy production and nuclear reaction above 1 MW is a category listed in this regulation as requiring a permit from NEPA. Since the proposed project will comprise a wind farm with a generation capacity of 24 MW at Great Valley, Manchester, a permit will be required from NEPA.

A permit application will be submitted to the National Works Agency and NEPA for onsite road construction in accordance with the established regulations.

The Natural Resources Conservation, (Ambient Air Quality Standards) Regulations, 1996

These regulations set the acceptable limits for common air pollutants in ambient air. Since this project proposes to construct wind power installations, controls will need to be in place to ensure that fugitive dust and heavy duty vehicular emissions during the construction phase do not contribute negatively to ambient air quality.

National Solid Waste Management Act 2001

This Act gives the National Solid Waste Management Authority (NSWMA) the power to take all steps as are necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, stored, transported, recycled, reused or disposed of in an environmentally sound manner and promote safety standards in relation to such waste. Solid waste generated as a result of construction activities will need to be collected, stored and appropriately disposed of at an approved municipal disposal site in accordance with the Act.

The Town and Country Planning Act, 1957

This legislation stipulates that in areas for which a Development Order has been prepared, planning permission is required from the Local Planning Authority before "development" as defined by the Act can be undertaken. In those areas for which no development orders have been prepared, no planning permission is required to undertake development. The

Development Order is therefore the legal document guiding development in Jamaica. These orders are prepared by the Town and Country Planning Authority in consultation with the Local Planning Authority (Parish Councils & KSAC). The Town and Country Planning Authority, which is a body established under the Act can "call in" an area for which a development order has been prepared. In this instance the Town and Country Planning Authority has the jurisdiction to oversee all development applications if it so desires within the area. This Act is currently administered by NEPA and is applicable to the proposed project.

The Parish Council Building Act, 1901

Construction of buildings in towns and any areas which may be delimited by the parish councils (Local Authority) is controlled under this legislation. The Parish Councils are allowed to impose suitable conditions with regards to size, elevation and structural integrity of buildings. To date regulations cover the principal towns of all the parishes. In those areas which have been delimited under the Building Act permission is to be obtained from the Council before construction commences.

The alteration of parochial roads and other road works will require approval from the Parish Council. Permission for the on-site sewage system will also be sought from the Parish Council.

Main Roads Act, 1932

This Act gives the Minister power via notice in the Gazette to charge the Chief Technical Director to lay out, make, repair, widen, alter, deviate, maintain or manage any parochial road, or any new line of road which it is desired to be laid out and made with a view to the same becoming a parochial road. This Act is applicable as there may be need to widen two (2) corners along the transportation route for heavy equipment.

The Wildlife Protection Act, 1945

The Wildlife Protection Act (1945) makes provision with respect to the management of wildlife, including fish, in Jamaica.

The Act makes provision for the protection of animals and birds and the protection of fish. Other provisions deal with the appointment of officers, regulations, power to enter lands, power of search, arrest without warrant, persons found offending, penalty for assaulting game warden, fishery inspector or constable, penalty for offences generally, jurisdiction over offences committed at sea, power to exempt from provisions of the Act, and forfeiture of things seized.

The Act specifies Game Sanctuaries and deals with hunting, etc. in a Game Sanctuary, prohibits the hunting of protected animals and protected birds, prohibits the hunting of animals and birds in and taking of eggs from the exclusive economic zone without a licence. Taking or killing of immature fish is declared an offence, and the use of explosives or other noxious materials in fishing is prohibited. It seeks to protect waters containing fish from

trade effluents and industrial waste. Every person who knowingly buys sells or has in his possession fish taken, killed or injured in contravention of the provisions of this Act or of any associated regulations shall be guilty of an offence against this Act.

The Wildlife Protection Act and Regulations are administered by the National Environment and Planning Agency.

3.3 Recommended Standards

Noise levels

The Jamaica National Noise Standards in Table 11 (as extracted from the Recommendations for National Noise Standards for Jamaica, 1999) recommends the zonal limits. If any wind turbine was to be located near to a residential area or institution such as a school, these noise limits would apply. Based on the final design of the wind farm, it is not expected that the wind turbines will have an adverse impact on residences or schools.

Table 11: Time Based Zonal Noise Limits

ZONE	7a.m. to 10:00p.m.	10:00p.m. to 7:00a.m.
Industrial	75dBA	70dBA
Commercial	65dBA	60dBA
Residential	55dBA	50dBA
Silence	45dBA	40dBA

The World Bank Noise limits are slightly lower than the Jamaican Guidelines but are generally within the same range (Table 12). World Health Organisation (WHO) Noise Guidelines are similar.

Table 12: World Bank Noise Level Guidelines

Receptor	One Hour LAeq (dBA)	
	Daytime	Nighttime
	07:00 - 22:00	22:00 - 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

3.4 The Application Process

NEPA requires the submission of permit application for the proposed Wind Farm at Great Valley Manchester project. This is to be submitted along with a Project Information Form and a Project Brief. After review by the agency, they advise on whether an Environmental Impact Assessment (EIA) is required or not. Projects of this nature usually require an EIA. Once an EIA is required, the first step is to agree on the Terms of Reference (TOR) for the

EIA. Draft TOR are submitted to NEPA for approval and once approved, the EIA can be done. It may be necessary to advertise the TOR and await comments from the public.

There must be stakeholder consultations throughout the process of conducting the EIA. Once the draft EIA is completed, a Public Meeting is usually required to present the findings to stakeholders and to solicit feedback. The Public Consultations must be done in accordance with NEPA's guidelines which can be viewed at: http://www.nepa.gov.jm/business/guidelines/general/GuidelinesforPublicPresentations2007.pdf

There are critical timelines that must be adhered to for the Public Meeting. There must be at least three weeks notice of the Public Meeting, advertised in the printed press in a format approved by NEPA. Special invitations can be sent to stakeholder groups. The public has 30 days from the date of the Public Presentation to submit comments to NEPA. Revisions to the EIA may be required. Once approved, the relevant permits will be granted with conditions.

4.0 Description of the Environment

4.1 Physical Baseline

4.1.1 General Climate

Temperature

Temperatures in coastal areas are comfortably warm, becoming cooler in the hilly and mountainous regions in the centre of the island, particularly in the Blue Mountain range with a peak of 2,256 metres (7,402 feet). 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.

In coastal areas, daily temperatures average 26.2ºC (79.2ºF), with an average maximum of 30.3ºC (86.5ºF) and an average minimum of 22.0ºC (71.6ºF). Inland, temperature values are lower, depending on elevation but, regardless of elevation, the warmest months are June to August and the coolest December to February.

The diurnal range of temperature is much greater than the annual range and exceeds 11.0ºC (20ºF) in mountainous areas of the interior. Night-time values range from 18.9 to 25.6ºC (66 to 78.1ºF) in coastal areas. At elevations above 610 metres (2,000 feet), minimum temperatures of the order of 10ºC (50ºF) have been reported occasionally when active cold fronts reach the island.

Wind

For most of the year, the daily wind pattern is dominated by the Northeast Trades. By day on the north coast, the sea breeze combines with the Trades to give an east-northeasterly wind and along the south coast, an east-south easterly wind. In the period December to March however, the Trades are lowest and the local wind regime is a combination of trades, sea breeze, and a northerly or north westerly component associated with cold fronts and high-pressure areas from the United States.

By night, the trades combine with land breezes which blow offshore down the slopes of the hills near the coasts. As a result, on the north coast, night-time winds generally have a southerly component and on the south coast, a northerly component. However, winds are generally lighter inland and towards the west.

Rainfall

An examination of weather parameters highlight that rainfall is the most variable. Rainy seasons are May to June and September to November. The rainfall is regionally very different in its intensity but show a likely annual distribution. Rainfall is comparatively higher from April to November with May and October being the

rainfall peak months. The driest period is usually December to March. Most of the rainfall during this period is associated with cold fronts migrating from North America. Whether during the dry or rainy season, however, other rain-producing systems are influenced by the sea breeze and orographic effects which tend to produce short-duration showers, mainly during mid-afternoon.

The Tropical storm and hurricane season is from June to November.

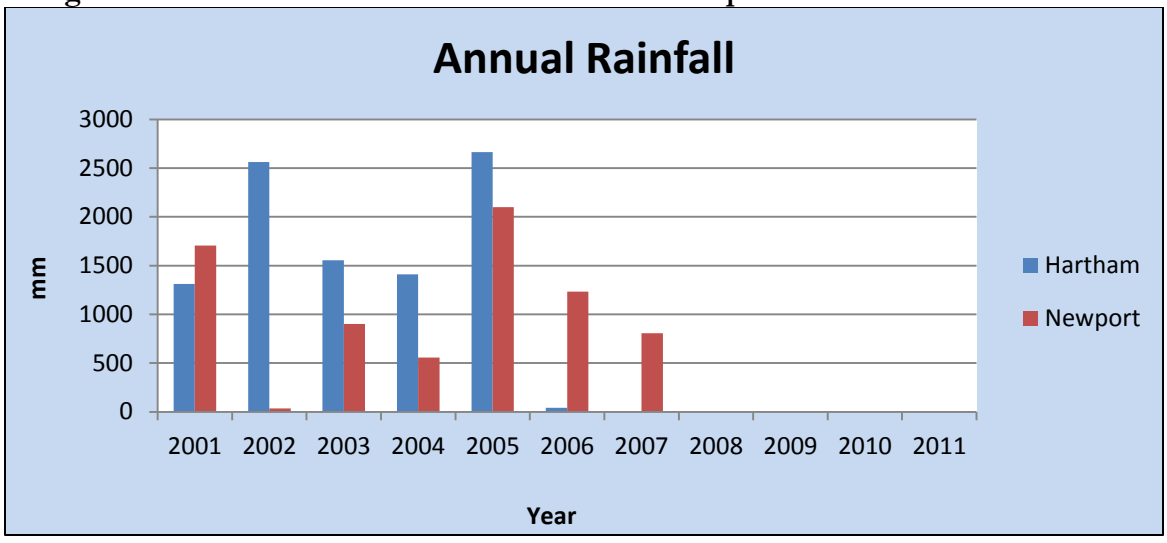
There are no primary rainfall stations in the communities of Cross Keys, Rest Store or Plowden Hill. The closest primary rainfall recording stations are located in Hartham and Newport. The stations are found 4.6km and 4km respectively from the community of Cross Keys. Between 2001 and 2005 the average annual rainfall recorded at the Hartham station was 1,900.8mm. Monthly averages recorded at the station over the five (5) year period ranged from a low of 109mm to a high of 222mm.

For the station at Newport, between 2003 and 2007 average annual rainfall recorded was 1,120mm. Monthly averages recorded at the station for the five (5) year period ranged from a low of 46.5mm to a high of 175mm. Since 2007 and 2008 no data has been recorded at the Hartham and Newport Stations respectively (Table 13 and Figure 14).

Table 13: Annual Rainfall Data Hartham and Newport Stations 2001-2011

	Annual Rainfall in millimeters										
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Hartham	1312	2562	1556	1410	2664	40	0	0	0	0	0
Newport	1707	35	901	558	2101	1233	807	0	0	0	0

Figure 14: Annual Rainfall Data Hartham and Newport Stations 2001-2011



4.1.2 Ambient Air Quality

The proposed project is not expected to be an air pollution source. The operation of wind turbines does not produce carbon dioxide, particulates and any other type of air pollutant as do other power sources e.g. those powered by fossil fuel. There are currently no air pollutant sources within the vicinity of the proposed project sites. If bauxite mining occurs in the future on the lands shared with the wind farm, fugitive dust emissions are likely to be the major threat to ambient air quality within the area.

4.1.3 Ambient Noise Levels

The Great Valley area is a sparsely inhabited area with no major noise generating activities. The Great Valley area is occupied mainly by residential and farming land uses, which are scattered across the community. In the surrounding communities of Broughton, Plowden Hill and Rest Store, noise emissions are mostly associated with typical residential and housing activities, such as conversations, operation of radios, televisions etc. In the community of Broughton, in addition to typical residential noise emissions, daily school activities are likely to contribute to noise emission levels.

Baseline noise level readings were conducted on February 1, 2012 at five (5) different locations on the proposed project site. The readings were undertaken using Quest Sound Level Meter 2100 model, a handheld meter with LCD display. The sound meter has two modes of operation. It measures sound pressure level (SPL) or maximum level (MAX), with a linear operating range of 32 to 140 dBA. The noise meter was calibrated using the Quest Model QC-10 acoustic calibrators.

The noise level readings for the various locations showed a maximum (background) noise level reading of 61 dBA and a high of 48dBA for the average reading. The lowest noise level measured was 38 dBA. (See Table 14)

Table 14: Noise Level Reading for Selected Turbine Sites

Turbine	Location	Time	SPL (avg.) reading	Max reading
#1 - #2	N 17° 53.106', W 77° 31.353'	12:35 PM	38	48
#4	N 17° 53.558', W 77° 31.473'	12:57 PM	39	50.1
#6	N 17° 53.768', W 77° 31.439'	11:00 AM	43.5	54.3
#7	N 17° 53.733', W 77° 31.395'	1:15 PM	48	61
#12	N 17° 52.998', W 77° 30.955'	12:01 PM	42	52

The highest baseline reading was recorded near turbine location #7 which is located near the Broughton Basic and Primary Schools. The schools are located approximately 500m from the proposed wind turbine #7. The lowest baseline noise level reading was at the exact proposed location for turbine #1. This proposed location is covered with secondary vegetation and is not situated in close proximity to active land uses or noise sources.

4.1.4 Topography

The Parish of Manchester consists largely of a limestone plateau, 380 to 915 metres (1,250 to 3,000 feet) above sea level, with shale mountains in the north, wetlands and beach on the coast and a sliver of the alluvial plain in the southeast

Caves

The geology of the parish of Manchester is underlain almost entirely by a large block of White Limestone. The pure, hard and massively bedded limestone displays typical karst weathering with abundant sinkholes, caves and dry valleys. There are three (3) caves found within the Cross Keys Area. This includes the Smokey Hole cave in Woodlands/Broughton and two (2) other unnamed caves in the community of Cross Keys. There are several caves located north of the Cross Keys community in the Newport community area.

4.1.5 Geomorphology

The proposed area is located in southwest Manchester within 1km of the coast. In general the land ward progression from the coast to the interior reaches of the mainland represents a plateau formation. There is a marked transition from a narrow coastal band to the elevated and flat area which forms the Alligator Gut watershed and generally, the physical boundary of the parish of Manchester. The study area is located approximately 650m above sea level.

This limestone plateau is the most extensive lithological unit within the area of interest and is bordered to the east and west by two north south trending faults. The eastern reaches are further defined by gravel fans and raised reefs, which are geologically significant features in the area.

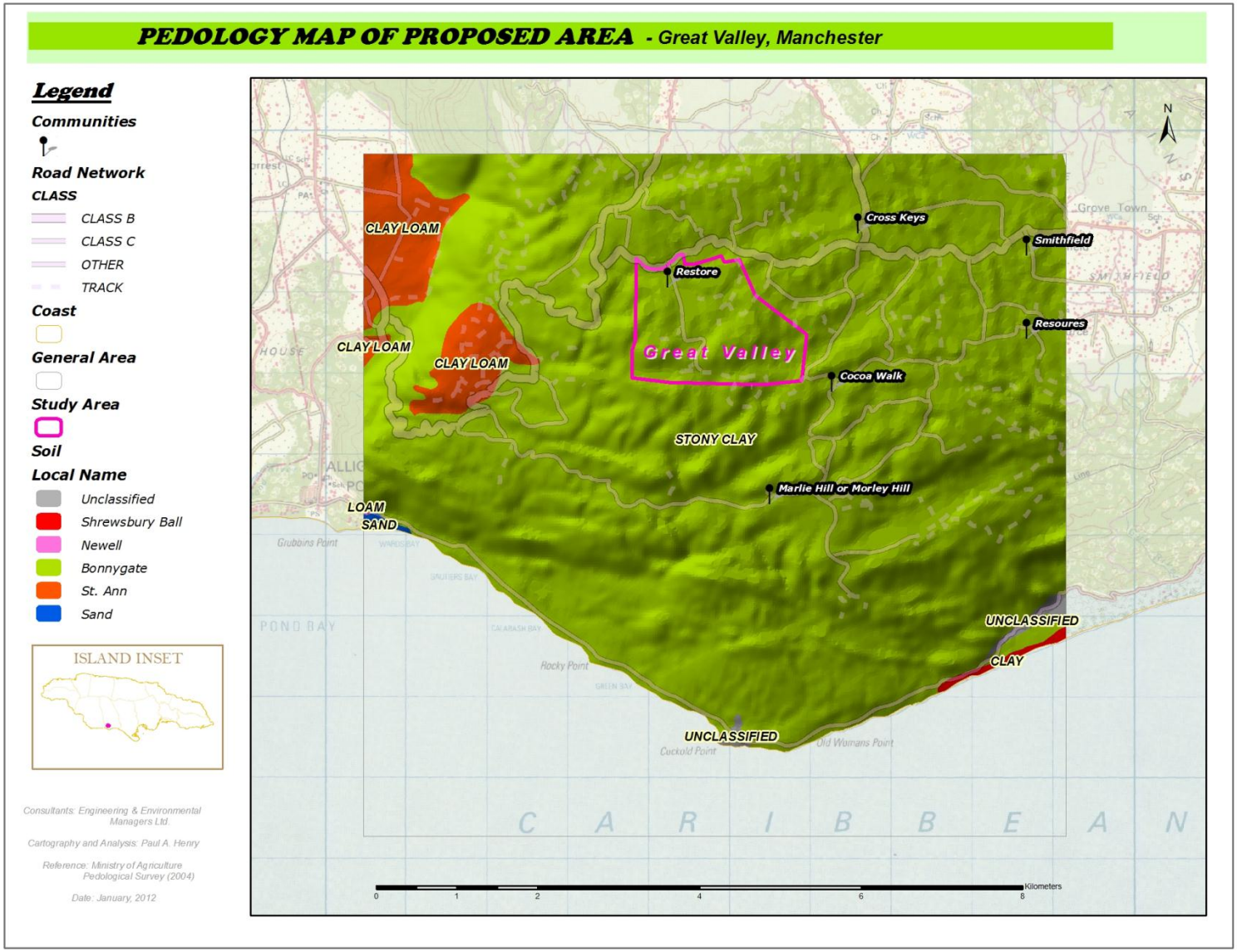
Vegetation cover is defined by bushes and shrubs apart from areas cleared for other purposes, and these can generally be defined as Dry Limestone Forests. Where soil cover is present, it is developed mainly on hill tops and within minor depressions.

4.1.6 Soil

In this analysis, the soil coverage in this area will be treated as a feature of geology. There is little deflection from the rule of thumb that the Bonnygate soil type will predominate in areas where there is the Newport Formation and is typically stony clay in texture. It should be noted that the geological analysis defines the area as a Newport Limestone (Figure 15).

Additionally, the analyses of the soil within the context of the wider area indicates solution depressions defining the topology of the area as concentrated with soils rich in aluminium silicates which are characteristic of Bauxite.

Figure 15: Pedology Map of Development Area



4.1.7 Geology

The area is represented by predominantly a homogeneous coverage of Newport Formation (Mn), which is one of the White Limestone Formations present within the central and southern regions of the island. In the eastern reaches of the study area, the Newport Formation is overlain in sections by recent alluvial sediments deposited by the main rivers within the Rio Minho Basin (Figure 16).

The Newport Formation occurs in a N-S belt and also forms the main hill along the coast to the south of the map. The White Limestone (Newport Formation) is gently dipping and consists of hard dense chalky limestone with joints present. It is mainly a hard compact recrystallized limestone but can have sections with a softer rubbly texture.

Bedrock

The Newport Formation is a well developed bedded and compact limestone. Larger fossils are not very abundant but foraminifera fossils are present. Joints are present and contribute to the permeability and form of the material.

Structure

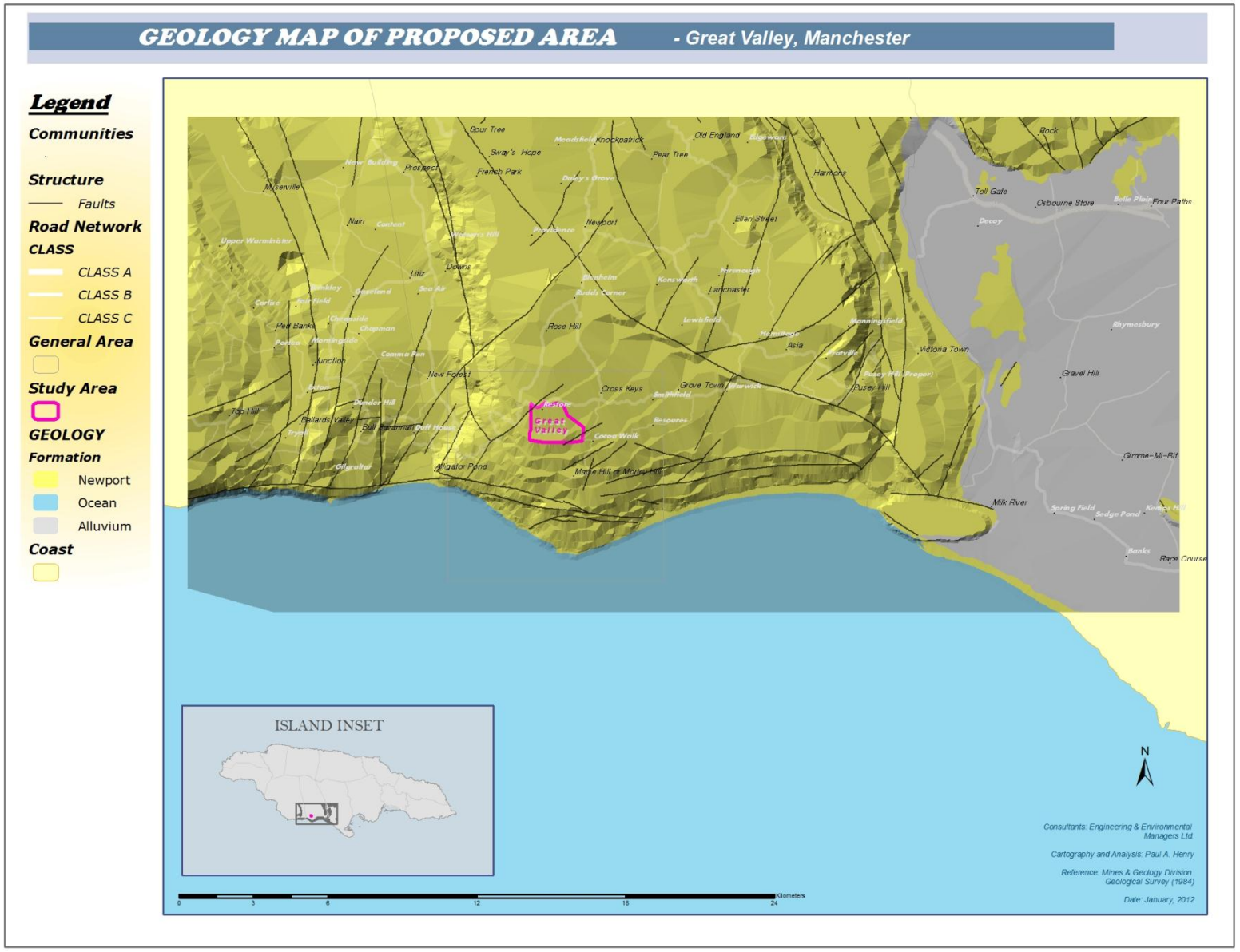
The dominant structural features in this area, as in most of the White Limestone terrain, are the joints present within the limestone beds. Prominent faults within this region are observed within the Newport Formation trending N-S, some correlating to existing drainage on the surface. There is a younger E-W fault which truncates the older set and differentiates the younger Round Hill features from the limestone hills within which the proposed wind farm site is situated.

Economic Geology

The hard and recrystallized nature of the Newport Formation makes it applicable for metallurgical and chemical purposes. However its most effective application within the Jamaican context is for construction aggregates ranging from pulverized hard-rocks for sand to dimension stones for structural work. Additionally, depending on the magnesium and calcium ratio, larger sized aggregates from this formation are integral in the production of Lime for local alumina production where it is required as an input to the Bayer process.

The softer chalky and rubbly sections can be for use for landfills. As is noted, Terra Rosa soils constituting the Bonnygate Soil type are rich in Aluminium Silicates which are Bauxitic in nature and hence rich economic reserves of bauxite exists in the wider locality

Figure 16: Geology Map of Development Area

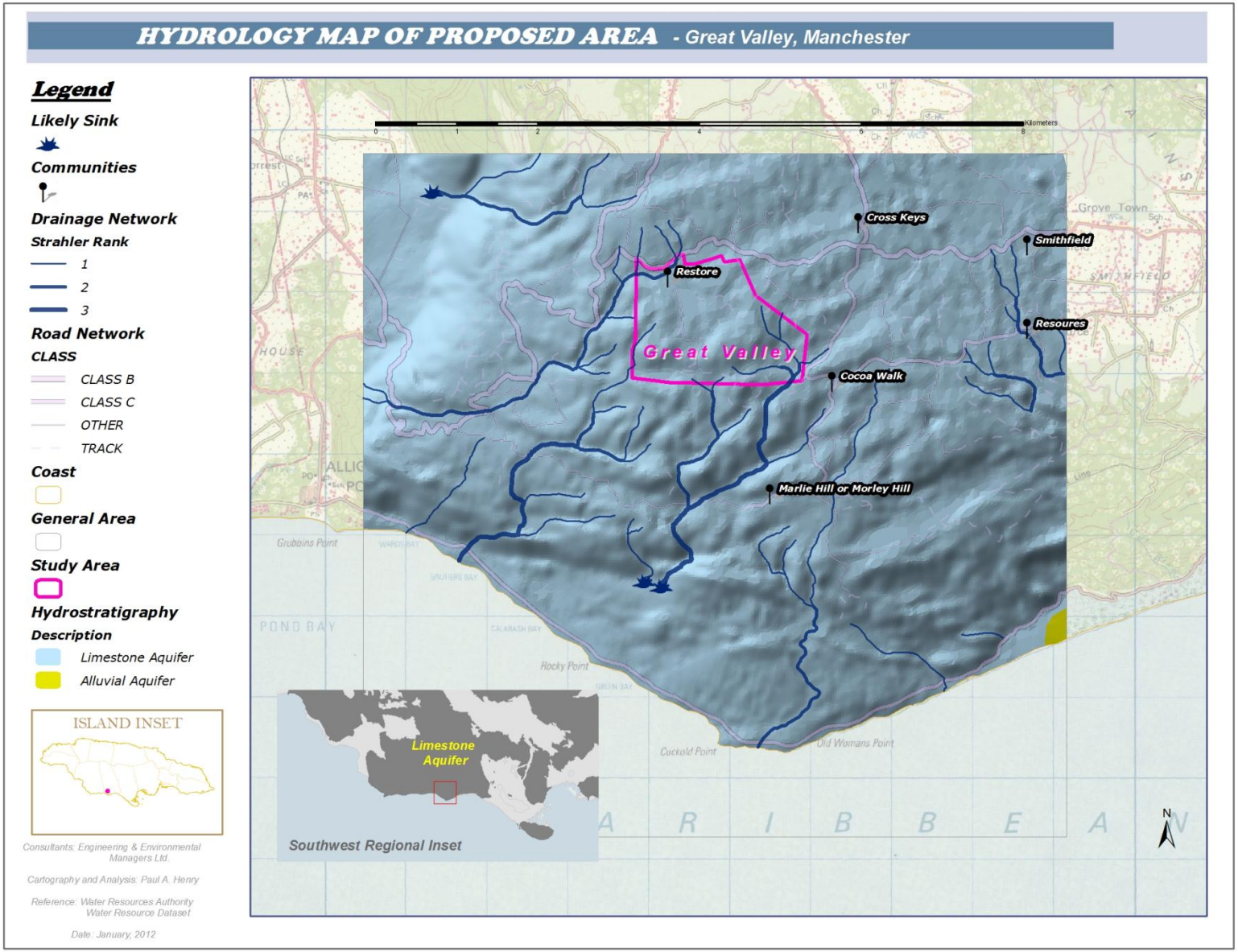


4.1.8 Hydrology

The hydrology of the area is best explained within the context of the watershed management basin associated with the area and sub-terrain water transmission. Despite majority of the aerial extent of the study area being defined by the Alligator Gut Water Management System, this is directly impacted by the hydrological variables associated with the Milk River system. This represents the drainage feature responsible for transmitting water from much of northern Manchester watersheds. Hence there is much contrast with the sustained flow of Gut and Rodgers Rivers compared to the non-existent surface drainage in the South Manchester area.

As indicated by the hydrology map (Figure 17), much of the hills to the east of the Milk River bear the function or characteristic of being a limestone aquifer. This suggests that these areas receive significant volumes of precipitation and transmit this water through infiltration/percolation via its porous and pervious nature. As a result, underground waterways and channels become prominently featured in these areas and given the huge volume of water collected within the upper reaches of the basin, a heightened or erratic water table regime is created in areas such as Porous and Milk River.

Figure 17: Hydrology Map of Development Area



4.2 Biological Baseline

4.2.1 Vegetation

Vegetation descriptions were done while surveying the entire property. The resultants were species lists of trees and other plant species inclusive of all plant life forms, endemics and native plants.

Table 15: Results of Vegetation Assessment at Selected Areas

GPS No.	COORDINATES (LAT/LONG)		ALTITUDE (m)	COMMENTS
345	17.88520340	-77.51587381	572	Degraded forest patches, with tree height of 7 – 10m. There is evidence of coppiced trees. Logwood is the visually dominant specie with other species such as mango, red birch and fig present.
346	17.88637477	-77.51357683	571	
347	17.88680820	-77.51534801	619	
348	17.88506627	-77.51783299	612	
349	17.88490484	-77.52132942	589	Disturbed mixed forest patch, with tree height of 8 – 12m. There is evidence of coppiced trees. Logwood is the visually dominant species with other species such as mango, and maiden plum present.
350	17.88428583	-77.52288083	579	
53	17.88808392	-77.52148784	617	Similar habitat as GPS point 58
54	17.88446571	-77.51839458	589	Area dominated by logwood, but several other species interspersed. Tree height 7-9m and presence of grass and limestone outcrops.
55	17.88422246	-77.51597959	592	Degraded forest patch, with tree height of 7m. There is evidence of coppiced trees. Logwood is the visually dominant specie with other species such as mango, and maiden plum present.
56	17.88291807	-77.51539277	584	Disturbed and degraded forest patch. There is clear evidence of coppicing. Also vegetation demonstrates scrub-like features. Tree height 7 – 10m with Logwood being visually dominant
57	17.88330649	-77.51583089	607	Observed mixed forest patch. Tree height 10 – 15m. Species observed include mango, Bamboo, Guango, and Dovewood.
58	17.88541705	-77.52243952	602	
59	17.89305288	-77.52433224	639	Similar Habitat observed as GPS point 55
60	17.88247366	-77.51457796	573	
61	17.89237822	-77.52501209	658	Similar habitat observed as GPS point 59
62	17.89538087	-77.52252979	652	Observed mixed forest patch. Tree height 10 – 15m. There were some areas dominated by Acacia, and showing scrub features. Other species observed include Mango, Sweetwood, Guango, and Dovewood.
63	17.89612410	-77.52123638	652	
64	17.89411135	-77.52276926	651	
65	17.89271836	-77.52157375	645	

A total of thirty-four (34) tree species were observed of which there were no endemic species. The DAFOR rating conducted identified fourteen (14) of the species as Rare (R), a similar number of species were identified as Occasional (O), four (4) as Frequent (F), one (1) as Dominant (D) and one (1) as Abundant (A).

Table 16: Tree Species Identified at Proposed Development Area

No.	Scientific Name	Common Name	Status	DAFOR Rating
1.	*Allophyllus cominia*		Native	O
2.	*Spathodea campanulata*	African Tulip	Native	O
3.	*Adeanthera pavonina*	Red Bead Tree	Native	O
4.	*Guazuma ulmifolia*	Bastard Cedar	Native	F
5.	*Cupania glabra*	Wild Ackee	Native	O
6.	*Ficus Americana*	Jamaican Cherry Fig	Native	R
7.	*Ficus membranacea*	Fig	Native	R
8.	*Haematoxylum campechianum*	Logwood	Native	D
9.	*Samanea saman*	Guango	Introduced	F
10.	*Psidium guajava*	Guava	Native	A
11.	*Magnifera indica*	Mango	Introduced	R
12.	*Comocladia pinnatifolia*	Maiden Plum	Native	O
13.	*Zanthoxylum martinicense*	Prickly Yellow	Native	O
14.	*Bursera simarouba*	Red Birch	Native	R
15.	*Coccoloba* sp.	Wild Grape	Native	R
16.	*Cecropia peltata*	Trumpet Tree	Native	O
17.	*Cedrela odorata*	West Indian Cedar	Native	O
18.	*Bauhinia divaricata*	Bull Hoof	Native	O
19.	*Senna bicapsularis*	Yellow Candle Wood	Native	O
20.	*Nectandra* sp.	Sweetwood	Native	F
21.	*Cananga odorata*	Ylang Ylang	Introduced	R
22.	*Dendropanax* sp.	Woman Wood	Native	R
23.	*Gliricidia sepium*	Quick Stick	Introduced	O
24.	*Albizia lebbeck*	Woman Tongue Tree	Introduced	O
25.	*Inga vera*	Panchok	Native	O
26.	*Zanthoxylum martinicense*	Prickly Yellow	Native	O
27.	*Calophyllum calaba*	Santa Maria	Native	R
28.	*Matayba apetala*	Cobywood	Native	F
29.	*Eugenia* sp.	Rodwood	Native	R
30.	*Alchornea latifolia*	Dovewood or LabLab	Native	R
31.	*Miconia* sp.	Melastome	Native	R
32.	*Blighia sapida*	Ackee	Introduced	R
33.	*Daphne occidentalis*	Burn Nose	Endemic	R
34.	*Bambusa vulgaris*	Bamboo	Introduced	R
Dafor Rating: F: Frequent O: Occasional A: Abundant R: Rare				

Twenty-seven (27) herbs and/or shrubs were observed from surveys of which there were no endemic species. The DAFOR rating conducted identified fourteen (14) of the species as being occasional (O), seven (7) as frequent (F), four (4) as rare and two (2) as abundant (A).

Table 17: Shrub and/or Herb Species Identified at the Proposed Development Area

No.	Common Name	Scientific Name	Status DAFOR Rating
1.	Black-eyed Susan	*Thunbergia alata*	(A)
2.	Blue Pea Vine	*Clitoria ternatum*	(O)
3.	Bougainvillea	*Bougainvillea* spp.	(O)
4.	Button Weed	*Borreria laevis*	(A)
5.	Climbing Bamboo	*Chusquea abietifolia*	(O)
6.	Chainy Root	*Smilax balbisiana*	(O)
7.	Deadly Nightshade	*Urechites lutea*	(O)
8.	God Okra	*Hylocerus triangularis*	(F)
9.	Jamaican Marigold	*Wedelia trilobata*	(F)
10.	John Crow Bead	*Abrus precatorius*	(R)
11.	Leaf of Life	*Bryophyllum pinnatum*	(O)
12.	Maiden Hair Fern	*Adiatum pedatum*	(F)
13.	Moses in the bulrushes	*Rheo spathacea*	(F)
14.	Pepper Elder	*Peperomia pellucid*	(O)
15.		*Peperomia acuminata*	(R)
16.	[Black] Jointer	*Piper* sp.	(O)
17.	Red Head	*Asclepias curassavica*	(R)
18.	Rosemarie	*Croton linearis*	(O)
19.	Shame-o-lady	*Mimosa pudica*	(O)
20.	*Sida* sp.		(O)
21.	Spanish Needle	*Bidens pilosa*	(F)
22.	Sweet Potato	*Ipomoea batatas*	(O)
23.	Susumber/Gully Bean	*Solanum torvum*	(R)
24.	Tank Bromeliad	*Tillandsia* sp.	(O)
25.	Wild Hops	*Flemingia (Moghania) strobilifera*	(F)
26.	Wild sage	*Lantana camara*	(F)
27.	Wait-a-bit	*Caesalpinia decapetala*	(O)
Dafor Rating: F: Frequent O: Occasional A: Abundant R: Rare			

Figure 18: Vegetation Specie on Proposed Development Site

4.2.2 Avifauna

Birds

A total of forty-six (46) bird species were observed. Thirteen (13) of the identified bird species were endemic. Other species identified included eight (8) endemic sub-species, seventeen (17) residents species, eight (8) Winter Migrants and two (2) introduced species.

Table 18: List of Endemic Species Observed at Proposed Development Area

No	Common Name	Scientific Name	Status
1.	Jamaican Tody	*Todus todus*	E
2.	Jamaican Vireo	*Vireo modestus*	E
3.	White-Chinned Thrush	*Turdus aurantius*	E
4.	Jamaican Stripe Headed Tanager	*Spindalis negricephalis*	E
5.	Red-Billed Streamertail	*Trochilus polytmus*	E
6.	Jamaican Woodpecker	*Melanerpes radiolatus*	E
7.	Sad Flycatcher	*Myiarchis barbirostris*	E
8.	Jamaican Euphonia	*Euphonia Jamaica*	E
9.	Arrow-Headed Warbler	*Dendroica pharetra*	E
10.	Yellow Shouldered Grassquit	*Loxipasser anoxanthus*	E
11.	Jamaican Crow	*Corvus jamaicensis*	E
12.	Orangequit	*Eunoernis campestris*	E
13.	Yellow Shouldered Grassquit	*Loxipasser anoxanthus*	E
E - Endemic			

Table 19: List of Other Observed Bird Species at Proposed Development Area

No	Common Name	Scientific Name	Status
1.	Vervain Hummingbird	*Mellisuga minima*	ES
2.	Northern Mockingbird	*Mimus polyglottos*	R
3.	Jamaican Oriole	*Icterus leucopteryx*	ES
4.	Common Ground-Dove	*Columbina passerine*	ES
5.	Bananaquit	*Coereba flaveola*	ES
6.	White Crowned Pigeon	*Patagioenas leucocephala*	R
7.	Loggerhead Kingbird	*Tyrannus caudifasciatus jamaicensis*	ES
8.	White Winged Dove	*Zenaida asiatica*	R
9.	Yellow-faced Grassquit	*Tiaris olivacea*	R
10.	Black-faced Grassquit	*Tiaris bicolor*	R
11.	Zenaida Dove	*Zenaida aurita*	R
12.	Smooth billed Ani	*Crotophaga ani*	R
13.	Caribbean Dove	*Leptotila jamaicensis*	R
14.	Olive Throated Parakeet	*Aratinga nana nana*	ES
15.	Grasshopper Sparrow	*Ammodrammus savannarum*	I
16.	White Collared Swift	*Streptoprocne zonaris*	R
17.	Greater Antillean Bullfinch	*Loxigilla violacea*	ES
18.	Ruddy Quail Dove	*Geotrygon montana*	R
19.	Nutmeg Mannikin	*Lonchura punctulata*	I
20.	Cattle Egret	*Bubulcus ibis*	R
21.	Common Yellowthroat	*Geothlypis trichas*	R
22.	American Kestrel	*Falco sparverius*	R
23.	Stolid Flycatcher	*Myiarchus stolidus*	R
24.	Ruddy Quail-Dove	*Geotrygon Montana*	R
25.	Jamaican Oriole	*Icteryx leucopteryx*	ES
26.	Mangrove Cuckoo	*Coccyzus minor*	R
27.	White Collared Swift	*Streptoprocne zonaris*	R
E: Endemic ES: Endemic sub-species I: Introduced R: Resident			

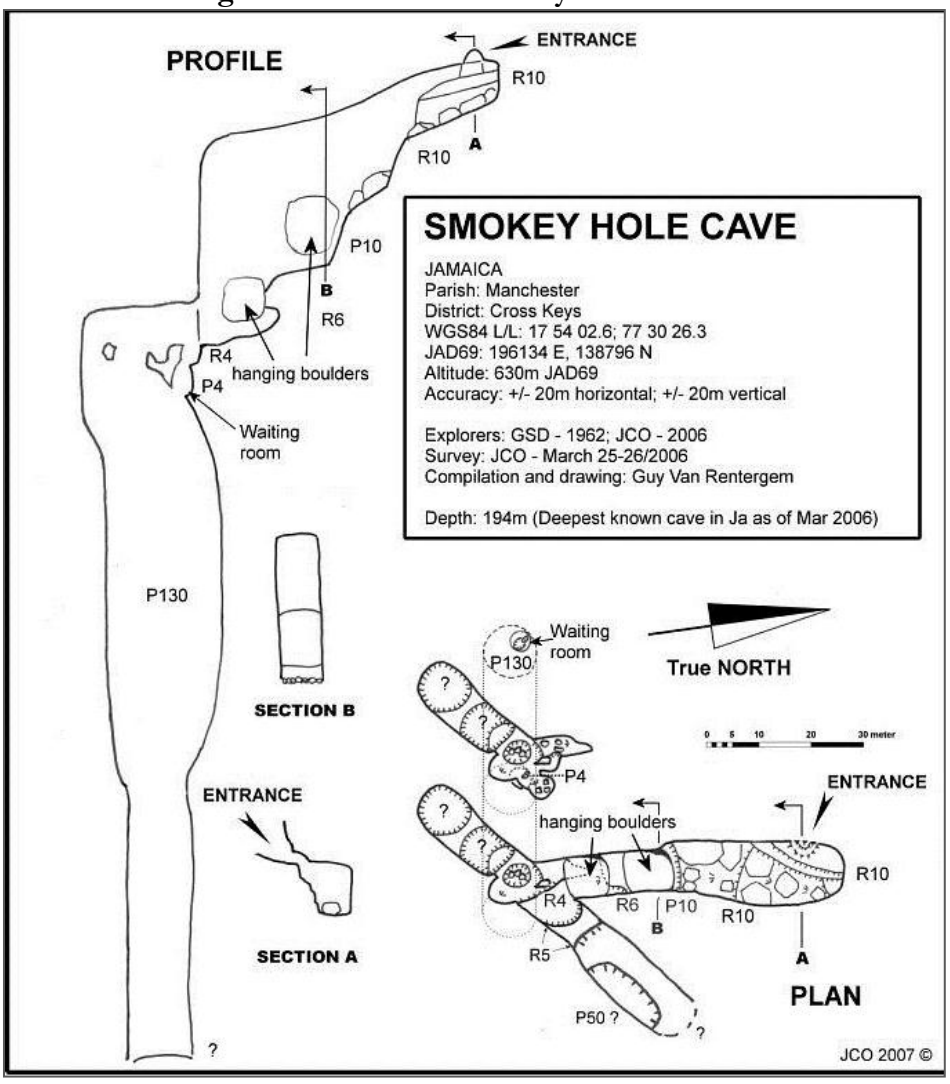
Table 20: List of Observed Winter Migrant Species at Proposed Development Area

No	Common Name	Scientific Name	Summer/Winter
1.	Black and White Warbler	*Dendroica pharetra*	Winter
2.	Prairie Warbler	*Dendroica discolor*	Winter
3.	Palm Warbler	*Dendroica palmarum*	Winter
4.	Rose Breasted Grosbeak	*Pheucticus ludovicianus*	Winter
5.	Black Throated Blue Warbler	*Dendroica caerulescens*	Winter
6.	Ovenbird	*Seiurus aurocapillus*	Winter
7.	Northern Parula	*Parula americana*	Winter
8.	American Redstart	*Setophaga ruticilla*	Winter

Bats

A bat assessment was undertaken by the National Environment and Planning Agency (NEPA) on October 8, 2009 at the Smokey Hole Cave in Broughton (Cross Keys) Manchester. The profile of the cave is shown at Figure 19. Monitoring at the entrance of the cave was conducted over a three hour period starting at 5:30pm and ending at 8:00pm. Harp was used to capture the bats, with the nets opening at 5:50pm and closing at 8:00pm. The emergence of the bats began approximately at 5:57pm and stopped at approximately 7:30pm. During the assessment two hundred and fifty-four (254) species were captured and information was recorded for one hundred and twenty-seven (127) bats. Sixty-eight (68) of the bats identified were males, with no information provided on the sex of two (2) of the bats captured.

Figure 19: Profile of Smokey Hole Cave



Source: Jamaica Cave Organisation, 2007

During the assessment six (6) species were identified. Mormoops Blanvilli was the most common bat specie identified. Of the six (6) species identified, five (5) are

listed on the International Union for Conservation of Nature (IUCN) Red List (Table 21).

Table 21: IUCN Red List Classification for Bat Species

Local Name	Scientific Name	IUCN Red List Classification
Jamaica Fruit Bat	(*Artibeus jamaicensis*)	Not on the List
Ghost-face Bat (Figure 20)	(*Mormoops blainvillii*)	Least Concern
Cuba Funnel-eared Bat	(*Chilonatalus micropus*)	Near Threatened
Leachy's Mustached Bat	(*Pteronotus macleayii*)	Threatened
Sooty Mustached Bat	(*Pteronotus quadridens*)	Least Concern
Parnell's Mustached Bat (Figure 20)	(*Pteronotus parnellii*)	Least Concern

All of species identified are cave roosting species and are insectivorous. The Jamaican Fruit bat, although a cave roosting specie, also uses trees as a roosting habitat. They search for insects in forested areas and around the crown of trees. The Ghost-faced bat, in addition to hunting for food around the edges of forested areas, also feed on insects close to bodies of water.

Figure 20: Local Bat Species

Ghost-faced Bat

Parnell's Mustached Bat

Butterflies

Twenty (20) species of butterflies were observed during the avifauna survey. Four (4) of the species were identified as being endemic species, fourteen (14) as Resident species and two (2) as endemic subspecies.

Table 22: Butterfly Species Observed at Proposed Development Area

No	Common Name	Scientific Name	Status
1.	Zebra	*Heliconius charitonius simulator*	R
2.	Cloudless Sulphur	*Phoebis sennae*	R
3.	Julia	*Dryas iulia delila*	R
4.	Jamaican Admiral	*Adelpha abyla*	E
5.	Buckeye	*Junonia genoveva*	R
6.	White Peacock	*Anartia jatrophae*	ES
7.	Jamaican Albatross	*Appias drusilla Castalia*	R
8.	Tropical Silverspot	*Agraulis (Dione) vanilla insularis*	R
9.	Jamaican Goatweed (Figure 21)	*Anaea portia*	R
10.	Checkered Skipper	*Pyrgus oileus*	R
11.	Cassius Blue	*Leptotes cassius theonus*	R
12.	Small sulphur	*Eurema lisa euterpe*	R
13.	Monarch	*Danaus eresimus eresimus*	R
14.	Jamaican Mestra	*Mestra dorcas*	E
15.	Malachite	*Siproeta stelenes stelenes*	R
16.	Jamaican Polydamas	*Battus polydamas jamaicensis*	ES
17.	Common Tailed skipper	*Urbanus proteus*	R
18.	Evan's Jamaican Skipper	*Polygonus leo hagar*	R
19.	Butler's Jamaican Skipper	*Astraptes jaira*	E
20.	Thersites	*Papilio (Heraclides) thersites*	E
E: Endemic ES: Endemic sub-species I: Introduced R: Resident			

4.2.3 Other Animals

In addition to avifauna and vegetation, other types of animals were observed at the proposed development site. These included the following:

- Snails – Three (3) species found (Family: Punctidae), with the possibility of all being endemic
- Dragonfly (2 species observed – Anisoptera)
- Wasp (1 species – possibly *Sceliphron assimile* DAHLBOM)
- Spider – *Argiope argentata* (Native) (Figure 21)
- Honey Bees – *Apis* sp.

Figure 21: Butterfly Goat-weed Specie and Native Spider


4.3 Socio-Economic Baseline

The parish of Manchester is located in the west-central region of Jamaica, in the county of Middlesex. Mandeville, which is the parish's capital, is a major business centre. Manchester has an area of approximately 830 km^2. The 2001 Census and the Jamaica Survey of Living Conditions report were used as the primary data sources for information presented in the socio-economic baseline for the EIA. The perception survey is also presented in this section of the report and the methodology used in gathering data is described in section 5.0.

4.3.1 Demography

The population for the parish of Manchester was approximately 190,000 at the end of 2008, a 2.7% increase over 2002 figures (Planning Institute of Jamaica, 2011). The parish is the 4th populous parish in Jamaica, representing an estimated 7% of the population. At the end of 2007, males represented 50.3% or 95,760 of the population and the females accounted for 49.7% or 94,661 of the population. Children represented approximately 29% of Manchester's population in 2008. The working age comprised approximately 60% and the dependent elderly, 11%. At the end of 2010, the population of the parish was 191,875.

Cross Keys Development Area

The Cross Keys Development Area (CKDA) includes the following Districts and communities:

- **Cross Keys**: Cross Keys Proper, Lang Syne, New Broughton, Restore, Salmon Town;
- **Plowden**: Plowden Proper, Mt. Endeavour, Pass, Pound, Thatch Walk;
- **Grove Town**: Grove Town Proper, Cocoa Walk, Resource, Smithfield, Warwick;
- **Marlie Hill**: Marlie Hill.

The CKDA had an estimated population of 6,576 in 2001. Males accounted for 52% (3,420) of the total population, with females representing the remaining 48% (3,156). The total population of the area represents 0.89% of the total population of the parish of Manchester. This is a decline of 0.4% and 0.5% over 1991 and 1982 figures respectively. The overall population of the area is said to be declining due to high migration rates. According to the Cross Keys Development Area Plan:

"The development area faces a high level of migration of young people in the 18-26 age group seeking a better life. This has robbed the community of its energy for development."

Based on the parish's annual population growth rate of 0.4% between 2002 and 2008, the CKDA at the end of 2008 should have an estimated population of 6,754. However based on recent trends showing the continuous decline of the population since 1982, the projected growth rate of 0.4% may not be applicable to this area.

4.3.2 Housing

According to the 2001 Census, the parish of Manchester had 50,628 total dwellings. The average persons per dwelling were 3.8, down from 4.5 in 1991. In 2008, the housing tenure data showed that approximately 65.7% of all dwellings in the parish of Manchester were 'owned' by the occupants. Approximately 16% of all occupants lived in 'rent free' dwellings, while 18.4% either rented or leased the dwelling they occupied (Refer to Table 23). According to the housing tenure data there were no 'squatter' occupants in the parish in 2008, compared to 2002, when 0.4% of persons indicated their housing tenure status as 'squatting.'

Table 23: Housing Tenure, Manchester 1992, 2002, 2008

Year	Own	Rent Free	Rent/Lease	Squatting	Other
1992	63.5	13.5	23.0	0.0	0.0
2002	64.2	22.7	11.7	0.4	1.0
2008	65.7	15.9	18.4	0.0	0.0
Source: Compiled by the PIOJ from data supplied by STATIN 1992, 2002 & 2008					

Based on the parish's average persons per dwelling, the number of dwellings in the CKDA in 2001 was approximately 1,730.

4.3.3 Utilities

1. Water

The parish of Manchester is supplied with 6 mgd of water from various sources within the parish. The Porous (2mgd) and Victoria (0.5mgd) wells are the major sources of supply within the parish. The major water supply system in the parish is the Greater Mandeville Water Supply System which obtains water from the Pepper area in St. Elizabeth. This system provides 3 mgd, primarily to Mandeville and its

environs. Various communities in the parish are supplied by small springs with low outputs ranging from 37, 854 to 189,270 litres per day (10,000-50,000 US gallons/day).

The communities of Cross Keys do not receive formal water supplies from the National Water Commission. Water is trucked to the area via Parish Council and or Private water trucks, for which residents pay a fee to have their tanks filled. Rain water harvesting is also practised by persons within the community.

2. Electricity

The Jamaica Public Service Company Limited (JPSCo.) supplies electricity to the parish via the Spur Tree substation. The substation supplies electricity to communities using 139/69KV transmissions lines.

3. Telecommunications

LIME (Cable and Wireless), and Digicel are the two main providers of telecommunication services in the project area. Residents living in the vicinity of the project area have access to cellular and internet services provided by LIME. LIME is also the sole provider of landline service in the area.

4.3.4 Municipal Services

1. Police Services

The communities of Cross Keys, Plowden Hill and Rest Store are served by the Cross Keys Police Station located in Woodlands. The police station is located approximately 2km from the proposed Great Valley Wind Farm. The Newport Police Station and the Mandeville Police Station also serve the communities and are found approximately 4km and 15km respectively from the community of Cross Keys.

2. Fire Services

The Mandeville Fire Station is the main emergency fire service centre serving the communities of Cross Keys, Plowden Hill and Rest Store. The station is located approximately 15-16km from the communities.

3. Health Services

The health care sector in Manchester is served by twenty-two (22) health care facilities, which includes two (2) hospitals. The Mandeville Hospital is a Type B hospital and is the main secondary health facility used by the residents of Cross Keys, Plowden Hill and Rest Stop. The Cross Keys Health Centre, a type III centre, is the primary health care facility used by the residents of Cross Keys, Plowden Hill

and Rest Store. The Mandeville Health and Newport Health Centres are also used by residents.

4. Municipal Solid Waste

Southern Parks and Market (SPM) is responsible for the collection and disposal of solid waste in parishes of Manchester and St. Elizabeth. There are two disposal sites that are used by the SPM: Martins Hill in Manchester and Myersville in St. Elizabeth. Martins Hill will be used as the disposal site for Great Valley Wind Farm. Martins Hill is located approximately 20km from the Great Valley Wind Farm site.

4.4 Economy

Manchester's economy is supported largely by the bauxite mining, agriculture and fisheries, trade, and personal services sectors. Smaller sectors such as manufacturing and food processing have recently emerged as potential contributors to the future expansion of the local economy. An overall decline in tourism, business and government services has been experienced within the last decade, however efforts are being made to take an integrated approach to the diversification of the local economy.

1. Mining

Bauxite mining has been the main economic activity in the parish of Manchester for the last fifty (50) years. The growth of mining in the parish has been supported by the vast amount of bauxite deposits found within the parish. The expected decline in the sector is fast approaching as bauxite reserves are being depleted at a rapid pace. An estimated timeline of 20-40 years is said to be left before the reserve is completely mined out.

In 2007, the sector began declining rapidly due to the global financial crisis. In 2008, the mining and quarrying sector rate of growth (value added) declined by 49.8% and 45% in 2009 (Table 24). This decline heavily impacted not only the national economy, but the local economic sector in the parish mainly because of the large number of labourers employed directly to the industry. In 2010, the re-opening of the bauxite mining company Windalco contributed to a 41.8% increase in the growth of the sector nationally. Alpart located in Nain, St. Elizabeth, near the Manchester-St. Elizabeth border was also a major contributor to economic activities in Manchester. The bauxite facility closed operations in 2010 due to the global financial crisis and recession and remains closed to date. This has resulted in a negative impact on the Manchester economy, which relies heavily on the mining sector.

The earnings by the sector have continued to decline since 2008. According to data from the STATIN gross value added in 2008 was estimated to be $31,492.90 (million) and $15,627.30 (million) in 2009; a decline of approximately 51% in earnings. In 2010, the sector grossed $14,957.90 (million), a decline of 4.3% over 2009 figures (Table 25).

Table 24: Rate of Growth of Gross Value Added By Industry at Current Prices 2007-2010 in %

INDUSTRY	2007	2008	2009	2010
Agriculture, Forestry & Fishing	1.1	19.7	22.2	4.5
Mining & Quarrying	18.7	-49.8	-45	41.8
Manufacture	13.9	18.1	8.9	3.6
Construction	13.3	9.3	3.7	8.1
Wholesale & Retail Trade; Repairs; Installation of Machinery	8.1	22.3	5.5	8.6

Source: Statistical Institute of Jamaica, November 7, 2011

Table 25: Gross Value Added By Industry at Constant Prices 2007-2010 $' Million

INDUSTRY	2007	2008	2009	2010
Agriculture, Forestry & Fishing	40,895.10	38,368.70	43,929.10	43,745.70
Mining & Quarrying	32,353.20	31,492.90	15,627.30	14,957.90
Manufacture	67,820.80	67,454.30	64,241.20	62,347.40
Construction	63,828.50	58,991.50	55,873.40	55,313.70
Wholesale & Retail Trade; Repairs; Installation of Machinery	142,126.10	141,591.60	138,017.50	133,368.00

Source: Statistical Institute of Jamaica, November 7, 2011

2. Agriculture and Fisheries

According to the Manchester Local Sustainable Development Plan [LSDP] (2007) "The agriculture sector will become an increasingly important mainstay of the economy as both the need for local food security and global demand for specialty products expand." Currently there is no large scale cultivation of crops in the parish due to its generally mountainous terrain. However, the agricultural sector remains the parish's largest source of employment and is the third largest grower of domestic produce. Additionally, with much of the lands once used for bauxite mining being leased, there is greater opportunity for the expansion of the sector.

The sector nationally has been declining steadily. In 2009, the sector recorded a growth of 22%, a 3% increase over 2008 figures. However in 2010, the sector grew only by 4.5%, a decline of approximately 18% over 2009 figures. The earnings within the sector have however remained fairly constant with earnings between $38,000 and $44,000 (million) annually. The Cross Keys Development Area is a predominant agricultural community.

To support the growth of the sector within the parish of Manchester the LSDP has out outlined the following goals and objectives:

- Develop new agricultural technologies to maximise the quantity and quality of products for the expanding population.

- Facilitate co-op among farming stakeholders to better represent the agricultural sector in the Parish's strategic decision-making.

- Explore and educate our farmers with the best farming techniques to maximise year round production.

- Encourage residents of the Parish to support locally grown agricultural products.

- Develop and expand the agro-processing industry with improved production and marketing strategies to provide better access to markets for local farmers across the Parish.

- Provide a "real time" distribution network for the export of the Parish's agricultural products taking full advantage of the Internet.

Fisheries

The Alligator fishing beach located in the parish is the second largest on the island and is said to support perhaps the largest number of fishermen and fish vendors and is the main source of local income. Over exploitation and the degradation of marine resources is however threatening the local fishing industry and economy. The LSDP has proposed the development of aquaculture in the parish to compensate for the depletion of fishing stock. The following actions are proposed:

- Support efforts to protect the marine ecosystem

- Support adoption of the recommendations outlined in the South Coast Sustainable Development Study.

- Strengthen the fishermen's cooperation in Alligator Pond.

- Educate fishermen and fishing communities about avoiding over-fishing and protecting the marine environment.

- Continue to support the establishment of a Coast Guard substation in Alligator Pond.

- Identify areas that would be suitable for aquaculture.

Other Economic Sectors

The Tourism, Trade and Construction sectors are expanding sectors in the parish of Manchester. The tourism sector, which has had to compete with the rapid expansion of the

industry on the north coast, is being revamped to capitalise on niche markets within the industry. These include eco-tourism, community tourism and heritage tourism. In 2010, the tourism industry earned approximately $78 billion. The LSDP has outlined its main goals for tourism as follows:

1. Achieving a sustainable tourism industry from community tourism, eco-tourism and heritage tourism to maximise the Parish's economic development potential.

2. Educating and training residents of the Parish to gain jobs and achieve full economic benefits from Manchester being a national and international travellers' or visitors' destination.

3. Protecting Manchester's cultural and heritage assets for future generations (first "free town", historic landmarks…).

4. Promoting the South Coast as the environmental destination and the Mile Gully area as the heritage destination.

There has been a recent increase in construction activities in the parish. The LSDP notes that Manchester has seen thousands of developments in the last decade ranging from housing to commercial buildings. The growth of the industry in the parish is being hinged on the use of mined out bauxite lands for medium-impact or other industrial operations. The industry recorded an 8.1% growth in 2010. This was an improvement over 2009 figures, where the industry grew by only 3.7%, a 5.6% decline over 2008 figures. In 2010 the industry earned approximately $55.3 billion.

Trade is one of the fastest growing formal sectors in Jamaica, but has much of its establishments outside the formal economy. The formal sector grew by approximately 8.6% in 2010, an increase of 3.1% over 2009 levels. The sector earns in excess of $133 billion annually.

The trade industry is made up largely of Micro, Small and Medium-sized enterprises (MSMEs) which employ approximately 80% of the labour force in Jamaica and contributes approximately 40% to Gross Domestic Product (GDP). The informal sector has been growing in Manchester and the LSDP has recognised the need to offer business service and support to this growing sector in order to foster business growth and expansion of the Manchester economy. The LSDP outlines its main goals for the local business and trade sector as:

1. Creating an economic climate conducive to entrepreneurialism, innovation, and growth of local businesses.

2. Sustaining a diverse economy that allows participation by all segments of the population.

3. Becoming a nation and region-wide leader in sustainable technology industries.

4.5 Land Use

4.5.1 Historical Land Use

The Cross Keys District is said to form the 'spine' of the South Coast Heritage Trail. The term is given to the district because of its rich historical heritage which dates back to the 1400s. The landscape of the area is littered with Amerindian settlements and ruins from the period of slavery. Farming was the main land use activity carried out in the area, with very sparse residential settlements decorating the landscape. The Tainos mainly farmed and fished as part of their daily activities. The introduction of slaves to Jamaica brought along a more intensive form of crop cultivation to the island, including the Cross Keys district. Sugar cane cultivation was not a popular activity in this area, instead cash crops such as yam, cassava, bananas etc. were cultivated.

Forested areas were cleared to support the expanding agricultural sector, with many tree, shrub and herb species removed. Over time forested areas became degraded, with patches of dry forest and limited shrub/herb constituting the land use cover of the area. There is no historical land use/cover data showing the extent of forested areas in the district prior to 1950s.

In the early 1930s a change in land ownership also signalled a change in (i) the types of land uses and (ii) the distribution of land uses in the District. Land was sold as part of a Land Settlement agreement, with only the Great Valley and Canoe Valley being left out of the agreement. Additionally nine hectares (9 ha) or twenty-three (23) acres of land was left for a community cemetery and a community centre in Cross Keys.

By the mid 1960s, farming plots were converted and used for residential and institutional type land uses. This included low density housing, churches, schools and other public buildings. During the growth and expansion of the mining industry, no lands were converted for industrial and/or mining activities in the District. Lands north of the District, which includes the community of Newport were mined and used as industrial land uses, while the lands within Cross Keys were reserved for future bauxite use.

The Cross Keys District has over twenty (20) historical and heritage settlements

4.5.2 Current Land Use

Agriculture is the dominant purpose for which land is used in the communities of Cross Keys. This land use accounts for approximately 70% of all active land uses within the community. Residential land use accounts for approximately 25% of all active land use, followed by institutional and commercial land uses which together account for the remaining land uses. The area has approximately <10% of its land area covered by forest patches, consisting of various trees, shrub and herb species. The intensification of agricultural and other build land use type activities have

continued to reduce the forest cover within the area. Mining activities to the north of the CKDA has also removed and cleared a significant portion of the forested areas.

Residential, commercial and institutional land uses are low density type land uses, located along major and minor access routes within the communities. The land uses are organised in a linear pattern in some sections of the communities and in other areas such as Plowden Hill a more clustered land use pattern is emerging. There is no evidence to suggest that proper land use planning techniques were used in the location and layout of human settlements. Lands have largely been sub-divided in an ad hoc manner with individual parcels ranging in size from approximately 360-900m^2.

The Cross Keys square is the only mixed land use area within the CKDA. Land uses include commercial, institutional, educational and recreational type land uses.

4.5.3 Heritage Sites

Warwick Yard

Warwick Yard is a property within the North Hill Division. Slaves owned this property. The remains of the slave house are still there. The slaves used to do farming for a living. Other heritage sites include:

- Slave House in Grove Town and Warwick
- Grove town Basic School and United Church (19th century buildings)
- New Broughton United Church.
- Amerindian cave in Canoe Valley
- Cross Keys court house (19th century building)

Canoe Valley

The name Canoe Valley is said to have some relation to indigenous Jamaicans, the Taino. About 600 years ago, the valley was heavily endowed with cotton trees, used by the Amerindians to carve canoes and other small craft. The Canoe Valley Park spans 1,200 hectares (3,000 acres), and is made up of mangrove swamps, limestone forests and herbaceous forests. The whole valley occupies approximately 2,000 hectares (5,000 acres).

These heritage sites will in no way be affected by this project.

5.0 Community Development: Perspective of Residents on Proposed Development

5.1 Methodology

As a means of gathering detailed information on the perspective of key stakeholders on the potential impacts associated with the development of a wind farm in the community of Great Valley, questionnaires were administered in communities located within a 4 km radius of the project site in the Cross Keys District, Manchester. Two hundred (200) questionnaires were administered in the communities; an overall representative sample of twelve percent (12%) of the total number of households within the District. Households are used to determine overall sample size as it allows for a greater level of participation from a wider cross section of residents. It also provides the opportunity for greater dissemination of information when more households are involved, rather than individuals.

The standardised open-ended questionnaire (Appendix 1) consisted of forty-two (42) questions covering key areas to determine the overall perspective of stakeholders on the level and types of impact the proposed wind farm development project would have on their community and Jamaica. The survey conducted on Saturday, February 11, 2012, had an overall response rate of eighty-seven percent (87%). The number of total respondents represented approximately 10% of the total number of households found within the CKDA and an estimated 14% of total households found within the surveying area. The results of the survey covering the one hundred and seventy-three (173) respondents are presented below.

5.2 General Profile of Respondents

5.2.1 Community Participation

Communities within a 2-3km radius from the proposed Great Valley project site were surveyed. Table 26 provides the name and population size of the communities falling within the survey boundary.

Table 26: Surveyed Communities and Population Size

Community Name	Population
Cross Keys	
• Cocoa Walk	823
• Buck Up	422
• Woodlands	418
• Resource	203
• Broughton	596
Plowden Hill	1,832
Great Valley/Rest Store	572
Total	**4,866**

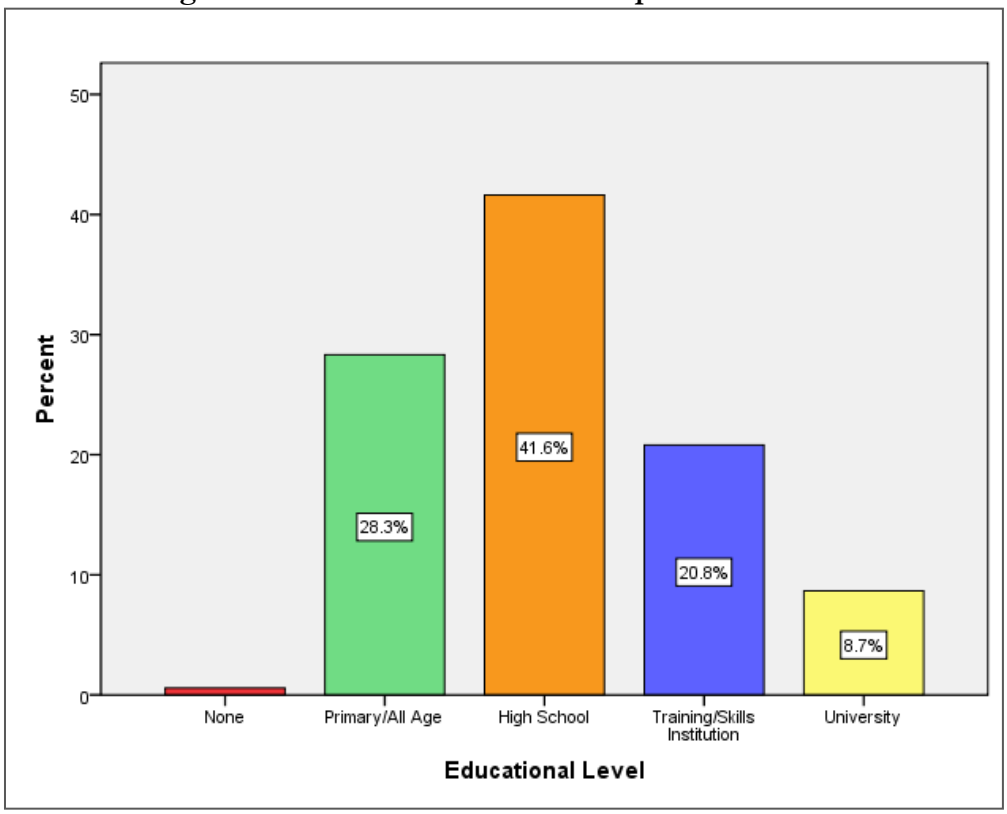
5.2.2 Gender and Age Distributions

Males accounted for approximately fifty-seven percent (57.2%) of total respondents, completing ninety-nine (99) of the one hundred and seventy-three (173) questionnaires completed. The age group category 18-29 accounted for the highest percentage of respondents at 32.4%, followed by the 30-39 age group category, which accounted for 20.2% of total respondents. Participation was lowest in the 60 and over age group category, with only 12% of respondents belonging to that age group. Approximately 68% of all respondents were between the ages of 18 and 49.

5.2.3 Educational Profile

All persons interviewed were found to have basic literacy skills, though not all respondents had received formal educational training. The data showed that the majority of respondents had been educated at the secondary level. Approximately 42% indicated that they had educational training up to the secondary level. Formal training at the primary level was received by an estimated 28% of respondents, while an estimated 21% received training via Training/Skills Institution. Only one (1) respondent indicated they had received no formal training, while 8.7% of respondents indicated they had been educated up to the tertiary level. Approximately 10% (17) of respondents are currently enrolled in school (Figure 22).

Figure 22: Educational Level of Respondents



5.2.4 Employment and Income

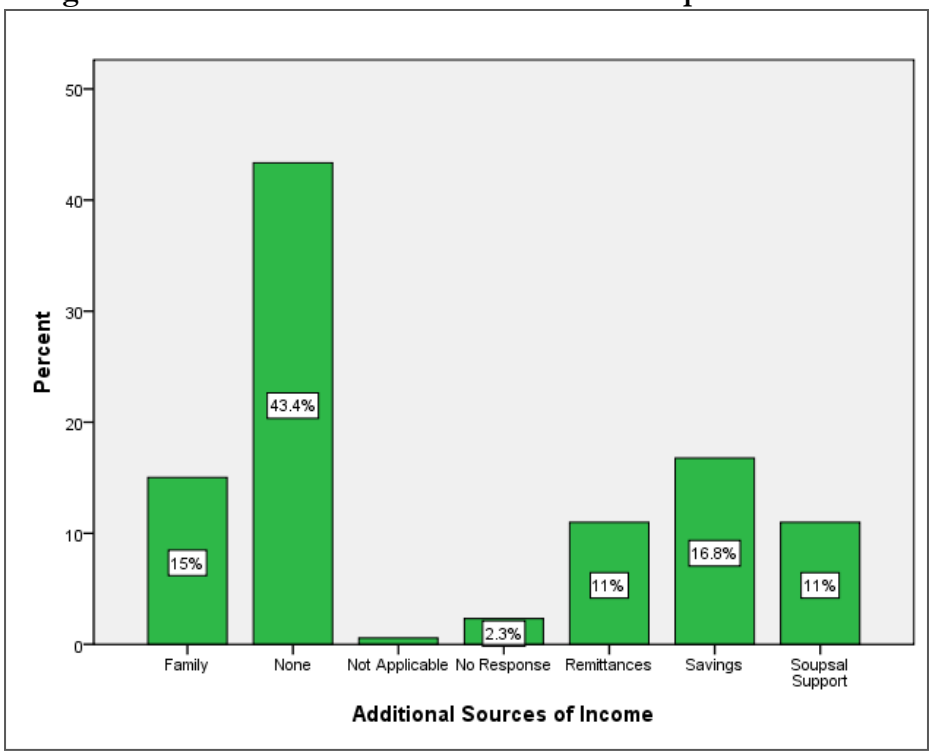
The employment rate amongst the individuals surveyed showed that 7 out of 10 persons were employed, with the vast majority, 44.5%, indicating their employment status as 'self-employed.' Only 16.8% of respondents noted they were employed on a 'full-time' basis, while 10.4% were employed 'part-time' in their current occupations. The estimated 28% of respondents who indicated their employment status as 'Other" were found to be unemployed, retired or currently enrolled in school (Figure 23).

Approximately 33.6% of all persons surveyed were employed as farmers. This was the largest occupation group identified amongst respondents. Approximately 6% of respondents were involved in trade related occupations (carpentry, welding, masonry, construction etc.). All other respondents either worked as civil servants or were employed privately, predominantly in the retail, trade and wholesale industries as hairdressers, shop attendants, storeowners and bartenders.

Only an estimated 43% (74) of respondents provided a response on their monthly income earned. This is found to be a typical response trend in conducting socio-economic surveys, where there is a general unwillingness to divulge earnings for fear of improper use of information offered in confidence. From the total number of persons surveyed, approximately 27.7% earned less than J$10,000 monthly, while a mere 2.3% earned in excess of $60,000 monthly. An estimated 12.7% of persons surveyed earned between $10,001 and $60,000 monthly.

For approximately 57% of respondents there was an additional source of income to supplement their typical monthly salary. Fifteen percent (15%) of all respondents received additional financial support from family, 16.8% used their savings, 11% received remittances and 11% depended on spousal support. An estimated 2% of respondents provided no response to the question asked about additional source of income.

Figure 23: Additional Sources of Income for Respondents



5.2.5 Land Tenure

Land ownership remains one of the major issues within the CKDA. Lands have been passed down from one generation to the next, but without formal documentation supporting claims of ownership. Details of the survey revealed that approximately 76% of all respondents indicated that they owned the lands they occupied, while an estimated 10% indicated that the lands were family owned. Only 3% of respondents leased the land they occupied (Table 27). Others indicated their tenure as 'rent' mainly because of their current housing tenure status.

Table 27: Land Tenure Status of Respondents

Tenure Status	Frequency	Percent	Cumulative Percent
Lease	5	2.9	2.9
Own	131	75.7	78.6
Other	17	9.8	88.4
Rent	20	11.6	100.0
Total	**173**	**100.0**	

5.2.6 Community Utilities and Infrastructure

1. Water

The subject of water reliability was identified in the Cross Keys Development Area Plan as one of the major issues facing the communities in the Districts. This issue

was reflected throughout the survey as approximately 66% of all respondents indicated that their water supply was unreliable. An estimated ninety-one percent (91%) of respondents supplied water to their households via privately or publicly trucked water or via rain water which had been harvested. All households surveyed had a tank in their yard for water storage. Only 5.2% of respondents had formal water supplies piped into their yard and/or dwelling, while 1.2% relied on a community tank and/or public standpipes to provide water to their households.

With this high level of discontent with current water supplies, it was not astonishing that approximately 69% of respondents indicated that improvement in water infrastructure and supplies was the type of improvement they most wanted to see in their community.

2. Lighting Service and Infrastructure

Electricity is used as the main source of lighting for an estimated 91% of households surveyed. Kerosene and Candles were used by 8.1% of respondents, while the remaining number of persons surveyed indicated they had no lighting source for their dwelling.

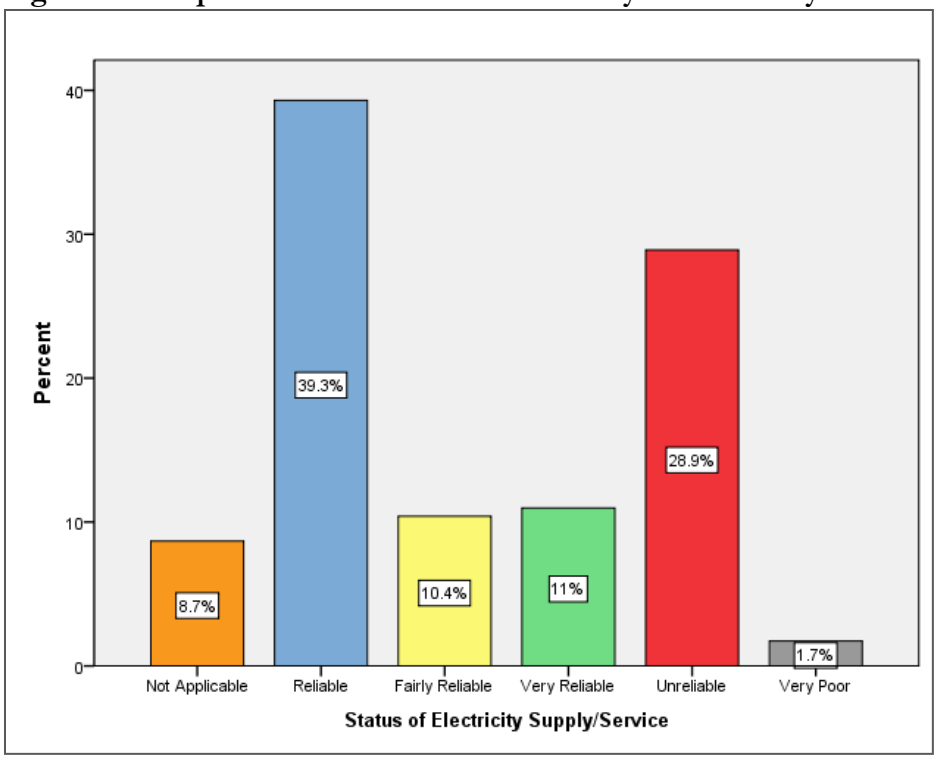
Electricity Cost: Statistical analysis of the data showed that within the surveyed communities a monthly average of J$5,069.00 is spent to cover the cost of electricity. The maximum spent was J$37,000 per month while the minimum amount was J$600.00. Approximately 64% of all respondents surveyed spent between J$600 and $5,000 monthly for electricity. Six percent (6%) of respondents spent in excess of J$10,000 monthly (Table 28).

Table 28: Average Monthly Cost of Electricity Services for Respondents

Price Range ($)	Frequency	%
$0	21	12.1
$600-1500	3	1.8
$2000-3000	33	19.1
$3500-5000	54	31.2
$5500-7500	31	17.9
$8000-10,000	20	11.6
>$10,000	11	6.4
Total	**173**	**100.0**

Electricity Service Reliability: Examination of the data gathered showed that the vast majority of respondents were satisfied with their electricity service, with eleven percent (11%) describing their service as 'very reliable.' An estimated 39% of respondents found their service to be 'reliable', while 10% described their service as being 'fairly reliable.' One-third of respondents (31%) described their electricity service as either unreliable or very poor (Figure 24).

Figure 24: Respondents View on the Reliability of Electricity Services



Further analysis of the data by location showed that the vast majority of respondents who found their electricity service unreliable and/or poor were from the community of Cross Keys. An estimated 47% of the total number of persons identifying their electricity service as unreliable and/or very poor was from this community. The community of Cocoa Walk accounted for 21% of respondents who had an issue with their electricity service.

The community of Plowden had the highest level of satisfaction; accounting for an estimated 31% (33 out of 105) of all persons surveyed indicating they were satisfied with their electricity service. In fact the community accounted for 12 of the 19 respondents (63%) who classified their service as 'very reliable' (Table 29).

Table 29: Respondents View by Community on Reliability of Electricity Service

Location	Fairly Reliable	Not Applicable	Reliable	Unreliable	Very Poor	Very Reliable	Total
Broughton	5	1	8	3	2	1	**20**
Cocoa Walk	2	0	7	11	0	0	**20**
Cross Keys	2	8	21	25	0	4	**60**
Plowden	3	6	18	1	0	12	**40**
Resource	0	0	5	0	1	0	**6**
Rest Store	6	0	2	4	0	0	**12**
Woodlands	0	0	7	6	0	2	**15**
Total	**18**	**15**	**68**	**50**	**3**	**19**	**173**

3. Antennae Infrastructure

Roof mounted antennae for television is the most widely used amongst respondents. An estimated 56.6% of respondents indicated having roof mounted antennae for their television only, compared to 2.9% that have radio antennae only and 0.6% who had cable antennae. Only one respondent indicated having all three types of antennae, while 12.1% had both radio and television antennae and 1.2% cable and television antennae. Twenty-six percent (26%) of respondents indicated having no form of antennae at their residence (Table 30).

Table 30: Types of Antennae Utilised by Respondents

Types of Antennae	Frequency	Percent	Cumulative Percent
All Three	1	0.6	0.6
Cable	1	0.6	1.2
Cable and Roof Mounted Antennae-Television	2	1.2	2.3
None	45	26.0	28.3
Roof Mounted Antennae-Radio	5	2.9	31.2
Roof Mounted Antennae (Radio/Television)	21	12.1	43.4
Roof Mounted Antennae-Television	98	56.6	100.0
Total	**173**	**100.0**	

5.2.7 Resource Usage and Management

Natural resources are materials from the earth that are used to support life and meet people's needs. Any natural substance that humans use can be considered a natural resource. Oil, coal, natural gas, metals, stone and sand are natural resources. Other natural resources are air, sunlight, soil and water. Animals, birds, fish and plants are also natural resources.[8]

All respondents acknowledged that their community had an abundance of natural resources, however only 82.7% of respondents indicated that they utilised these resources. From the total number of persons acknowledging use of the resources, 47% used the resources for domestic purposes only, 40% for domestic and commercial use and 5% for commercial uses only. Only 8% of persons indicated using the resources for recreational purposes. Recreational activities involved bird shooting/hunting.

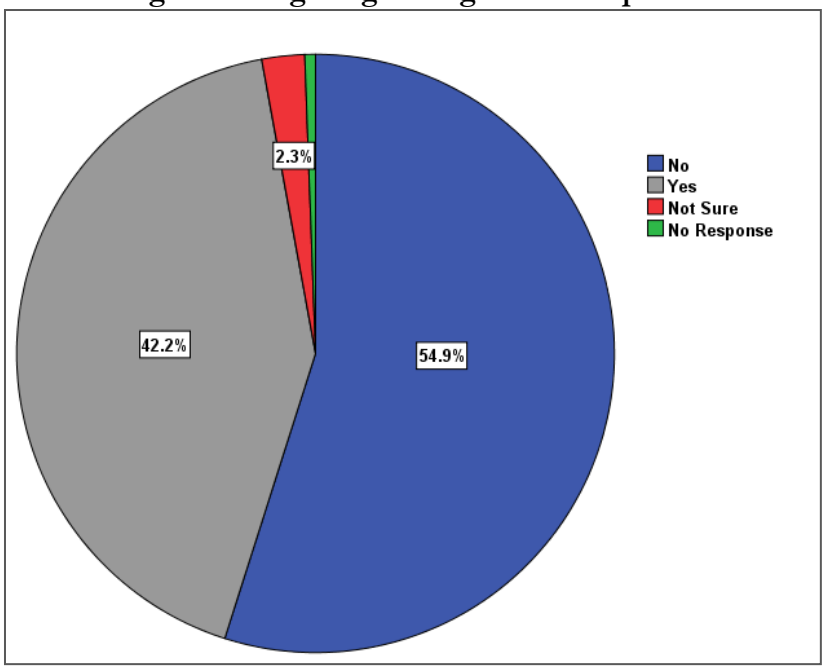
For ninety-four percent (94%) of respondents surveyed there existed no pollution threats affecting existing natural resources. Only 3.5% of respondents identified what they considered pollution threats. Threats included noise emissions, improper disposal of solid waste, deforestation and improper release of untreated effluent. The main sources of the pollution threats were citizens.

Birds

Ninety-seven percent (97%) of all persons surveyed acknowledged the presence of an abundance of bird species in their community. Only 42% however indicated that their community had migrant bird species. Persons who participated in annual bird hunting expeditions were more knowledgeable about migrant bird species. Migrant bird species were found to be most visible during the period September to December. An estimated sixty-six percent (66%) of respondents identified this period as the time migrant bird species are most visible (Figure 25).

[8] http://www.scdhec.gov/environment/lwm/recycle/pubs/natural_resources.pdf

Figure 25: Sighting of Migrant Bird Species



The majority of migrant bird sightings were by residents in the Cross Keys and Plowden Communities. Of the seventy-three (73) persons who indicated that their community received migrant bird species, forty-eight (48) persons were from these two communities; approximately fifty-seven percent (57.5%) of the total respondents (Table 31).

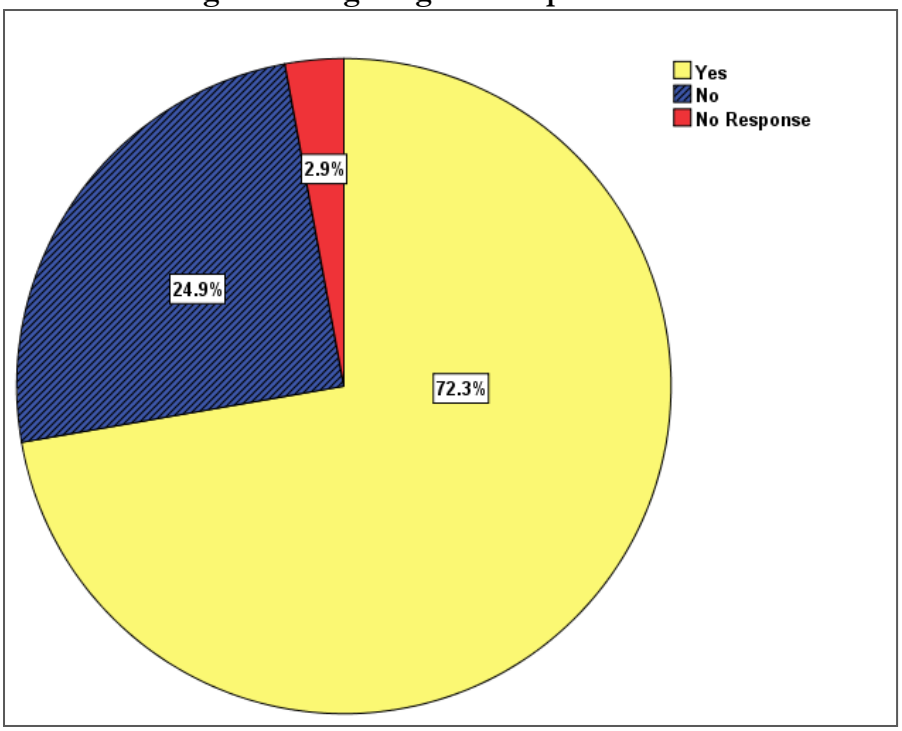
Table 31: Sighting of Migrant Bird Species (by Community)

Location	Presence of Migrant Birds in Community				
	No	No Response	Not Sure	Yes	Total
Broughton	16	0	0	4	**20**
Cocoa Walk	11	0	0	9	**20**
Cross Keys	29	0	0	31	**60**
Plowden	26	0	3	11	**40**
Resource	5	1	0	0	**6**
Rest Store	4	0	1	7	**12**
Woodlands	4	0	0	11	**15**
Total	**95**	**1**	**4**	**73**	**173**

Bats

Seventy-two percent (72%) of respondents noted that they had frequent bat sightings in their community. At least fifty percent (50%) of the respondents in each community surveyed indicated they had seen bats at some point or the other in their community (Figure 26).

Figure 26: Sighting of Bat Species



Bat sightings were most common in the community of Cross Keys, Cocoa Walk and Woodlands, where a third of respondents communicated that they see the fauna species on a nightly basis. In the community of Plowden, bat sightings were said to be most common during 'naseberry (sapodilla) season'. Naseberries have two seasons (i) February-April and (ii) October to December. Residents in Plowden confirmed that bats are frequently seen on average 6-7 months out of the year. A third of all persons surveyed indicated that though they saw bats, their sighting was not often.

Table 32: Bat Sightings (by Community)

Location	Presence of Bats in Community			
	No	No Response	Yes	Total
Broughton	5	1	14	**20**
Cocoa Walk	6	1	13	**20**
Cross Keys	17	3	40	**60**
Plowden	4	0	36	**40**
Resource	0	0	6	**6**
Rest Store	7	0	5	**12**
Woodlands	4	0	11	**15**
Total	**43**	**5**	**125**	**173**

5.2.8 Natural Disasters

The communities surveyed are all susceptible to natural disasters. All communities are exposed to hurricanes and all individuals surveyed acknowledged that at one point or the other they had been affected by the passage of a hurricane. Only five percent (5%) of respondents identified other natural disasters as being a potential threat to their community. Four percent (4%) of all respondents identified fire as a natural disaster affecting their community, while approximately one percent (1.2%) identified drought incidents.

One of the issues that featured prominently in the discussion on disaster occurrence and management was the lengthy time taken for utility services to be restored in the communities. For persons within the surveyed communities, the restoration of power supplies took in excess of one week in most cases. According to an estimated thirty-nine percent (39%) of respondents it took one to two weeks for electricity service to be restored to their households. For an estimated one-third of respondents (33%), it took one to two months for their households to have their electricity service reinstated, while thirteen percent (13%) of respondents complained that more than two (2) months elapsed each time before their service was restored.

Water service disruptions are more frequent, even in the absence of disasters, as the reliability of the supply within the community is based on (i) rainfall and (ii) availability of transport to truck water to the communities. According to residents trucks are not always readily available to transport water to their community. Changes in rainfall patterns has also identified as one of the issues affecting the reliability of water supply for individual households.

School facilities and churches are used as disaster shelters for approximately eighty-seven percent (87%) of respondents. Other facilities used includes: community centre, public facilities such as police stations and health centres and private residences.

Lightning Storms

The occurrence of lightning storms, based on the responses of the surveyed group, is highly infrequent in the communities. Only an estimated thirty-four percent (34%) of respondents indicated that the communities were affected by lightning storms. These storms are said to take place once or twice annually.

5.3 Community Organisation

Interaction and dialogue with community members, is arguably one the most critical aspects of the EIA report. The community structure is an important component, which ultimately creates the platform for which community members can share their concerns and outline their expectations as it relates to the introduction of developments within their community. This section of the survey provides an overview of the existing community structure and

provides a look at the leadership structure and social capital which exists within the community.

General awareness of the existence of a citizen's association was very low among all respondents. Only an estimated eighteen percent (18%) of respondents were aware of whether their community had a Citizen's Association (Table 33).

Table 33: Respondents Awareness of the existence of Citizen's Association

	Frequency	Percent	Valid Percent
No	135	78.0	78.0
Yes	31	17.9	17.9
Not Sure	7	4.0	4.0
Total	**173**	**100.0**	**100.0**

In every community surveyed, except for the community of Broughton, respondents were divided in their response on the existence of a Citizen's Association. In all other communities except Broughton, respondents noted that their community previously had an association, but they were now defunct. In Plowden, residents communicated that efforts were being made to re-establish a Citizen's Association (Table 34).

Table 34: Respondents Awareness of the existence of Citizen's Association (by Community)

Location	Existence of Community Citizen's Association			Total
	No	Not Sure	Yes	
Broughton	20	0	0	**20**
Cocoa Walk	17	0	3	**20**
Cross Keys	48	1	11	**60**
Plowden	24	3	13	**40**
Resource	4	1	1	**6**
Rest Store	8	2	2	**12**
Woodlands	14	0	1	**15**
Total	**135**	**7**	**31**	**173**

The survey also revealed that respondents were generally unaware of the existence of voluntary organisations and outreach programmes within the communities. Only an estimated eight percent (8%) of respondents were aware and able to identify voluntary organisations that have been involved in the community. Organisations that were identified included the Red Cross, Police Youth Group, Farmers Association and Taxi Association. The church was recognised by respondents as one of the most involved organisation within the community. The church's role in the community, based on the information received from respondents, was the development and execution of programmes targeting vulnerable groups such as children and the elderly and the operation of educational facilities/centres. General awareness amongst survey participants about the existence of outreach programmes

was also very low; only an estimated twelve percent (12.7%) of respondents were informed or aware of such programmes.

Respondents were found to be more knowledgeable about sporting programmes in their community. Additionally all respondents had knowledge of the presence of a community centre, though not all utilised the centre. The data revealed that twenty-six percent (26%) of the total number of persons surveyed used the community centre. The centre was used mainly for recreational purposes and/or the hosting of meetings or community forums.

Community Projects and Citizen Involvement

Seventy-one percent (71%) of respondents had some knowledge of the types of Labour Day activities that were undertaken in their community. Citizens were the main organisers of these activities, either through specialised groups, e.g. Taxi-men Association or Youth Club or as individual residents. Projects mostly involved community beautification (painting of community facilities, landscaping, etc.), repairing of road infrastructure, upgrading of educational facilities and caring for the elderly through food and clothing drives. Labour required for the execution of these projects was sourced from within the community. For construction related projects, community members were often supported by other migrant workers.

It is interesting to note that though community members were instrumental in the organisation of community projects, they were unaware about the process by which decisions were made concerning their community development, and most importantly who were the key decision-makers. Approximately Forty-five percent (45%) of persons surveyed were 'unsure' about how decisions were made concerning their community, while forty percent (40%) indicated that the major decision-makers were either the citizens themselves (20%) or political representatives (20%).

Community Challenges and Improvement

The absence of formal water supplies and the requisite supporting infrastructure, proper road infrastructure, skills training facilities and business development opportunities were the three (3) main areas of concern for the individuals surveyed. Respondents were concerned about the lack of community facilities that are in place to support the social and economic advancement of the community's youths. Similarly concerns were raised about the limited attention being placed on land and housing tenure issues within the community.

Improvement in utilities infrastructure, increased employment opportunities and introduction of youth/community development centres were the improvements most identified by respondents.

5.4 Social Assessment of Impacts

This section gives an overview of the perspective of stakeholders on the potential negative and positive impacts that may arise with the implementation of the proposed project.

Eighty percent (80%) of all respondents knew what a wind turbine was and the functions of such a technology. Forty-two percent (42%) of all respondents were already aware of the proposed project. Community members had been made aware of the project through dialogue with other community members.

5.4.1 Positive Impacts

1. Employment Opportunities

The local economy within the communities surveyed is supported mainly by the agricultural and trade industries. The need for greater diversification within the local economy is one of the major community improvements identified by respondents. All respondents expected that with the proposed development, employment opportunities would be provided to skilled workers from within the community. Fifty-two percent (52%) of all respondents indicated that they were hoping to be considered for positions during the construction and operational phases of the project.

2. Reduction in Electricity Costs

Respondents were largely sceptical about seeing a reduction in their electricity costs with the operation of the wind farm. However twenty-two percent (22%) of respondents identified possible reductions in their bills and improvement in their overall service as a potential positive impact. Respondents were more indecisive on the expect timeline to receive such benefits.

3. Promotion of Utilisation of Renewable Resources /Reduction in Fuel Cost

An overall reduction in fuel costs was identified by respondents as a potential positive to be had, not by them, but for the developers and JPSCo. Respondents were of the view that in the long-term the country would benefit greatly by using renewable energy resources to generate electricity, as this would help to reduce our dependence on oil. This overall savings from fuel imports, respondents felt could be diverted to other areas, particularly the ailing economy.

5.4.2 Potential Negative Impacts

1. Noise emissions

Increased exposure to noise nuisances was not a concern for the majority of respondents surveyed. Respondents living within close proximity to the Wigton Wind Farm in Rest Store voiced their concerns about the potential noise emission levels associated with the operation of the wind turbines. The noise emitted from the

Wind Farm was found to be loud and intrusive, especially at nights and in the early hours of the morning.

2. Limited/No reduction in electricity cost

Though community members were optimistic about the employment opportunities to be had from the project, they were highly sceptical about the benefits as it relates to a reduction in electricity costs 'trickling' down from the developer via the Jamaica Public Service Company (JPSCo) to them. Community members were very vocal concerning this matter, as many pointed to the promises that were made during the development of the Wigton Wind Farm, but were never kept. Approximately ninety percent (90%) of all respondents said they benefitted in no way from the construction and operation of the Wigton Wind Farm. The same outcome is expected for this proposed development.

3. Destruction of Farming Plots/Displacement of Farmers

The loss of farming plots was a concern for farmers who currently utilised the proposed development site. Farmers were concerned about the loss of earnings during the construction phase of the project, but mostly possible long-term disruptions associated with the project.

6.0 Identification of Environmental Impacts

The purpose of this task is to identify the major environmental and socio-economic impacts of the construction and operation associated with the proposed Wind Farm. Adverse impacts need to be identified so that alternative approaches and/or mitigation measures can be implemented. Positive impacts are also noted as this provides justification for the project.

The main activities to be undertaken for this project include:

- Construction Phase
  - Land Clearing
  - Blasting for construction of wind turbine foundations
  - Construction (roads and wind turbines)
  - Transportation of heavy duty equipment, turbine parts and construction material
  - Operation of heavy duty equipment
  - Fuel storage and dispensing for heavy duty equipment
  - Stockpiling of construction material
  - Commissioning
- Operation Phase
  - Turbine operation
  - Maintenance
- Decommissioning

Table 35 provides a summary of the potential aspects and associated negative impacts.

Table 35: Summary of Potential Aspects and Associated Negative Impacts

	ASPECT	POTENTIAL NEGATIVE IMPACTS
Construction phase		
1.	Noise	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
2.	Fugitive dust emissions	• Air pollution • Respiratory problems
3.	Vehicular emissions	• Air pollution • Respiratory problems
4.	Solid waste (top soil, vegetation, construction debris, garbage)	• Land and water pollution
5.	Human waste	• Land and water pollution
6.	Use of fuel	• Depletion of (oil) resources
7.	Removal of vegetation	• Habitat destruction • Disruption of ecosystems • Displacement of small farmers
8.	Soil erosion	• Off-site effect is the movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil
9.	Construction work	• Accidents causing death or injury
10.	Increased traffic movement	• Traffic congestion • Motor vehicle accidents
11.	Use of water	• Depletion of water resources
12.	Spills	• Land and water pollution
Operation Phase		
1.	Disruption of air traffic	• Plane crashes
2.	Lightning strikes	• Fires • Disruption in electricity supplies
3.	Flickering	• Health impacts – epilepsy in rare cases
4.	Diffraction/Shadowing, Reflection, Scattering	• Electromagnetic interference which can affect radar and radio communication
5.	Vibration	• False earthquakes detected on seismograph monitoring equipment
6.	Noise	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
7.	Oil spills/leaks	• Land and water pollution

	ASPECT	POTENTIAL NEGATIVE IMPACTS
8.	Disruption in avifauna flight patterns	• Bird and bat deaths
9.	Land use	• Alteration of development and land use in the area • Depreciation of land value
10.	Aesthetics	• Visually unattractive
Maintenance		
1.	Oil spills/leaks	• Land and water pollution
2.	Solid waste	• Land and water pollution
3.	Human waste	• Land and water pollution
4.	Maintenance work	• Accidents
Decommissioning		
1.	Solid waste	• Land and water pollution
2.	Noise from maintenance equipment	• Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)
3.	Oil spills/leaks	• Land and water pollution
4.	Human waste	• Land and water pollution

6.1 Potential Negative Impacts

6.1.1 Construction Phase

1. Air pollution

It is anticipated that during the site development and construction phase that air quality could be adversely affected by land clearing (for wind turbines and access roads), blasting for the excavation of turbine foundations, access road construction, road widening and the movement of heavy duty vehicles carrying construction material (e.g. sand, gravel etc.). These activities may increase the volume of fugitive dust at the project sites and in the local surroundings which in addition to causing air pollution could cause health impacts such as respiratory problems. This negative impact will be short term and can be mitigated.

The use of heavy duty vehicles and equipment fuelled by diesel is expected to result in an increase in vehicular emissions during the construction phase of the project. Diesel emissions contain over 40 different components identified as being toxic, e.g. carbon dioxide, nitrogen oxide, sulphur dioxide etc. In addition to causing air pollution, vehicular emissions contain greenhouse gases, a contributor to global warming. While there are no vehicular emission standards, one criterion for motor vehicle fitness is that there are to be no visible emissions. This negative impact will be short term.

2. Noise Emissions

Site preparation activities including blasting for the excavation of turbine foundations, road widening activities, the movement and use of heavy equipment and vehicles, installation of turbine components, including excavation and filling of the foundation for the turbines will likely result in an increase in ambient noise levels at the project site and within local surrounding areas. Persons working on the site are likely to be impacted by the noise from construction related activities. Current users of the site, which include farmers, will also be affected by changes in ambient noise levels.

The noise level survey conducted at various locations showed a maximum ambient noise level reading of 61 dBA and a high of 48dBA for the average reading. The lowest baseline noise level measured was 38 dBA (Table 14).

Mitigation measures can be instituted to deal with the impact of noise on workers. The other potential impacts are noise on neighbouring communities from increased truck traffic and construction site activities. There are several residential developments that fall within the 2km radius of the project site. Additionally there are two schools, the Broughton Basic and Primary Schools, which are located approximately 500m from the project site. All other schools, e.g. the Cross Keys High School, are located approximately 1.5km from the construction area. Jamaica's Noise Standards do not suggest any guidelines for institutional land uses (Table 36). Noise from the construction site is expected to have some impact on the Broughton basic and primary schools located close to wind turbine #7. Schools located greater than 1km from the project site, due to the distance of these institutions, are not expected to be significantly impacted. Truck and vehicle traffic will likely increase the nuisance noise to the schools located closest to the project boundary. The duration is expected to last for only the construction period and it is likely to be intermittent. Mitigation measures can be implemented to reduce the impact on the nearby schools from construction related activities.

Table 36: National Noise Standards

National Noise Standards				
	Jamaica NRCA 1999 Recommended		World Bank (IADB) Thermal Power Guidelines for New Plants (1998)	
	dBA		dBA	
Zone	7 a.m. – 10 p.m.	10 p.m. – 7 a.m.	7 a.m. – 10 p.m.	10 p.m. – 7 a.m.
Industrial	75	70	70	70
Commercial	65	60	70	70
Residential	55	50	55	45
Silence	45	40	-	-

3. Loss of Productive Farm Lands and Relocation/Displacement of Farmers

The property proposed for the Wind Farm is owned by the National Land Agency (NLA). The NLA, through a lease arrangement, gave access to the lands to the bauxite mining company Alpart, which in turn leased the land to local farmers. The farmers have occupied these lands for approximately twenty-five (25) years. Currently there are more than twenty (20) farmers working on the land, cultivating approximately 16-18 hectares (40-45 acres). Animal rearing is also done on the property.

No adverse impacts on the farmers are expected as a result of the new access road to be constructed as it will run around the perimeter of the property and will not interface with the existing farming activities. No work will be done on the existing access road used by the farmers which cuts across the property. Additionally the farmers will not be adversely impacted by the construction of the turbines as they are situated around the perimeter of the property and not in the centre where farming activities take place.

4. Loss of Vegetation/Disturbance of Biological Habitats

Approximately 2.5 hectares of vegetation will be cleared during the construction of the wind turbines. Vegetation will be removed during the construction of (i) access routes to the turbine sites and (ii) foundation for turbines.

The foundation for each turbine is 19m x 19m and will require clearance of approximately 0.04 ha. In total, for eight (8) turbines the vegetation cleared will be approximately 0.32 hectares.

The main access route to the turbines on the property will measure 6 metres in width and 3,100 metres in length. An estimated 1.86 hectares of vegetation will be removed during the construction of this main access route on the property.

Construction activities associated with the installation of wind turbines and the construction of roads can alter ecosystems through the clearing of vegetation, soil movement, and increase the potential for erosion and noise. These changes can lead to habitat loss and fragmentation for forest-dependent species. The area is not a forested area, as the vegetation has undergone significant changes due to land clearance activities associated with farming. There are however areas that have significant secondary growth, where several tree species have been identified. Mitigation measures can be implemented to minimise and in some cases eliminate the adverse impact on vegetation by making minor changes to the location of turbines to avoid removing sensitive habitats.

5. Land Pollution

The following aspects could cause land pollution:

- Fuel spills from fuel storage and dispensing
- Inappropriate disposal of solid waste which could consist of:
  - Top soil from land clearing
  - Garbage associated with administrative and welfare activities
  - Packaging waste
  - Construction debris
- Inappropriate disposal of human waste
- Sediments in storm water from land clearing, erosion and aggregate stockpiles

It is unlikely that there will be any pollution of water resources as there are no surface waters in the area and the groundwater resources are very deep underground. Additionally potential spills would be small in volume. The potential for land pollution exists however if the listed aspects are not managed

6. Traffic Disruptions and Vehicle Conflicts

During the movement and installation of the wind turbines, it is anticipated that the movement of heavy vehicles and equipment will have an impact on existing traffic patterns within the vicinity of the project sites. The main road from Rest Store to Cross Keys will provide access to the site. The equipment and vehicles to be used at the site will enter the site from the direction of Rest Store. This roadway is used predominantly by private vehicles and route taxis. It is a narrow and winding roadway with deep corners. The proposed travel route is similar for the most part to the route used by the Petroleum Corporation of Jamaica (PCJ) in the transportation of the turbines for the Wigton Farm. The route used by PCJ ended in the community of Wigton, which is the community adjoining the community of Rest Store. The roadway leading from Rest Store to Cross Keys is considered the potential impact area, as it is the only new addition to the route in the transportation of the turbines.

The roadway is not a high traffic roadway given the size of the population and the overall dependence on taxis for transportation services. However the roadway is used by pedestrians, which includes school children. There is an increased risk for vehicle accidents, but there is also the potential for vehicle-pedestrian conflicts given the current usage pattern of the roadway

7. Use of Fuel

Fuel is essential to operate construction equipment and to transport material and equipment to the site. The contribution to depletion of oil resources is negligible.

8. Use of Water

Water will be trucked to the site by a contracted service. Water is essential for construction activities and welfare facilities (drinking water and sanitation). The contribution to depletion of water resources is negligible.

6.1.2 Operational Phase

1. Noise emission

The noise generated from wind turbines is very directional which exposes receptors located away from the immediate vicinity of wind farms to noise generated at the site. Noise is caused when turbulent air flows over the sharp edge of the blade. This causes the sound to radiate, resulting in noise emissions being heard from some distance away from the site of the turbines.

Newer, larger turbines, as is the case for this project, are far less noisy than the smaller, older ones. This is as a result of modern technological changes to the shape of the rotor blades which has helped to control the disruptive pattern of turbulence. Larger models are being designed to facilitate greater conversion of acoustic noise generated from the wind into rotational torque. Proper siting and the use of insulating materials can help to reduce noise impacts.

The Great Valley Wind Farm site is surrounded by residential communities and schools and it is expected that receptors, including biological receptors will be affected by noise emissions generated from the turbines. The effect of noise on residents is likely to fall within one or more of the following categories:

- Subjective effects including annoyance, nuisance, dissatisfaction
- Interference with activities such as speech, sleep, and learning
- Physiological effects such as anxiety, tinnitus, or hearing loss

Wind turbine generates two types of noise: aerodynamic (from the blades) and mechanical (from the rotating machinery). Concerns about noise from a wind turbine may be dependent on several factors:

- The level of intensity, frequency, frequency distribution and patterns of the noise source;
- Background sound levels;
- The terrain between the emitter and receptor
- The nature of the receptor; and
- The attitude of the receptor about the emitter

In the case of the selected wind farm site the topography consists of steep and gently sloping hills, with interspersed pockets of flat land in valley areas. This type of terrain

contributes to uneven noise patterns as emissions are deflected. As such it is difficult to determine the level of impact on receptors. It is recommended that prior to the installation of the turbines that a noise modeling exercise be done that determines the cumulative noise levels from the wind turbines at the nearest receptors. This will help to situate the turbines at the best locations relative to potential receptors.

The noise from the proposed wind turbines at different speeds is provided in Table 37. The information presented shows that the decibel level on the "A" scale ranges from a low of 97.9 to a high of 106.9.

Table 37: Sound Power Data for Vestas V90-3MW Wind Turbine

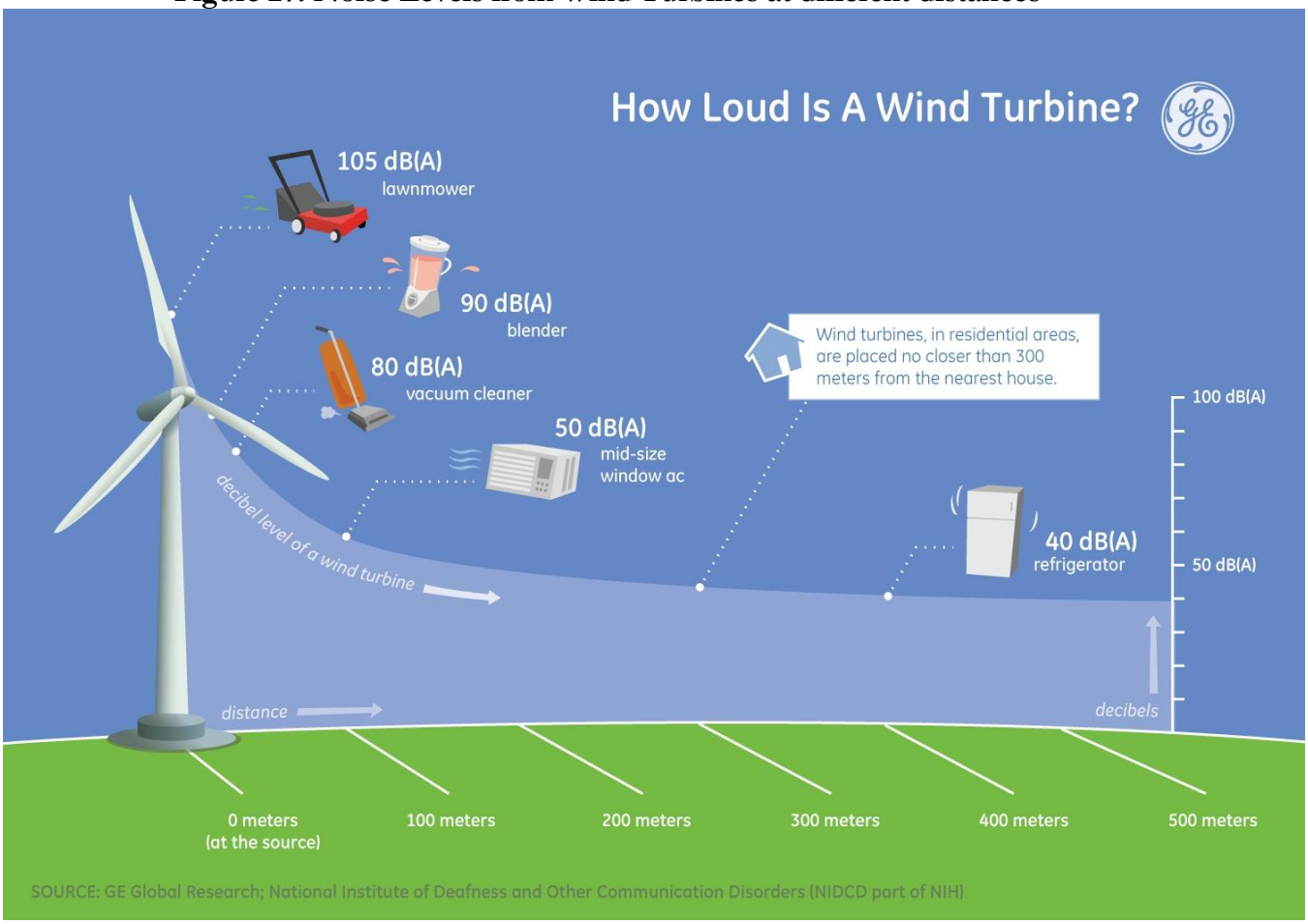
Wind Speed	**Sound power (10 m above ground, hub height 80 m, standard air density 1,225 kg/m^3)**
4 m/s	97.9 dB(A)
5 m/s	100.9 dB(A)
6 m/s	104.2 dB(A)
7 m/s	106.1 dB(A)
8 m/s	107.0 dB(A)
9 m/s	106.9 dB(A)

Studies indicate however that noise levels drop off significantly at a distance of 300 m to between 40 and 50 decibels, somewhere between an air conditioner and a refrigerator. At about 500 meters, the levels drop to about 38 decibels, which is well below the typical 40-45 decibels of background noise in a populated area, meaning that a turbine's noise would be lost amongst it. (Figure 27)

While this is the case, some persons are still affected by the rotational sound from the turbines as far as 1.6 m from the turbines which causes them annoyance and in some cases distress. The issues of noise pollution from wind turbines is very subjective so it is very important to site the wind turbines as far away from residences and schools as possible and to communicate with the stakeholders on the likely impacts associated with the development. It is usually unmet expectations from stakeholders based on ineffective communication by the developer that leads to discord.

The final design of the wind farm by the supplier Vestas has determined the locations for the wind turbines to eliminate the potential noise impact on receptors.

Figure 27: Noise Levels from Wind Turbines at different distances



Source: http://www.gereports.com/how-loud-is-a-wind-turbine/

2. Reduction in Ecological Species

One of the major environmental impacts associated with wind turbines is the adverse effects of wind facilities on avifauna (birds and bats). In many areas across the globe where there are a number of wind farms, thousands of birds and bats die each year due to collision with wind turbine blades.

Increased Bird Mortality

The risk of collision with wind turbines is one of the major potential threats faced by birds. Bird mortality rates are found to be high in areas where wind farms have been established due to collision with wind turbine blades. Poorly sited turbines are the major contributing factor affecting bird mortality rates. In areas that have large bird communities and is also used frequently by migratory birds there is a higher rate of bird kills.

Studies conducted in the United States of America (USA) estimates that less than one-tenth of unnatural bird deaths in the USA are caused by wind turbines. In fact studies show that wind farms currently kill far fewer birds than the estimated 550 million that fly into glass buildings, or up to 100 million killed yearly by cats (Table 38). According to the United Kingdom Centre of Sustainable Energy (CSE) "for every bird killed by a turbine, 5,820, on average, are killed striking buildings, typically glass windows."[9]

Wind turbine blade designs are another contributing factor to bird mortality rates. Older wind turbines have smaller blades that rotate frequently over the period of a minute. These design features have increased the risk of collision for birds as most are clipped while attempting to fly across wind farms. With modern changes to wind turbine designs, blades are being built larger and have fewer rotations per minute compared to smaller turbines.

During the fauna assessment forty-six (46) bird species were observed, including migrant species. Based on research, all bird species are expected to be impacted, however the degree and scale of impact cannot be immediately determined. Long-term observation of the site will be necessary, supported by the implementation of suitable mitigation measures.

Table 38: Causes of Bird Mortality

Causes of bird mortality	Annual bird mortality estimate
Buildings/windows	550 million
High tension lines	130 million
Cats	100 million
Vehicles	80 million
Pesticides	67 million
Communication towers	4.5 million
Wind turbines	28.5 thousand
Aeroplanes	25 thousand

Source: Ericksonn, W. Johnson, G. and Young, D. (2005), USA

Bat Mortality Rate

The Smokey Hole Cave based on the bat assessment is not only the deepest cave in Jamaica, but also one of the largest bat roosts on the island. Similar to birds, bats face tremendous threats from the erection of wind turbines. Collision with turbines is becoming one of the leading causes of increased bat mortality rates. In the USA and Europe the majority of bats killed by turbines are species that rely on trees as roosts throughout the year and migrate long distances. Bat fatalities peak during the summer and autumn in these regions and coincide with migration and mating periods for tree bats (Cryan, 2006).

[9] http://www.guardian.co.uk/environment/2012/feb/27/wind-energy-myths-turbines-bats?newsfeed=true

The species of bats identified in the Smokey Hole Cave are predominantly cave roosting species. However some species such as the Jamaican Fruit Bat (*artibeus jamaicensis)* are tree roosting species. The Jamaican Fruit Bat, similar to other tree roosting species roost at artificial roosting sites such as the roof of buildings, historical ruins and wells. It is this roosting behaviour of tree species that scientists believe attract tree bats to wind turbines.

The species of bats identified in the assessment are insectivorous and leave roosting sites in the evening in search of food. Insectivorous bat species generally hunt for food near the edges of forested areas and around the crown of trees. In the case of the Ghost-faced Bat (*Momoops Blanvilli*) they hunt insects found close to bodies of water. As previously mentioned in section 4.2.2, five (5) of the six (6) species identified are said to be under threat and have been listed on the IUCN Red List.

Wind turbines, according to the US National Research Council (2007) cause two thirds more deaths in bats than birds. Bats use their echolocation to avoid collisions with man-made objects. However there is no evidence that the echolocation calls work with non-stationary structures such as the spinning blades of the turbine. Spinning blades cause a drop in the localised air pressure around the blades and this is reported to make them undetectable to the bats, causing a serious hazard. The drop in air pressure is also said to result in an expansion of the lungs of the bats which causes internal haemorrhaging resulting eventually in their death.

The proposed wind farm by all accounts will pose a significant threat to the bat species located within the community. The major impacts include:

1. Mortality through collision with rotary blades – typically at or near the tips of blades where circumferential velocities are high;

2. Barotrauma – mortality when bats' lungs are damaged when they enter or are sucked into the low pressure area over the rotating blade;

3. Loss of foraging habitat – either due to wind farm construction or because bats avoid the wind farm area;

4. Loss of roosting habitat – either loss of vegetation for tree-roosting species or the wind farm is constructed too close to a roosting / maternity cave;

5. Barrier effect on commuting and migration routes – either due to the physical presence of the wind farm or the open space created in a previously-forested location in which "cluttered space" forest-dependent species travel.

Monitoring and an in-depth assessment of the roosting, hunting and mating behaviour of the bats will be necessary in order to determine the most suitable mitigation measures to ensure the protection of these species.

3. Electromagnetic Interference

It is a known fact that tall buildings and structures may disrupt or have an impact on wireless services which are delivered via Radio Frequency (RF) Signals. More specifically, several studies have shown that the rotating blades and the support structure of a wind turbine can impact RF signals adversely.

Wind turbines can potentially impact RF signals based on **diffraction (shadowing), mirror-type reflection or scattering.**

The following systems could potentially be impacted negatively by wind turbines based on the proximity of the turbines to the RF signals used in the operation of the systems.

- Broadcasting – Radio (AM and FM) and Television (TV)
- Subscriber TV Operations (Head-end)
- Mobile Cellular Networks and other such networks
- Aeronautical Communications Systems
- Point-to-Point (P2P) Radiocommunication systems
- Point-to-Multipoint Radiocommunication systems
- Satellite Uplinks and receive systems (e.g. VSATs)
- Direct-To-Home (DTH) satellite receive systems
- Radar (defence, air traffic, weather)

Wind turbine impacts on RF signals are assessed in two categories based on the nature of transmission and reception of the signal. These categories are Radiocommunication systems and Radar systems.

3 (a) Impact on Radiocommunication Systems

The impact on Radiocommunication systems may be divided into two categories:

a. Impact on broadcast type systems which include radio, TV and cellular type networks, and

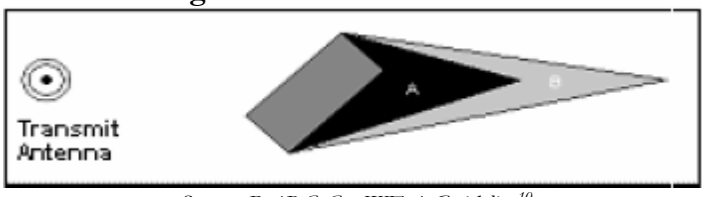
b. Impact on Point-to-Point systems such as microwave links connecting cellular sites, radio links referred to as Studio-to-Transmitter Link (STL) and Transmitter-to-Transmitter Link (TTL); as well as Point-To-Multipoint systems such as those used to deliver wireless cable service.

The likely impact on Radiocommunication sites by wind turbines is dependent on the proximity of the turbines to the RF signals and its alignment relative to the signal path between transmitter and receiver. Hence the impact could be due to either diffraction (shadowing), mirror-type reflection or scattering.

Diffraction (Shadowing)

Point-to-Point (P2P) systems require a clear line of sight between transmitter and receiver for optimum operation. Where a wind turbine falls within the line of sight, or near to the path of a radio link, it can create shadowed areas which then block the path of the signal resulting in either complete signal loss, or a degradation of signal strength between the transmitter and receiver. The shadowed areas (shown as A and B in Figure 28) would appear in the section of the path between the wind turbine and the receiver, i.e. away from the transmitter.

Figure 28: Diffraction

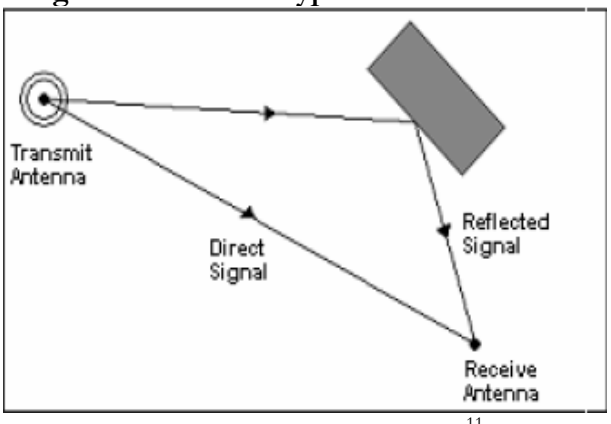


Source: RABC-CanWEA Guideline[10]

Mirror-Type reflections

It is possible for an obstacle such as a wind turbine, although not in the direct path of a radio link (i.e. line of sight from transmitter to receiver) to affect the quality of the signal at the receiver. This may occur if the transmitted signal bounces off (i.e. is reflected from) the obstacle and creates an alternate path to the receiver. This alternate path is longer than the direct signal path and hence the reflected signal is delayed in time and arrives at the transmitter marginally later than the direct signal (Figure 29).

Figure 29 - Mirror Type Reflection



Source: RABC-CanWEA Guideline[11]

[10] Radio Advisory Board of Canada – Canadian Wind Energy Association : Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radiocommunication, Radar and Seismoacoustic Systems
[11] Radio Advisory Board of Canada – Canadian Wind Energy Association : Technical Information and Guidelines on the Assessment of the Potential Impact of Wind Turbines on Radiocommunication, Radar and Seismoacoustic Systems

When the two signals are received, one with a time delay, then the delayed signal can cause a degradation of the quality of the received signal. This scenario is referred to as mirror-type reflection.

Scattering

If a RF signal reaches the rotating blades of a wind turbine, then the blades can produce a pulse scattering of the signal which would be synchronised with the rotational speed of the blades. The resulting Doppler Effect[12] produces variations in the scattered signal's phase and amplitude.

When this scattering occurs behind the turbine within an area of approximately 72 degrees in width (the front scatter zone), this effect is analogous to shadowing. The remaining 288 degrees of the arc is referred to as the back scatter zone and when this effect occurs in this area it is similar to a mirror-type reflection.

Thus the scattering effect produced by the rotating blades of wind turbines can result in either a scattering effect or a combination of both a scattering effect and the mirror-type reflection; depending on the alignment of the turbine and its proximity to transmitters and receivers. If this occurs for a TV signal and the scattered signals are strong enough at a TV receiver, then this could lead to a distortion of the picture which is referred to as "ghosting."

3 (b) Radar Systems

The potential impact of wind turbines on radar systems, unlike Radiocommunication systems, is not proximity dependent and therefore is not easily determined. It is recommended that each site proposed for a wind farm is reviewed with respect to any radar system within its environs since each radar has a different coverage footprint which is dependent on its location and the topographical layout of the area.

The operational performance of radars, especially weather radars, could be impacted by a wind turbine in close proximity to it. This could lead to 'blockage' which describes the scenario where a certain angular sector of the radar beam is blocked by some external object. Another potential impact of wind turbines on radar systems is referred to as 'clutter' which is essentially unwanted echoes on the radar display. If a wind turbine is in the line of sight of air traffic control radar then this could potentially impact the ability of the radar to provide air traffic services.

Consultation Zones

In order to understand the nature of the RF signal environment within the environs of the proposed site, consultations with the users of RF signals was necessary. Since the most important factor is the proximity of the turbines to the signals, the

[12] The Doppler Effect is the change in frequency of a wave for an observer moving relative to the source of the wave.

Consultation Zone must be defined i.e. the geographical area where the turbines will impact on RF signals.

The "Guidelines for Determining Consultation Zone" developed by the RABC-CanWEA indicate that for the typical RF systems (such as Broadcast transmitters and Point-to-Point) that may be impacted by the operation of wind turbines, then for proximity reasons:

- The radius of the Consultation Zones is 1.0 km around:
  - Fixed Land Mobile Radios (LMR) stations,
  - Point-to-Point (P2P) stations below 890 MHz,
  - Cellular and other wireless mobile service provider stations.

- The consultation zones specifically for Broadcast transmitters are:
  - AM station – 5.0 km (single tower), 15km (multiple towers)
  - FM station – 2.0 km
  - TV station – 2.0 km

- The consultation zones specifically for Over-the-Air reception are:
  - Analog TV station – 15 km
  - Digital TV station – 10 km

  For other RF systems such as radars, the following Consultation Zones are recommended:

a) Weather radars: A minimum of 50 km
b) Air Traffic Control radars: A minimum of 60 km for military or civilian airfield

   For air defence and vessel traffic radars, it is important that the project proponent consults with the relevant local authority to determine if the turbines will have any impact on radars providing such services.

3 (c) Radiocommunication Systems in Jamaica

The Spectrum Management Authority (SMA), the governmental body mandated to manage the RF Spectrum on behalf of the Government of Jamaica, has details on all licensed/authorised users of the spectrum (including broadcasters) who may have Radiocommunication facilities within the proposed site of the wind farm. In addition, the Broadcasting Commission regulates Subscriber TV Operators (cable service) and therefore has relevant information on the providers of cable service within the vicinity of the proposed wind farm.

Information on licensed/authorised users of the RF Spectrum and STV Operators (cable service) within a 5 km radius of the proposed site, gathered through formal requests from the SMA and the Broadcasting Commission respectively is presented in Table 39 and (Figure 30).

The SMA provided information to indicate that the following RF signal sites are within 5 km of the proposed wind farm site.

Table 39: RF Signals within 5 km of Project Site Boundary

Site Name	Site Location	Distance from Project site (km)	Frequency Band	Type of Service
1. Cross Keys	17° 54' 50"N, 77° 29' 45"W	3.57	10 GHz	Fixed Link (P2P)
2. Sea Air	17° 55' 25"N, 77° 34' 08"W	5.67	13 GHz	Fixed Link (P2P)
3. Rose Hill	17° 55' 31"N, 77° 31' 44"W	3.24	8, 11, 15 GHz	Fixed Link (P2P)
			800 MHz	Trunking
			5 GHz	Fixed Link (P2P)
			136-174 MHz	Land Mobile
			6 GHz	Fixed Link (P2P)
4. Downs	17° 56' 24"N, 77° 34' 00"W	4.99	15 GHz	Fixed Link (P2P)
			10,11 GHz	Fixed Link (P2P)
5. Grove Town	17° 54' 18"N, 77° 31' 38"W	1.04	15 GHz	Fixed Link (P2P)

Source: Spectrum Management Authority, Jamaica, April 2012

The types of radio frequency service at these sites are classified as either 'fixed link (P2P)', 'land mobile' or 'trunking'. Research conducted globally and the experience of existing wind farms in countries such as Australia, indicate that interference to fixed link (P2P) services caused by wind turbines would be negligible[13]. In fact, interference is likely only when the wind turbine is in the direct path of the signal being transmitted. This is very unlikely for fixed link services which require direct line of sight between the transmitter and receiver for a given signal path.

For land mobile services (2-way radio services using VHF[14] or UHF[15]), in the unlikely event a radio user should experience interference due to the proposed wind farm, then the user would be able to eliminate such interference by a marginal change in their physical position. This is consistent with the modus operandi for the use of such radio systems whenever a user encounters interference caused by any land-based object that may block the radio signal.

[13] Woodlawn Wind Farm EIS: http://www.woodlawnwind.com.au/_PDF/_Sections/15.pdf
[14] VHF: Very High Frequencies
[15] UHF: Ultra High Frequencies

Figure 30: RF Signals within 5 km of Project site

Mobile Cellular Service

Mobile Cellular Networks comprise of cellular base stations (which link with mobile phones) as well as fixed link (P2P) sites for carrying traffic between cellular base stations. From Table 39 with the list of radio frequency sites within 5 km of the project area:

a) There are no point-to-point stations below 890 MHz which would fall within the 1.0 km consultation zone. Further the fixed link (P2P) stations which are within 5 km of the site do not transmit or receive RF signals which would be impacted by the turbines. In fact the propagation of RF signals from each of these P2P stations is in a direction away from the proposed project site.

b) There are no cellular mobile service provider stations (base stations) within the 1.0 km consultation zone, or even within 5 km of the site.

Therefore the wind farm should not have any impact on mobile cellular service within the environs of the proposed project site.

Radio and TV Broadcasting Services

There is the potential for interference to radio and TV signals caused by wind turbines. Such interference would be due to one of two effects, either 'Shadowing' (Diffraction) or 'Reflection'; both of which have been explained earlier in this document. Generally, 'shadowing' leads to a reduction of the signal strength which may manifest itself as a degradation of picture quality, loss of colour or a buzz sound for TV reception. If a TV's signal is affected by 'reflection' then the delay in reception of the reflected signal will create a pale shadow(s) to the right of the main picture; this is called "ghosting."

In both instances, the wind turbine would have to be physically close to the radio or TV transmitter site for the transmitted signals to create the 'shadow' effect or the 'reflection' effect. Then too, the locations which would experience such interference would have to be within the 'shadow' zone of radius up to 5 km or the 'reflection' zone of a circle of radius 500 m from the wind turbine[16]. Furthermore, the fibre glass reinforced blades of the wind turbines are essentially transparent to electromagnetic waves which significantly reduce the reflective effect that could cause interference.

Based on the information provided by the SMA, there is no radio or TV transmitter site within 5 km of the proposed wind farm site. In fact, supplemental information provided by the SMA confirms that no radio or TV transmitter site is within 10 km of the proposed wind farm site. Therefore, it can be concluded that it is very unlikely that TV reception will be affected within the environs of the proposed site for the wind farm due to interference with radio and TV transmission. However there is the possibility that TV reception could be affected by the operations of the wind turbines as the receivers are within the 15 km for analog TV stations (Jamaica does not have digital free-to-air TV signal at this time).

In the unlikely event some TV reception is impacted by the wind turbines then the mitigation measures include:

- Installing an outdoor antenna if none exists
- Realigning the TV antenna to point directly at the TV transmitter
- The installation of more directional or higher gain antenna at the affected residences
- Relocating the antenna to a less affected position
- A combination of the above measures

Based on the socio-economic survey conducted for this EIA, of the respondents:

- 70% have roof mounted antennae for TV stations,
- 15% surveyed have roof mounted antennae for radio stations
- 26% have no antennae.

[16] Ofcom: Tall Structures and their impact on broadcast and other wireless services - http://www.ofcom.org.uk/radiocomms/ifi/licensing/classes/fixed/Windfarms/tall_structures/tall_structures.pdf

These percentages indicate that a majority of the members of the surrounding communities have already implemented the mitigation measure of installing an outdoor antenna. If these members are impacted, the other mitigation measures would apply.

Subscriber Television Service (Cable TV)

The Broadcasting Commission responded to the request for information indicating that based on their records, there are no licensed Subscriber Television Operators (STVO) with headend facilities within 5 km of the proposed site at Great Valley. Also, based on the field survey conducted the residences within the environs of the proposed wind farm do not have cable TV service.

The Operator licensed to provide cable services closest to the Great Valley area is McKoy's Cable Television Company Limited serving the Southfield and Junction zones which are outside of the 5 km radius.

From the above information, it can be concluded that the installation of the proposed wind turbines at Great Valley will not impact Subscriber TV (cable) services.

3 (d) Radar Systems in Jamaica

The Meteorological Service Office confirmed that there is only one weather radar station in Jamaica located at Coopers Hill, St. Andrew which communicates with a receiver at the Norman Manley International Airport, Palisadoes, Kingston.

The weather radar station at Coopers Hill is approximately 72 km from the proposed site which is outside of the recommended consultation zone of 50 km within which one would assess the potential impact of the wind turbines on weather radars. Therefore, it may be concluded that the proposed wind farm at Great Valley will not have a negative impact on the weather radar operated by the Meteorological Service.

CAEL, the Project Proponent made direct contact with the Jamaica Civil Aviation Authority (JCAA) and provided them with the required information. The JCAA advised in their response that the nearest Government Aerodrome is the Norman Manley International Airport, Palisadoes, Kingston (77 km from project site) and the nearest private aerodrome is in Nain, St. Elizabeth (11 km from project site). The JCAA therefore approved the project stating that the wind turbine is located beyond the Outer Horizontal surface limits of the Norman Manley International Airport and Nain aerodrome.

The closest air traffic monitoring and control radar to the wind turbine site operated by the JCAA is located at Pike in Manchester which is approximately 37 km from the proposed project site. Based on the approval letter issued by the JCAA (Appendix 5), it is very unlikely that the operation of the wind turbine will have an impact on this radar.

4. Seismological Monitoring Equipment

Wind turbines could potentially have a negative impact on the operation of seismological monitoring equipment depending on the proximity of the wind turbines to the equipment and the level of noise and vibration from the turbines. The noise and vibration from the turbines could be interpreted by the seismological monitors as a 'false' earthquake.

The extent to which low frequency noise and vibration from any source impacts seismological monitoring equipment will be dependent on the sensitivity of the selected technology for the monitoring equipment and any mitigating measures implemented during construction of the vault used to house the equipment.

The UWI Earthquake Unit advised that there are twelve (12) seismograph stations positioned across Jamaica in the locations shown in Table 40.

Table 40: Seismograph Stations Across Jamaica

No.	Location	Parish
1	University of the West Indies – Mona Campus	St. Andrew
2	Stony Hill, Wireless Road	St. Andrew
3	Greenwich, Newcastle	St. Andrew
4	Kempshot, Montego Bay	St. James
5	Munro College	St. Elizabeth
6	Portland Cottage – Light house	Clarendon
7	Yallahs	St. Thomas
8	Bonny Gate	St. Mary
9	Bamboo	St. Ann
10	Pike, Mount Denham	Manchester
11	Mount Airy, Negril	Westmoreland
12	Castle Mountain	Portland

Consultation zones recommended for seismological equipment is a minimum of 10 km around a single station. The closet seismograph station is found at Munro College in St. Elizabeth, which is approximately 20km from the proposed site and therefore outside the recommended consultation zone of 10km. There is one seismograph station in the parish of Manchester. This is located in the community of Pike, Mount Denham in north Manchester and is approximately 37km from the proposed wind turbine site.

5. Shadow Flicker

Shadow flicker is defined as "the on-and-off flickering effect of a shadow caused when the sun passes behind the rotor of a wind turbine."[17] This occurs under certain specific conditions and its intensity varies depending on factors such as:

[17] As defined by the UK Government

- The size of the turbine and its geographic location
- The angle and intensity of the sun
- The time of year and the number of day-light hours
- The distance from the turbines to the shadow receptors
- The height of the sun

This shadow flickering effect mainly occurs when the sun is low in the sky and the rotating blades of the turbine cast patches of shade that flicker through a narrow aperture such as a window or door opening.

A primary factor which determines the intensity of shadow flicker at a potential receptor (i.e. the facility where the shadow falls) is the distance of the wind turbine from that receptor. Shadows that are cast close to a turbine will be more intense than those at some further distance. Based on research and scientific studies, it is widely accepted that shadow flickering effects are not experienced at a distance of greater than the equivalent of 10 times the rotor diameter of the turbine; and further, only receptors that lie within 130º either side of North will be so impacted. The distance of 10 times the rotor diameter is called the zone of influence for shadow flickering. In this case the zone of influence is 900m.

Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance. In general, the largest number of shadow flicker hours, along with greatest shadow flicker intensity, occurs nearest the wind turbines.

An analysis was conducted of the buildings which appear within the 900m consultation zones around each proposed wind turbine location for the shadow flicker effect. This was done using the latest Google Earth image available within the public domain on-line with an imagery date of March 6, 2010 of the proposed project area and the surrounding communities. **Figure 31** shows the proposed location of each turbine and the overall combined consultation zone for the shadow flicker effect. The analysis also assumes that all buildings located within the consultation zone are within the 130° on either side North of each turbine as required for the effect to be noticeable.

The analysis indicates that there are several buildings within the 900m consultation zone for the shadow flicker effect and are therefore likely to be impacted. Most of these buildings are located in the communities of Broughton and Rest Store while a few are located in Cocoa Walk. The majority of the buildings in the consultation zones for each turbine are located in the northern hemisphere of the overall combined consultation zone (see **Figure 32**). Further, most of the buildings within the zone appear to be closer to the boundary of the consultation zone (i.e. within the range of 450-900m) than to the wind turbines.

Given the fact that the shadow flicker effect diminishes with increasing distance from the turbines, it is likely that most of the buildings within the overall combined consultation zone will experience reduced levels of shadow flicker impact. Few of the buildings in the Rest Store and Broughton communities are located closer to the

turbines than to the boundary of the consultation zone. These buildings are highlighted by the circles in **Figure 33** and are therefore expected to experience a higher level of the shadow flicker effect particularly from wind turbines 5, 6 and 7.

The supplier of the wind turbines, Vestas has taken these potential impacts into consideration and has determined the optimum location for the wind turbines to eliminate the impact of shadow flicker on nearby buildings.

5 (a) Photosensitive Epilepsy

"Photosensitive epilepsy is the name given to epilepsy in which all, or almost all, seizures are provoked by flashing or flickering light, or some shapes or patterns."[18] Generally, epilepsy affects only a very small portion (0.005%) of the general population, and photosensitive epilepsy affects only approximately 3-5% of those who suffer from epilepsy.

The factors that trigger photosensitive epilepsy include the frequency and intensity of flickering, the pattern of the image as well as the area the light stimulus occupies in the visual field. The threshold frequency for triggering a seizure varies from one individual to another but is generally between 5 to 30 Hz[19]. Research also indicates that less than 5% of photosensitive epileptics are sensitive to the lowest frequencies of 2.5 Hz to 3 Hz.

The technical specification for the proposed wind turbines to be installed by CAEL indicates that the rotation speed for the turbines ranges between 9.3 rpm and 16.6 rpm. The flickering frequency of the shadow generated by the turbine will be equivalent to 3 times the wind turbine operating speed, therefore at the slow end of the range this will be 0.47 Hz and at the maximum speed it will be 0.83 Hz.

The threshold frequency for triggering photosensitive epilepsy is generally 5 Hz, and for a very small percentage of persons affected it is 2.5 Hz. Based on the fact that the maximum flicker frequency anticipated by the turbines to be installed by CAEL is 0.83 Hz then it may be concluded that the proposed wind farm by CAEL should not trigger photosensitive epilepsy.

[18] http://www.epilepsy.org.uk/info/photo.html
[19] http://www.epilepsyfoundation.org/about/photosensitivity/gerba.cfm

Figure 31: Wind Turbine locations and the corresponding Consultation Zone for the potential effects of shadow flicker

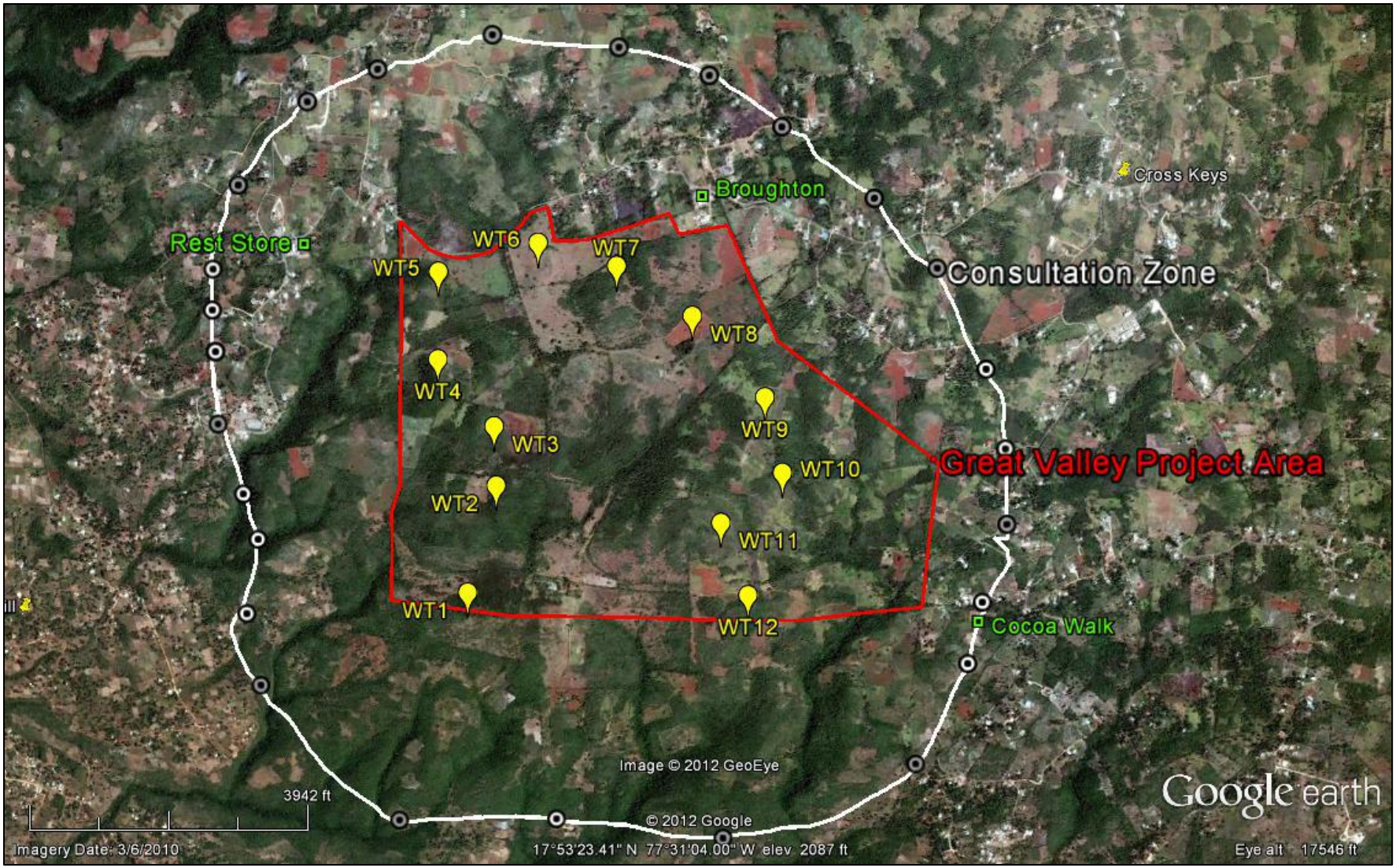


Figure 32: Northern Hemisphere of Consultation Zone for the potential effects of shadow flicker

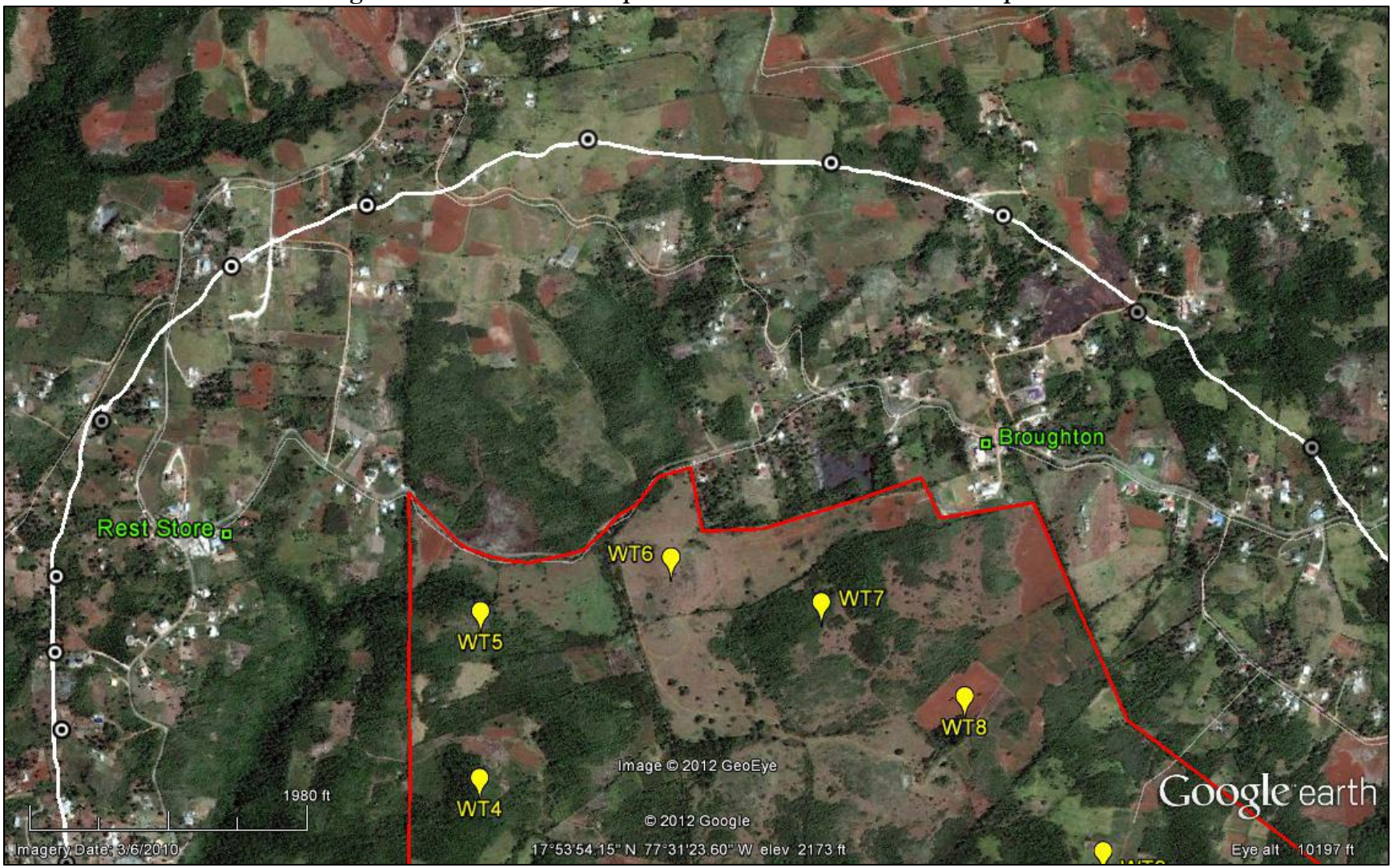
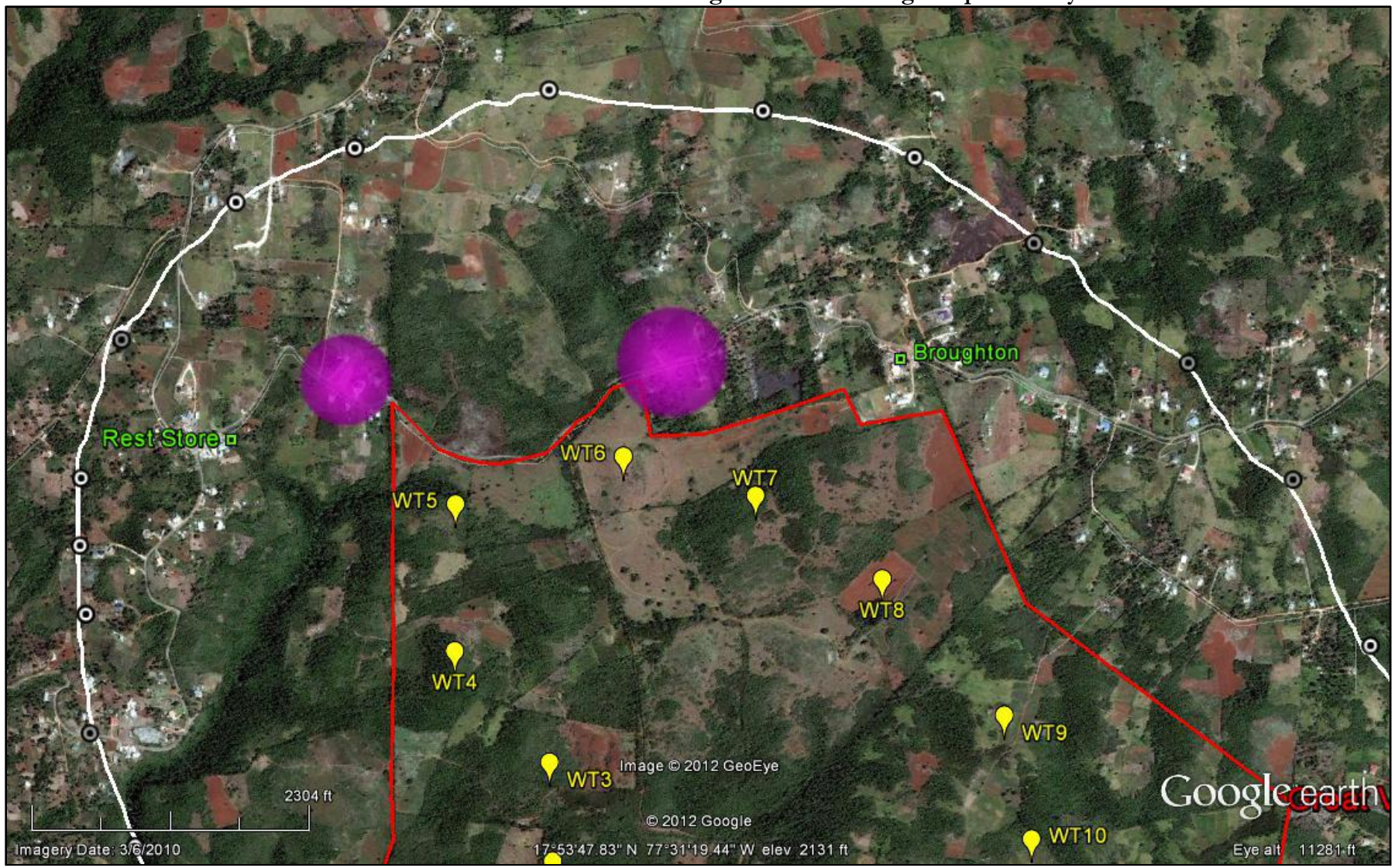


Figure 33: Northern Hemisphere of Consultation Zone for the potential effects of shadow flicker showing the areas with highest probability circled



6. Land and water pollution

Lubricating oil leaks from wind turbines could cause land and water pollution as the oil could be spread around the area by the blades of the wind turbine. It is unlikely that there will be any pollution of water resources as there are no surface waters in the area and the groundwater resources are very deep underground. Additionally the volume of oil is small and insufficient to cause any significant impact. The potential for land pollution exists however if spills and leaks are not managed.

7. Reduction in the Aesthetic Value of the Physical Landscape

Some persons feel that wind turbines reduce the aesthetic value of the landscape. This view is however subjective. In the case of wind farms, their siting influences the aesthetic appearance of a particular area, as the cluster of turbines can block areas considered scenic. Where there are single erected turbines or only a few as in this case, it is difficult to determine the extent to which the aesthetic value of a landscape is reduced. Persons from communities surrounding the project sites did not indicate that the wind turbines would be aesthetically displeasing.

8. Obstruction to Air Traffic

The height of the towers could theoretically pose obstruction to air traffic. The Jamaica Civil Aviation Authority (JCAA) was advised of the proposed project and their approval sought for the turbine sites in relation to air traffic movements. Their reports indicated that the turbines are beyond the Outer Horizontal limits of Norman Manley International Airport and Nain Aerodrome and would therefore not pose obstructions to air traffic. (Appendix 5)

6.2 Significant Environmental and Social Impacts

Negative impacts are undesirable, but not all negative impacts are equal. There are some that are considered significant based on a number of criteria. This section determines the significance of each impact according to the specific criteria presented at Table 41: Significant Impact Assessment Criteria. The significant impact determination/assessment is presented at (Table 42).

Table 41: Significant Impact Assessment Criteria

CRITERIA	Minor	Moderate	Severe
Scale takes into consideration the spatial/ geographic extent of the impact	On site or within project site boundaries	Beyond site boundary but within community/local area around project site (2 km)	Widespread or at a regional//national/inter national scale
Duration is the overall length of time an identified impact is likely to persist	Short term (less than 5 years); less than project lifespan; quickly reversible	Medium-term (5-15 years), over the lifespan of the project; reversible over time	Long-term (more than 15 years); permanent; irreversible
Intensity (Baseline Change) examines the severity of the impact on the physical, biological and socio-economic baseline of the project area and examines the change from the pre-project or current baseline conditions	Disturbance of degraded areas, with little conservation value Minor change in species occurrence or variety Limited or no adverse change to the baseline status of social, economic and environmental receptors	Moderate disturbance of areas that have potential conservation value Complete change in species occurrence Disturbance of community's environmental, social and economic fabric Potential conflict with community's development plans	Significant adverse environmental impacts (quality of land, air and water resources) Widespread disturbance of community's social and economic fabric Substantial increase in solid waste generation, increase in potential for erosion, flooding or leaching. Removal and or destruction of large quantities of flora and fauna, including endangered or threatened species; substantial interference with the movement of migratory species
Affected Numbers takes into account the number of individuals or receptor population (organisms, people etc.) that stand to be affected by the project	<5% of the population or habitat is directly exposed	5-10% of the population or habitat is directly exposed	>10% of the population or habitat is directly exposed
Secondary Effects considers the indirect effects of the project	Few indirect impacts	Moderate amount of indirect impacts	Substantial amount of indirect impacts (generational impact)

CRITERIA	Minor	Moderate	Severe
Reversibility evaluates the extent to which the affected receptor can be returned to its pre-project state after experiencing an adverse impact	Completely reversible (0-5 years); not costly	Reversible (5-15 years); may or may not be costly	Irreversible (damage cannot be reverted to original condition within a 50-100 year period)
Acceptability takes into account the willingness of stakeholders to make trade-offs, given the potential benefits of the project, limited environmental changes or the ability to mitigate adverse impacts	No risk to public health. Modification of landscape without down grading special social, economic and aesthetic values Within legal thresholds and allowable limits Some loss of biological populations and habitats	Conflict with policies or land-use plans Loss of populations of commercial biological species Community stakeholders willing to make trade-offs Projected impacts (environmental, social and economic) can be managed through the implementation of alternatives, mitigation measures and with regulatory controls	Large scale loss of productive capacity of renewable resources Increases level of risk to public health Project needs to be redesigned Extinction of biological species, loss of diversity, rare or endangered species and critical habitats Legal thresholds and allowable limits exceeded/ breached Can lead to widespread public outcry

Table 42: Significant Impact Assessment - Negative

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		Construction phase	
1.	**Fugitive dust emissions & Vehicular emissions** • Air pollution • Respiratory problems	SCALE • The highest concentration of fugitive dust and vehicular emissions is expected to occur at the project sites. • Road construction activities may affect the local area • Fugitive dust from trucks transporting (uncovered) aggregate • Some fugitive dust will be generated as a result of blasting for turbine foundations • High wind speeds are expected to rapidly disperse fugitive dust and diesel emissions DURATION • Short-term - This is expected to last for the duration of the construction phase (9-12 months) of the project INTENSITY (BASELINE CHANGE) • Major change from present baseline conditions given the extensive construction works to be undertaken at the project site. • Though farming activities are extensive within the communities, the associated activities have not resulted in any major disturbance to ecological species or people. • The concentration of activities within the anticipated construction period is likely to impact receptors within close proximity to the project site. • It is not anticipated that there will be any adverse changes to the baseline status of social, economic and environmental receptors in the long-term. AFFECTED NUMBERS • Between 1-5% of the population stand to be affected given the proximity of the proposed site to the community of Broughton. The community has 2 educational institutions and it is anticipated that the pupils and staff will be affected. • The Broughton Basic and Primary Schools are located on the eastern boundary of the project site in the community of Broughton about 500 m from the proposed turbine#7. • The biological community within the project area is likely to face some stress during this phase. Access paths construction, clearance of vegetation and the release of noxious emissions associated with the movement of heavy vehicles and equipment will result in disturbance to the existing biological species. • It is not anticipated that the impact will be adverse as the biological community on site has been exposed to external	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		stresses associated with farming and land clearance activities. SECONDARY IMPACTS • Increase in greenhouse gas emissions from motor vehicles that contribute to global warming and climate change REVERSIBILITY • Completely reversible: dust will eventually settle or clear out of the atmosphere as a result of wind and rainfall and emissions will be dispersed. ACCEPTABILITY • Fugitive dust, not acceptable; must be mitigated and kept at a minimum • Stakeholders will be willing to make trade-offs in respect of the temporary nuisances provided that appropriate mitigation measures are implemented.	
2.	**Noise** • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	SCALE • Beyond site boundary but within community/ local area around project site (2 km) • Noise may affect the schools (Broughton Primary and Basic Schools) • Some noise will be generated as a result of blasting for turbine foundations DURATION • Short term (during work hours), quickly reversible • This impact is expected to last for the duration of the construction period (9-12 months) INTENSITY • Disturbance of community's social fabric • Nuisance noise during construction is expected to be a noticeable change in the immediate area of construction AFFECTED NUMBERS • Less than 1-5% of the population is directly exposed; given the location of residences, educational and religious institutions to the project site • Workers at the site could be affected by construction related noise • Students and staff at the Broughton Primary and Basic School, the closest building to wind turbine #7 (~ 500 m), may experience increased noise nuisance during work hours for the duration of the construction period (9-12 months)	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		• Increased truck traffic passing through communities en route to the site can cause an increase in noise nuisance intermittently throughout the construction period SECONDARY IMPACTS • Temporary or long term hearing impairment for persons on the construction site without hearing protection (Appendix 6) REVERSIBILITY • The effects of the temporary nuisance are completely reversible with cessation of the construction activities. • Permanent hearing loss is irreversible ACCEPTABILITY • In general, stakeholders are willing to make trade-offs in respect of temporary nuisances provided that available and appropriate mitigation measures are implemented.	
3.	**Loss of Productive Farm Lands and Temporary Displacement of Farmers**	SCALE Onsite DURATION Farming activities will not be affected by the construction INTENSITY - AFFECTED NUMBERS None SECONDARY IMPACTS - REVERSIBILITY Not applicable ACCEPTABILITY -	**NO**
4.	**Removal of vegetation** • Habitat destruction • Disruption of ecosystems	SCALE • Onsite, within project site boundaries; specific areas identified for access roads and wind turbine towers. • Regional; modification of two (2) corners en route to site to facilitate transportation of heavy equipment and large components of wind turbines • Acreage of temporarily cleared land is 5.3 ha • Acreage of permanently cleared land is relatively small (3.5 ha)	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		DURATION • Long term and likely to be permanent: roadways (3.6 ha); substation (0.0048 ha); wind turbines (0.53 ha) • Short term, for duration of project: crane pads and construction laydown area INTENSITY • Minimal loss of flora along the on property access route to the construction sites. • Depending on flora removed there could be loss of habitat for observed fauna. Fauna to be impacted include all observed species of butterflies, snails and other insects as well as impact to native (including endemic) and migratory bird species which were observed utilizing these marginal habitats for feeding and foraging. • Preliminary information for the development proposal has indicated that several wind turbines have been earmarked for the pinnacle of hills located on the property. It is anticipated that these areas which currently have disturbed and/or degraded forest could see loss of some vegetation which can affect the habitat of butterflies as well as native, endemic and migratory bird species. However mitigation measures can be implemented such as making minor modifications to the location of the turbines to minimise or eliminate adverse impacts on flora. AFFECTED NUMBERS • <5% of the population will be directly exposed as there are very few residences in Great Valley. • <1% of birds and bats are likely to be affected, if some trees and other flora are removed. • The effect on vegetation will be moderate since the area has been disturbed as a result of farming activities, and as such changes are not considered new and sudden. SECONDARY IMPACTS • Modification of landscape REVERSIBILITY • Areas temporarily cleared will be naturally restored over time, at no cost, that is, grass will fill in those areas cleared where no structure has been erected. Alternatively, these areas can be restored by planting grass at a low cost ACCEPTABILITY • Modification of landscape without down grading special social,	

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		economic and aesthetic values • Given the tremendous benefits to be had from the use of alternative energy sources, persons will be willing to accept land use changes	
5.	**Solid waste (top soil, vegetation, construction debris, garbage)** • Land and water pollution	SCALE • Onsite (within project site boundaries) land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Limited disturbance of secondary growth areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Garbage may attract rodents and flies • Uncontained garbage can affect aesthetics • Uncontained top soil can be washed away during rainfall events REVERSIBILITY • Completely reversible at minimal cost ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**NO**
6.	**Increased traffic movement** • Traffic congestion • Motor vehicle accidents	SCALE • Beyond site boundary but within community/local area around project site (2 km) DURATION • Short term for the duration of the project INTENSITY • Disturbance of community's environmental, social and economic receptors	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**	**SIGNIFI-CANT**
		AFFECTED NUMBERS • It is anticipated that between 30-40% of the population will be directly exposed as the main town of Cross Keys is used frequently by residents within the surrounding communities. Taxis and private vehicles frequently use the roadway passing the entrance to the site en route to the Cross Keys town centre. It is expected that all road users in the area will be affected • Residents in Rest Store and Broughton are likely to be the most impacted given the proximity of these communities to the site. Schools located in Broughton and settlements (residential and commercial establishments) between Rest Store and the entrance to the site are likely to face the most direct disruptions due to anticipated movement of vehicles along this section of the travel route. • The location of key commercial establishments in the town centre e.g. restaurants, gas station, supermarkets, etc. will likely attract workers, which can result in the movement of trucks and other vehicles along other indirect access routes to the site SECONDARY IMPACTS • Increased fuel consumption as a result of traffic congestion • Death and injury as a result of accidents • Increased vehicular emissions • Increased wear and tear of road surfaces • Increased travelling and waiting times REVERSIBILITY • Traffic congestion reversible after construction ends • The effects of motor vehicle accidents are not reversible ACCEPTABILITY • Some level of tolerance is expected by the residents in the communities surrounding the project sites	
7.	**Use of fuel** • Depletion of (oil) resources	SCALE • National/international scale as an imported non-renewable energy source is being used DURATION • Short term, for the duration of the project INTENSITY • Contribution to global depletion of resources is negligible	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		AFFECTED NUMBERS • Contribution to national and global demand is low SECONDARY IMPACTS • Contributes to greenhouse gas emissions • Contributes to air pollution • Contributes to high fuel bill and foreign exchange demand REVERSIBILITY • Permanent ACCEPTABILITY • Acceptable given the type of project; no alternatives available	
8.	**Human waste** • Land and water pollution	SCALE • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Foul odours • May attract rodents and flies REVERSIBILITY • Quantity of sewage small, land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**NO**
9.	**Soil erosion** • Off-site effect is the	SCALE • Sediments may be transported by storm water beyond the site	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
	movement of sediment and agricultural pollutants into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil	boundary but within the community/local area around the project site (2 km) DURATION • Short term, for duration of project INTENSITY • Soil excavation and filling will be a large component of the project. During access road construction and installation of the wind turbine foundations, it is likely that large volumes of top soil will be removed and rocks excavated to ensure proper levelling of the road surfaces and foundation sites. This activity will represent a major change from present baseline conditions and is likely to result in the destruction of biological habitats and disruption of ecosystems. • There are not many surface or ground water resources within the project boundary, however there are evidence of drainage networks on site, which disappear just beyond the project boundary, indicating the presence of sinkholes. Increased run-off is likely to increase sediment loadings into the nearby drainage channels/networks and may result in contamination of underground water sources, if present. AFFECTED NUMBERS • It is anticipated that approximately 10-20% of the flora and fauna on site will be affected. • Less than <2% of the human population is likely to be affected, given their location in relation to the proposed site. Fugitive dust emissions are likely to be the main threat associated with excavation works and soil erosion. SECONDARY IMPACTS • Loss of biological habitats and disruption of ecosystems • Possibly pollution if groundwater resources, if present • Blockage of drainage channels/networks REVERSIBILITY • Permanent ACCEPTABILITY • Not acceptable; mitigation required	
10.	**Construction work** • Accidents causing death or injury	SCALE • Onsite within project boundaries DURATION	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**	**SIGNIFI-CANT**
		• Short term for the duration of the project INTENSITY • Has the possibility to disturb the baseline social and economic receptors AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS - REVERSIBILITY • Death and serious injury not reversible ACCEPTABILITY • Not acceptable, mitigation measures must be implemented	
11.	**Use of water** • Depletion of water resources	SCALE • Beyond site boundary but within community/local area around project site (2 km) DURATION • Short term for the duration of the project INTENSITY • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS - SECONDARY IMPACTS - REVERSIBILITY • Permanent ACCEPTABILITY • No alternative, water needed for construction	**NO**
12.	**Fuel and oil spills** • Land and water pollution	SCALE • Onsite (within project site boundaries) land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		DURATION • Short term, for the duration of the project INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Unsightly appearance of areas where spills occur • Quantities are likely to be small but they may be transported to other locations via storm water • Land and water pollution associated with waste disposal REVERSIBILITY • Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
		Operation Phase	
1.	**Noise** • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	SCALE • The noise emitted from the wind turbine will vary considerably within and around wind farms. Wind turbines create more sound as the wind speed increases, with the sound emitted decreasing as the distance from its source increases. The sound from turbines will therefore extend beyond the boundary. DURATION • Long term, permanent; for as long as the wind turbines are in operation. INTENSITY • Broughton Primary and Basic Schools are likely to be the most affected by the sounds emitted by wind turbine #7 as it will be located approximately 500 m from the Broughton Basic school and is likely to generate noise in excess of the acceptable level of 55 dBA daytime. • Residents living less than 1 km from any of the turbines will be impacted by the noise from the turbines which is likely to exceed	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		55dBA (daytime) and 50 dBA (night-time) • Though the increase in noise level is considered a moderate increase in baseline levels, ecological species are not expected to be adversely affected. AFFECTED NUMBERS • The Broughton Basic and Primary Schools have an estimated population size of two hundred (200) students and ten (10) teachers. • It is anticipated that the entire student and staff population will be impacted, including other users of the schools, including parents and auxiliary workers. Students and staff will be the most impacted. • The exact number of residences located within 1 km of any of the turbines is not known but based on the publicly available Google Earth Image for March 2010, some residences in Rest Store, Cocoa Walk and Broughton will be impacted adversely. (Refer to **Figure 31** which shows the 900 m boundary around all the turbines). SECONDARY IMPACTS • Discontent amongst community members REVERSIBILITY • Only reversible if the turbines are not in operation or decommissioned ACCEPTABILITY • Residents, particularly those located within close proximity to the site may not willingly accept the increased noise level associated with the operation of the turbines. There will be concerns from parents, as well as staff members at the schools that will be affected based on their proximity to the wind farm. • Appropriate measures will need to be put in place to mitigate the noise impacts and respond to complaints associated with increased noise levels from the turbines. If these measures are effective, then residents will generally be accepting of the moderate change in noise levels.	
2.	**Disruption in avifauna flight patterns** • Bird and bat deaths	SCALE • Beyond site boundary but within community/local area around project site DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation.	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**	**SIGNIFI-CANT**
		INTENSITY • The degree of intensity cannot be accurately assessed given limited information on the behaviour of the avifauna, particularly bats and their interaction with the proposed site. It is anticipated that the change to the existing baseline will be moderate to significant as it relates to bat deaths. The change to the baseline status of birds is likely to be negligible. AFFECTED NUMBERS • Birds – the site is actively used by several bird species, but the interaction of birds with turbines has shown that the overall impact is very limited. It is therefore not anticipated that more than 1% of the bird species utilising the site will be impacted. The greatest impact may be for migrant bird species. This impact is expected to be a short-term impact, as over time migrant species will be more aware of the change in the environment. • Bats – the impact is expected to be adverse, given limited knowledge on the behaviour of bat species in the community and their interaction with the site. SECONDARY IMPACTS - REVERSIBILITY • There is likely potential for long-term impacts on specie abundance within the area. The projected operation timeline of twenty (20) years can result in large volumes of bat and bid species being killed. With proper mitigating measures, the impacts could be reduced and over-time be considered likely reversible. ACCEPTABILITY • Acceptability will depend on the effectiveness of mitigation measures. Mitigation measures can help to reduce the likely impacts on avifauna; however these methods may not immediately reduce the anticipated changes in baseline conditions. • Long-term monitoring of the behaviour of avifauna will be required.	
3.	**Diffraction/Shadowing, Reflection, Scattering** • Electromagnetic interference which can affect radar and radio communication	SCALE • Beyond site boundary but within community/local area around project site DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation.	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		INTENSITY • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS • Consultations and information received indicate that the wind turbines will pose no interference to radio frequency signals in the area except for the potential impact on TV reception at the neighbouring communities. However, the results of the socio-economic survey indicate that the majority of the occupants have externally mounted roof antennae which already mitigates against the impact on the TV reception caused by the operation of the wind turbine. SECONDARY IMPACTS - REVERSIBILITY • Reversible once the turbines are no longer in operation ACCEPTABILITY • Acceptable based on the benefits to be derived and the fact that the potential impact can be mitigated	
4.	**Disruption in air traffic** • Plane crashes	SCALE • Beyond site boundary outside of community and local area around project site DURATION • The Jamaica Civil Aviation Authority has indicated there are no risks posed to the aircraft based on current flight paths • So no disruption to air traffic is expected as long as the turbines exist and the flight paths remain the same. INTENSITY • Based on the existing flight paths of aircrafts from the Norman Manley International Airport, it is not likely that there will be any adverse impacts or changes to the existing baseline status of social, economic and environmental receptors AFFECTED NUMBERS With the existing flight paths no persons or habitats will be affected SECONDARY IMPACTS • In the event of an accident:	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		○ Fires ○ Loss of built structures ○ Oil/fuel spills REVERSIBILITY The impacts associated with plane crashes may not be reversible. ACCEPTABILITY • Acceptable given the current 'no risk' assessment and mitigation measures to reduce and/or eliminate potential threats and/or disruptions	
5.	**Lightning strikes** • Fires • Damage to wind turbines • Disruption in electricity supplies	SCALE • On site or within project site boundaries - fires • Widespread or at a regional/national scale – potential for the disruption of electricity supplies DURATION • Repair or replacement of wind turbines damaged is costly and may take some time INTENSITY • The degree of change to social receptors will be negligible as JPS will still remain the major supplier of electricity. Disruptions to the turbines are likely to affect CAEL only. • Significant economic impact if CAEL has to repair or replace turbine • Air pollution from emissions associated with fires AFFECTED NUMBERS • Less than <1 of the population or habitat is directly exposed; persons within the community and/or regionally may be affected by the short term loss of power SECONDARY IMPACTS • Land pollution from disposal of damaged equipment REVERSIBILITY • Reversible but likely to be costly ACCEPTABILITY • Not acceptable, measures should be taken to minimise or eliminate the impact of lightning strikes	**YES**
6.	**Flickering** • Photosensitive	Health impacts such as photosensitive epilepsy occur in extremely rare cases. The analysis of the frequency of wind turbines indicate	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**	**SIGNIFI-CANT**
	epilepsy	that this impact is not expected to occur.	
	• Shadow Flicker	SCALE • Within the 900 m boundary around the wind farm, particularly buildings in Broughton and Rest Store DURATION • Long term, for as long as the turbines are in operation INTENSITY • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • 5 – 10 % of the population may be directly exposed SECONDARY IMPACTS • Social discontent amongst affected community members REVERSIBILITY • Reversible once the turbines no longer operate ACCEPTABILITY • Not acceptable; measure to mitigate incidence of shadow flicker should be implemented	**YES**
7.	**Oil spills/leaks** • Land and water pollution	SCALE • Quantities are likely to be small • Onsite within project site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities DURATION • Short term, for the duration of the project INTENSITY • Disturbance and pollution of farming plots • Limited change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Unsightly appearance of areas where spills occur • Quantities are likely to be small but they may be transported to	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		other locations via storm water • Land and water pollution associated with waste disposal REVERSIBILITY • Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
8.	**Aesthetics** • Visually unattractive	SCALE • Beyond site boundary but within community/local area around project site DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation. INTENSITY • Disturbance of degraded areas, with little conservation value • Minor change in species occurrence or variety • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS • >20% of population is affected as the wind turbines can be seen from far away SECONDARY IMPACTS - REVERSIBILITY • Only reversible if the turbines are removed ACCEPTABILITY • Acceptable based on the benefits to be derived	**NO**
9.	**Land use** • Alteration of development and land use in the area • Depreciate land value	SCALE • Beyond site boundary but within community/local area around project site DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation.	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**	**SIGNIFI-CANT**
		INTENSITY • Minor change in species occurrence or variety • Disturbance to the community's social, economic and environmental fabric • No change in existing land ownership rights expected AFFECTED NUMBERS • >10% of population will be affected regarding value of land • Small farming activities can coexist with the wind turbines SECONDARY IMPACTS • Restricts housing development within the area as this would pose a conflict REVERSIBILITY • Only reversible if the turbines are decommissioned • In the event that occupation rights are revoked, removal of the wind turbines will prove costly. ACCEPTABILITY • Acceptable use of land based on the benefits to be derived	

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
10.	**Vibration and noise** • False earthquake signals received by seismological equipment	SCALE • Beyond site boundary DURATION • Long term, permanent. For as long as the wind turbines are installed and in operation. INTENSITY • Limited or no adverse change to the baseline status of social, economic and environmental receptors AFFECTED NUMBERS • Receptors on site and within the immediate boundary of the project site are likely to be the most impacted. SECONDARY IMPACTS - REVERSIBILITY • Only reversible if the turbines are removed ACCEPTABILITY • There is no seismological monitoring equipment at Great Valley or Cross Keys. The seismological monitoring equipment located nearest to the site is found at Munro College, which is approximately 20m away. The turbines will pose no interference to the seismological monitoring equipment at Munro College.	**NO**
		Maintenance	
1.	**Oil spills/leaks** • Land and water pollution	SCALE • Quantities are small • Onsite within site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities DURATION • Short term, for the duration of the maintenance activity INTENSITY • Disturbance of secondary vegetated areas and farming plots • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**	**SIGNIFI-CANT**
		SECONDARY IMPACTS • Unsightly appearance of areas where spills occur • Quantities are likely to be small but they may be transported to other locations via storm water • Land and water pollution associated with waste disposal REVERSIBILITY • Quantities are likely to be small; can be cleaned up; land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
2.	**Solid waste** • Land pollution	SCALE • Onsite within site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project sites or within the surrounding communities DURATION • Short term, for the duration of the maintenance activity. INTENSITY • Disturbance of secondary vegetated areas and farming plots • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Garbage may attract rodents • Uncontained garbage can affect aesthetics • Uncontained top soil can be washed away during rainfall events REVERSIBILITY • Completely reversible at minimal cost ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
3.	**Human waste** • Land and water pollution	SCALE • Onsite within site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities DURATION • Short term, for the duration of the maintenance activity INTENSITY • Disturbance of secondary vegetated areas and farming plots • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Foul odours • May attract rodents and flies REVERSIBILITY • Quantity of sewage small, land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**NO**
4.	**Maintenance work** • Accidents causing death or injury	SCALE • Onsite within site boundaries DURATION • Short term for the duration of the maintenance activities INTENSITY • Has the possibility to disturb the baseline social and economic receptors AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS -	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		REVERSIBILITY • Death and serious injury not reversible ACCEPTABILITY • Not acceptable, mitigation measures must be implemented	
		Decommissioning	
1.	**Solid waste** • Land and water pollution	SCALE • Onsite within site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities DURATION • Short term, for the duration of the decommissioning INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Garbage may attract rodents and flies • Uncontained garbage can affect aesthetics • Un-vegetated soil can be washed away during rainfall events REVERSIBILITY • Completely reversible at minimal cost ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	**YES**
2.	**Noise from equipment** • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	SCALE • Beyond site boundary but within community/ local area around project site (2 km) • Noise may affect the schools (Broughton Primary and Basic School) DURATION • Short term (during work hours), quickly reversible	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		• This effect is expected to last for the duration of the decommissioning exercise INTENSITY • Disturbance of community's social fabric • Nuisance noise during decommissioning is expected to be a noticeable change in the immediate area AFFECTED NUMBERS • Between 10-20% of the population will be directly exposed, given the proximity of the site to residential areas, such as Broughton and educational facilities also located in the community. • Workers at the site could be affected by noise related to the decommissioning exercise • Students and staff at the Broughton Primary and Basic Schools, the closest buildings to WT#7(<1km), may experience increased noise nuisance during work hours for the duration of the decommissioning exercise • Increased truck traffic passing through communities en route to the site can cause an increase in noise nuisance intermittently over the decommissioning exercise SECONDARY IMPACTS • Temporary or long term hearing impairment for persons on the construction site without hearing projection (Appendix 6) REVERSIBILITY • The effects of the temporary nuisance are completely reversible with cessation of the decommissioning activities. • Hearing loss and other permanent impacts are not reversible. ACCEPTABILITY • In general, stakeholders are willing to make trade-offs in respect of temporary nuisances provided that available and appropriate mitigation measures are implemented.	
3.	**Oil spills/leaks** • Land and water pollution	SCALE • Onsite within site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the site or within the surrounding communities DURATION • Short term, for the duration of the decommissioning	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		INTENSITY • Disturbance of secondary vegetated areas and farming plots • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Unsightly appearance of areas where spills occur • Quantities are likely to be small but they may be transported to other locations via storm water • Land and water pollution associated with waste disposal REVERSIBILITY • Quantities are likely to be small; can be cleaned up; land pollution reversible over time naturally • Avoidable with good maintenance practices ACCEPTABILITY Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	
4.	**Human waste** • Land and water pollution	SCALE • Onsite within site boundaries land pollution can occur • No threat to water resources as there are no ground or surface water resources at the project site or within the surrounding communities DURATION • Short term, for the duration of the decommissioning INTENSITY • Disturbance of degraded areas, with little conservation value • No change in species occurrence or variety • Disturbance of community's environmental and social fabric AFFECTED NUMBERS • <1% of the population or habitat will be directly exposed SECONDARY IMPACTS • Foul odours • May attract rodents and flies REVERSIBILITY	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA	SIGNIFI-CANT
		• Quantity of sewage small, land pollution reversible naturally over time ACCEPTABILITY • Not acceptable; appropriate facilities must be provided for collection, treatment and disposal	

6.3 Cumulative Impacts – Operational Phase

There are two (2) main operational impacts, noise impacts and shadow flicker, which need to be assessed using appropriate modelling techniques together with wind speed, to determine the optimum locations for the proposed eight (8) turbines. This is necessary to minimise and where possible eliminate adverse cumulative noise and shadow flicker impacts on nearby communities while still getting the optimum output from the turbines.

6.4 Potential Positive Impacts

6.4.1 Construction Phase

Stimulation of Local Economy and Employment Opportunities

CAEL has indicated that 100 persons will be employed during the construction phase of the project. It is anticipated that during the construction phase engineers, architects, construction workers, truck drivers, equipment operators, security guards, surveyors, building contractors and unskilled labour, will all benefit from the project.

Local contractors and workers will be utilised as much as possible. However if the required number of workers or level of expertise cannot be found within nearby communities, then contractors and workers will be sourced regionally, nationally and internationally, in that order of priority.

The increased income for local residents will likely cause an increase in commercial activity in the nearby towns of Rest Store and Cross Keys.

Infrastructural Improvement

Widening and levelling of the main access road to the proposed wind farm and the construction of access routes to the individual turbines will improve onsite access. Additionally the installation of water and power infrastructure will contribute to an overall improvement in the infrastructural capacity of the site. Currently there is no formal water supply infrastructure on the property.

6.4.2 Operational Phase

Stimulation of Local Economy

During the operational phase of the project maintenance workers and engineers will be required for the operation and maintenance (O&M) of the wind turbines. It is expected that local personnel will be involved in this aspect of the project given their close proximity to the turbines and ability to respond immediately (or faster) in the event of an emergency.

Maintenance personnel are expected to receive formal training in the maintenance and operation of the turbines, including the use of monitoring equipment, such as noise meters. The training received by operation and maintenance personnel will be a long-term benefit.

Reduction in greenhouse gas emissions

One of the benefits of electricity production from wind turbines is that it does not lead to the emission of greenhouse gases or other noxious emissions as is the case with fossil fuels. Wind energy is a clean renewable form of energy that requires significantly less consumption of natural resources, such as land and water.

Reduction in Fuel Consumption and Costs

The constant fluctuation and drastic increases in fuel costs has made it increasingly important for developing and non-producing oil nations to explore and utilise alternative and cleaner energy sources. The largest fuel cost associated with production of electricity from wind sources is in the construction phase of the project for the transportation of equipment and wind turbine parts and the use of heavy duty equipment. These fuel costs are relatively low and short term in duration. Since no fuel is used to generate electricity from wind turbines there is a net reduction in fuel consumption per kW of electricity generated by CAEL.

Data from Renewable UK (2010)[20] indicates that the capital cost of turbines i.e. construction of turbine, foundation, electrical equipment and grid connection is a capital intensive-technology. In 2009 the installed cost for turbines was approximately US$2,000-2,500 per kW. This compared to gas and coal which had an average installed costs of US$1,014 and US$2,574 respectively. Wind turbine technology is however found to be less costly during the operation and maintenance (O&M) mainly due to the fluctuating cost of fuel for conventional technologies. The European Wind Energy Association estimated that in 2008, wind power saved the European Union €6.5 billion in fuel costs and €2.3 billion in carbon dioxide emissions costs. It is projected that wind energy will avoid fuel costs of €27.7 billion in 2020 and €55.5 billion in 2030.[21]

[20] http://www.bwea.com/pdf/briefings/Wind-Energy-Generation-Costs.pdf
[21] http://www.ewea.org/fileadmin/ewea_documents/documents/publications/factsheets/Factsheets.pdf

CAEL is estimated to save Jamaica US$4.0 million per year in fuel import costs annually, as approximately 40,183 barrels of oil equivalent will be saved per year in imports at an average price of US$100.

Promotion of Alternative Sources of Energy

Non-producing oil nations have led the charge in developing cleaner and more affordable alternative energy sources to reduce (a) their dependence on foreign oil, (b) the percentage of Gross Domestic Product spent on crude oil (c) reduce greenhouse gas emissions (d) reduce the threats of global warming and (e) develop more sustainable approaches towards conserving limited natural resources.

Climate change is the most serious environmental threat facing the world today and clean renewable energy sources like wind power are a significant part of the solution. Wind power is plentiful in many parts of the world and can be harnessed safely to generate electricity, without producing any dangerous waste or unwanted by-products

Potential Tourist attraction

The installation of the wind farm at Great Valley may lead to an increase in visitors to the area. There will likely be school trips as well as visits by persons who are interested in viewing the installation. This may lead to increased commercial activity in the nearby towns. The Wigton Farm located less than 5km from the proposed Great Valley Wind Farm is said to receive thousands of visitors annually. School visits are the most popular visits made to the site.

Table 43: Significant Impact Assessment - Positive

	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		Construction phase
1.	Employment Opportunities	SCALE • Regional DURATION • Short-term for contracted workers - This is expected to last for the duration of the construction phase (9-12 months) of the project INTENSITY (BASELINE CHANGE) • Opportunities that provide employment to members of the public are viewed as a welcome change to present baseline conditions • Increased commerce in neighbouring communities will result in changes to economic baseline AFFECTED NUMBERS

	POTENTIAL BENEFITS	**SIGNIFICANT IMPACT ASSESSMENT CRITERIA**
		• It is anticipated that 100 persons will benefit from employment on the proposed project; some likely to be from neighbouring communities SECONDARY IMPACTS • Increased income earning potential for workers • Increased standard of living • Increased commercial activities for the duration of the project in neighbouring communities • Reduction in unemployment REVERSIBILITY • Short term employment ends after project is completed ACCEPTABILITY • Acceptable, persons are in need of employment
		Operational Phase
1.	Reduction in greenhouse gas emissions	SCALE • Regional/National/International DURATION • Long-term INTENSITY/BASELINE • This is a minor change from current baseline conditions. Jamaica, (as part of the entire Caribbean Region) accounts for 1% of total greenhouse gas emissions globally. The reduction in greenhouse gas emissions locally can however make a small, but meaningful contribution in helping to solve the world's growing climate change problem . AFFECTED NUMBERS • Unknown how many persons or ecological species could benefit, but the impact is expected to be global SECONDARY EFFECTS • Reduced global temperatures (negligible impact) • Improved local conditions (temperature) • Improved air quality
2.	Reduction in fuel costs and demand for foreign exchange for the importation of oil	SCALE • National DURATION • Long-term INTENSITY/BASELINE • The reduction in fuel costs and consumption will take place incrementally

	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		and will therefore be seen as a minor change from existing baseline conditions. AFFECTED NUMBERS • All members of the population will be impacted either directly or indirectly. SECONDARY EFFECTS • Increased potential to reduce dependency on oil (long-term) • Increased financial resources for other renewable energy projects
3.	Promotion of use of alternative energy	SCALE • Regional/National/International DURATION • Long-term INTENSITY/BASELINE • This will represent a major change from existing baseline conditions, particularly in developing countries AFFECTED NUMBERS • The entire population stands to benefit from such an initiative SECONDARY EFFECTS • Reduces the percentage of GDP spent on oil imports • Reduces the severity of climate change impacts • Creates employment opportunities • Reduces greenhouse gas emissions
4.	Potential tourist attraction	SCALE • Local DURATION • Long-term INTENSITY/BASELINE • Moderate to significant change in social and economic fabric of the communities AFFECTED NUMBERS • The entire population stands to benefit from such an initiative SECONDARY EFFECTS • Increased commercial activity • May encourage more alternative energy projects

	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		Maintenance
1.	Maintenance activities	SCALE • Regional DURATION • Long-term – for as long as the wind turbines are in operation INTENSITY (BASELINE CHANGE) • Small increase in commercial activity when maintenance work is being done in the area AFFECTED NUMBERS - SECONDARY IMPACTS • Increased income earning potential for workers • Increased standard of living • Reduction in unemployment ACCEPTABILITY • Acceptable, persons are in need of employment
		Decommissioning
1.	Decommissioning and removal of wind turbines Employment Opportunities	SCALE • Regional DURATION • Short-term for contracted workers - This is expected to last for the duration of the decommissioning exercise INTENSITY (BASELINE CHANGE) • Opportunities that provide employment to members of the public are viewed as a welcome change to present baseline conditions • Increased commercial activities for the duration of the decommissioning exercise AFFECTED NUMBERS • Some local residents will benefit from short term employment SECONDARY IMPACTS • Increased income earning potential for workers • Increased standard of living • Increased commerce in neighbouring communities • Reduction in unemployment

	POTENTIAL BENEFITS	SIGNIFICANT IMPACT ASSESSMENT CRITERIA
		ACCEPTABILITY • Acceptable, persons are in need of employment

6.5 Summary of Significant Impacts

Table 44 presents a summary of the significant aspects for the construction, operation, maintenance and decommissioning phases of the project. Eleven (11) significant impacts have been identified, six (6) of which are associated with the construction phase of the project. The operations of the wind turbine have three (3) significant impacts: (i) susceptibility of turbines to lightning strikes (ii) disruption to avifauna species and (iii) increased noise nuisances. Though in all cases steps can be taken to mitigate against the negative impacts, there is no certainty that proposed mitigation measures will be successful in reducing the overall negative impacts on bats.

Table 44: Summary of Significant Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
	Construction phase	
1.	Fugitive dust emissions & vehicular emissions • Air pollution • Respiratory problems	**NO**
2.	Noise • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	**YES**
3.	Loss of Productive Farm Lands and Temporary Displacement of Farmers	**NO**
4.	Removal of Vegetation • Habitat destruction • Disruption of ecosystems • Displacement of small farmers	**YES**
5.	Solid waste (top soil, vegetation, construction debris, garbage) • Land and water pollution	**NO**
6.	Increased traffic movement Traffic congestion Motor vehicle accidents	**YES**
7.	Use of fuel • Depletion of (oil) resources	**NO**
8.	Human waste • Land and water pollution	**NO**
9.	Soil erosion • Off-site effect is the movement of sediment and agricultural pollutants	**YES**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
	into watercourses • On-site impact is the reduction in soil quality which results from the loss of the nutrient-rich upper layers of the soil	
10.	Construction work • Accidents causing death or injury	**YES**
11.	Use of water • Depletion of water resources	**NO**
12.	Fuel and oil spills • Land and water pollution	**NO**
	Operation Phase	
1.	Noise • Nuisance to persons • Habitat disturbance	**YES**
2.	Disruption in avifauna flight patterns • Bird and bat deaths	**YES**
3.	Diffraction/Shadowing, Reflection, Scattering • Electromagnetic interference which can affect radar and radiocommunication	**NO**
4.	Disruption in air traffic • Plane crashes	**NO**
5.	Lightning strikes • Fires • Damage to wind turbines • Disruption in electricity supplies	**YES**
6.	Flickering • Photosensitive epilepsy	**NO**
	• Shadow flicker	**YES**
7.	Oil spills/leaks • Land and water pollution	**NO**
8.	Aesthetics • Visually unattractive	**NO**
9.	Land use • Alteration of development and land use in the area • Depreciate land value	**NO**
10.	Vibration and noise • False earthquake signals	**NO**
	Maintenance	
1.	Oil spills/leaks • Land and water pollution	**NO**
2.	Solid waste • Land pollution	**NO**
3.	Human waste • Land and water pollution	**NO**
4.	Maintenance work • Accidents causing death or injury	**NO**

	ASPECT /POTENTIAL NEGATIVE IMPACTS	SIGNIFICANT
	Decommissioning	
1.	Solid waste • Land and water pollution	**YES**
2.	Noise from equipment • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	**YES**
3.	Oil spills/leaks • Land and water pollution	**NO**
4.	Human waste • Land and water pollution	**NO**

7.0 Mitigation Measures

Negative environmental impacts can be mitigated by implementing measures during the construction, operating, maintenance and decommissioning phases to eliminate or significantly reduce them.

Mitigation measures to address the potential negative impacts, significant or not, associated with this project are presented in Table 45.

Table 45: Mitigation Measures for Negative Impacts

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
	Construction phase	
1.	Fugitive dust emissions & Vehicular emissions • Air pollution • Respiratory problems	• Cover haulage vehicles transporting aggregate, soil and cement • Cover onsite stockpiles of aggregate, cement, soil etc. • Ensure proper stock piling/storage and disposal of solid waste • Wet cleared land areas regularly • Blasting should be done in accordance with the requirements of the Mines and Geology Department • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. dust masks and ensure that they are worn • Operate well maintained vehicles and equipment
2.	Noise • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	• Advise schools and residents in the surrounding communities of construction dates and times • Ensure that construction activities are undertaken within the stipulated times • Blasting should be done in accordance with the requirements of the Mines and Geology Department • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn
3.	Loss of Productive Farm Lands and Temporary Displacement of Farmers	• Farmers should be advised of the project and that it will not adversely affect their farming activities
4.	Removal of Vegetation • Habitat destruction • Disruption of ecosystems	• Only areas that are absolutely necessary for clearance should be cleared • Where possible modifications will be made to the siting of turbines where sensitive habitats exist • In areas where vegetation has been removed and the lands have not been converted to access roadways or used for siting turbines, replanting exercises should be undertaken
5.	Solid waste (top soil, vegetation, construction debris, garbage)	• Contain garbage and construction debris and dispose of at the

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
	• Land and water pollution	approved municipal disposal site at Martins Hill • Landscape project sites with top soil excavated
6.	Increased traffic movement • Traffic congestion • Motor vehicle accidents	• Erect signs along main transportation route and in sensitive areas such as schools • Transport heavy equipment and wind turbine parts during off-peak traffic hours (between (2:00 to 4:00 a.m.) with police outriders • Trucks transporting construction material should be advised to comply with the speed limits • Use traffic signals or flagmen to manage traffic flows where road improvement works are being undertaken
7.	Human waste • Land pollution	• Use a reputable company to provide portable toilets for workers
8.	Soil erosion • Sediments in storm water runoff	• Only clear top soil from areas to be used • Place berms around stockpiles of top soil
9.	Construction work • Accidents causing death or injury	• Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures
10.	Fuel and oil spills • Land and water pollution	• Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site and dispose of waste in accordance with best practices
	Operation Phase	
1.	Noise • Nuisance to persons • Habitat disturbance	• Situate wind turbines as far away as possible from residences and schools. Where possible turbines should be 2 km or more away from these receptors. • Wind farm noise limits should be set relative to existing background noise levels and should not exceed 55 dB (daytime) and 50dBA (night time) at receptors such as schools, residences and commercial establishments. • It is recommended that prior to the installation of the turbines that a noise modeling exercise be done that determines the cumulative noise levels from the wind turbines at the nearest receptors. This will help to situate the turbines at the best locations relative to potential receptors. • Establish barriers to deflect sound e.g. trees • Develop a shut down strategy during times of excessive wind when noise is likely to exceed the acceptable threshold • Wind turbines should contain no tonal component • Monitor sound levels to ensure that they are within acceptable limits • Consider elimination or relocation of turbines #6 and #7

	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
		which are closest to the schools and are likely to cause noise nuisance ***(The wind farm design by Vestas eliminated these locations)***
2.	Disruption in avifauna flight patterns • Bird and bat deaths	The following mitigation measures are proposed for the protection of local bat species: • Reduce the number of proposed turbines • Target hilltops as turbine sites which will result in minimal removal of vegetation; reducing potential cumulative habitat loss • Develop a bat monitoring plan for the pre-construction, construction and post-construction phases of the development. • Establish a buffer zone 200 m from forested areas and shrubs • Shut down turbines during high risk conditions • Alter blade speed during high risk periods • Increase blade 'cut in' speed • Locate turbines away from the flight paths of bats • Install deterrents such as ultrasound blasters to scare away bats from turbines
3.	Diffraction/Shadowing, reflection, Scattering • Electromagnetic interference which can affect radar and radio communication	If television reception is affected:: • Install an outdoor antenna if none exists • Realign the TV antenna to point directly at the TV transmitter • Install more directional or higher gain antenna at the affected residences • Relocate the antenna to a less affected position
4.	Disruption in air traffic • Plane crashes	The Jamaica Civil Aviation Authority has indicated that the wind turbines pose no risk to aircraft as they are not along a flight path. However the following actions are recommended: • The rotor blades, nacelle and upper two-thirds of the supporting mast of the wind turbines should be painted white. • The nacelle must be lit by a medium density obstacle light of 2000 candelas per m^2 showing flashing red. The obstacle light should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any directions. • The lights should operate at 20-60 flashes per minute and flash simultaneously with lights installed at other wind turbines to show the extent of the wind farm. • The tower should be inspected regularly to detect any failure of these lights which must be replaced in minimum time.
5.	Lightning strikes • Fires • Damage to wind turbines • Disruption in electricity	• Lightning arrestors and lightning masts are an integral part of the wind turbine installations • A SCADA system to remotely monitor the turbines will be used and includes features to shut down the turbines in the

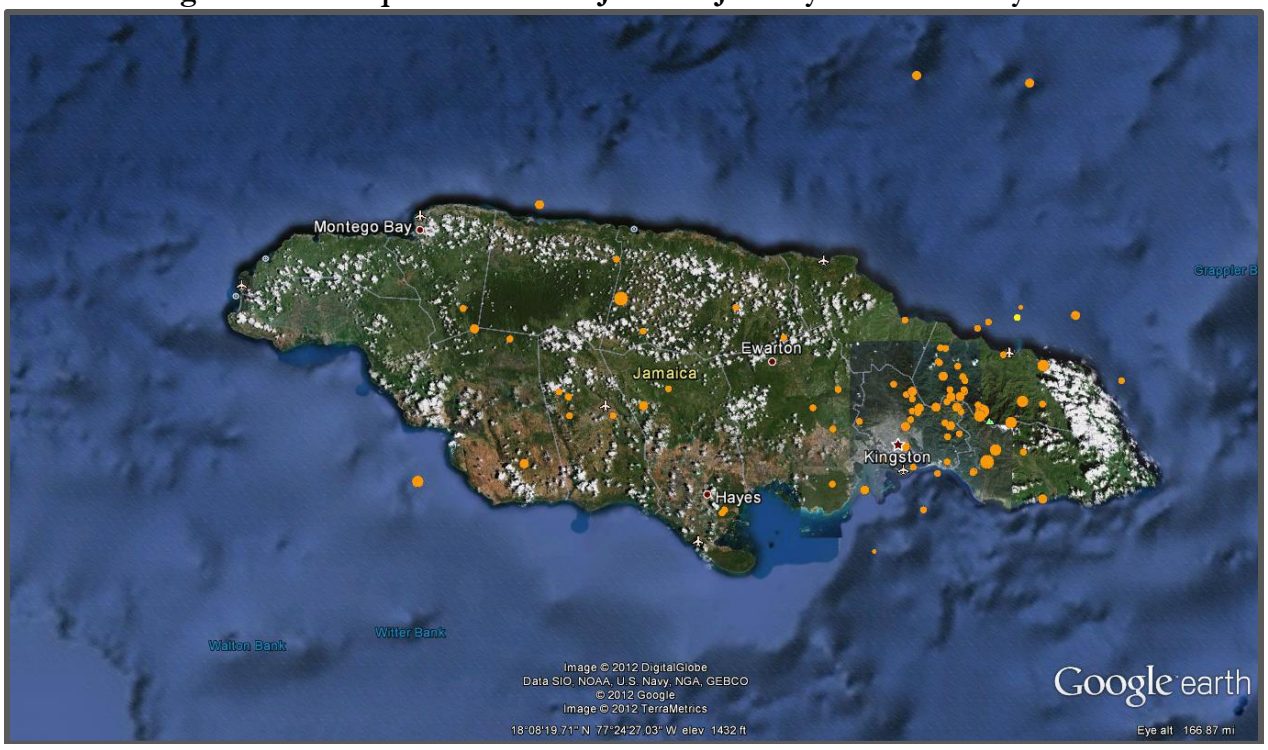
	ASPECT /POTENTIAL NEGATIVE IMPACTS	MITIGATION MEASURES
	supplies	event of a fire
6.	Land use	• Plant vegetation and landscape areas that are not paved where possible
7.	Shadow Flicker	• Wind turbines of particular concern are 5, 6 & 7. ***(The wind farm design by Vestas eliminated these locations)*** • Relocate these turbines so that they fall outside the shadow flicker zone or abandon these locations • Align wind turbines where possible so that the affected areas fall outside of the potential flicker zone which is 50º on either side of South of each turbine • Situate turbines so that they are greater than 900 m from the areas that can be affected
	Maintenance	
1.	Solid waste • Land pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Martins Hill
2.	Human Waste • Land and water pollution	• Use a reputable company to provide portable toilets for workers
3.	Maintenance work • Accidents causing death or injury	• Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures
	Decommissioning	
1.	Solid waste • Land pollution	• Contain garbage and construction debris and dispose of at the approved municipal disposal site at Martins Hill
2.	Noise from maintenance equipment • Nuisance to persons • Habitat disturbance • Hearing impairment (temporary, permanent)	• Advise schools and residents in the surrounding communities of decommissioning dates and times • Ensure that decommissioning activities are undertaken within the stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn
3.	Oil spills/leaks • Land pollution	• Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site and dispose of waste in accordance with best practices
4.	Human Waste • Land and water pollution	• Use a reputable company to provide portable toilets for workers

8.0 Emergency Preparedness and Response

The wind turbines have been designed to withstand hurricanes and earthquakes.

Between the period January 1, 1970 and February 1, 2012, one hundred and eight (108) earthquakes were recorded during the forty-two (42) year period (Figure 34). All earthquakes recorded had an estimated depth between 0-35km. There are no recorded earthquake events, which have originated in the parishes of Westmoreland or Hanover, and their origination in the parishes of St. James, St. Elizabeth and St. Mary in the east is quite scarce.

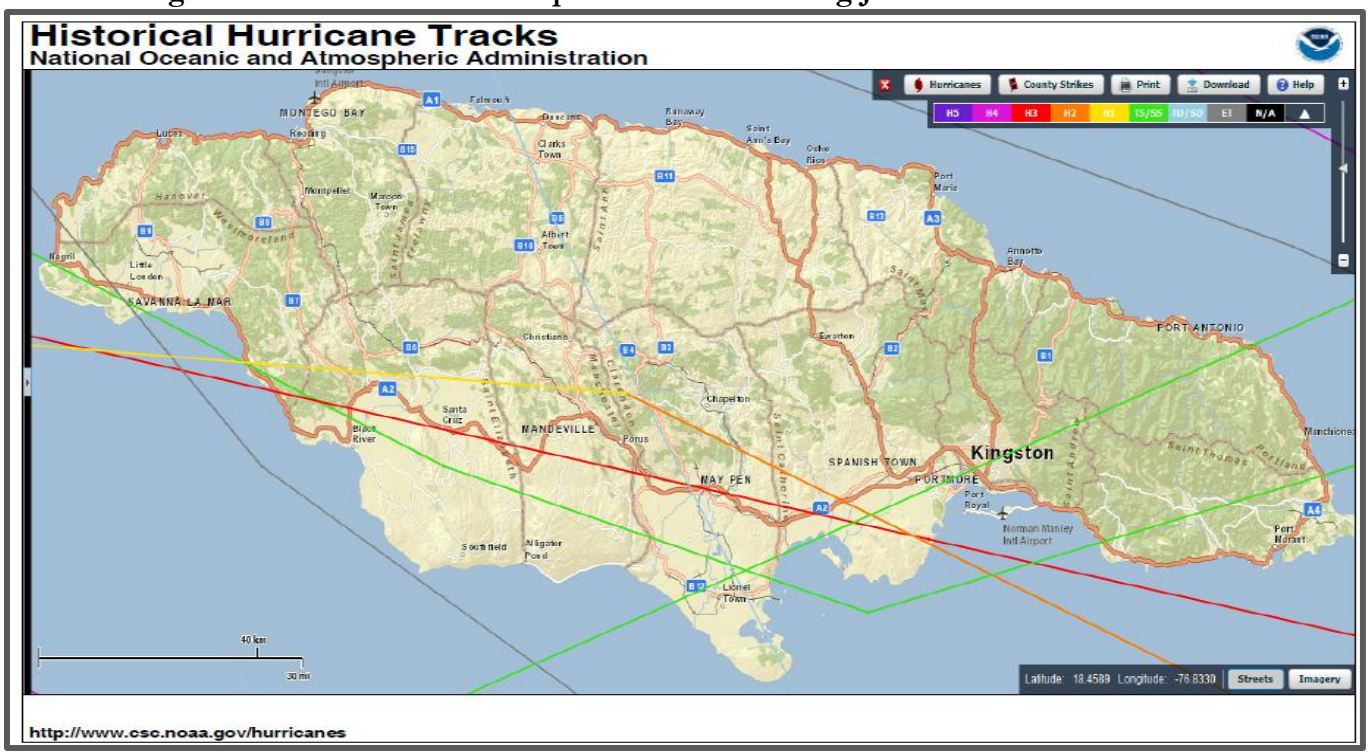
Figure 34: Earthquake Events in Jamaica January 1970- February 2012



In the parish of Manchester, earthquakes have originated only in the northern part of the parish. There is no evidence on the origination of earthquake events at the proposed site or in the southern part of the parish. Only one earthquake event originated within close proximity to the site. The earthquake event took place in the community of Malvern/Munro, located approximately twenty metres (20m) from the project site.

Wind turbines have been designed to withstand aerodynamic forces however more attention is now being paid to the impact of earthquakes on wind turbines. Wind turbines are now being designed based on the results of seismic loading procedures that are undertaken during the design phase of the turbines. Turbines are being designed with an emergency stop and additional research is being undertaken to assess the structural resistance of wind turbines to earthquakes.

Figure 35: Hurricanes and Tropical Storms Affecting Jamaica 1951-2008



The entire island of Jamaica is susceptible to hurricanes and tropical storms (Figure 35). The parishes of St. Elizabeth, Clarendon, Kingston and Manchester have been the most susceptible to the impacts of hurricane events based on information provided by the National Oceanic and Atmospheric Administration (NOAA).

The Wigton Wind Farm situated in Manchester- located less than 5km from the proposed Great Valley Wind Farm has experienced at least two hurricanes and one tropical storm wind conditions as follows

- 2004: Hurricane Ivan (Category 5) – Repair cost approx. US$640K
- 2007: Hurricane Dean (Category 4) – Repair cost approx. US$106K
- 2008: Tropical Storm Gustav – No repair cost

In the event of a hurricane, the following procedures will be followed:

- All turbine blades will be SHUT DOWN
- The hurricane will be monitored for direction and wind speed
- Ratchet straps will be placed on nacelle covers
- The turbines will be manually yawed 90^0 clockwise out of the wind 12 hours after a hurricane warning is issued
- Turbines will be freewheeled to 'rabbit ears' position to minimise stress
- The main circuit breakers for the turbines will be opened
- Liaise with CAEL System control
- The site will be secured

9.0 Environmental Health and Safety Management and Monitoring Plan

In accordance with the approved terms of reference (TOR), this Environmental Management Plan (EMP) has been prepared to ensure that all activities undertaken during the construction and operations of the proposed development are done in a manner that will reduce and/or eliminate the identified adverse impacts associated with the proposed project. The EMP serves to outline the prevention methods and procedures that should be adopted by the developers and operators of this development to ensure that the physical, biological and social environments are protected. This plan will therefore cover the following:

i. Management Objectives during Construction and Operational Phases
ii. Management and Monitoring Actions to be implemented
iii. Persons responsible for the implementation and management of monitoring actions
iv. Performance targets and specifications
v. Implementation Schedule

9.1 Environmental Management Objectives

1. Construction Phase

a. Establish controls for contractors to ensure that the proposed mitigation measures are implemented in a timely and effective manner. This includes provisions for worker safety, road safety, waste and materials management.
b. Effectively minimise risks and negative environmental effects of natural disasters and hazards (hurricanes, fires, earthquakes, oil spills and accidental leaks).
c. Reduce and manage predicted waste-streams.
d. Minimise construction nuisances to other land users, including adjoining land users throughout the development phase of the project.

2. Operational Phase

a. Develop and implement comprehensive environmental management plans, which clearly identify targets for environmental performance.
b. Develop and implement saftey procedures and operation and maintenance training that must be undertaken by all staff members and visitors to the site.
c. Ensure that staff is trained in environmental management and monioring procedures.
d. Conduct maintenance operations in a way that is compliant with environmental and turbine manufacturer regulations.
e. Properly maintain the project area to ensure that the adjacent ecosystems and their aesthetic appearance are not negatively impacted.

9.2 Safety Requirements

1. Construction & Decommissioning Phases

The contractor shall comply with safety rules and regulations that are enforced at the site in accordance with local and international safety standards such as Occupational Health and

Safety Administration (OHSA) and the provisions of the draft Jamaica Occupational Safety and Health Act (JOSHA).

a. The contractor shall be solely responsible for the safety of his subcontractor's employees. It is mandatory that all personnel required to perform work at the site be fitted with approved PPE such as safety helmet, glasses and boots at minimum while on site. Additional PPE must be worn based on the hazards identified. Failure to comply with these requirements will result in the expulsion of the offending individual(s) from the site. A pre-start site conference meeting on safety will be held by the Project Manager to advise the contractor of the safety standards and requirements expected.
b. The contractor shall promptly correct any unsafe conditions brought to his attention.
c. In the event of an accident, the contractor shall provide the Project Manager with a written report of all pertinent details of the accident within twenty-four (24) hours of its occurrence. This report shall include recommended actions to prevent future occurrence.
d. The contractor shall provide protection and storage for his equipment, general property, vehicles and personnel during all phases of the work.
e. The contractor shall be responsible for his sub-contractors' compliance with safety regulations.
f. The contractor shall provide a first-aid station and people who can administer first aid on site.
g. The contractor shall ensure that his on-site work force is fully equipped with the required safety gears, e.g. hats, boots, gloves, overalls, goggles, equipment for working at high elevations etc.

2. Operational Phase

a. Signs, notices and directions must be erected in clear view of visitors, outlining all safety rules and regulations governing the use of the wind farm and its facilities.
b. Fire extinguishers, fire alarms, smoke detectors and other safety equipment should be placed in strategic locations across the property. Operation and Maintenance Staff should be trained in the use of all safety equipment. Visitors to the site should also be briefed on the safety requirements at the wind farm, prior to touring the turbines.
c. Emergency assembly sites should be clearly labelled and communicated to visitors to the Great Valley Wind Farm, site.

9.3 Post Permit Documentation Requirements

1. Emergency Preparedness Response Plan

An Emergency Preparedness and Response Plan (EMP) has been prepared under separate cover.

The goal of this plan is to prevent where possible and minimise the effects of emergencies, disasters and accidents on the operations of the attraction. Emergency preparedness should help to reduce human suffering and economic losses that could arise. The specific objectives of the plan are to:

a. Implement measures to minimise the likelihood of emergencies that can adversely impact humans and the environment.
b. Provide an immediate and effective response to incidents that represent a risk to human safety, public health or the environment.
c. To ensure that the Wind Farm can be operational as quickly as possible after the occurrence of an emergency and/or disaster situation.

The approach taken to emergency response planning is four-fold:

a. Prevention: actions to reduce exposure to or eliminate the hazard. Reducing the degree, extent and magnitude of hazards can be achieved through the proper scaling, designing and redesigning of elements of the project.
b. Preparedness: actions to plan, equip and train for the event, which includes the education of both visitors and staff utilising the premises.
c. Response: action to save lives and property during the event. This includes safety procedures, methods and equipment required.
d. Recovery: actions taken to resume pre-event conditions.

2. Bat Monitoring Plan

The potential impacts on the local bat community could be significant with possible long-term impacts. The threats faced by the bat species warrants the development of a monitoring plan to ensure that the species are protected from any adverse impacts. The plan will take into account the measures that will be put in place to monitor the behaviour of bats i.e. feeding, foraging and roosting behaviour. The Monitoring Plan will consist of (i) Pre-construction and Construction monitoring and (ii) Post construction monitoring.

Pre-Construction and Construction Monitoring

- Data Searches & Desktop Study*:* Collation and review of existing literature, maps and remotely-sensed images, to identify the roosting, foraging and commuting areas within 5-km of the proposed wind farm site, including those onsite and (ii) identification of Surrounding Protected Areas or areas identified as Important Bird Areas (IBAs) or Key Biodiversity Areas (KBAs) must be identified within the landscape matrix, to predict the importance of the proposed site (e.g., as a corridor) or to identify its degree of isolation. The literature review will include all EIAs conducted for neighbouring sites.

- Site Walkover*:* In preparation of systematic field data collection, an initial "ground truthing" will be conducted whereby the site is traversed to search for features that may influence bat usage of the area, including (positively) large fig trees (*Ficus spp*), linear features such as ridges and water courses, other water bodies, or (negatively) monocultures of non-native vegetation such as giant bamboo (*Bambusa vulgaris*) or Asian ferns (e.g. *Nephrolepis multiflora*). This initial assessment will enable a qualitative assessment of overall habitat quality and connectivity and enable identification of discrepancies between current conditions and the remotely-sensed images, which may be out-of-date.

- Bat Survey to determine species presence, relative abundances and activity**:** A survey will be conducted over a 12 month period to observe 'species' usage of the project area. The minimum of 12 months is required for bats since at least one complete breeding cycle must be evaluated and the time of year when food resources are most limited must be identified. It must also be noted that breeding seasons in Jamaica are not synchronized amongst the different foraging guilds of bats (nectarivores, frugivores, omnivores, and piscivores), but are, instead, timed to availability of food resources.

- Acoustic surveys of Insect-feeding bats Turbines**:** Ultrasonic acoustic recording devices ("bat detectors") will be deployed where each wind turbine is proposed to be located. Devices will be mounted to ensure that microphones detect the complete vertical strata and circumference of the rotor-swept area of anticipated species. The location of each proposed turbine will be evaluated two nights per month, timed to the lunar phases of new moon and full moon (e.g., + 2 nights of the newmoon and + 2 nights of the full moon). Recording will commence 1 hour before sunset and terminate no earlier than 30 minutes after sunrise. Recording will either be continuous or in one-minute pulses to generate manageable files.

- Acoustic surveys of Forest and non-forested habitats**:** Each major land-use category at the proposed site will be surveyed acoustically so that:

  a. A minimum 10% of each habitat type is assessed with fixed-station automatic detectors; and
  b. The entire site is traversed with a manual detector.

  Stationary bat detectors will be deployed at permanent fixed-locations for a continuous recording session one night per month, for 12 months. Deployment should be timed + 4 days of the new moon, recording will commence one hour before sunset and terminate no earlier than 30 minutes after sunrise. Microphone height will be determined by the height of the forest canopy, to be positioned in the sub-crown, or if in open habitat (e.g., pasture), at a height of 2-meters.[22]

  "Walked transect" surveys will be designed to traverse the proposed wind farm site, with 5-minute sample recording at intervals of 100-meters. Recording at the first sample point will commence 30 minutes before sunset and the survey concluded within three hours. This is the period when bats are commuting from their cave roost and when insectivore hunting activity is high. Deployment will be timed +4 days of the new moon and the observer will wait for one minute after arriving at a survey point, with headlight turned off, before launching the "bat detector" recording device.

[22] Microphone detection range of forest- and edge-hunting insectivorous Jamaican bats is < 15m). At each fixed-location station, flowering and fruiting phenology must be recorded for plants within 20m of the microphone. Stationary bat detectors are more likely to detect rare species than "walked transect" surveys.

- Turbine and Forested / Non-forested acoustic surveys will generate data on species identity and habitat usage. Although it is not possible to determine the number of individuals using the area, a monthly comparison can be made of changes in species composition and the percent-time spent engaged in activity for each species detected (i.e., a bat activity index = number of bat contacts per hour, including identification of feeding buzzes).

- Roost Surveys*:* All bat-occupied caves located within the proposed site or within 5 km of its periphery will be surveyed at least one night every three months for one year in order to determine species composition and reproductive status of the colony. Survey frequency is intended to determine whether the cave serves as both a roosting and nursery colony while attempting to minimize actual disturbance to the colony.

- Mist-netting of Nectarivores and Frugivores Turbines**:** Mist nets will be deployed to survey for nectar- and fruit-eating bats, which belong to the "whispering" family Phyllostomidae and often do not emit echolocation calls loud enough to be detected with "bat detectors". These will be placed in areas that are forested. A minimum of 10, 10-12m long mist nets will be deployed per hectare to ensure adequate sampling effort. Mist nets will be opened 30-minutes before sunset and closed 30-minutes after sunrise to minimise risk of capturing birds. As with acoustic survey efforts, mist net surveys at each proposed turbine location will be conducted two nights per month (one night + 5 days of the new moon; one night + five days of the full moon), for 12 months. Mist net deployment will not be necessary for certain areas of the proposed site as the area is already a converted and open canopy habitat (e.g., pasture). Bats, in the absence of cluttered vegetation, will detect and avoid mist nets.

    - Forest and non-forested habitats**:** Each major land-use category at the proposed site will be surveyed with mist nets so that a minimum 10% of each habitat type is assessed. Mist net deployment effort is as described under Turbines, except that surveys in forested and non-forested habitat not in the direct footprint of each proposed turbine need be conducted one night per month, timed to the new moon. Any fruits carried by bats and dropped below mist nets must be collected and identified botanically.

Post Construction Monitoring

- Recording Bat Fatalities: Monthly monitoring reports will be prepared on bat fatalities at the wind farm site. The reports should include the number of fatalities, the type of species, location of bat on site and an estimate of the overall fatality rate at the site.

The estimated cost of doing the survey is J$3.0 million.

3. Closure Plan

This project is expected to have a life of 20 years. As such a Closure Plan will be developed under separate cover to govern the decommissioning activities with the objective of minimising adverse environmental impacts.

9.4 Mitigation and Monitoring Programme

Table 46 presents the Environmental Management and Monitoring Plan for the construction and operation of the Great Valley Wind Farm facility to be operated by Clean Alternative Energy Limited (CAEL).

Table 46: Management and Monitoring Plan

	Management Plan	Monitoring Programme
Construction phase		
1.	Fugitive dust emissions & vehicular emissions • Cover haulage vehicles transporting aggregate, soil and cement • Cover onsite stockpiles of aggregate, cement, soil etc. • Ensure proper stock piling and disposal of solid waste • Wet cleared land areas regularly to control fugitive dust • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. dust masks and ensure that they are worn • Operate well maintained vehicles and equipment	• CAEL is to ensure that the contractor implements the required mitigation measures by conducting periodic audits • The Contractor's monthly report to provide details of the mitigation measures implemented
2.	Noise • Advise schools and residents in the surrounding communities of construction dates and times • Ensure that construction activities are undertaken within the stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn	• CAEL is to check periodically with the schools and residents to find out if they have any complaints • CAEL is to respond promptly to correct confirmed complaints related to the project • The Contractor's monthly report to provide details of the mitigation measures implemented
3.	Loss of Productive Farms and temporary Displacement of Farmers	• CAEL is to ensure that farmers are relocated to areas that are suitable for farming • CAEL is to ensure that during construction, operation and decommissioning phases there are no adverse threats to pose to farmers
4.	Removal of Vegetation	• CAEL is to ensure that contractors only clear vegetation that have been identified for clearance during the construction phase of the project • CAEL is to ensure that replanting

	Management Plan	Monitoring Programme
		exercises are undertaken following the completion of road works
5.	Solid waste (top soil, vegetation, construction debris, garbage) • Contain garbage and construction debris and dispose of at the approved municipal disposal site at Myersville • Landscape project sites with top soil excavated	• CAEL is to obtain verification that the contractor has disposed of solid waste at an approved municipal disposal site • The Contractor's monthly report to provide details of the mitigation measures implemented
6.	Increased traffic movement • Erect signs along main transportation route and in sensitive areas such as schools • Advise contractor of the need to their drivers are to obey speed limits • Transport heavy equipment and wind turbine parts during off-peak traffic hours (between 2:00 to 4:00 a.m.) with police outriders • Notify relevant communities of the transportation of heavy equipment through their communities • Use traffic signals or flagmen to manage traffic flows where road improvement works are being undertaken	• The Contractor's monthly report to provide details of the mitigation measures implemented
7.	Human waste • Contract a reputable company to provide portable toilets for workers	• CAEL is to verify that waste is being taken to an approved wastewater treatment facility
8.	Soil erosion • Only clear top soil from areas to be used • Place berms around stockpiles of top soil and aggregate	• CAEL is to conduct periodic audits of contractor operations • The Contractor's monthly report to provide details of the mitigation measures implemented
9.	Construction work • Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures	• Conduct periodic audits of contractor operations • The Contractor's monthly report to provide details of the mitigation measures implemented
10.	Fuel and oil spills • Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site	• CAEL is to conduct periodic audits of contractor operations • The Contractor/CAEL is to respond and clean up spills in accordance with emergency preparedness and response plans • The Contractor is to report to CAEL on emergencies • CAEL is to report to NEPA in accordance with permit requirements • The Contractor's monthly report to

	Management Plan	Monitoring Programme
		provide details of the mitigation measures implemented
Operation Phase		
1.	• Noise	• CAEL is to maintain turbines in accordance with manufacturer's requirements • During commissioning of wind turbine CAEL is to assess noise levels at the hub, 500 m, at Broughton Primary and Basic Schools to have a record of noise levels during operations • CAEL is to check with Broughton Primary and Basic School within the first month of operation of the turbines to determine if they have any concerns • CAEL is to assess noise levels within a 2 km zone around the wind farm and check with residents to determine if there are any adverse impacts
2.	Disruption to avifauna	• CAEL is to implement a pre-construction, construction and operation monitoring programme to assess how the bats will be affected by the turbine operations
3.	Disruption in air traffic	• CAEL is to ensure that all lights are operating in accordance with guidelines provided by the Jamaica Civil Aviation Authority • CAEL is to ensure that the towers are inspected quarterly to inspect lights to detect any failure
Maintenance Phase		
1.	Solid waste • Contain garbage and construction debris and dispose of at the approved municipal disposal site at Martins Hill	• CAEL is to obtain verification that solid waste is disposed of at an approved municipal disposal site
2.	Human waste • Contract a reputable company to provide portable toilets for workers	• CAEL is to obtain verification that waste is being taken to an approved wastewater treatment facility
3.	Maintenance work • Erect signs during construction activities • Provide workers with the necessary Personal Protective Equipment (PPE) • Train construction personnel in good safety practices and emergency preparedness and response measures	• CAEL is to maintain preventive and unscheduled/emergency maintenance records

	Management Plan	Monitoring Programme
Decommissioning phase		
1.	Solid waste • Contain garbage and construction debris and dispose of at the approved municipal disposal site at Martins Hill	• CAEL is to obtain verification that contractor has disposed of solid waste at an approved municipal disposal site
2.	Noise from equipment • Advise schools and residents in the surrounding communities of decommissioning dates and times • Ensure that decommissioning activities are undertaken within the stipulated times • Provide workers with the necessary Personal Protective Equipment (PPE) e.g. hearing protection and ensure that they are worn	• CAEL is to check periodically with the schools to find out if they have any complaints
3.	Oil spills/leaks • Store fuel with secondary spill containment infrastructure • Utilise proper dispensing equipment • Have spill containment and cleanup equipment on site	• CAEL is to conduct periodic audits of contractor operations • The Contractor/CAEL is to respond and clean up in accordance with emergency preparedness and response plans • The Contractor is to report to CAEL on emergencies • CAEL is to report to NEPA in accordance with permit requirements

9.5 Reporting

During the construction phase:

1. The contractor will submit monthly reports to CAEL outlining work progress including environmental mitigation measures that must be implemented, accidents, incidents requiring activation of the emergency response plans and breaches in environmental requirements, if any.
2. CAEL will submit monthly reports to NEPA outlining work progress including environmental mitigation measures that must be implemented, accidents, incidents requiring activation of the emergency response plans and breaches in environmental requirements.

During the operating and maintenance phases CAEL will submit the following reports to NEPA

1. An annual report outlining the monthly generating capacity of the wind turbines and indicating any anomalies that occur.
2. Reports on accidents and incidents requiring activation of emergency response plans within 48 hours of occurrence.

References

Stark J. 1967 Soil and land use surveys No. 17. Jamaica (Parish of Manchester) The Regional Research Centre, Dept. of Soil Sciences, UWI, Trinidad W.I.

GSD 1981 The mineral resources of Jamaica, Bulletin No. 8 2nd Edition, Revised 1981, Editor Allison Fenton 104pp.

GSD 1983 A Geotechnical classification of Jamaican Rocks. Bulletin No. 10 by M O'Hara and R. Bryce

GSD 1974 Imperial Geological Sheet No. 16 Alligator Pond, Scale 1:50,000.

Appendix 1: NEPA's Information Requirements

NATIONAL ENVIRONMENT & PLANNING AGENCY

10 & 11 Caledonia Avenue, Kingston 5, Jamaica W.I. Tel: (876) 754-7540/3 Fax: (876) 754-7595-6 Tollfree: 1-888-991-5005
E-mail: ceo@nepa.gov.jm, Website: http://www.nepa.gov.jm

Ref: 2011-12017-EP00168

17 February 2012

Mr Roger Williams
Director
Clean Alternative Energy Limited
4 Duke Street
Kingston C.S.O

Dear Mr. Williams,

Re: Application for Permit under Section 9 of the Natural Resources Conservation Authority Act, 1991, in respect of 2011-12017-EP00168 Power Generation (Wind Turbines) Great Valley, Manchester

The National Environment and Planning Agency (NEPA) is in receipt of the captioned application. Your application has been reviewed and a site inspection conducted. Based on our review and inspection the Agency has determined that the following additional information is required to submit the following information (11 copies) to facilitate the continued processing of your application:

- A detailed description of the project including but not limited to: the footprint of the development (turbine locations, access roads, etc.,), proposed route for the transport of the turbines from the importation point to the location, transmission lines, substations, ancillary buildings and associated facilities
- Layout of the power generation facility
- The final number of turbines and the final coordinates for the siting of the turbines
- The design and specifications of each turbine, including but not limited to: height, power generating capacity, rotor diameter, life span of turbines, distance between turbines
- Distance of turbines from public buildings and residences
- Description of the environment including but not limited to geology, topography, soil, drainage features, vegetation cover and faunal species. An avifauna survey: The avifauna survey should be conducted to indicate whether the area is within the flight paths of any birds populations including migratory species and the frequency of use; a night survey should also be conducted for a minimum of two nights to detect whether the proposed area is being utilized by bats.
- Potential Impacts of the proposed development including cumulative impacts
- Mitigation and management of negative impacts
- Construction/Implementation Schedule
- Emergency Response Plan
- Closure Plan

Any reply or subsequent reference to this communication should be addressed to the Chief Executive Officer, to the attention of the officer dealing with the matter, and the reference quoted where applicable.

Managing and protecting Jamaica's land, wood and water
A Government of Jamaica Agency

Mr. Roger Williams
Director
17 February 2012
Page 2

In addition to submitting the information above, you are required to conduct a public presentation on the proposed project to be scheduled for a time and date in conjunction with the Agency. This presentation is to be conducted in conformance with the Guidelines for Conducting Public Presentations which can be accessed on the NEPA website at http://www.nepa.gov.jm/business/guidelines/general/GuidelinesforPublicPresentations2007.pdf.

While it is assumed that the requested information will be submitted in a timely manner, if a response is not received within forty (40) days of the date of this letter, your application may be removed from the list of applications being actively processed by the Agency.

If there are any queries, do not hesitate to contact the Applications Secretariat Branch at 754-7540 or email applications@nepa.gov.jm .

Yours sincerely
National Environment & Planning Agency

Ainsley Henry
Director, Applications Management Division
***for* Chief Executive Officer**

AH/jj

Appendix 2: Letter from the Manchester Parish Council Widening of 2 Corners

PARISH COUNCIL OF MANCHESTER
HEAD OFFICE
32 HARGREAVES AVENUE
MANDEVILLE, JAMAICA, W.I.
TELEPHONE – 962-2278/9; 962-0612
FAX – 962-0611; EMAIL – MPC-ADMIN@CWJAMAICA.COM

Our Ref: E/3/1

Date: July 10, 2012

Mr. Wesley McLeod
Managing Director
Clean Alternative Energy Limited
4 Duke Street
Kingston

Dear Sir:

Re: Clean Alternative Energy Limited (CAEL)

Your letter dated May 10, 2012 in respect of the caption matter refers.

The Council at its Infrastructure and Traffic Committee Meeting held on July 5, 2012 discussed CAEL's proposal for developing a green energy facility at Great Valley in Manchester to produce electricity from wind turbine equipment. Also discussed was your request for the corners on roadway between Restore and Cross Keys to be widened to accommodate the movement of the delivery vehicles with the wind turbines.

Please be advised that an inspection was carried out by the Council's Chief Technical Officer and it was confirmed that the two corners identified on the roadway between Restore and Cross Keys on Google Maps pose a challenge for the heavy equipment to navigate same.

The Council offers no objection to the widening of the said corners subject to the following conditions:

- That the Council be advised of the time period when such works would be undertaken to allow Officers of the Council to monitor same.
- That the reinstatement of the roadways be in accordance with Council's standards to ensure that the affected areas are returned to the required driving surface.

If you need further clarification, please contact the Acting Superintendent, Roads and Works on the following numbers: 961-0925/625-2325.

Please be guided accordingly.

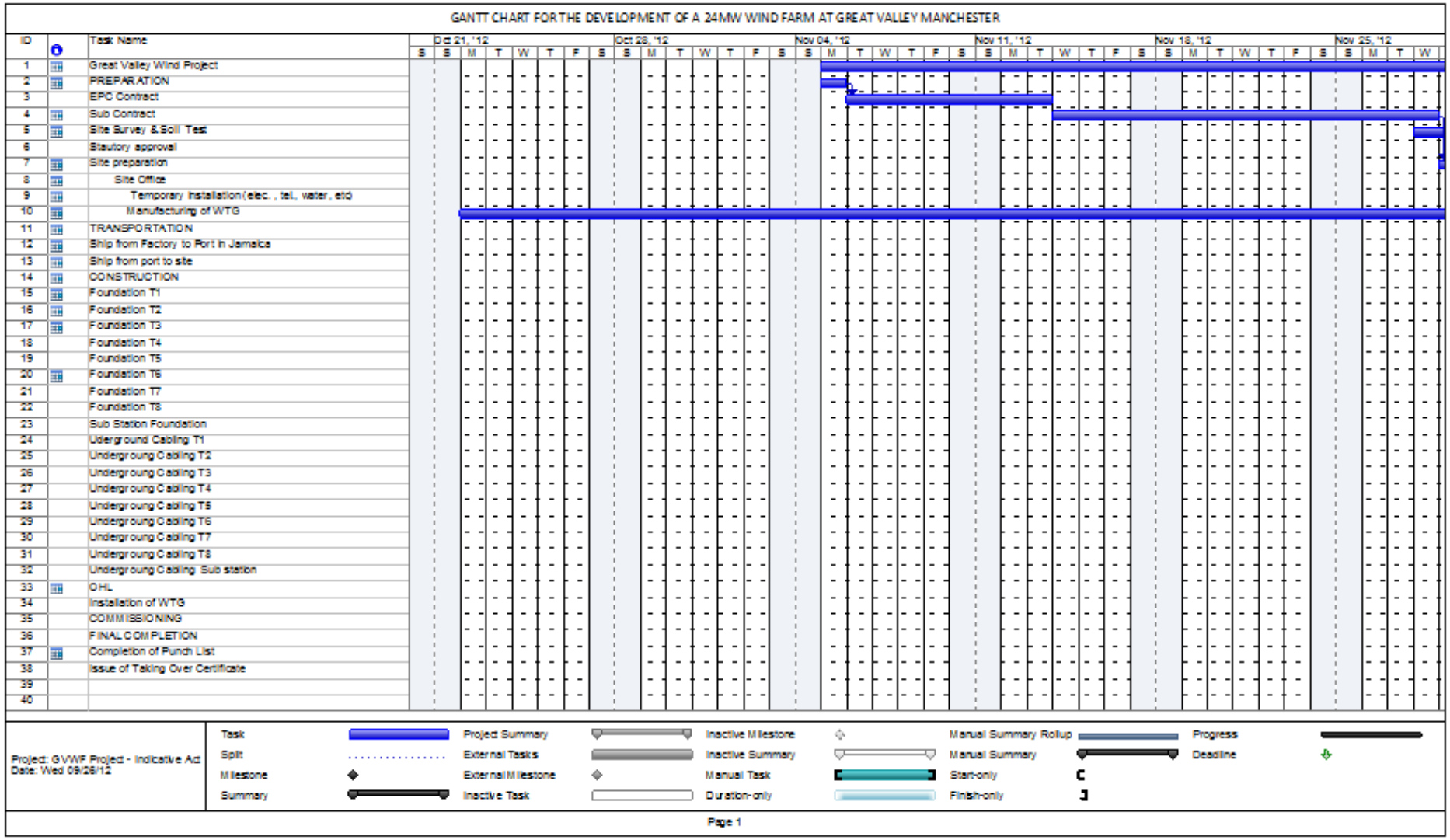
Yours truly,

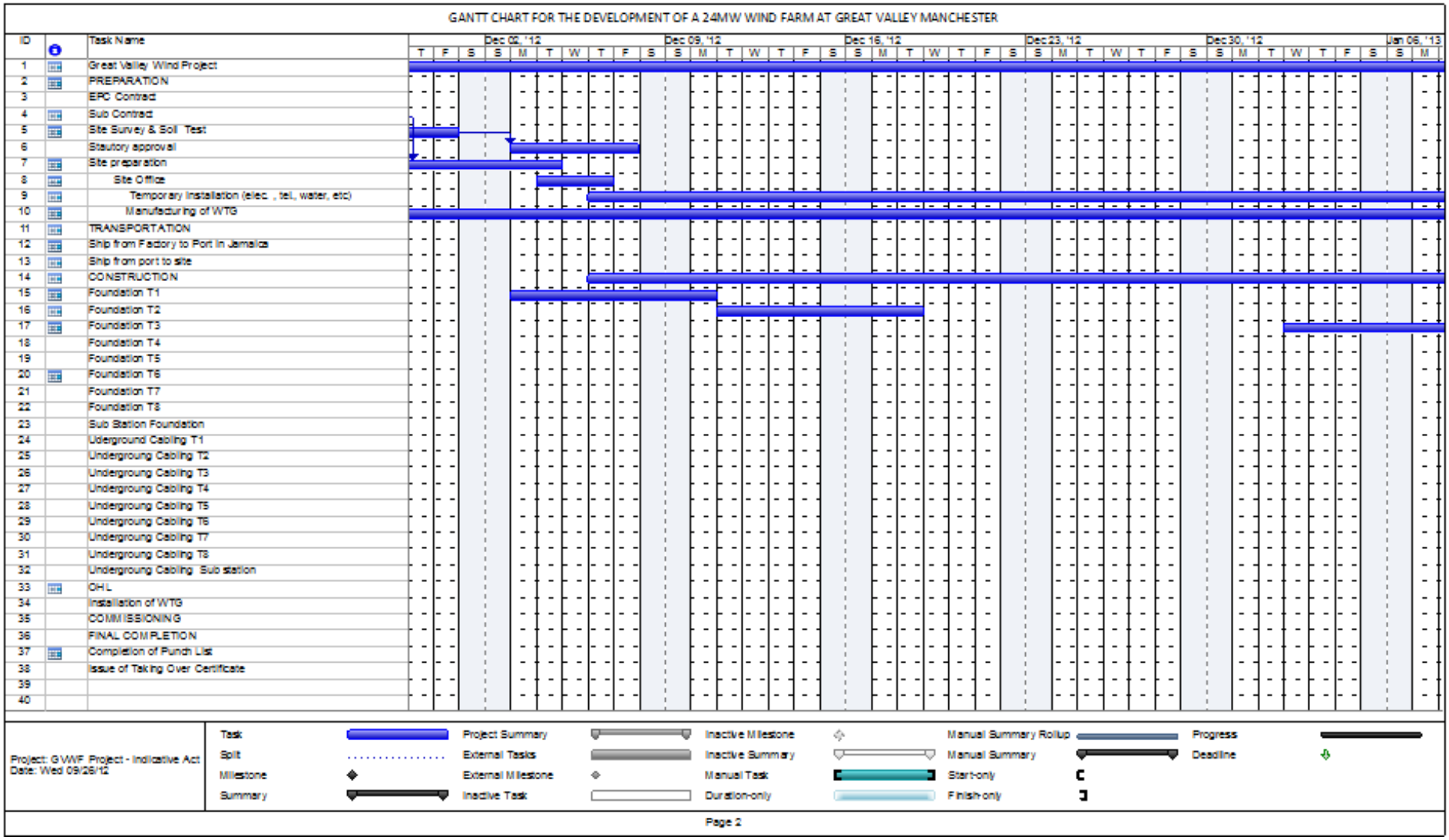
Michael Morris, J.P.
Secretary/Manager
Parish Council, Manchester

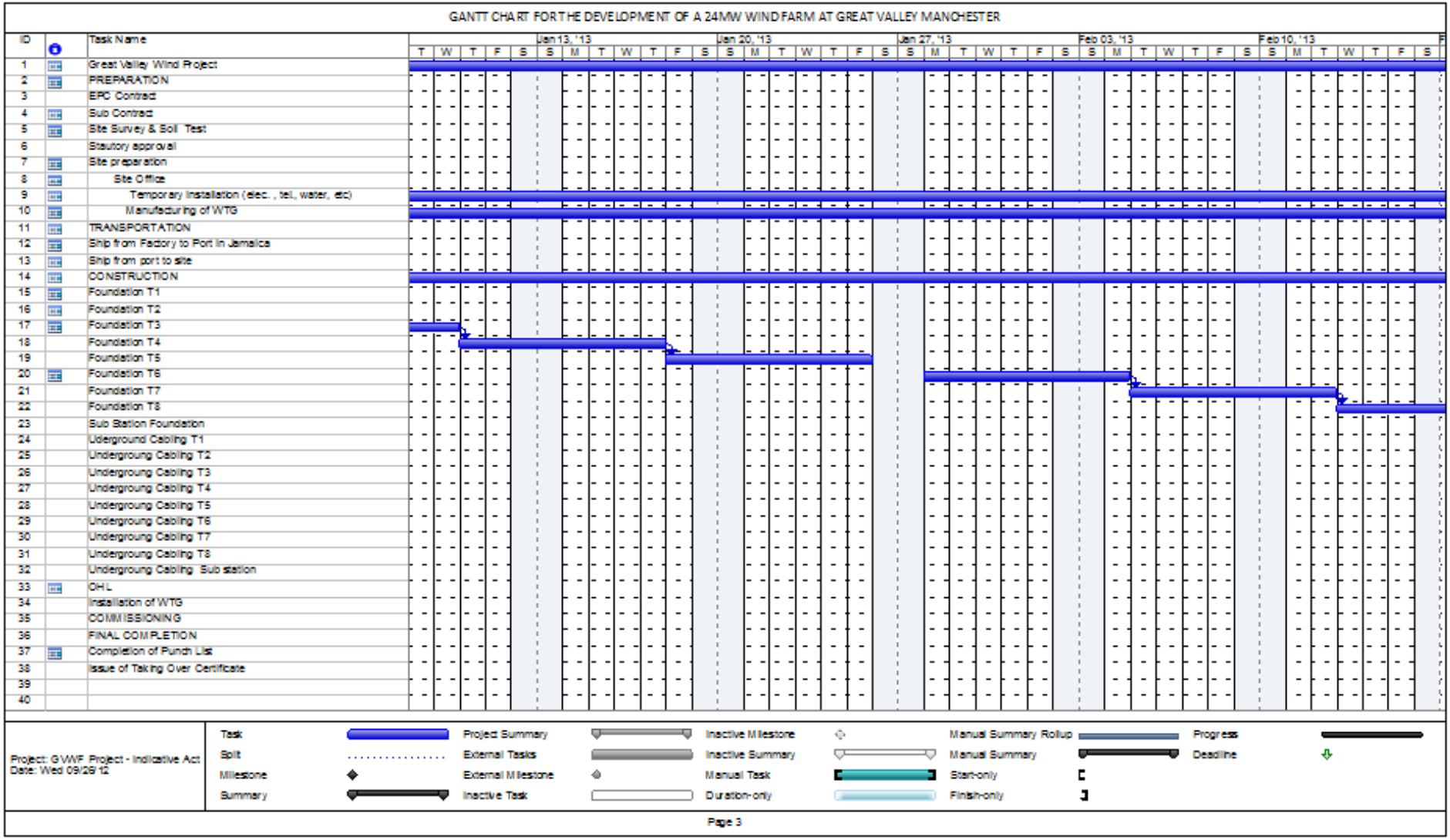
MM:ich

Post-it® Fax Note 7671	Date 12/7/12	# of pages ▸ 1
To Mr. W. McLeod	From M. Morris	
Co./Dept. CAEL	Co. MPC	
Phone # 967-9494	Phone # 962-2278	
Fax # 948-6696	Fax # 962-0611	

Appendix 3: Gantt Chart for Proposed Project




GANTT CHART FOR THE DEVELOPMENT OF A 24MW WIND FARM AT GREAT VALLEY MANCHESTER
ID
Task Name
Dec 02, '12
Dec 09, '12
Dec 16, '12
Dec 23, '12
Dec 30, '12
Jan 06, '13
1 Great Valley Wind Project
2 PREPARATION
3 EPC Contract
4 Sub Contract
5 Site Survey & Soil Test
6 Statutory approval
7 Site preparation
8 Site Office
9 Temporary installation (elec. , tel., water, etc)
10 Manufacturing of WTG
11 TRANSPORTATION
12 Ship from Factory to Port in Jamaica
13 Ship from port to site
14 CONSTRUCTION
15 Foundation T1
16 Foundation T2
17 Foundation T3
18 Foundation T4
19 Foundation T5
20 Foundation T6
21 Foundation T7
22 Foundation T8
23 Sub Station Foundation
24 Underground Cabling T1
25 Undergroung Cabling T2
26 Undergroung Cabling T3
27 Undergroung Cabling T4
28 Undergroung Cabling T5
29 Undergroung Cabling T6
30 Undergroung Cabling T7
31 Undergroung Cabling T8
32 Undergroung Cabling Sub station
33 OHL
34 Installation of WTG
35 COMMISSIONING
36 FINAL COMPLETION
37 Completion of Punch List
38 Issue of Taking Over Certificate
39
40
Project: GVWF Project - Indicative Act
Date: Wed 09/26/12
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline
Page 2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ID
Task Name
Jan 13, '13
Jan 20, '13
Jan 27, '13
Feb 03, '13
Feb 10, '13
T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S
1 Great Valley Wind Project
2 PREPARATION
3 EPC Contract
4 Sub Contract
5 Site Survey & Soil Test
6 Statutory approval
7 Site preparation
8 Site Office
9 Temporary Installation (elec. , tel., water, etc)
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31 Undergroung Cabling T8
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34 Installation of WTG
35 COMMISSIONING
36 FINAL COMPLETION
37 Completion of Punch List
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39
40
Project: GWF Project - Indicative Act
Date: Wed 09/26/12
Task
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Summary
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External Tasks
External Milestone
Inactive Task
Inactive Milestone
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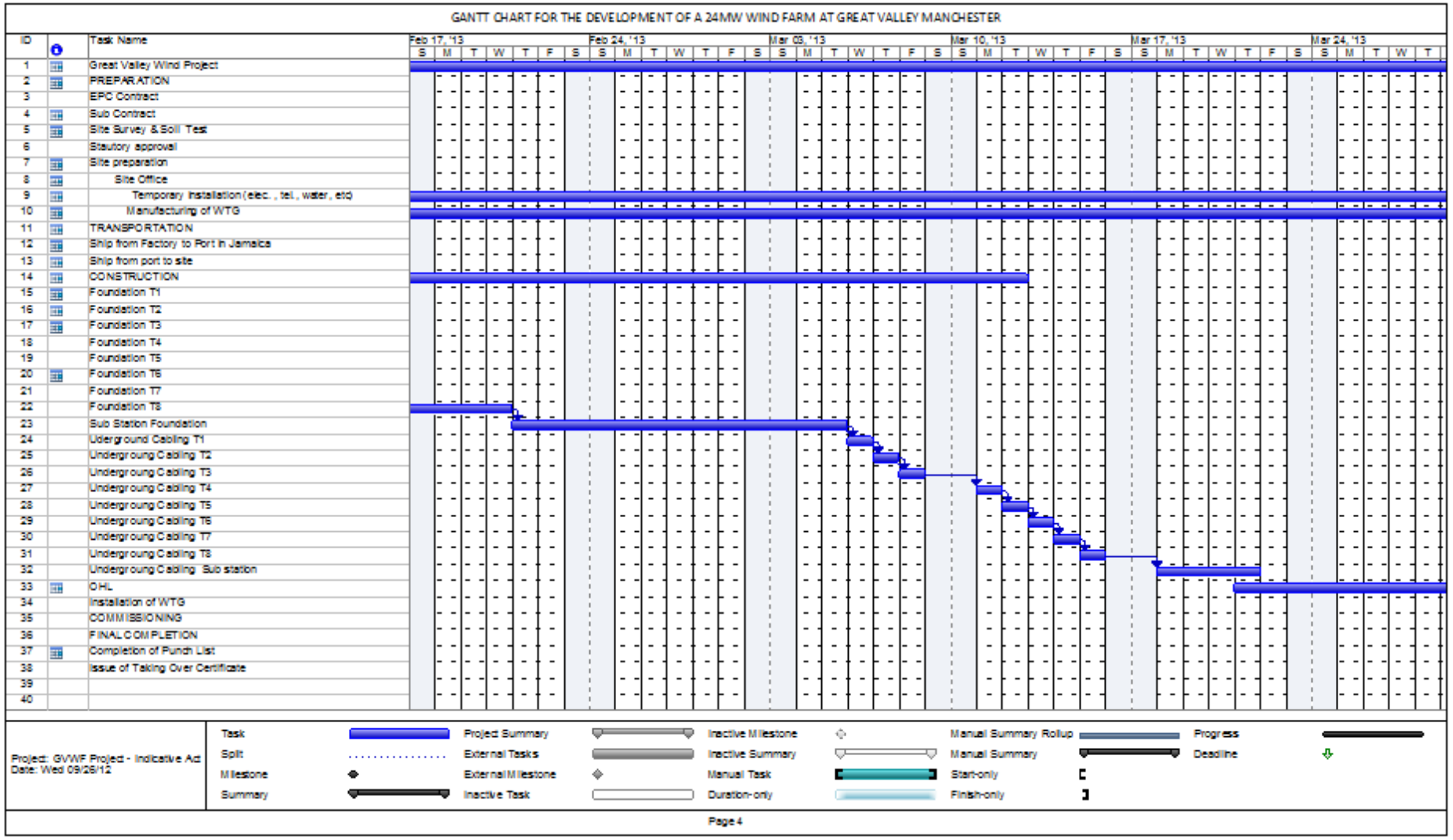
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline
Page 3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Feb 24, '13
Mar 03, '13
Mar 10, '13
Mar 17, '13
Mar 24, '13
1 Great Valley Wind Project
2 PREPARATION
3 EPC Contract
4 Sub Contract
5 Site Survey & Soil Test
6 Statutory approval
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8 Site Office
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Split
Milestone
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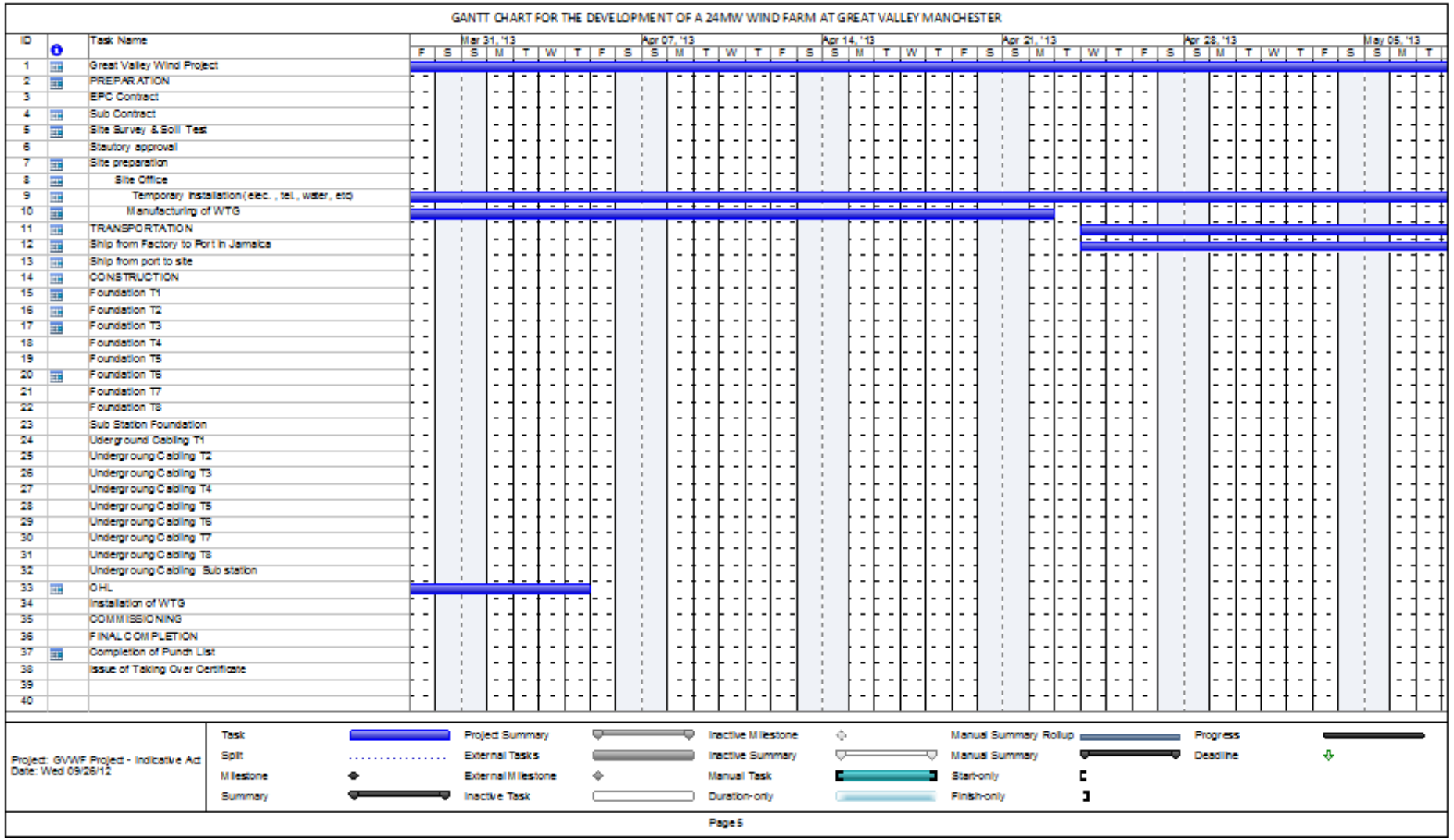
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline
Page 4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ID
Task Name
Mar 31, '13
Apr 07, '13
Apr 14, '13
Apr 21, '13
Apr 28, '13
May 05, '13
1 Great Valley Wind Project
2 PREPARATION
3 EPC Contract
4 Sub Contract
5 Site Survey & Soil Test
6 Statutory approval
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8 Site Office
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Project Summary
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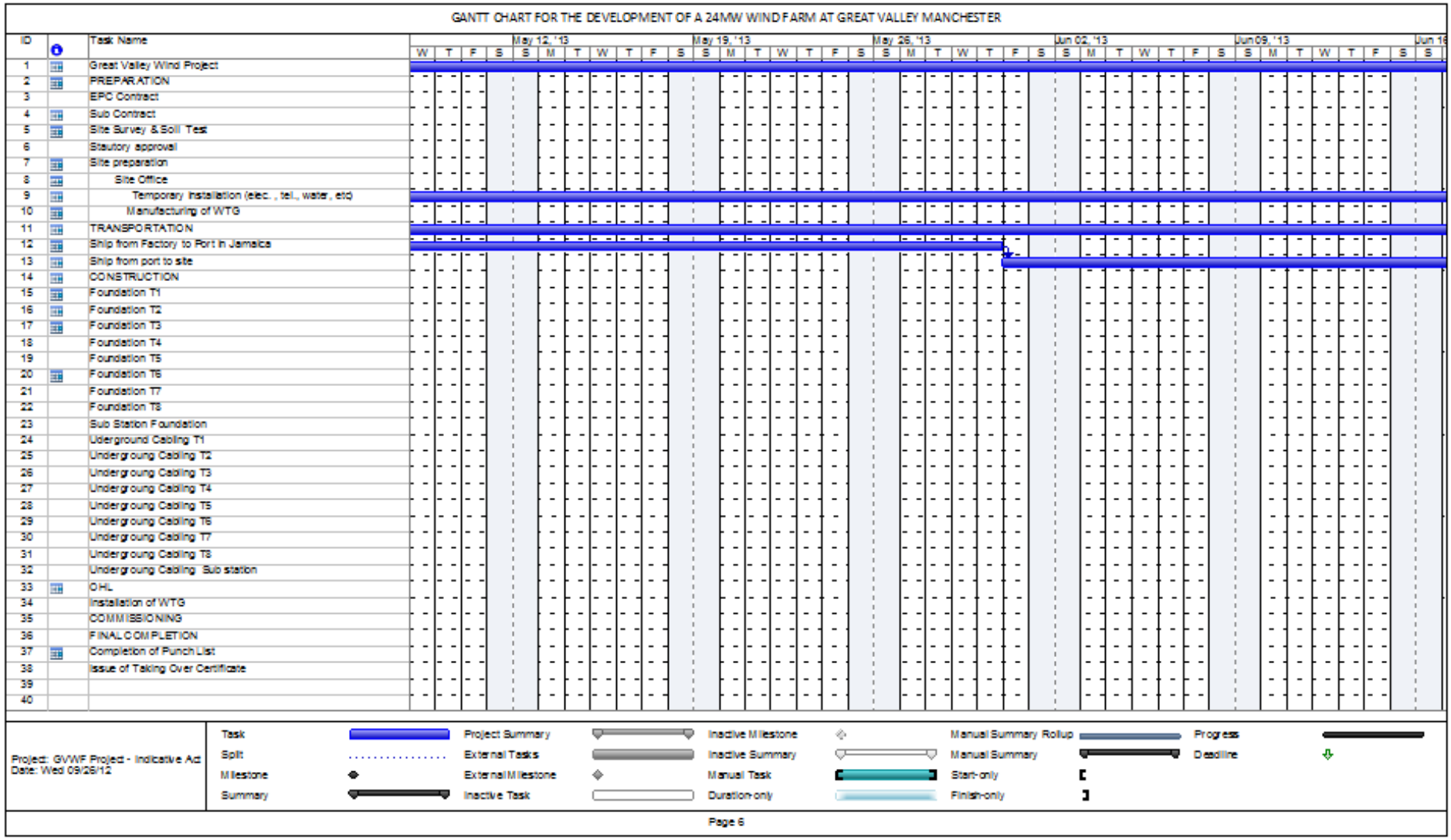
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline
Page 5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ID
Task Name
May 12, '13
May 19, '13
May 26, '13
Jun 02, '13
Jun 09, '13
1 Great Valley Wind Project
2 PREPARATION
3 EPC Contract
4 Sub Contract
5 Site Survey & Soil Test
6 Statutory approval
7 Site preparation
8 Site Office
9 Temporary installation (elec. , tel., water, etc)
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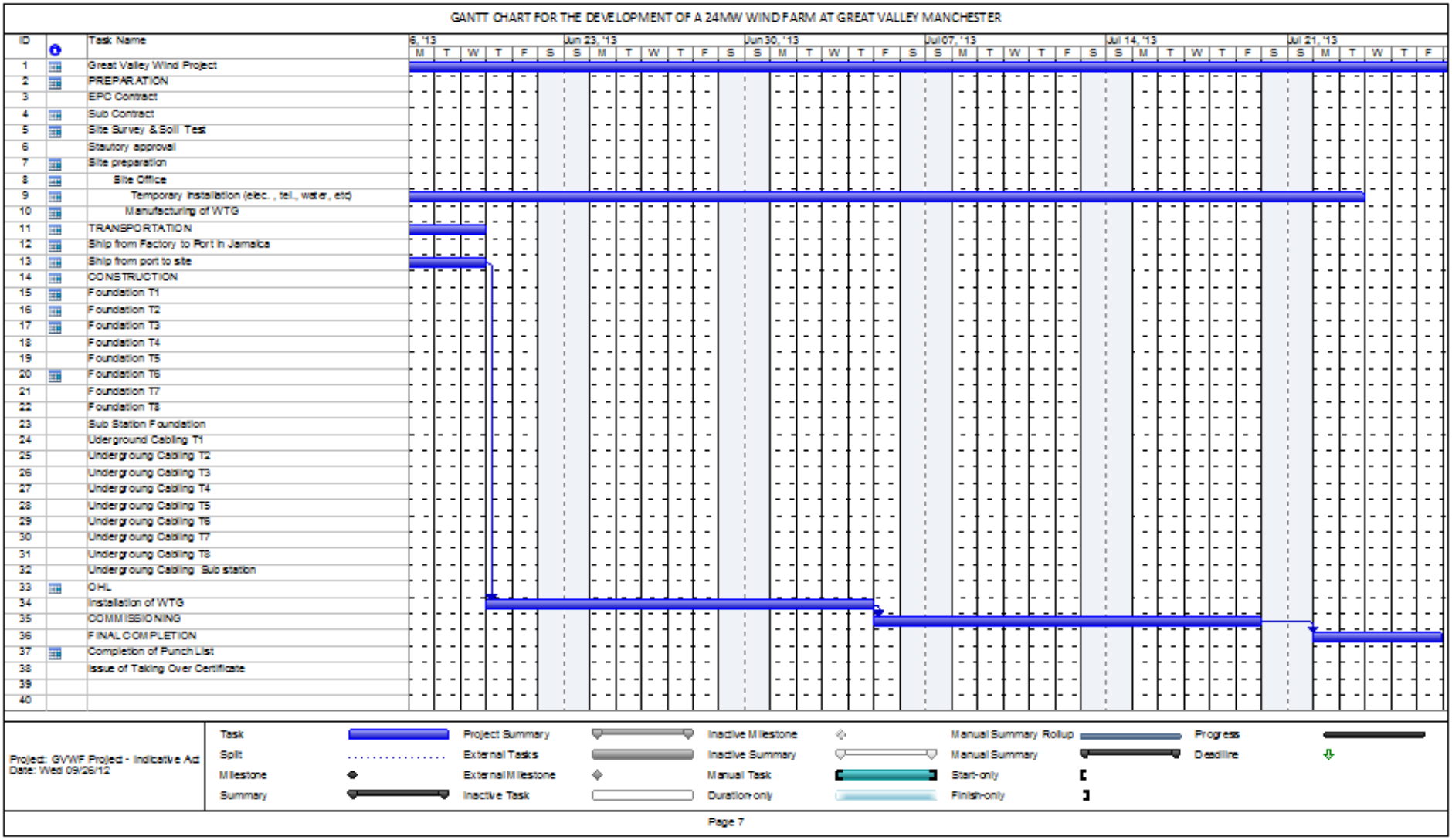
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline
Page 6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ID
Task Name
Jun 23, '13
Jun 30, '13
Jul 07, '13
Jul 14, '13
Jul 21, '13
1 Great Valley Wind Project
2 PREPARATION
3 EPC Contract
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40
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Date: Wed 09/26/12
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Summary
Project Summary
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Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Progress
Deadline
Page 7

GANTT CHART FOR THE DEVELOPMENT OF A 24MW WIND FARM AT GREAT VALLEY MANCHESTER

ID	Task Name
1	Great Valley Wind Project
2	PREPARATION
3	EPC Contract
4	Sub Contract
5	Site Survey & Soil Test
6	Statutory approval
7	Site preparation
8	Site Office
9	Temporary installation (elec., tel., water, etc)
10	Manufacturing of WTG
11	TRANSPORTATION
12	Ship from Factory to Port in Jamaica
13	Ship from port to site
14	CONSTRUCTION
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30	Undergroung Cabling T7
31	Undergroung Cabling T8
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35	COMMISSIONING
36	FINAL COMPLETION
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39	
40	

Jul 28, '13 | Aug 04, '13 | Aug 11, '13 | Aug 18, '13 | Aug 25, '13 | Sep 01, '13

S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W T F S S M T W

Project: GVWF Project - Indicative Act
Date: Wed 09/26/12

Task | Project Summary | Inactive Milestone | Manual Summary Rollup | Progress
Split | External Tasks | Inactive Summary | Manual Summary | Deadline
Milestone | External Milestone | Manual Task | Start-only
Summary | Inactive Task | Duration-only | Finish-only

Page 8

Appendix 4: Social Survey Questionnaire

SOCIO-ECONOMIC SURVEY (February 2012)
Proposed Wind Farm Development Project, Great Valley (Cross Keys), Manchester, Jamaica

PERSONAL/CONFIDENTIAL

Personal Interview Schedule (Target: Head of Household or Persons above 18 years of age)

Interviewer: _____ Respondent ID: _____(name)
Date: _____ Location: _____

In order to determine the social and economic characteristics of the area, and garner your views, perspectives and acceptance of the proposed development I would like to ask you some questions.

Interviewers: Please note that more than one answer can be provided for a particular question

A. Demographic Profile

1. Sex: Male ☐ Female ☐ (please provide the sex of the head of household)

2. To what age group do you belong?
   18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60 and over ☐

3. How long have you lived in this community? _____

4. Where are you originally from (Town and Parish)? _____

Education

5. What is the highest level of education you have attained? None ☐ Primary/All Age ☐
   High School ☐ Training/Skills Institution ☐ University ☐
   Other, specify _____

6. Are you presently attending school? Yes ☐ No ☐

B. Quality of Life Indicators

Employment and Income

7. Are you employed? Yes ☐ No ☐

Please tick the box which best describes your type of employment
Full-time ☐ Part-time ☐ Self-employed ☐ Other, specify _____

8. What is your present means of livelihood (occupation)? _____

9. What is your main means of travel? (work, shopping etc.)?
Private vehicle ☐ Bus ☐ Taxi ☐ Other, specify _____

10a. What is your weekly/monthly income in Jamaican Dollars (JMD)? (optional)

Less than $10,000 ☐ $10,001-$30,000 ☐ $30,001-$60,000 ☐
$60,001-$90,000 ☐ $90,001-$120,000 ☐ $120,001 – $150,000 ☐ Above $150,000 ☐

10b. Do you have any additional sources of income?
Remittances ☐ Spousal support ☐ Family ☐ Savings ☐

Municipal Services

11a. Do you have access to a steady supply of water? Yes ☐ No ☐

11b. What is the main source of domestic water supply for the household?

Public piped water into dwelling ☐ Private Tank ☐ Public piped water into yard ☐
Community Tank ☐ Government Water Trucks (free) ☐ Public Standpipe ☐
Private Water Trucks (paid) ☐ Spring or River ☐ Other, specify _____

12a. What is the main source of lighting for your home?
Electricity ☐ Kerosene ☐ Candles ☐ Other, specify _____

12b. What is the average monthly cost of your electricity bill? _____

12c. How reliable is your electricity supply? _____

13. What type of fuel is used mostly by the household for cooking?
Gas☐ Electricity☐ Wood☐ Kerosene ☐ Other, specify _____

14. Does your house have the following:
Cable ☐ Roof mounted antennae (TV)☐ Roof mounted antennae (radio)☐

15. What is the main method of garbage disposal for your household?
Public Garbage Truck☐ Private Collection☐ Burn☐ Other, specify _____

16. Do you _____ the land on which your house is located?
Own☐ Lease☐ Rent ☐ Other, specify _____

17a. Do you have access to the following services?

Type of Service	**Location**	**Distance Travelled (km)/miles**
Health Care		
Police Station		
Fire Station		
Post Office/Agency		

17b. Do you have health insurance? Yes ☐ No ☐

C. Community and Recreational Development

18. What do you value most about your community?
_____
_____
_____

19. What types of improvement are needed in the community?
_____
_____
_____

20a. What types of recreational resources are available in your community? (Please tick one)
NB administrator: State the location of recreational facilities or resources if not in community

Dance/parties ____ Youth Clubs _____
Sports Clubs _____ Charity _____

Church groups _____ Other, specify_____
Beach _____
River/Stream/Pond_____

20b. If you selected beach and/or river, what is the name of the beach/river you most frequently use?

_____

20c. Is there a community centre in your community? Yes ☐ No ☐

20d. Do you use the community centre located in the town? Yes ☐ No ☐
If yes, how often and for what purpose(s)? _____

21. Is the community usually affected by Hurricanes/natural disasters (flooding, fire, earthquake etc.,) How did you fare in the last Hurricane/tropical storm/natural disaster?

_____
_____
_____

22. How long was it before water, power and telephone were restored after each disaster?

_____

23. Is your community affected by lightning? Yes ☐ No ☐ If yes, How often and in what ways?

_____

24. Where do people go in the event of a disaster? _____

D. Social Capital

25. Does your community have a citizen's association? Yes ☐ No ☐

26. Are there any other organisations within your community (voluntary or otherwise)?
Yes ☐ No ☐
*Please State*_____

27. What is the role of the church in your community?_____

28a. Are there outreach programmes/ adult literacy programmes in your community?
Yes ☐ No ☐

28b. If yes, Who or what organisations are in charge of these programmes and how are they funded?

_____

29a. Does the community undertake Labour Day or other voluntary projects? Yes ☐ No ☐
*Please State Type of Project*_____

29b. What groups or organisations arrange these projects?_____

29c. Are the work skills required for these projects available in the community?
Yes ☐ No ☐
If no, where do the workers come from?_____

29d. For construction projects in your community, where do the workers come from?

_____

30a. Does your community have sports clubs and/or teams? Yes ☐ No ☐

30b. Do they participate in community, parish and/or national competitions? Underline response

30c. Who provides the funding for these teams?_____

31a. How are decisions about the community's development made?_____

31b. Are there elders in your community that residents go to for advice? Yes ☐ No ☐

E. Natural Resources Usage and Management

32. Which of the following natural resource is available in your community?
Water: beach ☐ river ☐ pond ☐ lake ☐ **Vegetation**: plants ☐ fruit crops ☐
Animals: birds☐ fish ☐ bats ☐ **Land**: Forestry ☐ mangrove ☐ Minerals ☐

33. Do you use any of these resources? Yes ☐ No☐ If Yes, which ones and for what purpose(s)?

_____

_____

34. Are there any pollution sources or stress factors affecting these resources?
Yes ☐ No☐ If yes, please state source_____

Wildlife

35a. Are there birds within your community? Yes ☐ No☐

35b. Do you get different birds other than local birds at various times in the year?
Yes ☐ No☐

If yes, at what times during the year are they most visible?_____

36. Do you ever see bats in your community? Yes ☐ No☐ If yes, how often?

F. Perception of the Proposed Development

37. Do you know what a wind turbine is? Yes☐ No ☐ (If yes, please explain its use)
_____
_____
_____

38. Are you aware of the planned wind turbine energy development at Great Valley (Cross Keys)?
Yes☐ No ☐ If yes, through what medium? _____

39. What kind of impact do you think this development will have on the community?
_____
_____
_____
_____
_____

40. Do you think there will be any direct benefits to you from this project? Yes☐ No ☐
(State reason for answer)_____

41. What are your views on private companies building wind turbines to satisfy electrical demand by the country?
_____
_____
_____
_____
_____
_____
_____

42. What do you think will be the benefits of expanding renewable energy sources such as wind turbines in your community and Jamaica?

_____
_____
_____
_____
_____
_____

Thank you for your cooperation and participation in this survey☺

Interviewer Comments and Observations

_____
_____
_____
_____

Appendix 5: Letter from the Jamaica Civil Aviation Authority

JAMAICA CIVIL AVIATION AUTHORITY
AIR NAVIGATION SERVICES
Obstacle Evaluation Form

4 Winchester Road
Kingston 10
Mailing Address
P.O. Box 8998
CSO. KINGSTON

Site Identification No TURBINE1 CAE12001	Operating Company CLEAN ALTERNATIVE ENERGY LIMITED	Site Location GREAT VALLEY	Parish MANCHESTER
WGS-84 Coordinates of Site N17:53:00.01 W77:31:35.26	Clark 1880 Coordinates of Site	Nearest Govt. Aerodrome (A) NORMAN MANLEY INTERNATIONAL	Nearest Private. Aerodrome (B) NAIN
Threshold Coordinates of Runway of nearest Aerodrome (A) WGS-84 N17:56:24.92 W76:47:57.73		Direction from nearest Runway (A) 265°T	Distance from nearest Runway (A) 77298m
Affected Annex 14 Surface Outer Horizontal ☐ Approach ☐ Conical ☐ Inner Approach ☐ Inner Horizontal ☐ Strip ☐ Transitional ☐ Intermediate ☐ Inner Transitional ☐ En-route ☐		Base of Lowest Surface	Base Elevation 576.92m MSL
		Height of Structure Tower/hub = 80m Blade radius = 45m Total = 125m AGL	Elevation of Apex 701.92m MSL

Penetration

Effect of Penetration

Recommendation **APPROVED**- The wind turbine is located beyond the Outer Horizontal surface limits of Norman Manley International Airport and Nain aerodrome. The rotor blades, nacelle and upper two-thirds of the supporting mast of the wind turbines should be painted white. The nacelle must be lit by a medium intensity obstacle light of 2000 candelas per metre square showing flashing red. The obstacle lights should be installed on the nacelle in such a manner as to provide an unobstructed view for aircraft approaching from any direction. The lights should operate at 20 – 60 flashes per minute and flash simultaneously with lights installed on other wind turbines to show the extent of the wind farm. The tower should be inspected regularly to detect any failure of these lights which must be replaced in minimum time.

Electromagnetic Interference

Nearest Navigational Aid	Distance from Navigational Aid	Type of Structure Metallic ☐ Non metallic ☐
Finding	Recommendation	Specialist: Dwight Dietrich Signature Date March 06, 2012

Appendix 6: Environmental Noise

Environmental Noise	
Weakest sound heard	0dB
Whisper Quiet Library	30dB
Normal conversation (3-5')	60-70dB
Telephone dial tone	80dB
City Traffic (inside car)	85dB
Train whistle at 500', Truck Traffic	90dB
Subway train at 200'	95dB
Level at which sustained exposure may result in hearing loss	*90 - 95dB*
Power mower at 3'	107dB
Snowmobile, Motorcycle	100dB
Power saw at 3'	110dB
Sandblasting, Loud Rock Concert	115dB
Pain begins	*125dB*
Pneumatic riveter at 4'	125dB
Even short term exposure can cause permanent damage - Loudest recommended exposure WITH hearing protection	*140dB*
Jet engine at 100', Gun Blast	140dB
Death of hearing tissue	180dB
Loudest sound possible	194dB

OSHA Daily Permissible Noise Level Exposure	
Hours per day	Sound level
8	90dB
6	92dB
4	95dB
3	97dB
2	100dB
1.5	102dB
1	105dB
.5	110dB
.25 or less	115dB